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Graduating, Engraving and Etching

by Franklin D. Jones[1]
and Edward K Hammond[1]

In shop parlance some confusion exists as to the use of the terms graduating, engraving and etching. These operations are decidedly different, but as the same general result may be obtained by graduating or by a combination of graduating and etching, and by engraving or by a combination of engraving and etching, these terms have come to be used interchangeably, which is incorrect. In this article information is given concerning modern practice in performing these three methods of marking, and the kind of work for which each is adapted.

CUTTING graduation marks and figures that indicate the values of successive graduations may involve three distinct operations. Graduation marks may be cut directly in the metal, or an acid "resist" may be applied to the steel and the graduation marks cut in this protective coating. Where the latter method is employed, the marking of the graduations is done by immersing the work in acid so that the surface of the metal from which the resist has been removed by the graduating tool may be "cut" by the etching solution. In any case, a graduated scale would be incomplete without figures to indicate the values of successive graduations, and these may be cut in several different ways. The simplest method would be to cut the figures by hand, but such a procedure would involve considerable time and expense. A better way is to either do the work on an engraving machine, the operation of which is controlled by a pantograph mechanism and master copy, or to use a graduating machine which is designed in such a way that it can also be used for cutting figures and other irregular designs, such as trademarks, etc. As in the case of cutting the graduation marks, the figures may be cut directly in the metal or they may be cut in a protective coating applied to the metal and etched by immersing the work in acid. Similar methods may be employed for trademarking the work, but where there is a considerable amount of detail in the design it may be more economical to use certain labor-saving methods, to which reference will be made later. It is the purpose of this article to give a comprehensive description of various methods of graduating, engraving and etching, and to explain the different classes of work for which each of these methods is especially adapted.

Methods of Graduating

The degree of accuracy required in graduating varies considerably with different classes of work. The instruments used in connection with astronomical observations require the greatest degree of precision obtainable, while the graduations on surveying and nautical instruments, machinist's and toolmaker's scales and protractors, and similar tools and instruments, do not require the extreme accuracy of the astronomical instruments, although such graduations must be very accurate. The type of machine or tool used for graduating and the method of producing the graduation marks or lines varies with different classes of work, depending upon the degree of accuracy necessary and the form of the parts to be graduated. The extent to which graduating is done or the quantity of work handled may also affect the type or design of the machine or tools used. The work of graduating may be divided into two branches—the method of spacing, and the means for making suitable marks or lines upon the parts to be graduated.

Spacing Methods

The machines used in laboratories and by tool and instrument manufacturers, for graduating various kinds of straight scales, may be classified as the precision screw type and the pantograph type. The former is equipped with a very accurate lead-screw, which, by means of an indexing or spacing mechanism, is rotated an amount depending upon the spacing required, and as this screw actuates the work holding table, a tool that is given a cross-movement makes graduation lines either in a "resist" or directly upon the work. The pantograph machines have a pantograph mechanism which serves to reproduce, on a smaller scale, the graduation lines or figures that have been previously cut in a pattern or master scale. Machines of the two general types referred to are generally

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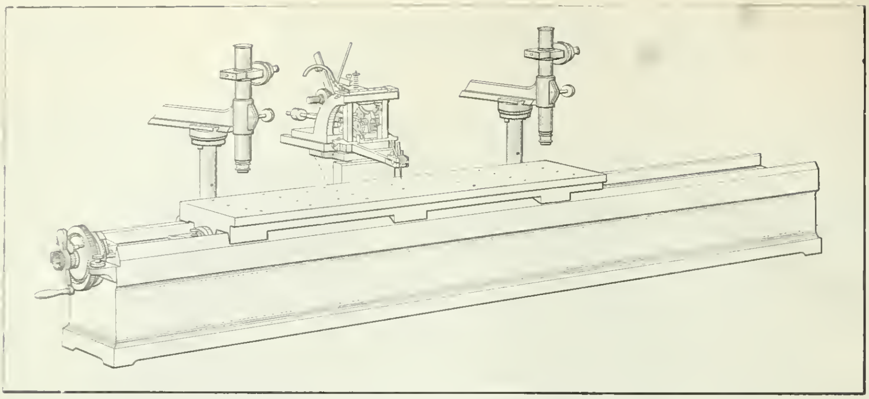

Fig. 1. Hand-operated Linear Dividing Engine or Graduating Machine of Precision Screw Type

used for linear graduations, although some designs are also adapted for circular graduating. A design intended especially for circular work has an accurately cut worm-wheel connecting with a circular work-table, and a meshing worm which is rotated by an indexing or spacing mechanism, in accordance with the circular spacing required.

Formation of Graduation Lines

The marks or lines which represent divisions or spaces on graduated scales, etc., may be formed by the etching process, by the direct-cutting action of a tool, or, for some grades of work, by the stamping or impression process. With the etching process, the part to be graduated is first covered with some acid-resisting material or "resist," as it is called, and then the lines or figures are cut into this resist by a mechanically guided graduating tool, thus exposing the metal wherever these lines or figures are made. An etching acid is then applied, and, wherever the metal is exposed, the acid eats into the surface and forms the division lines. When very fine graduation lines are needed the general practice is to employ the direct-cutting method, since the marks obtained by a very sharp-pointed tool are finer and more accurate than can be obtained by the etching process. There are two general types of cutting tools, one of which operates with a plain draw stroke, whereas the other is a rotary tool and revolves at a speed of about from 8000 to 10,000 revolutions per minute. Diamond points are also used for cutting very fine graduation lines, the diamond being drawn across the work without a rotating movement.

Screw Type of Linear Graduating Machine

A linear dividing or graduating machine of the screw type, which is adapted for precision work on scientific instruments or for other work in which a high degree of accuracy is necessary is shown in Fig. 1; and Fig. 2 illustrates a power-driven machine of the same general design. The bed of this machine is provided with planed ways upon which a work carriage is mounted. This carriage is traversed by a lead-screw located inside the bed, and in the case of the hand-operated machine, the screw is turned by the small handwheel at the left-hand end of the bed. After each movement of the carriage has been completed, a tool supported by the toolhead at the back of the machine makes a graduation mark on the work which is secured to the carriage. The handwheel at the end of the lead-screw is provided with a graduated dial, each space of which corresponds to 1/200 millimeter. Secured to the handwheel is an adjustable stop which may be set to obtain the required distance between consecutive graduation lines. This stop engages cams at the front and back of the handwheel, which are brought into position to engage the limit stop, by means of a thread on the circumference of the handwheel meshing with small worm-wheels that actuate the cams. The engagement of the thread on the handwheel with the worm-wheels may be so adjusted that the limit stop comes into contact with the cams after part of a revolution of the handwheel or after more than one complete revolution, according to the requirements of the work.

In operating the machine, the handwheel is turned back until the stop comes into contact with one of the cams. This backward movement is effected without turning the lead-screw on the machine; then the handwheel is turned forward and in this direction a ratchet and pawl causes the lead-screw to be locked to the handwheel so that the screw is turned, and advances the carriage and work until the limit stop comes into contact with the cam at the opposite side of the handwheel. When this position has been reached, the operator pulls forward a small hand-lever on the tool-head, which results in drawing the tool across the work and making a graduation line.

The machine is provided with means for making graduations of different lengths. For instance, it may be necessary to make each fifth graduation mark longer than adjacent marks, each tenth mark still longer, etc. On this machine, such variations in length are effected by means of three stop-screws which come into contact with a notched wheel, the movement of the tool and length of graduation mark being limited by the engagement of one of these screws with the wheel. At each stroke of the toolpost, the three sections of this wheel are advanced by means of a ratchet and pawl, and the three wheel sections may be adjusted in relation to each other so that the desired relation is obtained between the position of notches and intermediate faces on the different wheels. In this way, the stop-screws come into contact with the wheel on either faces or notches as required, thus varying the lengths of the graduation lines according to requirements. In addition to its use for graduating, this machine may also be employed as a comparator, and for this purpose two microscopes are provided which enable the position of graduations on a scale to be accurately compared with the position of graduations on a standard scale.

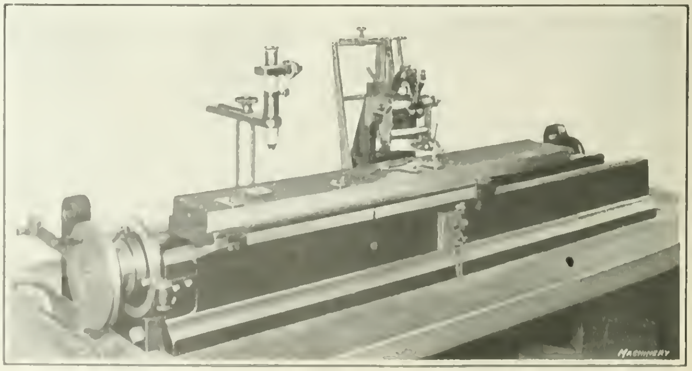

Fig. 2. Power-driven Linear Dividing Engine or Graduating Machine similar in Design to Machine shown in Fig. 1

Calibrating the Lead-screw

From the preceding description, it will be apparent that the degree of accuracy obtained with a machine of this kind is dependent upon the precision of the lead-screw. In making the machine, the greatest possible care is exercised in cutting the screw and nut, and the bearing of the nut on the screw is then perfected, as far as possible, by a lapping operation performed by introducing fine rouge or some similar abrasive into the nut. This does not provide for correcting inequalities in the lead of the thread, and, where a high degree of accuracy is necessary, the lead-screw is calibrated. For this purpose, a standard scale is mounted on the carriage, and the carriage is then advanced through suitable increments of length, as shown by the divided dial at the left-hand end of the lead-screw. After each movement of this kind, the amount of travel is noted by referring to the standard scale on the carriage with a microscope. The results obtained in this way are plotted on a chart and either of two conditions may be found: it may be that there is a uniform accumulated error extending from one end of the screw to the other, or it may happen that the error is irregular. In either case, the same method of compensation is employed. Secured to the nut on the lead-screw is a short finger extending down into the groove of a guide placed inside the bed of the machine. In the case of an accumulative error resulting in a gradual increase in the lead of the lead-screw, this guide is set at such an angle that the movement of the finger in the guide will result in turning the nut back slightly, thus compensating for the increase of lead. If the accumulative error were such that the lead gradually decreased, the nut would be turned forward in order to advance the movement of the carriage instead of to retard it. In cases where the error in the lead-screw is irregular, the lead being first too long and then too short, the same method of correction is employed, except that the guide groove is given a suitable curve of irregular form, instead of having a straight guide set at an angle.

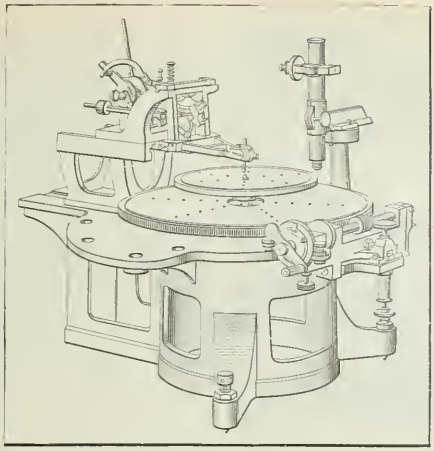

Fig. 3. Hand-operated Circular Dividing Engine or Graduating Machine

Circular Dividing Machine

Fig. 3 shows a dividing engine for use in graduating circular dials and other work of similar form. The general principles governing the operation of this particular machine are the same as for the linear dividing engine already described, except that the machine shown in Fig. 3 has been designed especially for circular work. A circular dial mounted on a pivot is used instead of a carriage traveling on straight ways on the bed, and rotation of the dial is effected by a worm which meshes with worm-wheel teeth cut into the periphery of the dial. The worm that governs the rotation of the dial is carried by a shaft, on the end of which there is a handwheel and stop mechanism for limiting the space between the graduations, this mechanism being of the same form as that described for the linear machine. The tool for performing the graduating is carried by a toolpost and head of the same form as those used on the machine for graduating straight work. Some machines are so designed that they may be used for either linear or circular dividing, there being a lead-screw for linear work and a circular table for dividing arcs or circles.

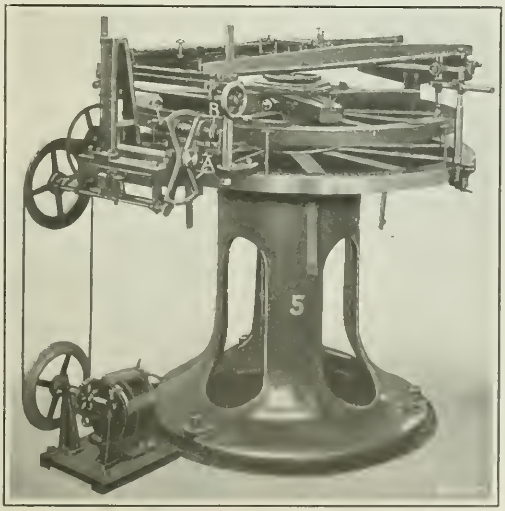

Fig. 4. Power-driven Circular Dividing Engine or Graduating Machine used in Shops of C. L. Berger & Sons

Automatic Circular Dividing Engine

For graduating the dials on sextants and other surveying and scientific instruments, C. L. Berger & Sons, 37 Williams St., Boston, Mass., have made the special circular dividing engine shown in Fig. 4. In constructing this machine, advantage has been taken of every means that would tend to give greater accuracy of the graduations on the work. For instance, the machine is housed in a room with double walls having the space between the walls packed with fiber; in this way the machine and work can be kept at practically a uniform temperature and errors due to expansion and contraction are avoided. Working with this degree of care, circular scales are graduated which are guaranteed not to have an error exceeding three seconds; in many cases the actual error is not greater than 1½ second of arc.

Circular scales are usually divided into 360 degrees; each degree is subdivided into 60 minutes, and each of these minutes is further subdivided into 60 seconds. This is known as the sexagesimal system. Attempts have been made to divide the circle into 400 degrees, *i. e.*, according to the centesimal system, thus making each quadrant susceptible of decimal division. It is difficult to apply the decimal system, chiefly because the circle with its commonly employed sexagesimal system of graduation is intimately connected with time, and this system lends itself to the making of calculations in connection with the division of hours into minutes and seconds. The degree has been decimally divided, and this has been found useful in laying down railway curves, due to its correspondence with the decimal division of the measures in use. The Berger circular dividing engine shown in Fig. 4 is adapted for graduating circles in either the sexagesimal or centesimal system.

In precision circular graduating it is of importance to have the work held in a truly horizontal plane and also to have the work concentrically mounted with the worm-wheel of the dividing engine. To secure this condition, a special form of level is used in the Berger shops, the method of employing it being illustrated in Fig. 5. This level is supported by a bracket screwed to the frame of the graduating machine, and the bar *A* that supports the level tube is pivoted to the main bracket.

At the opposite end of the bar from the pivot, it will be seen that there is a pin that bears against the surface of the work to be graduated; and after the level has been set up in this way the work is rotated in contact with the pin. Under these conditions any marked deflection of the bubble in the level tube indi-

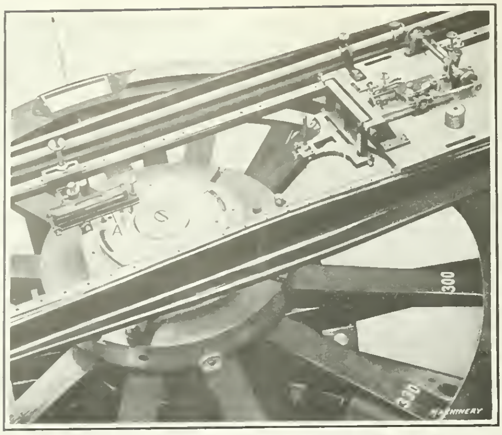

Fig. 5. Method of adjusting Work on Machine shown in Fig. 4

cates lack of accuracy in setting up the work, and suitable adjustment must be made until the test may be made without deflection of the bubble. This is a severe test because the level used for this purpose is extremely sensitive.

After setting up the work and making all adjustments of the machine, the operator leaves it and does not start the machine running until the next morning, because while setting up the work the heat of his body raises the temperature of both the machine and work somewhat above normal, and as a result there is a gradual contraction until the normal temperature is reached, which would result in introducing inaccuracies into the work. The next morning he comes into the room, starts the machine up and leaves before there is time for the heat from his body to cause any serious amount of expansion. The machine runs automatically until the graduating operation has been completed, when an automatic stop is tripped, which disengages a clutch that transmits power from the driving motor.

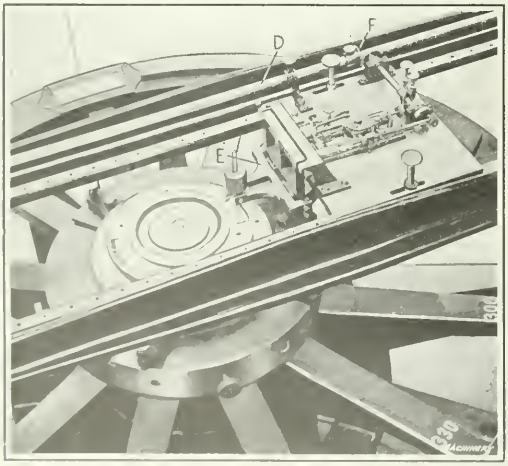

Fig. 6. Close View of Tool Carriage Mechanism of Graduating Machine shown in Fig. 4

In this article we are interested in results rather than in machines by which these results are obtained, but a brief description of the Berger graduating machine will doubtless prove of interest. It will be seen in Fig. 4 that the drive is provided by an individual motor bolted to the floor, and the work-table is rotated by a worm meshing with worm-wheel teeth cut in the periphery of the table. Graduations are cut by a reciprocating tool which cuts on the draw stroke and is lifted clear of the work on the return stroke. It will, of course, be obvious that indexing and graduating operations take place alternately and this result is obtained as follows: From the first driving shaft power is transmitted through gearing to an intermediate shaft, on the right-hand end of which there is a double segment gear *A* which meshes with pinion *B* carried at the rear end of the shaft carrying driving worm *C*, that engages the worm-wheel on the work-table. While the segment gear is in mesh with the pinion, it causes driving worm *C* to rotate, and this indexes the work. During this time the graduating tool is idle; but when the segment gear runs out of engagement with its pinion, the work has been brought to the desired position, and at this time the graduating operation may be performed. Extending across the top of the machine is a shaft *D*, best shown in Fig. 6, which transmits power to the tool carriage *E*. The machine is used for graduating circles on dials of various diameters, and to adapt it for handling these different sizes of work provision must be made for setting the tool at various distances from the center of rotation of the table on which the work is held. This is done by having the tool carriage mounted on a slide so that its position may be adjusted as required; and to transmit power to the carriage in any position the bevel pinion *F* on the driving shaft, is so arranged that it may be slid along the shaft and secured in any position by a capscrew. This bevel pinion transmits power to a cross-shaft which, in turn, operates a link mechanism under the carriage that gives the tool its reciprocating motion. The tool cuts on the draw stroke and is lifted clear of the work on the return stroke. As in the case of the Geneva dividing engines, to which reference has already been made, means are pro-

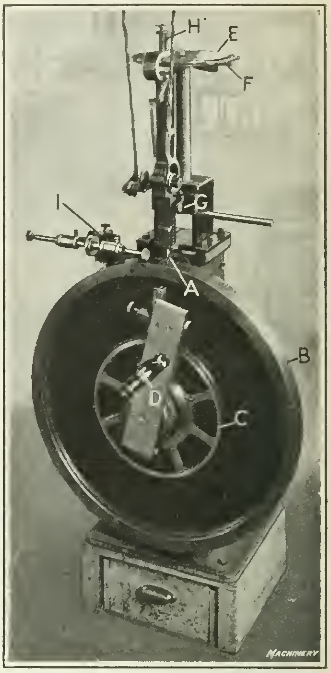

Fig. 7. Simple Circular Graduating Machine used in Instrument Shops of William Gaertner & Co.

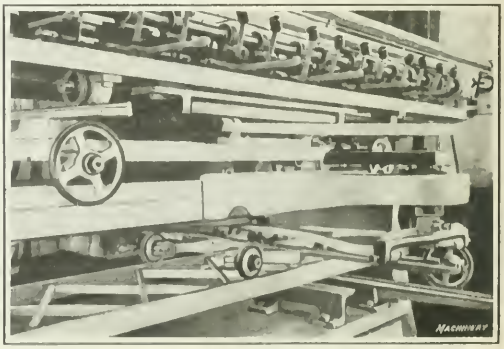

Fig. 8. Close View of Carriage that supports Control Mechanism on Hope Graduating Machine

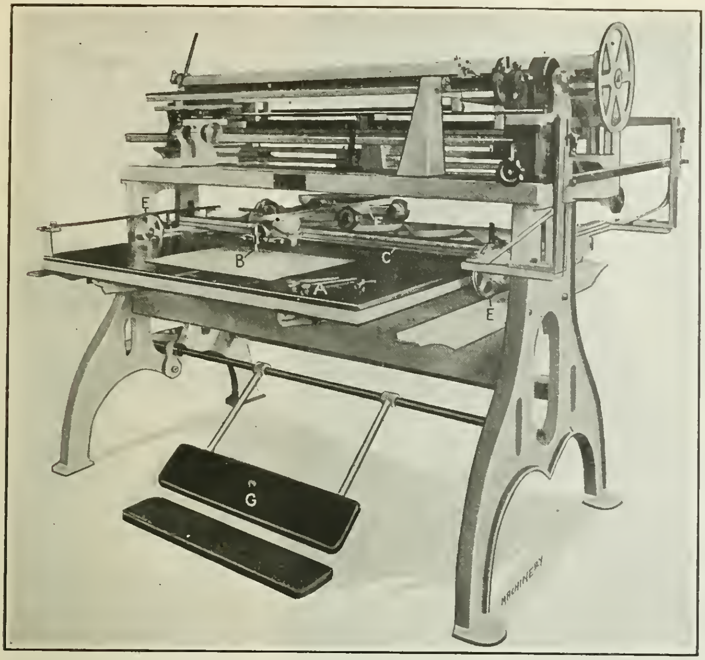

Fig. 9. Hand-operated Multiple Graduating Machine built by John Hope & Sons

vided on this machine for cutting graduation marks of different lengths at any required intervals. This is done by the same arrangement of notched wheels and screws used in the Geneva machines, operated by a ratchet mechanism.

Cutting Worm-wheel Teeth for Index Mechanism

A little thought will be sufficient to show that the accuracy of the results obtained in the operation of this machine is dependent upon the precision of the worm-wheel teeth that index the work between successive strokes of the graduating tool. These teeth are hobbed in the periphery of the work-table, and experience has shown that it is impracticable to obtain the degree of accuracy required for a machine of this kind without taking special pains to eliminate errors in the teeth that could safely be overlooked in many classes of gearing. The object is to have the worm-wheel teeth so cut that each tooth advances the work-table through the same angle.

After the worm-wheel teeth have been hobbed, the method of procedure is to graduate a circle on the work-table. Four microscopes are then mounted at equidistant points around the periphery of the table and there are cross-hairs in the eye-pieces which may be lined up with graduations on the table. Having proceeded to this point—with the microscopes lined up over the 90-, 180-, 270- and 360-degree graduations, the work-table is indexed through one-quarter revolution, using the regular worm drive to obtain this table movement. Then observations are taken, and if the worm-wheel teeth are accurate it will be found that the four quadrant graduations line up properly with cross-hairs in the microscopes which are now located over graduation marks 90 degrees from those with which they were formerly in alignment. It is more likely to be found, however, that a slight discrepancy exists in the worm-wheel teeth in the zero to 90-degree quadrant, which will be indicated by the fact that the four quadrant graduation marks do not line up accurately under the cross-hairs in the microscopes.

If this is the case it is necessary to correct the spacing of the teeth until the test can be made with satisfactory results. After this has been done, the table is advanced through another 90 degrees and observations are again made to find out if any correction is necessary in the teeth between the 270- and 360-degree graduations. This is repeated four times, and after corrections have been made it should be possible to rotate the work-table through another quadrant and find that the graduations line up properly under all four of the telescopes spaced around the table. In practice, smaller angles than 90 degrees are dealt with, but to simplify the description we have considered that not less than one-quarter revolution of the table is made between successive corrections of errors in the teeth.

Circle Dividing Machine

William Gaertner & Co., Inc., 5345 Lake Park Ave., Chicago, Ill., builds many astronomical instruments, and for graduating the circular dials required in this work, use is made of the special machine shown in Fig. 7. A variety of work can be handled with this equipment; the illustration shows the machine graduating the declination circle for a large telescope. This graduating machine is of the type on which the lines are cut by a revolving tool *A*, and the method of operating

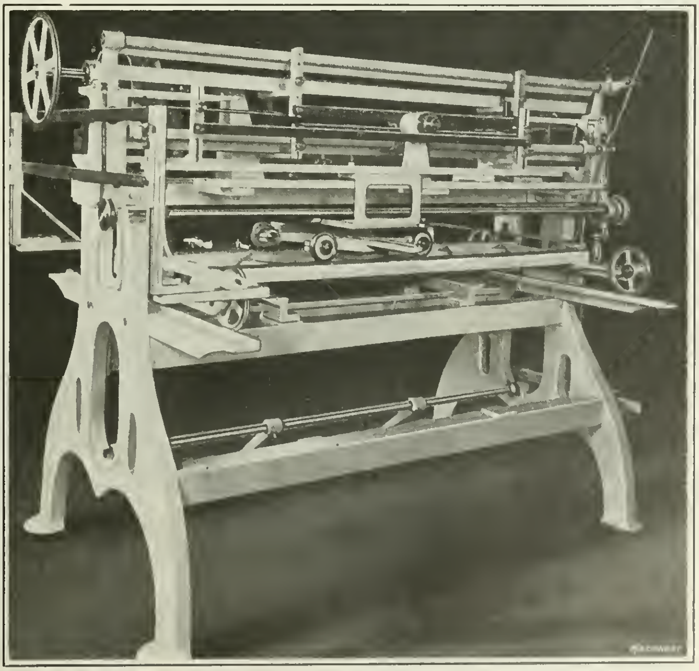

Fig. 10. Opposite Side of Hope Graduating Machine shown in Fig. 9. This Machine graduates Forty-eight Scales at a Time

the machine is as follows: Work *B* is supported on an arbor in such a way that it is free to revolve but may be secured in any desired position by tightening a quick-acting clamp. Fastened to the work there is a "master circle" *C* on which are the same graduations that it is required to cut in the periphery of work *B*. A bracket secured to the end of the arbor that supports work *B* is fitted with a telescope *D*. in the field of which is placed a cross-hair that may be lined up with any desired graduation on master circle *C*. In operating the machine, the first line is cut, after which the clamp is released and work *B* is rotated until the next line on master circle *C* comes into coincidence with the cross-hair in telescope *D*, after which the clamp is tightened to secure the work in this position ready for the next line to be graduated. This process is continued until the lines have been cut all the way around the periphery of work *B*.

As in the case of most graduating operations, it is necessary in handling this work to cut lines of various lengths, and on the present machine this is accomplished by having a master plate *E* on which are cut lines of varying lengths, which correspond with those to be graduated on the work. It will be seen that the periphery of this plate has notches cut in it to receive index plunger *F*, and each time the work is indexed by means of master circle *C* and telescope *D*, plate *E* is also rotated to bring plunger *F* into the next notch, thus locating a line of the proper length under the stylus *H*. It will be seen that engraving tool *A* is mounted at the lower end of a vertical arm, which is pivoted at *G*, the location of this pivot being adjustable so that various ratios may be obtained between the length of lines cut on work *B* and the length of lines in master plate *E*, over which stylus *H* is moved. It will also be apparent that the indexing of plate *E* is for the purpose of bringing successive lines on this plate into position for engagement by stylus *H*, thus enabling a sequence of lines of the desired lengths to be cut on the work. At *I* is shown a grinding attachment for sharpening engraving tool *A* when necessary.

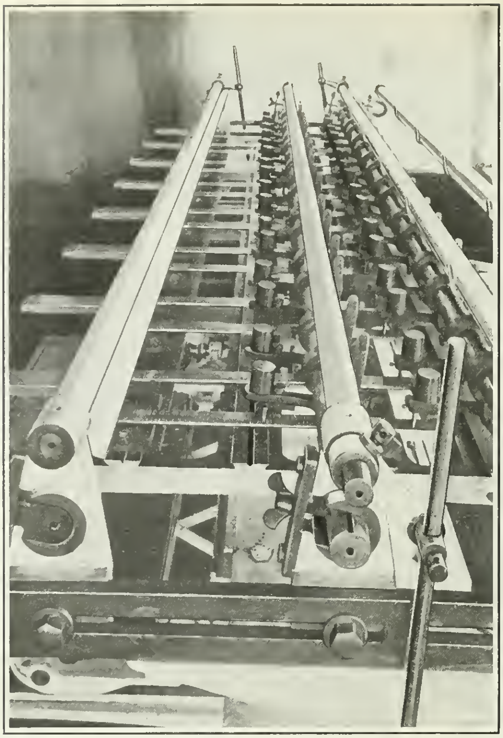

Fig. 11. Close View of Work-holders and Graduating Tools on Hope Machine

Pantograph Type of Graduating Machine

Graduating machines of the pantograph type are extensively used wherever graduating must be done on a commercial basis. Some of these machines are designed for graduating or engraving one part at a time, whereas others are intended for multiple graduation. A well-known machine of the multiple type, adapted for graduating steel rules, machinists' scales, and similar tools, on a manufacturing basis, is shown in Figs. 9 and 10. This machine is built by John Hope & Sons, Elmwood, Providence, R. I., and is so arranged that many duplicate scales or other parts may be graduated at the same time. A master scale or pattern is first made as accurately as possible and to an enlarged scale. The machine, with its pantograph reducing mechanism, is then used to reproduce this master scale onto the work. The pattern is attached to table *A* and, as the lines or figures, or whatever outline or design is to be reproduced, are followed by the tracer or pointer *B*, the movements are transmitted through the pantograph mechanism to the parts to be graduated. The tools do not cut the lines into the metal, but mark through a thin coating of acid-resisting material that has been previously spread over the surface of the work. When all the lines required have been cut into the resist, the work is removed and a suitable etching acid applied which eats into the metal and forms lines wherever the resist has been removed by the marking tools. Ordinarily, these tools or points are diamond chips, set into steel holders. The diamond chips last two or three years before repointing is necessary. Some concerns use hardened steel marking points.

When graduating steel scales on this machine, forty-eight six-inch scales may be operated on simultaneously, in which case a corresponding number of diamond points is employed. There are four work-holders, each of which has a capacity for holding six feet of work, *i. e.*, twelve six-inch scales. When the machine is in operation, movement of the tracer point *B* is transmitted to all the marking points, which are located at the top of the machine. The tracer point may be moved in any direction for following straight lines, figures, or any irregular

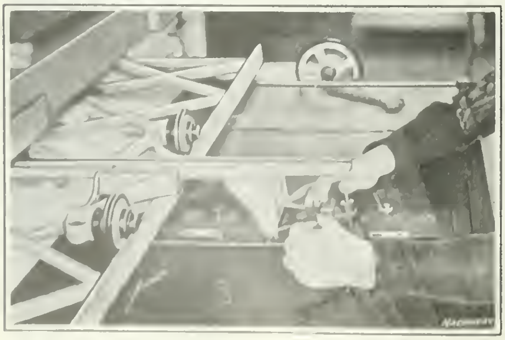

Fig. 12. Close View of "Master" or "Copy," illustrating Method of guiding Stylus over Graduated Marks

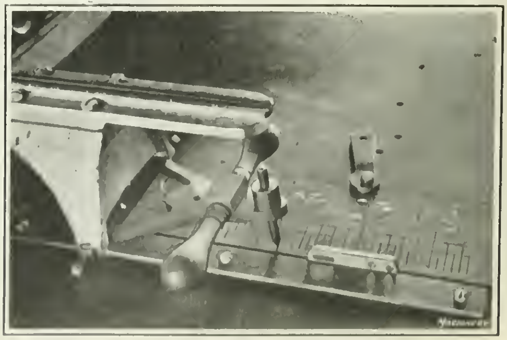

Fig. 13. View of Master Copy, Stylus and Handles for operating Stylus

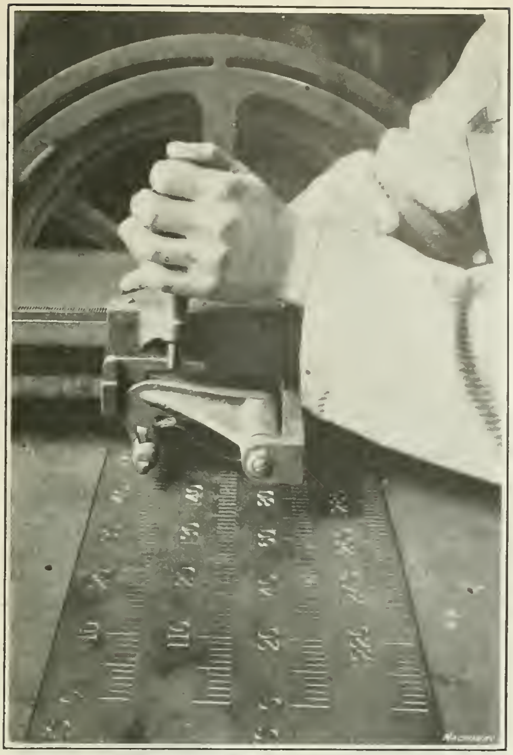

Fig. 14. Close View of Graduating Tool used on Machine shown in Fig. 15

design. When marking ordinary graduation lines on scales, the tracer (which is guided by the operator) is made to traverse each line on a master scale clamped to table *A*. The lateral movements of the tracer cause the main carriage *C*, which is mounted on wheels *E*, to move along the track shown, whereas the longitudinal movements shift the smaller carriage *F* along the track formed on carriage *C*. Every movement of the tracer is transmitted through the pantograph mechanism to the work-table which holds the scales or other parts to be graduated. The pantograph mechanism may be adjusted to reproduce the pattern on any scale varying, on this particular machine, from one-third to one-twentieth the size of the pattern or copy. The foot-treadle *G* is used to bring the diamonds into contact with the work. An idea of the rate of production will be gathered from the fact that in the plant of the Sawyer Tool Mfg. Co., Ashburnham, Mass., girls who operate these machines each mark 200 feet of scales per day. The master scale is made on a special machine, shown in Figs. 14 and 15, consisting principally of a precision lead-screw, a large dividing wheel for accurately spacing the division lines, and a tool for cutting these lines. The figures may be engraved on an ordinary engraving machine or they may be cut into the master by hand.

The master scale is not always in the form of an enlarged copy of the scale to be reproduced. A special design used for graduating steel rules is shown in Fig. 16. It is 12 inches long and has four sides (see end view), on which are the different graduations required. This cross-shaped master is mounted in bearings so that any side may be turned to the upper or operating position, thus locating the face of that particular side just a little above the graduating machine table. The tracer of the machine is not pointed, but is chisel shaped, to correspond with the V-shaped grooves in the master. The length of the various division lines is regulated by a fixed plate or gage above the master, which has slots that limit the movement of the tracer. The space between the grooves on the master is much wider than on the graduated scales, the necessary reduction being obtained by the pantograph mechanism. The master is twelve inches long, but it is provided only with the graduations corresponding to a length of one inch on the scale. After marking the graduation lines for a length of one inch, the diamonds on the graduating machine are set in alignment for graduating the next successive inch division. This master is used on a machine of the type shown in Figs. 9 and 10, forty-eight steel rules being graduated simultaneously. These rules have one-half inch of excess metal at each end, which is cut off after graduating. This excess length enables the rules to be held readily. The marking of the figures into the resist involves a separate operation.

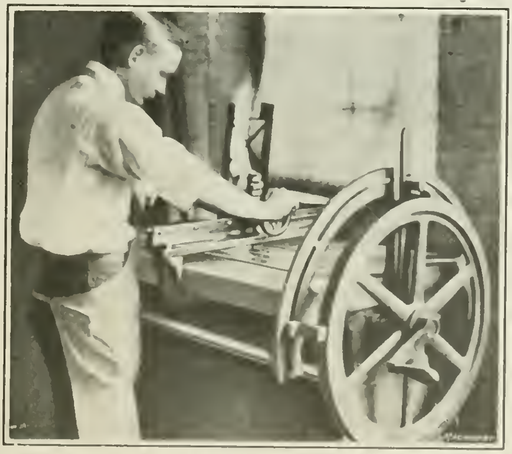

Fig. 15. Method of making Master Scales on Special Graduating Machine

Increasing Visibility of Graduation Lines

In order to secure a greater contrast between the graduation lines and the background, the lines are sometimes filled with a pigment such as black sealing wax or white lead, depending upon whether the background is light or dark. In some cases the lines are filled with block tin, which is melted into them. The surface is then polished so that the lines or figures are in clear contrast with the background. A mixture of paraffin and lampblack is also used on light work. One method of treating graduation lines which have been cut into black vulcanized rubber, by means of a machine of the Gorton type having a rapidly revolving cutter, is as follows: The lines formed by the engraving machine are filled with a paste composed of zinc oxide mixed with enough paraffin to give it a plastic consistency. A small amount of this paste is rubbed over the graduation marks and the surplus is wiped off with a cloth. This paste is very hard and durable when dry, and the white lines on the black rubber background are readily seen.

Graduating by Impression Method

When large numbers of duplicate parts require to be graduated and extreme accuracy is not necessary, the lines are sometimes formed by the use of steel stamps for flat work, or rolls for circular parts. The stamp or roll, as the case may be, has the lines and figures formed on it and is hardened so that, when the graduating tool is pressed against the work, the lines are reproduced. Fig. 18 shows a special tool for graduating index collars such as are used on the feed-screws of machine tools. The tapering arbor *A* is fitted into the lathe spindle and holds the part to be graduated at its outer end. A gear forming part of this arbor meshes with gear *B*, which is keyed to stud *C*. This stud is mounted in a holder *D* that is fastened in the toolpost of the lathe. The graduating roll is keyed to the stud *C* and is forced against the work so that the graduation lines and figures on it are reproduced on the index collar as the two revolve together. The geared drive is preferable to a friction drive between the graduating roll and work-arbor, because it is positive and prevents any shifting of the work relative to the graduating roll.

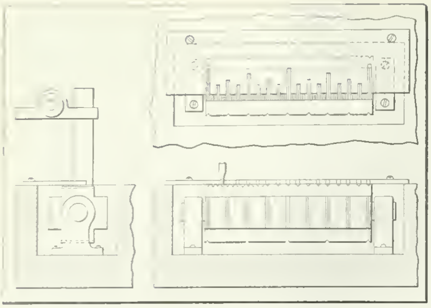

Fig. 16. Type of Master Copy used for graduating Scales on Hope Machine

Machine for Graduating Dials for Lathes

In building Conradson engine lathes, the Phoenix Mfg. Co. of Eau Claire, Wis., uses a special bench machine shown in Fig. 17 for graduating micrometer dials. It will be seen that this machine is of the type in which impressions are made by a hardened roller *A*, which is forced into work *B* without removing any metal. This is a hand-operated machine, which is actuated by turning handwheel *C* mounted at the end of a cross-shaft, on the opposite end of which there is a pinion that meshes with gear *D*. In graduating dials, it is necessary to make lines of different lengths; for instance, it may be required to cut four lines of the same length and then a fifth line of greater length. Movement of the slide that carries hardened steel roller *A* is obtained by means of a multiple-lobed cam located inside the rim of gear *D*, which engages with a roller mounted at the lower end of lever *E*. This lever has its fulcrum at *F*, and makes connection with the slide by means of a pin extending into slot *G*, the roller that engages the multiple cam being located at the opposite side of fulcrum *F* from the pin that extends into slot *G*.

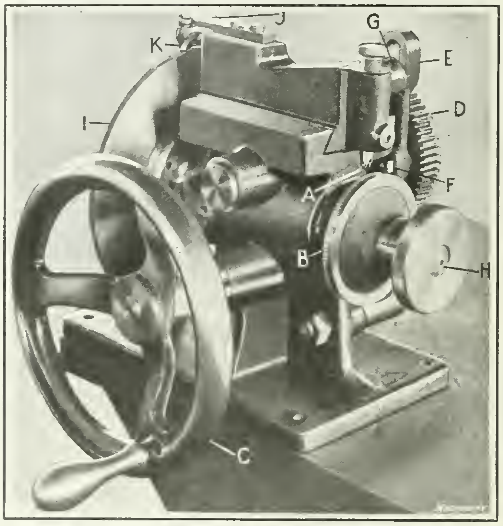

Fig. 17. Special Machine designed for rolling Graduation Marks into Feed Collars used on Conradson Engine Lathes

As gear *D* revolves, the roller at the lower end of lever *E* rides over successive lobes on the cam inside the rim of gear *D*, and as each lobe is passed the upper end of lever *E* is rocked forward, which results in feeding the hardened steel graduating roller *A* over the surface of work *B*. The length of stroke of roller *A* is regulated by the height of the different cam lobes, which provides for marking lines of the desired lengths. It will be seen that work *B* is carried on a horizontal mandrel *H*, and for indexing the work, there is a ratchet wheel *I* at the rear end of mandrel *H*, which has the same number of teeth as there are graduations to be cut in the complete circle on the work. To provide for automatic indexing, a cam *J* is secured to the back of the slide that carries marking roller *A*, and this cam engages with a roller mounted on the pivoted bracket that supports pawl *K*. During each return stroke of the ram, cam *J* moves pawl *K* forward, thereby advancing ratchet wheel *I* through one tooth space which corresponds to one division on the work. Then, as the ram moves forward to cut the next graduation mark, cam *J* allows a spring to draw pawl *K* back so that it drops into engagement with the next tooth on ratchet wheel *I*. It will be of interest to note that feed dials have been completely graduated in this way in a little less than two minutes.

A fixture for graduating the sleeves of drilling machines is shown in Fig. 19. The casting *A* of this fixture is machined to fit the drill press sleeve as shown. The latter has a spline in it in which the block *B* is held by screw *C* for retaining the sleeve in the correct position. The hardened steel stamp *D* (see also enlarged view at *F*) is made to graduate the sleeve for a length of one inch, the graduations being to sixteenths of an inch. This stamp *D* is held in a slot in the fixture by means of a cap *G*. When a sleeve is to be graduated, it is placed in the fixture with one end against the the stop *H*. The stamp is then given a blow with a hammer, after which the spring plunger *I* is withdrawn, thus allowing rod *J* and stop *H* to be shifted to the next successive hole, which locates the stamp for graduating the next inch division. This operation of shifting the sleeve and the stop is repeated until the sleeve has been graduated to the required length.

Graduating with Milling Machine

A milling machine equipped with a spiral head is sometimes used for graduating verniers, flat scales, and other parts requiring odd fractional divisions or graduations. The spiral-head spindle should be geared to the table feed-screw so that a longitudinal movement of the table is secured by turning the indexing crank. When using a Brown & Sharpe machine, the gear for the spiral head is mounted on the differential index center inserted in the main spiral-head spindle. By varying the indexing movement, graduations can be spaced with considerable accuracy. The graduation lines are cut by a sharp-pointed tool held either in a fly cutter arbor mounted in the spindle, or between the collars of a regular milling cutter arbor. The lines are drawn by feeding the table laterally by hand, and the lengths of the lines representing different divisions and subdivisions can be varied by noting the graduations on the cross-feed screw. The gearing between the spiral-head spindle and feed-screw should be equal or of such a ratio that the feed-screw and spindle rotate at the same speed. Assuming that the lead of the feed-screw thread is 0.25 inch and that 40 turns are required for one revolution of the spiral-head spindle; then one turn of the index-crank will cause the table to move longitudinally a distance equal to one-fortieth of 0.25, or 0.00625 inch. ($1/40 \times 25/100 = 0.00625$.) Suppose graduation lines 0.03125 or 1/32 inch apart were required on a scale. Then the number of turns of the index-crank for moving the table 0.03125 inch equals $0.03125 \div 0.00625 = 5$ turns. If the divisions on a vernier reading to thousandths of an inch were to be 0.024 inch apart, the indexing movement would equal $0.024 \div 0.00625 = 3.84$ turns. This fractional movement of 0.84 turn can be obtained

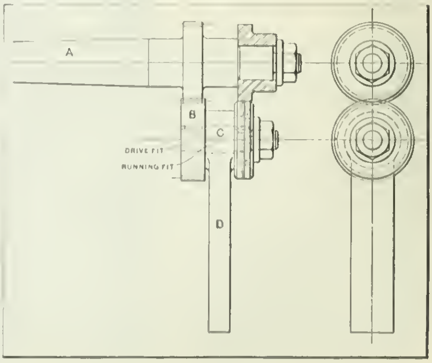

Fig. 18. Tool for graduating Index Collars by Impression Method

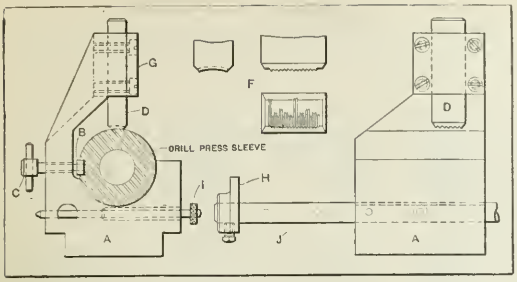

Fig. 19. Fixture for graduating Drill Press Sleeves with a Stamp

within very close limits by indexing 26 holes in the 31-hole circle; thus, three complete turns will move the work 0.00625 × 3 = 0.01875 inch, and 26/31 turn will give a longitudinal movement equal to 0.00524 +; therefore, a movement of 3 26/31 turns = 0.01875 + 0.00524 = 0.02399 inch, which is 0.00001 inch less than the required amount.

The accompanying table "Indexing Movements for Graduating with Milling Machine" was compiled by the Brown & Sharpe Mfg. Co., and will be found convenient for determining what circle to use and the number of holes to index for given dimensions. The whole number of turns required is first determined and then the indexing movement for the remaining distance is taken from the table. Thus, for graduation lines 0.0218 inch apart, three complete turns give a movement of 0.00625 × 3 = 0.01875 inch. 0.0218 — 0.01875 = 0.00305 inch. By referring to the table, it will be seen that a movement of 21 holes in the 43-hole circle equals 0.00305 +. Therefore, to index the work 0.0218 inch, the crank should be given 3 21/43 turns. In graduating in this way, the index-crank should always be turned in one direction after beginning the graduating operation, in order to prevent errors being made in the work due to any play or backlash that might exist between the table feed-screw and nut.

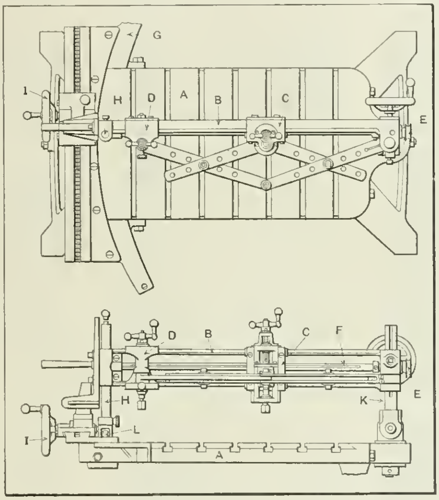

Fig. 20. Engraving and Die-sinking Machine of Pantograph Type

Graduating Tool for Fine Lines

The special form of tool shown in Fig. 21 has been used successfully for cutting fine lines of uniform depth when graduating with the milling machine. This tool is held on a regular cutter-arbor by means of the collar *A*, and, when graduating, the spindle of the machine is locked to prevent any rotary movement. The lines are cut by a sharp-pointed tool *D* made of drill rod. This tool is held in block *C* by screw *E*, the block being split as shown. The lower part of block *C* is provided with a shoe *F* which may be adjusted by screws *G* and *H*. This shoe rests upon the surface of the part to be graduated and regulates the depth of the graduation lines. When using this tool, the work-table is adjusted vertically so that the tool is sprung upward slightly or until the flat spring *B* gives sufficient pressure to overcome the resistance of the cut. As the tool is always in contact with the work, the lines are cut to a uniform depth, even though the surface being graduated is not perfectly flat. This tool was designed for graduating the scales on chronographs. The work was held in a lengthwise position on the table and the lateral movements for controlling the length of the different graduation lines were regulated by inserting small parallel strips of different thicknesses between stops on the cross-slide, which were set for the length of the longest line.

Engraving Machines

It is generally understood that graduating machines are used for cutting the division lines on various forms of scales, and that engraving machines are used for cutting letters, figures and designs in the work. These two classes of machines are naturally associated with each other, because there are a number of graduating machines on which no provision is made for cutting figures to indicate the value of scale graduations or the manufacturer's name, trademark, etc. As a matter of fact, the distinction between these two types of machines is rather fine, because many engraving machines can be used for graduating when suitable provision is made for handling this class of work. Further discussion of this subject will appear in a subsequent part of this article.

Engraving machines are designed to reproduce the form of a pattern or model on the part to be engraved, by means of a mechanism which transmits the movement of a tracing point to a suitable cutting tool. In the operation of the machine, the tracing point is made to follow the pattern or model, usually by guiding it with the hand. There are two general types of engraving machines. On one type the tool does not revolve, but is drawn across the work so that it operates the same as a planing tool. The angular position of the graver or tool may be varied to secure different effects, and the tool-holder may also be turned on some machines so that the graver will be kept facing the changing direction of the cut, but the tool does not revolve continuously.

Engraving machines may be further classified according to the form of mechanism utilized for reproducing the pattern or model on the engraved part. Many of the types intended more particularly for engraving letters or ornate designs on nameplates, dies, silverware, etc., have a pantograph mechanism for reproducing the pattern or model on a reduced scale. Other machines of the reducing type, or those using a model that is considerably larger than the design or form to be engraved, are so arranged that the necessary reduction between the movement of the tracing point which bears against the pattern and the tool or cutter is obtained by simply attaching the tracer and cutter-head to a lever at distances from the pivot of the lever proportional to the reduction required between the pattern and engraved part. Another type of engraving machine does not have a reducing mechanism, but the tracing point bears against a model corresponding in size to the impression to be engraved, and this tracing point guides the cutting tool by a direct connection with the cutter-spindle or the member in which it is mounted.

Engraving Machine of Pantograph Type

While many engraving machines have the same type of mechanism for causing the cutter to reproduce the movement

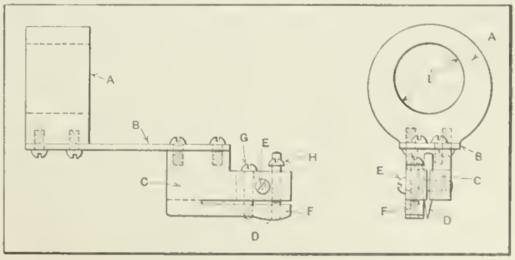

Fig. 21. Graduating Tool for cutting Fine Lines of Uniform Depth

INDEXING MOVEMENTS FOR GRADUATING WITH MILLING MACHINE

Movement of Table	Holes	Circle	Movement of Table	Holes	Circle	Movement of Table	Holes	Circle	Movement of Table	Holes	Circle
0.0001275	1	49	0.0008621	4	29	0.0016128	8	31	0.0023706	11	29
0.0001330	1	47	0.0008721	6	43	0.0016204	7	27	0.0023809	8	21
0.0001454	1	43	0.0008929	7	49	0.0016303	6	23	0.0023937	18	47
0.0001524	1	41	0.0008929	3	21	0.0016447	5	19	0.0024038	15	39
0.0001603	1	39	0.0009146	6	41	0.0016581	13	49	0.0024192	12	31
0.0001689	1	37	0.0009259	4	27	0.0016666	4	15	0.0024235	19	49
0.0001894	1	33	0.0009308	7	47	0.0016768	11	41	0.0024306	7	18
0.0002016	1	31	0.0009375	3	20	0.0016892	10	37	0.0024390	16	41
0.0002155	1	29	0.0009469	5	33	0.0017045	9	33	0.0024455	9	23
0.0002315	1	27	0.0009616	6	39	0.0017241	8	29	0.0024622	13	33
0.0002551	2	49	0.0009869	3	19	0.0017288	13	47	0.0024710	17	43
0.0002660	2	47	0.0010081	5	31	0.0017361	5	18	0.0025000	8	20
0.0002717	1	23	0.0010136	6	37	0.0017442	12	43	0.0025000	6	15
0.0002907	2	43	0.0010174	7	43	0.0017628	11	39	0.0025266	19	47
0.0002976	1	21	0.0010204	8	49	0.0017857	6	21	0.0025339	15	37
0.0003049	2	41	0.0010417	3	18	0.0017857	14	49	0.0025463	11	27
0.0003125	1	20	0.0010638	8	47	0.0018144	9	31	0.0025510	20	49
0.0003205	2	39	0.0010671	7	41	0.0018292	12	41	0.0025640	16	39
0.0003289	1	19	0.0010776	5	29	0.0018382	5	17	0.0025736	7	17
0.0003378	2	37	0.0010869	4	23	0.0018518	8	27	0.0025862	12	29
0.0003472	1	18	0.0011029	3	17	0.0018581	11	37	0.0025915	17	41
0.0003676	1	17	0.0011218	7	39	0.0018617	14	47	0.0026164	18	43
0.0003788	2	33	0.0011363	6	33	0.0018750	6	20	0.0026209	13	31
0.0003826	3	49	0.0011479	9	49	0.0018896	13	43	0.0026316	8	19
0.0003906	1	16	0.0011574	5	27	0.0018939	10	33	0.0026515	14	33
0.0003989	3	47	0.0011628	8	43	0.0019021	7	23	0.0026596	20	47
0.0004032	2	31	0.0011718	3	16	0.0019132	15	49	0.0026785	9	21
0.0004167	1	15	0.0011824	7	37	0.0019231	12	39	0.0026785	21	49
0.0004310	2	29	0.0011905	4	21	0.0019396	9	29	0.0027028	16	37
0.0004361	3	43	0.0011968	9	47	0.0019532	5	16	0.0027174	10	23
0.0004573	3	41	0.0012096	6	31	0.0019737	6	19	0.0027243	17	39
0.0004630	2	27	0.0012195	8	41	0.0019818	13	41	0.0027344	7	16
0.0004808	3	39	0.0012500	4	20	0.0019947	15	47	0.0027440	18	41
0.0005068	3	37	0.0012500	3	15	0.0020161	10	31	0.0027618	19	43
0.0005102	4	49	0.0012755	10	49	0.0020271	12	37	0.0027777	8	18
0.0005319	4	47	0.0012820	8	39	0.0020350	14	43	0.0027777	12	27
0.0005435	2	23	0.0012930	6	29	0.0020485	16	49	0.0027925	21	47
0.0005682	3	33	0.0013081	9	43	0.0020833	13	39	0.0028017	13	29
0.0005814	4	43	0.0013158	4	19	0.0020833	5	15	0.0028060	22	49
0.0005952	2	21	0.0013257	7	33	0.0020833	11	33	0.0028125	9	20
0.0006048	3	31	0.0013298	10	47	0.0020833	9	27	0.0028225	14	31
0.0006098	4	41	0.0013513	8	37	0.0020833	7	21	0.0028409	15	33
0.0006250	2	20	0.0013587	5	23	0.0020833	6	18	0.0028717	17	37
0.0006377	5	49	0.0013722	9	41	0.0021277	16	47	0.0028846	18	39
0.0006410	4	39	0.0013888	6	27	0.0021342	14	41	0.0028963	19	41
0.0006465	3	29	0.0013888	4	18	0.0021552	10	29	0.0029070	20	43
0.0006579	2	19	0.0014031	11	49	0.0021682	17	49	0.0029167	7	15
0.0006649	5	47	0.0014113	7	31	0.0021738	8	23	0.0029256	22	47
0.0006757	4	37	0.0014422	9	39	0.0021802	15	43	0.0029337	23	49
0.0006944	3	27	0.0014535	10	43	0.0021875	7	20	0.0029412	8	17
0.0006944	2	18	0.0014628	11	47	0.0021960	13	37	0.0029605	9	19
0.0007268	5	43	0.0014706	4	17	0.0022059	6	17	0.0029762	10	21
0.0007353	2	17	0.0014881	5	21	0.0022176	11	31	0.0029890	11	23
0.0007576	4	33	0.0015086	7	29	0.0022436	14	39	0.0030094	13	27
0.0007622	5	41	0.0015152	8	33	0.0022607	17	47	0.0030172	14	29
0.0007653	6	49	0.0015202	9	37	0.0022728	12	33	0.0030241	15	31
0.0007813	2	16	0.0015244	10	41	0.0022866	15	41	0.0030303	16	33
0.0007979	6	47	0.0015306	12	49	0.0022959	18	49	0.0030406	18	37
0.0008012	5	39	0.0015625	5	20	0.0023027	7	19	0.0030448	19	39
0.0008064	4	31	0.0015625	4	16	0.0023148	10	27	0.0030488	20	41
0.0008152	3	23	0.0015957	12	47	0.0023257	16	43	0.0030524	21	43
0.0008333	2	15	0.0015989	11	43	0.0023438	6	16	0.0030586	23	47
0.0008446	5	37	0.0016026	10	39	0.0023649	14	37	0.0030611	24	49

Machinery

of the tracing point on a smaller scale, the general design of different machines varies considerably. A machine built by an English manufacturer (Thomas Auty & Co.) is illustrated in part by the front elevation and plan view, Fig. 20. This type of machine is used for a variety of die-cutting work, as well as for general engraving operations. The desired form is reproduced from an enlarged former or model, by means of a pantograph mechanism, shown more clearly in the plan view. The part to be engraved is clamped to table *A* under the head *C*. The head carries a milling cutter which moves in the same direction as the tracing pin in head *D*, only on a reduced scale, the reduction depending upon the adjustment of the pantograph mechanism. The arm *B* which extends across the work-table is pivoted so that it can be traversed in a horizontal plane around the axis of the vertical stud *K*. This horizontal arm *B* is supported at its outer end by a roller *L* on the end of rod *H*, the roller traveling along the circular path *G* of the machine table. The horizontal movement of arm *B* may be effected either directly by hand or mechanically through a rack and pinion by turning handwheel *I*. The stud *K*, upon which arm *B* is pivoted, is connected to the table by a joint which permits the arm to rise and fall in a vertical plane, so as to accommodate itself to any irregular surfaces on the work. By traversing the tracing head *D* longitudinally along the arm,

INDEXING MOVEMENTS FOR GRADUATING WITH MILLING MACHINE—*Continued*

Movement of Table	Holes	Circle	Movement of Table	Holes	Circle	Movement of Table	Holes	Circle	Movement of Table	Holes	Circle
0.0031250	9	18	0.0038564	29	47	0.0046194	17	23	0.0053572	18	21
0.0031250	10	20	0.0038692	13	21	0.0046296	20	27	0.0053781	37	43
0.0031250	8	16	0.0038794	18	29	0.0046371	23	31	0.0053880	25	29
0.0031889	25	49	0.0038853	23	37	0.0046473	29	39	0.0054057	32	37
0.0031915	24	47	0.0039063	10	16	0.0046512	32	43	0.0054170	13	15
0.0031978	22	43	0.0039246	27	43	0.0046543	35	47	0.0054348	20	23
0.0032014	21	41	0.0039352	17	27	0.0046875	15	20	0.0054434	27	31
0.0032050	20	39	0.0039475	12	19	0.0046875	12	16	0.0054486	34	39
0.0032095	19	37	0.0039540	31	49	0.0047195	37	49	0.0054522	41	47
0.0032197	17	33	0.0039636	26	41	0.0047256	31	41	0.0054690	14	16
0.0032257	16	31	0.0039773	21	33	0.0047299	28	37	0.0054848	43	49
0.0032327	15	29	0.0039894	30	47	0.0047349	25	33	0.0054878	36	41
0.0032408	14	27	0.0040064	25	39	0.0047414	22	29	0.0054924	29	33
0.0032607	12	23	0.0040322	20	31	0.0047620	16	21	0.0055148	15	17
0.0032738	11	21	0.0040443	11	17	0.0047796	13	17	0.0055238	38	43
0.0032895	10	19	0.0040541	24	37	0.0047873	36	47	0.0055555	24	27
0.0033088	9	17	0.0040625	13	20	0.0047968	33	43	0.0055555	16	18
0.0033164	26	49	0.0040700	28	43	0.0048074	30	39	0.0055746	33	37
0.0033245	25	47	0.0040759	15	23	0.0048384	24	31	0.0055852	42	47
0.0033333	8	15	0.0040817	32	49	0.0048470	38	49	0.0055925	17	19
0.0033431	23	43	0.0040948	19	29	0.0048613	14	18	0.0056035	26	29
0.0033538	22	41	0.0041160	27	41	0.0048613	21	27	0.0056088	35	39
0.0033654	21	39	0.0041223	31	47	0.0048782	32	41	0.0056123	44	49
0.0033784	20	37	0.0041666	22	33	0.0048912	18	23	0.0056250	18	20
0.0034091	18	33	0.0041666	14	21	0.0048989	29	37	0.0056403	37	41
0.0034273	17	31	0.0041666	18	27	0.0049202	37	47	0.0056450	28	31
0.0034375	11	20	0.0041666	12	18	0.0049244	26	33	0.0056546	19	21
0.0034439	27	49	0.0041666	10	15	0.0049345	15	19	0.0056690	39	43
0.0034482	16	29	0.0041666	26	39	0.0049420	34	43	0.0056816	30	33
0.0034574	26	47	0.0042091	33	49	0.0049569	23	29	0.0057065	21	23
0.0034722	10	18	0.0042152	29	43	0.0049677	31	39	0.0057180	43	47
0.0034722	15	27	0.0042232	25	37	0.0049745	39	49	0.0057400	45	49
0.0034885	24	43	0.0042338	21	31	0.0050000	16	20	0.0057433	34	37
0.0035063	23	41	0.0042553	32	47	0.0050000	12	15	0.0057692	36	39
0.0035156	9	16	0.0042685	28	41	0.0050308	33	41	0.0057874	25	27
0.0035255	22	39	0.0042765	13	19	0.0050402	25	31	0.0057927	38	41
0.0035325	13	23	0.0042971	11	16	0.0050532	38	47	0.0058142	40	43
0.0035474	21	37	0.0043104	20	29	0.0050596	17	21	0.0058187	27	29
0.0035714	12	21	0.0043268	27	39	0.0050676	30	37	0.0058336	14	15
0.0035714	28	49	0.0043368	34	49	0.0050785	13	16	0.0058466	29	31
0.0035904	27	47	0.0043477	16	23	0.0050876	35	43	0.0058512	44	47
0.0035984	19	33	0.0043562	23	33	0.0050928	22	27	0.0058599	15	16
0.0036186	11	19	0.0043605	30	43	0.0051022	40	49	0.0058674	46	49
0.0036289	18	31	0.0043750	14	20	0.0051136	27	33	0.0058710	31	33
0.0036339	25	43	0.0043883	33	47	0.0051281	32	39	0.0058825	16	17
0.0036585	24	41	0.0043922	26	37	0.0051474	14	17	0.0059027	17	18
0.0036637	17	29	0.0043980	19	27	0.0051627	19	23	0.0059122	35	37
0.0036765	10	17	0.0044119	12	17	0.0051721	24	29	0.0059215	18	19
0.0036858	23	39	0.0044210	29	41	0.0051830	34	41	0.0059294	37	39
0.0036990	29	49	0.0044354	22	31	0.0051861	39	47	0.0059375	19	20
0.0037038	16	27	0.0044643	15	21	0.0052083	15	18	0.0059455	39	41
0.0037163	22	37	0.0044643	35	49	0.0052296	41	49	0.0059524	20	21
0.0037234	28	47	0.0044871	28	39	0.0052327	36	43	0.0059598	41	43
0.0037500	12	20	0.0045060	31	43	0.0052365	31	37	0.0059782	22	23
0.0037500	9	15	0.0045140	13	18	0.0052419	26	31	0.0059841	45	47
0.0037793	26	43	0.0045213	34	47	0.0052635	16	19	0.0059951	47	49
0.0037878	20	33	0.0045259	21	29	0.0052884	33	39	0.0060188	26	27
0.0038043	14	23	0.0045452	24	33	0.0053030	28	33	0.0060346	28	29
0.0038112	25	41	0.0045610	27	37	0.0053125	17	20	0.0060480	30	31
0.0038195	11	18	0.0045732	30	41	0.0053194	40	47	0.0060607	32	33
0.0038265	30	49	0.0045835	11	15	0.0053242	23	27	0.0060812	36	37
0.0038305	19	31	0.0045920	36	49	0.0053364	35	41	0.0060898	38	39
0.0038460	24	39	0.0046055	14	19	0.0053572	42	49	0.0060980	40	41

Machinery

the tracing pin is moved in or out as the arm swings horizontally, in order to follow the outline of the former or pattern. Any movement that is given to the tracing head *D* is reproduced by the cutter-head *C* on a reduced scale. The cutter-spindle is driven by a shaft *F* which carries a belt pulley *E*. Motion is transmitted from the shaft *F* to the cutter-spindle, through helical gearing in the cutter-slide. The arm *B* is secured to stud *K* by means of a set-screw, and the height of the arm may be varied according to the height of the work being operated upon. There is a spring-support on the end of rod *H*, which takes the weight of the arm when vertical movements are required. A thumb-screw is provided for preventing the spring from acting when vertical movements are not required.

Engraving Machine Having Graduated Pantograph

Another engraving machine which operates on the pantograph principle, but differs in design from the one previously described, is shown in Fig. 22, which illustrates the pantograph mechanism and the method of rotating the cutter-spindle. This machine is used for engraving nameplates, trademarks, letters, numbers, etc., on steel stamps, dies and other products. A pattern of the required design is placed in a slot in the pattern table *A*, where it is clamped in position. At

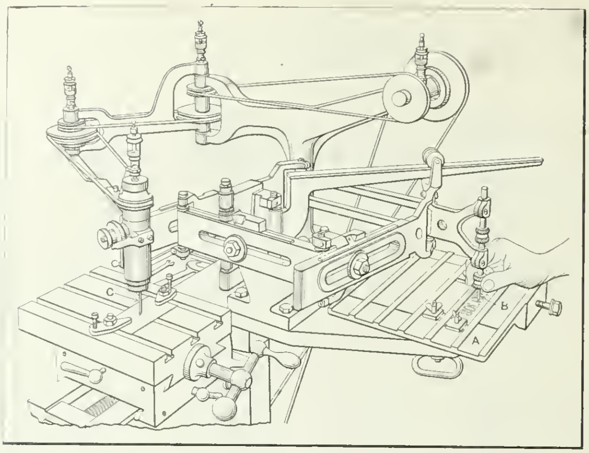

Fig. 22. Pantograph Mechanism provided with Graduated Scale Adjustment

one end of the pantograph, there is a tracing or guiding point *B*, which is made to follow the pattern or letters which are to be reproduced on the work. The engraving tool *C* is carried by a spindle at the opposite end of the pantograph mechanism. Three of the arms on the pantograph are provided with scales by means of which the relation between the lengths of the arms can be adjusted to obtain any desired size of an engraved design, the limit of the machine being from a ratio of 1 to 1 between the size of the work and pattern, down to a ratio of 1 to 10. When the pattern is to be used repeatedly, it is carefully made and, in the case of letters, these are cut into the pattern plate, thus forming a positive guide for the tracing point. When only a few pieces are to be engraved, the design may be drawn on bristol board, but when such a design is used more care is required in operating the machine, because the movements of the tracing point must be controlled entirely by hand. Owing to the universal movements of the engraving tool, it is necessary to provide a flexible system for driving the cutter-spindle. The arrangement of the belt drive in this particular case is apparent from the illustration.

The engraving tool used on this machine is cylindrical in shape, except at the lower end, where for about 1½ inch a flat is ground so that about one-half of the metal is removed, and a suitable cutting edge is formed on the lower end. Experience has shown that the best results are obtained by having the ground surface of the tool of an elliptical section instead of circular, and this special form is obtained by a grinding attachment used in connection with the machine. By means of this attachment, the motion of the tool is controlled when in contact with the grinding wheel, by means of a cam which forms part of the attachment.

Engraving Cylindrical or Conical Surfaces

When cylindrical or conical surfaces are to be engraved on the machine shown in Fig. 22, an attachment is used which consists principally of a work-holding device that can be tilted to any desired angle, in order to locate the surface in the proper position relative to the engraving tool. This work-holding device can also be rotated or indexed for the accurate spacing of designs to be engraved on different parts of the work. In most cases where engraving is done on cylindrical or conical surfaces, the pattern itself is flat and is clamped to the pattern table in the usual way, to transfer the marking to the work.

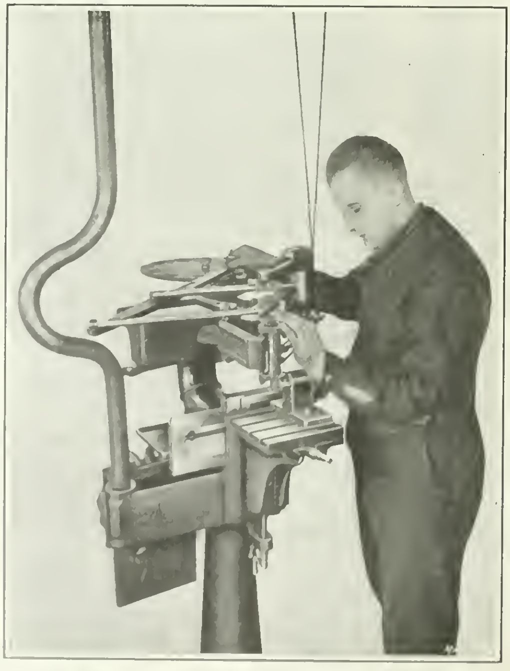

Fig. 23. Method of engraving Figures on Cylindrical Work—Illustration shows George Gorton Engraving Machine

Engraving Concave or Convex Surfaces

Either concave or convex surfaces can be engraved on this machine by using an attachment designed for the purpose. When doing work of this kind, it is necessary to have the engraving tool cut to a uniform depth, but the tool must also follow the contour of the work. This means that the tool must be moved vertically as it is traversed in a horizontal direction, the extent of the vertical movement depending upon the curvature of the work. This movement is obtained as follows: The work, instead of being clamped directly to the work-table, is supported by a plate which is mounted upon four studs so that there is a space beneath the plate. On the bottom plate, which is attached to the lower ends of the four supporting studs, there is a master blank which conforms to the curvature on the work. A guide point, connected by a bracket with the cutter-spindle, is in contact with this master blank, so that, as the cutter-spindle is moved horizontally, it also moves vertically, thus causing the tool to cut to a uniform depth. The tracing point is guided by a flat pattern so that the engraved design is not an exact reproduction of the pattern, owing to the curvature of the surface upon which the tool operates. Unless the radius of curvature is very small, however, the error in reproduction is so slight as to be negligible. The work-table of this machine is carried by a knee which may be adjusted vertically along the face of the machine column, and it has, in addition, longitudinal and transverse adjustments.

Gorton Engraving Machine

Another design of engraving machine of the pantograph type which is built by the George Gorton Machine Co., Racine, Wis., is shown in Fig. 24. With this machine, reductions in size varying from 3 to 1 to zero may be obtained. In other words, the pantograph mechanism can be adjusted to reduce the size of any particular pattern or copy from one-third down to the point where the movement of the tracer point or stylus does not transmit any motion at all to the engraving tool. The part to be engraved is attached to table *G* which is provided with slots for receiving clamping bolts. This table is mounted upon a knee and can be adjusted vertically and horizontally. The engraving is done by cutters of different shapes which are held either in a chuck or directly in the spindle. The latter method is employed for the larger sizes having tapered shanks.

The cutter-spindle is located below the sliding block

B and is driven by a small band or belt connecting with an overhead countershaft and passing over the idler pulleys *J* to a pulley on the spindle. For engraving brass, the cutter is rotated at a speed varying from 8000 to 10,000 revolutions per minute. For soft steel, the speed is 4000 revolutions per minute and for tool steel, from 2500 to 3000 revolutions per minute. For engraving glass or on carbon brushes, a diamond tool is used. Black diamonds, like those used for truing grinding wheels, are employed for work of this kind. Cutters for ordinary work are usually made from Stubs drill rod, and after the cutters have been formed to the proper shape, they are hardened in water and drawn to a light straw color.

The construction of the spindle of the Gorton engraving machine is shown in Fig. 25. The cutter-spindle *A* is located inside a cylinder having a lower bearing *B* made of tool steel, hardened and ground. The upper end of the spindle is tapered to an angle of 60 degrees and runs in a hardened and ground conical bearing *C*, provided with an oil-hole for lubricating the spindle with fine sperm oil. The spindle carrier is held in position by conical screws *D*, which are so adjusted that the spindle frame is free to move, but without lost motion.

When the graduated collar *E* is set at zero, the cutter may be moved up or down by turning the screw *F*, and the stop-rod *G* may be set to control the depth at which the cutter operates. Instead of feeding the cutter down to a fixed stop, the graduated scale *E* may be used for feeding the cutter to any required depth, as measured from the surface of the work being engraved.

The divisions on the scale indicate hundredths of an inch. The thumbscrew *H* is released when collar *E* is to be adjusted. In order that the cutter may be raised and then lowered to the same point without difficulty, two stops *M* and *N* are provided between which the pin *O* operates. The screw *F* is turned until the cutter just touches the surface of the work, and it is then turned backward until pin *O* comes against stop *N*, which locates the cutter at the required depth.

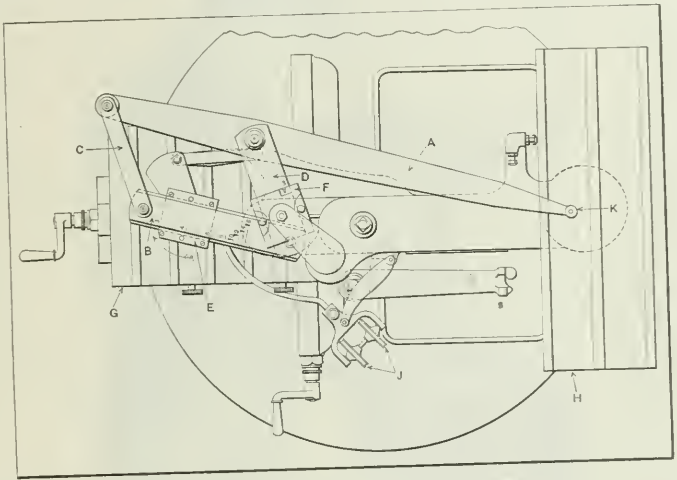

Fig. 24. Pantograph Mechanism on Gorton Engraving Machine

The pantograph mechanism, a plan view of which is shown in Fig. 24, has one long and one short arm. The main pantograph arm carries the stylus or tracer point *K* which follows the copy or model that is clamped to table *H* at the rear of the machine. This arm is connected to the long arm *B* by means of a link *C*; the short arm *D* also forms a connecting link between arm *B* and the stylus bar *A*. The relation between the movement of the stylus point at *K* and the movement of the cutter is governed by the relative positions of the sliding blocks *E* and *F* on the long and short arms *B* and *D*. To set the pantograph for a given reduction, the bolts on slides *E* and *F* are loosened and these slides are then set at whatever distances from the datum lines are required to give the necessary ratio of reduction. As previously mentioned, the least reduction is one-third and, consequently, the graduations begin at 3. A table accompanying the machine shows the various positions for blocks *E* and *F* which are necessary to obtain any reduction from 3 to 1 to 30 to 1. The movable arms are provided with ball bearings to reduce friction to a minimum.

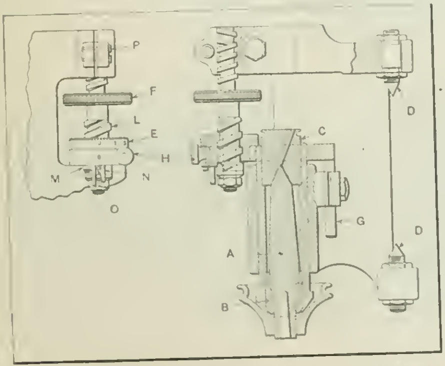

Fig. 25. Cutter-spindle Construction of Gorton Engraving Machine

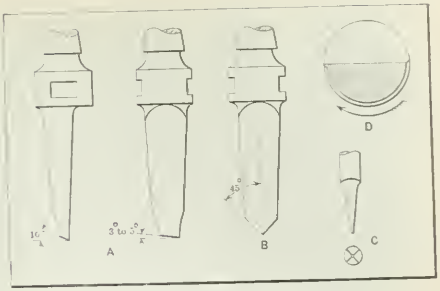

Fig. 26. Types of Cutters used for Engraving Operations

Cutters Used for Engraving

The three principal types of engraving cutters used in the machine shown by the plan view, Fig. 24, are illustrated in Fig. 26. The roughing type of cutter shown at *A* is flattened on one side and is sharpened on the point so as to penetrate the work like a drill when it is first fed down for starting a cut. It is ground with a slope of from 3 to 5 degrees, and is given a clearance of about 10 degrees. The cutter shown at *B* is used for finer work and is known as a conical pointed cutter. It is generally ground to an angle of 45 degrees and is made flat on one side, similar to the form shown at *A*. The cutter shown at *C* is used for very fine work. The cutting end is tapering and of square cross-section. This cutter is only used for operating against the side of an engraved surface and cannot be fed down into the work. Cutters of this type are only about 0.100 inch in diameter, and are held in a chuck.

The cutters should revolve in a clockwise direction as viewed from above, and the cutting edge should be backed off as shown by the enlarged section *D*. The pointed cutter shown at *B* should be sharpened carefully, to insure that the point of the cutter will be absolutely true and that the entire cutting edge will have the proper amount of clearance. When grinding the small cutter shown at *C*, it is essential that the cutting end be true with the axis, and an indexing fixture is generally employed for grinding. The cutter is tested on the machine to see that the point runs true. The edges of this cutter should also be finished with an oilstone.

Making Patterns for an Engraving Machine

The "copy" or pattern used on an engraving machine as a guide for the tracer point is made of various materials, such as zinc, celluloid,

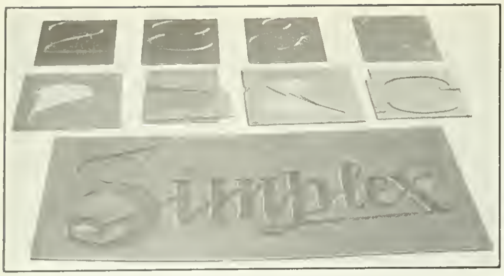

Fig. 27. Top Row, Master Copies for Permanent Use; Second Row, Sheet Metal Templets for making Master Copy; Bottom Row, Master Copy for Temporary Use, made of Cardboard and varnished

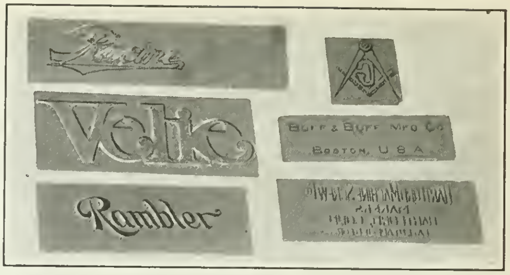

Fig. 28. Examples of Flat Work engraved on Machines manufactured by the George Gorton Machine Co., of the Type shown in Fig. 29

hard rubber, and brass. In some cases, heavy paper or bristol board is used, especially when only a few parts are to be engraved and the expense of making a more substantial pattern is not warranted. Brass is often used when a large number of duplicate parts are to be engraved. These patterns are made in different ways, the method depending somewhat upon the accuracy required and the kind of pattern needed. If the pattern is for a new or original design, one method is to first lay out the design on heavy paper to an enlarged scale. This design is then used for engraving the pattern which is attached to the regular work-table of the machine. In order to provide a more positive guide for the tracer, several thicknesses of paper, cut to the required form, may be mounted on a sheet of metal with shellac. The shellac not only holds the paper in position, but hardens the edges which serve as a guide for the pantograph tracing point when engraving the pattern. Another method of making the pattern is to engrave the required design directly upon the pattern by hand. The design is sometimes engraved by hand in a sheet of hard rubber which is either used as the regular pattern or is employed temporarily for engraving a duplicate in brass, especially when a very durable pattern is required. Still another method is to make an enlarged drawing of the design and transfer the outline to a sheet of transparent celluloid which is placed over the drawing. The celluloid is then cut out to conform to the design, thus obtaining a male and female model. This method is useful when making punches and dies of irregular shape.

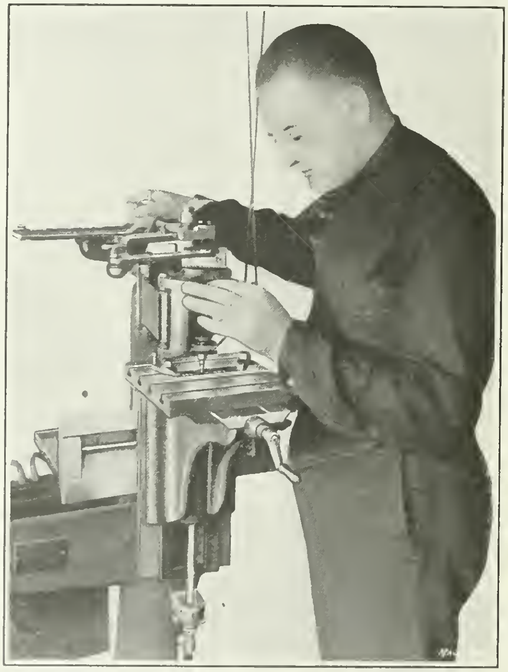

Fig. 29. Engraving Nameplate on Gorton Engraving Machine of Type shown in Fig. 24

Patterns for engraving letters are furnished in different styles and sizes by the manufacturers of engraving machines. These individual letters are arranged in a suitable holder in the desired position on the pattern or copy table, and are used as a pattern for engraving the work.

Reproducing Pattern from Sample

In many cases, manufacturers send an engraved sample which is to be duplicated. One method of making a pattern from a sample is as follows: The shape of the design is first transferred to tracing paper, either by a rubbing process or in any convenient way, and the design is then thrown upon a screen with a projecting lantern, to a scale which may be twenty times the size of the sample. The outline of the image is traced in pencil upon a sheet of manila paper, after which the tracing is tacked on a drawing-board and any slight irregularities and distortions are corrected. The sketch is then cut out and mounted on a sheet of galvanized steel by using shellac, and by applying several thicknesses of paper an edge is formed which serves as a guide for the tracer point. This temporary pattern is used to generate a more substantial one either in brass or other material, as previously explained.

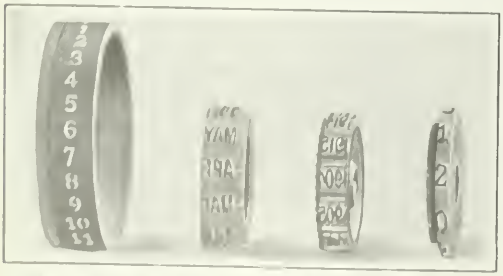

Fig. 30. Examples of Figures, Letters and Graduation Marks cut on Cylindrical Work

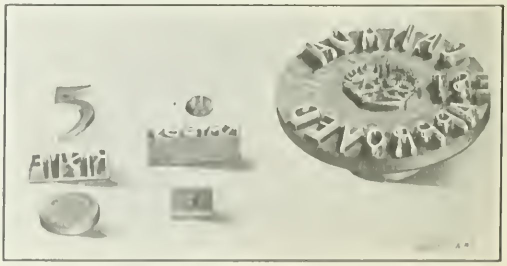

Fig. 31. Examples of Engraving where Design is in Intaglio and in Relief, Illustrating Range of Work that can be handled on Engraving Machines

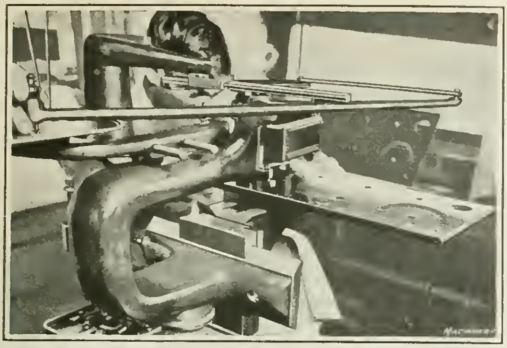

Fig. 32. Work of graduating Instrument Board of Type shown in Fig. 35

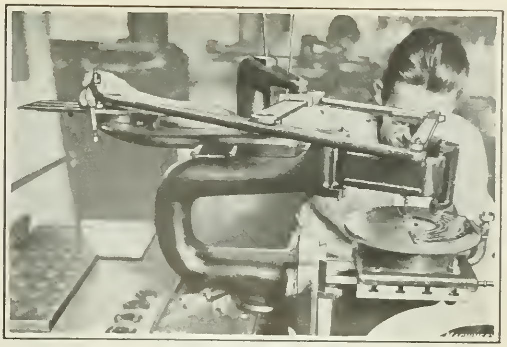

Fig. 33. Universal Indexing Fixture for graduating Standard Circular Scales

Making Masters for "Copy" on Gorton Machines

The George Gorton Machine Co., of Racine, Wis., uses the following methods for making "copy" used on engraving and graduating machines of its manufacture. In making the copy for graduating scales and similar work, the lines are laid off by means of a dividing engine in cases where a high degree of accuracy is required; but for work that does not demand so high a degree of precision, the dividing head of the milling machine or feed mechanism of the lathe may be relied upon to give sufficiently accurate results.

In cases where the Gorton machines are used for engraving, the "copy" for figures, letters or designs that are to be cut can be made by a variety of different methods, the most common of which is to cut out a templet from sheet metal or paper (if paper is used it must be varnished) and use the templet as copy for engraving a master from metal that will be used in cutting subsequent work produced on the machine. Fig. 27 shows in the top row, a set of finished masters, and in the middle row the sheet metal templets that were first cut out for use in making these masters. It will be of interest to note that it is not always necessary to make a complete templet, because in any cases where the figure, letter, or design has straight lines of considerable length, it is often possible to use the slides on the machine for rapidly cutting such lines. For instance, in the case of the templet for cutting a 2, it will be seen that the curved stroke of the figure is the only part that is produced on the templet. After the templet has been followed to cut this curved stroke, the cross-slide on the machine is brought into action and the straight base of the figure is rapidly finished. Copy for letters and numbers is ordinarily made in ¾-, 1½- and 3-inch sizes to fit the standard copy-holders provided on the machines.

An interesting principle is shown in the case of the preliminary sheet metal templet for an ampersand (&). In engraving, uniform results would not be obtained if it were necessary to interrupt the movement of the engraving tool in following the outline of a letter, and to produce a continuous movement of the tool, an ingenious arrangement of "switches" has been provided at the junction between the upper and lower sections. It will be seen that these switches can be so set that the tool follows around continuously in cutting the upper and lower sections of the symbol. In most cases, the sheet metal templets are used as copy in making masters from metal, but where there are only a few pieces to be engraved, the sheet metal or paper templet is used as the copy from which engraving is done directly on the work. An example of this kind is shown in the case of the paper templet for engraving the word "simplex."

Quite a wide range of work can be handled on the Gorton machines, as will be seen from Figs. 28, 30 and 31, which illustrate typical examples of flat work on which the engraved design is in relief and intaglio, and of rolls on which the engraving and graduating operations have been performed on a convex surface. Machines are shown in operation performing all these classes of work, and the description already given covers such operations, with the exception of engraving designs on rolls, for which a special fixture is required. Fig. 23 shows a graduating machine equipped with one of these fixtures, and it will be seen that the copy consists of a flat dial on which the required notations have been cut.

The work is secured at the end of an arbor carried by the fixture, and at the opposite end of the arbor is an index plate. In operating the machine, the master plate or copy is moved around so that the desired notation is brought under the stylus and the copy is then held in this position by means of a plunger that enters one of the index notches in the periphery of the plate. The work is secured in the initial position by means of a plunger that enters one of the notches of an index plate at the rear end of the work-holding mandrel after which the engraving operation is conducted in the usual way. To provide for engraving subsequent notations on the work, both the master and work are indexed, engraving and indexing operations being performed alternately until the job has been completed.

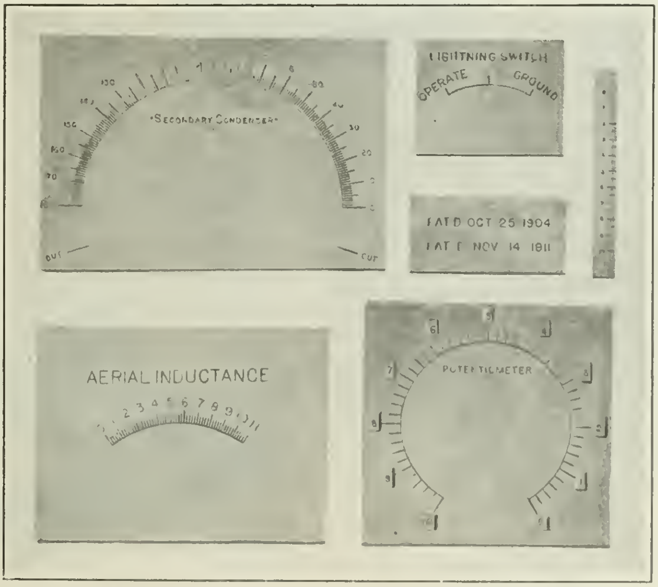

Fig. 34. Master Copies used for graduating Work of General Type shown in Fig. 35

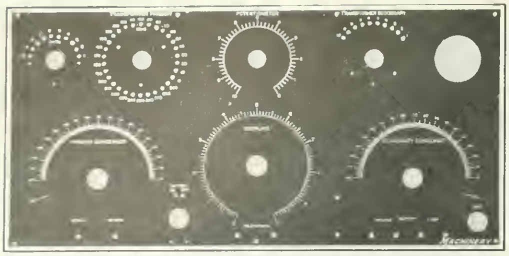

Fig. 35. Instrument Board for Marconi Wireless Telegraph Apparatus, on which all Graduating and Engraving Operations were performed on Gorton Machine

Engraving Surfaces of Varying Curvature

On at least one class of convex work, the curvature of each part to be engraved varies more or less, so that a single former for guiding the cutter vertically cannot be used. The mother-of-pearl handles used on revolvers and automatic pistols are an example of work of this kind. As each half of a pearl revolver handle is of different shape and thickness and no two are exactly alike, an individual former must be provided for every piece. A method of doing work of this kind is as follows: Separate formers of sealing wax are made in a mold for each handle, and the pearl handle to be engraved and the wax former are sent to the engraving machine together. A special fixture is used for making these wax formers, so arranged that melted wax can be poured around the handle, which forms an impression in the wax. When the mold is being made, the handle is mounted on a plate which engages grooves in the bottom of the fixture. The jig for holding the handle on the engraving machine has corresponding grooves so that the handle is properly located with reference to the wax former. The latter is attached to the machine directly over the cutter-spindle where it is fixed in a dovetailed holder. A guide point on top of the cutter-spindle casing is held in contact with the former by a spiral spring.

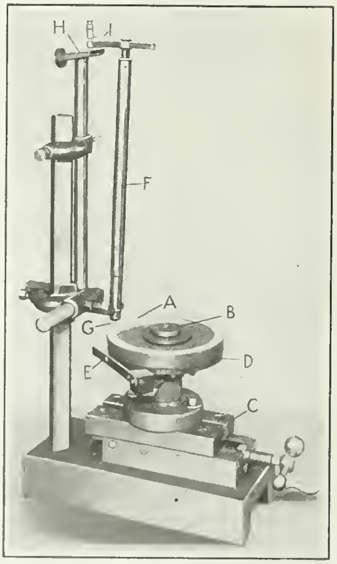

Fig. 36. Special Engraving Machine used in Instrument Shops of William Gaertner & Co. for engraving very Small Figures and Notations

Graduating Scales for Marconi Wireless Telegraph Instruments

For engraving the various forms of scales used on the instruments of its manufacture, the Marconi Wireless Telegraph Co. employs machines operating on the pantograph principle in its plant at Aldene, N. J. Most of these scales are graduated on plates or dials composed of "Bakelite" (a material resembling hard rubber), and in order to make the graduations easily read, zinc oxide mixed with a sufficient quantity of paraffin to give the required consistency is rubbed into the graduation marks after they are cut on the machines. This mixture hardens through exposure to the air, giving a high degree of durability, and as it affords a combination of white graduations on a black background, the scales are easily read. Fig. 35 shows an example of one of these graduated plates and in Figs. 32 and 33, graduating machines are shown producing work of this kind. A model is made in which graduations are cut to correspond with the required graduations on the work, and this model is set up in the copy-holder on the machine so that the tracer point can run over it. Various forms of engraving tools are used according to the nature of the work; where fine lines are to be cut the tool is generally in the form of a pointed "cannon drill," while for heavier classes of work end mills of various forms are employed.

The size of model used also varies according to the character of the work. In cases where fine graduating is to be done on a relatively small area, it is desirable to make the model several times larger than the work, as it is more convenient to make it in that way, while in the case of simple designs the model may be of the same size as the work or even smaller. Adjustment of the pantograph linkage is provided in order to obtain any required ratio between the size of the model and the work. Fig. 34 shows examples of different models used on Gorton graduating machines at the plant of the Marconi Wireless Telegraph Co.; these are made of brass and it will be evident that they can be conveniently cut on a milling machine or circular dividing engine.

In the manufacture of wireless telegraph apparatus, there are many cases where circles have to be divided into degrees, examples of this kind being shown on scales marked "Primary Condenser" and Secondary Condenser," which will be seen at the lower left- and right-hand sides of Fig. 35. In order to avoid having to make special models for this purpose, the expedient has been adopted of producing a universal fixture which is shown in operation in Fig. 33. This fixture is secured to the work-table and has a pivoted disk with 360 equally spaced teeth cut in its periphery. On the model table there is a simple plate with graduations cut in it of the required lengths for the scale to be produced on the work. The work is strapped to the top of the pivoted plate of the fixture and indexed space after space by means of teeth in the periphery of this plate. After each setting of the work has been made, the tracer point is drawn over the graduation mark on the model, which governs the length of graduations cut on the work. This fixture can be used for graduating any scales requiring circles or parts of circles to be divided into degrees.

Small Engraving Machine for Use on Bench

The distortion resulting from the use of hardened steel stamps for marking gages and other forms of measuring tools or delicate instruments is generally recognized among machinists and toolmakers. The engraving machine illustrated in Fig. 37 was designed for marking all sorts of fine tools that might be injured by the use of stamps. A suitable resist is applied to the surface of the hardened tool and the machine is used for tracing the letters or designs required, which are afterward cut into the surface by applying an etching fluid. The machine operates on the pantograph principle. It is equipped with metal matrices or copy blocks which can be arranged like type in any desired combination of letters or figures.

In use, the stylus is guided by these matrices and the tracing point reproduces the lettering or figures on a smaller scale. The pantograph mechanism gives a reduction of 4 to 1 so that

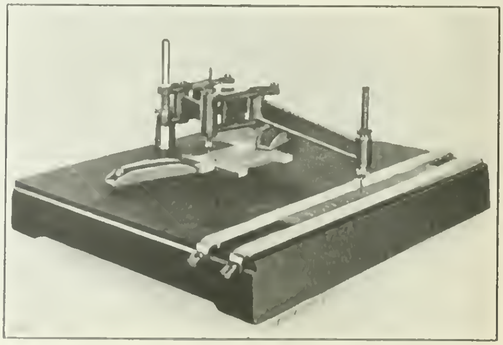

Fig. 37. Bench Type of Engraving Machine Suitable for handling General Classes of Work of Moderate Size

if ⅛-inch characters are required on the work, matrices with ½-inch face are necessary. The part to be etched is held in position on the table of the machine by the clamps shown, and the matrices are held in proper alignment by two parallel strips or bars, as the illustration shows. This machine is built by the Spicer Tabulating Machine Co., 3318 Volta Place, N. W., Washington, D. C.

In Fig. 36 is shown a machine of somewhat similar design to the one described in connection with Fig. 7. It was built by William Gaertner & Co. and is used in their instrument shop for cutting notations that are desired on different classes of work—particularly for numbering graduated scales. The operation is similar to that of the previous machine, Fig. 7, except that in this case the work *A* is held on a vertical arbor *B* supported on a slide *C*, the position of which may be regulated for engraving work of various radii. Secured to mandrel *B* is a notched index plate *D*, which is engaged by a plunger carried on spring *E*. It will be seen that the engraving tool is carried at the lower end of vertical arm *F*, which is pivoted at *G*, the ratio being such that the machine is only adapted for cutting exceedingly small letters. Master letters are secured to copy-holder *H*, and stylus *I* is run over these letters in the usual manner.

Etching and Etching Fluids

A common method of etching names or simple designs upon steel is to apply a thin, even coating of beeswax, or some similar substance that will resist acid; then mark the required lines or letters in the wax with a sharp-pointed scriber, thus exposing the steel (where the wax has been removed by the scriber point) to the action of an acid, which is finally applied. To apply a very thin coating of beeswax, place the latter in a silk cloth, warm the piece to be etched, and rub the pad over it. Regular coach varnish is also used instead of wax, as a "resist."

Etching Fluids for Steel

An etching fluid ordinarily used for carbon steel consists of nitric acid, 1 part; water, 4 parts. It may be necessary to vary the amount of water, as the exact proportion depends upon the carbon in the steel and whether it is hard or soft. The acid oxidizes the metal along the lines that have been exposed by the marking points of the graduating machine, and leaves these lines darker than the surrounding metal so that they may readily be seen. For hard steel, use nitric acid, 2 parts; acetic acid, 1 part. For high-speed steel, nickel, or brass, use nitro-hydrochloric acid (nitric, 1 part; hydrochloric, 4 parts). For high-speed steel it is sometimes better to add a little more nitric acid. For etching bronze, use nitric acid, 100 parts; hydrochloric acid, 5 parts. For brass, nitric acid, 16 parts; water, 160 parts; dissolve 6 parts of potassium chlorate in 100 parts of water; then mix the two solutions and apply.

A fluid that may be used either for producing a frosted effect or for deep etching (depending upon the time it is allowed to act) is composed of 1 ounce of sulphate of copper (blue vitriol); ¼ ounce of alum; ½ teaspoonful of salt; 1 gill of vinegar; and 20 drops of nitric acid. For aluminum, use a solution composed of alcohol, 4 ounces; acetic acid, 6 ounces; antimony chloride, 4 ounces; water, 40 ounces.

Etching Names on Tools

The National Twist Drill Co. employs the following method for etching on cutters and other tools: The steel is brushed with asphaltum varnish, which is allowed to stand until it thickens and hardens to the right degree; then the desired inscription is pressed through the asphaltum with a rubber stamp and the etching fluid (nitro-hydrochloric acid or *aqua regia*) is applied with a medicine dropper. Practice and experience are required to judge just when the varnish has dried to the right consistency.

A similar method, which has been successfully used for etching names on cutlery, is to coat the surface with gum guaiacum varnish. A rubber stamp having the name or design is then moistened with a thin layer of potash solution. When this stamp is applied to the work, the varnish is "cut" by the potash wherever the coated stamp comes into contact with it; the surface is then brushed lightly with water in order to remove the loosened varnish and expose the lettering or design, which is then etched by applying dilute nitric acid. The rubber-stamp method is a very cheap and rapid process. One method of applying the potash is to press the stamp against a pad soaked with the solution.

The action of etching fluids on steels varies somewhat according to the composition, high-carbon and alloy steels being acted upon more slowly than low-carbon steel or wrought iron. Etching fluids that work successfully on low-carbon steel may not work well on high-carbon steel or cast iron. The usual difficulty is that the carbon liberated by the etching fluid settles to the bottom and prevents further action. This difficulty can be overcome, however, by frequently renewing the acid and cleaning out the carbon deposit so that the fresh acid will come into direct contact with the metal.

Etching Brass

The first step in etching is to see that the parts that are to be etched are carefully ground and polished. The only cleaning that will be found necessary can be satisfactorily done by wiping the work with a dry rag. One method of etching brass is as follows: First heat the work and then dip it into molten paraffin, after which it should be removed and allowed to stand until cool. The pattern that is to be etched is marked in the paraffin in order to expose the metal. The etching is done with undiluted nitric acid. If the etched lines are to be very deep, the work should be immersed in lukewarm water occasionally to remove the copper nitrate which forms in the etched lines. This will prevent the lines from spreading. It is only necessary to leave the work under water for a few seconds in order to remove the copper nitrate.

The preceding instructions also apply to etching steel with the important exception that the etching solution is composed of 1 part of nitric acid and 1 part of hydrochloric acid. The paraffin may be removed from the work by first dipping it in boiling water and then in cold water; this treatment causes the paraffin to contract and peel off.

For etching brass, a satisfactory ground can be made from equal parts of beeswax, Burgundy pitch, and asphaltum. These constituents are melted together and thoroughly stirred in order to secure a uniform mixture. This ground is warmed before using and spread evenly over the surface that is to be etched. After the ground has had time to cool, it is removed from those sections of the metal that are to be etched, after which the etching fluid is applied. A satisfactory etching fluid consists of 1 part of nitric acid to 4 parts of water. After the etching has been completed, which takes only a few minutes, the work is dipped in hot water to wash off the acid. The surface of the work can then be cleaned by wiping it with a cloth dipped in benzine or gasoline.

For use on brass castings, the following method is recommended: After cleaning the work with gasoline, place it in clean boiling water. A pot of beeswax is melted and kept at a temperature of from 200 to 250 degrees F., by standing it on a gas plate or some other heater that will retain the desired temperature. After the work has been washed, the surface to be etched is painted with wax and the work is then hung up to cool. The surplus wax will drain off and some sort of pan should be provided to catch the drippings. This process leaves a very thin coat of ground which adheres firmly to the metal. The preheating tends to bind the ground securely.

The following is a satisfactory formula for an etching solution: Nitric acid, 16 parts; hydrochloric acid, 4 parts; water, 100 parts. Dissolve 6 parts of potassium chlorate in 80 parts of water. The two solutions produced in this way are then thoroughly mixed and allowed to stand for a few minutes until the gases have escaped. The solution is then stirred, after which it is ready for use.

Etching Glass

A simple method of etching glass is to coat it with melted paraffin, and draw the pattern to be etched in the wax with a sharp needle point. Then expose the glass to the action of vapor of hydrofluoric acid, produced by the action of warm hydrochloric acid on fluorspar. The gas must be generated in a lead vessel, as it attacks most substances. It is very poisonous, and therefore care must be taken not to inhale it. A little pigment is sometimes rubbed into the graduations to make them show more plainly.

Dry Etching on Glass

For dry etching on glass, as required for graduating volumetric glassware used in scientific laboratories, etc., etching and printing materials were obtained in time of peace from G. Mederow, Kettbuser-Strasse 8, Berlin S. O. 26, Germany. These include one bottle of salt and one bottle of printing ink (one kilogram etching salt under label Berliner Kalt-Aetzsals für E. Nienstadt's Trocken-Aetzverfahren U.S.W.) and ¼ kilogram printing material (Druckmasse) for a dry etching process. One kilogram of the salt costs about 15 marks ($3.57); ¼ kilogram printing ink, 5 marks ($1.19); postage, etc., about 5.20 marks ($1.24), which does not include duty.

In using this method of etching, it is necessary to use gelatine pads, which could probably be purchased from some of the companies making duplicating materials. However, these pads can be made by heating together over boiling water 100 grams of photographic gelatine, 160 cubic centimeters of glycerine, and 100 cubic centimeters of water. This will make six pads 0.5 by 5 by 20 centimeters in size. When thoroughly mixed, pour the liquid into molds which may be most conveniently made of five separate pieces. The bottom and three of the sides are made of pieces of brass held together by screws, while the fourth side is made of a plate of glass with the inside surface ground. This plate of glass is held in place by two clamps. Before filling the mold, a thin coating of grease or graphite is applied to the inside surface of the metal parts so that they may be easily removed from the gelatine pad after it has cooled. For stamping, the side of the gelatine pad is used that was next to the ground glass at the time the pad was molded.

A gelatine roller is made of the same mixture as the pads, and this roller is cast on a core of metal tubing which is left permanently in the roller. A convenient mold may be made of thin glass tubing, 2 centimeters in diameter and 7 centimeters long, into one end of which is fitted a stopper with a hole in the center. The core of 6-millimeter brass tubing is held in place by fitting one end into this stopper and the gelatine mixture is poured into the mold. After the gelatine has cooled sufficiently the glass tubing is broken away from it and the handle attached to the roller.

Next it is necessary to make a stamp corresponding in design to that of the marking it is desired to put on the glass. With the gelatine roller, spread a thin layer of printing ink on a smooth glass plate, and from this use the roller to apply a uniform layer of ink on the gelatine pad, by first running the roller over the ink on the glass plate and then over the pad until the proper thickness has been obtained. From the inked gelatine pad, the metal stamp is used to transfer an inked impression to a clean gelatine pad, care being taken not to press too hard with the metal stamp and also to re-ink the stamp before making each new impression.

These inked impressions on the gelatine pads are transferred to the glass, which is then sprinkled with the etching salt, using a camel's hair brush to remove excess salt from the glass where it does not adhere to the ink. The salt is then exposed to the action of hot steam until a clear narrow border appears along its edges with a slight cloudiness outside. After steaming it may be found necessary to let the work stand for a few minutes, but as soon as the stamp appears to be finished it should immediately be wiped off. A good stamp should be white and clean cut.

Attention is called to the fact that the amount of time a salted impression is allowed to steam will vary considerably with atmospheric conditions, so that in order to obtain good results one must have past experience in the use of the method with pieces of waste. Good results may be obtained by heating the salted impression over a gas flame until it turns to brown and then to white. An apparatus which has been graduated must not be heated to a temperature where deformation of the glass will cause a change in the volumetric capacity. The gelatine pads are cleaned by wiping them off with strong alcohol; water cannot be used, as it will dissolve the gelatine.

In order to obtain the best possible results, the etching salt should be perfectly dry and ground rather fine. If too coarse, it produces a ragged stamp, but if too fine a sufficient quantity will not adhere to the inked impression. The salt is dried by placing it in a metal can with a tight fitting cover, in which there is a small hole to allow water vapor to escape. This can and its contents are heated to about 50 degrees C., which may be done by setting the can in a water-jacketed vessel and running a stream of hot water through the vessel. After drying, the salt is powdered, and when not in use it is kept in a tightly covered vessel.

"Resists" Used for Graduating

Various acid-resisting materials are used for covering the surfaces of steel rules, etc., prior to marking off the lines on a graduating machine. When the graduation lines are fine and very closely spaced, as on machinists' scales which are divided into hundredths or sixty-fourths, it is important to use a thin resist that will cling to the metal and prevent any under-cutting of the acid; the resist should also enable fine lines to be drawn without tearing or crumbling as the tool passes through it. One resist that has been extensively used is composed of about 50 per cent asphaltum, 25 per cent beeswax, and, in addition, a small percentage of Burgundy pitch, black pitch, and turpentine. A thin covering of this resisting material is applied to the clean polished surface to be graduated, and after it is dry the work is ready for the graduating machine. For some classes of work, paraffin is used for protecting the surface surrounding the graduation lines to be etched. The method of application consists in melting the paraffin and raising its temperature high enough so that it will flow freely; then the work on which the graduating is to be done is held at a slight angle and the paraffin is poured on its upper edge. As the melted paraffin flows across the surface of the work, the latter will be covered with a thin protective coating.

* * *

ENGINEERING COUNCIL

Since its organization, June 27, the Engineering Council of the United Engineering Society has considered many matters coming both from the founder societies and from the councils' predecessor, the Joint Conference Committee of National Engineering Societies. The following standing committees have been appointed:

Public Affairs, C. W. Baker, G. F. Swain, S. J. Jennings, and E. W. Rice, Jr.; Rules, J. P. Channing, Clemens Herschel, N. A. Carle, and D. S. Jacobus; Finance, B. B. Thayer, I. E. Moultrop, Calvert Townley, and Alexander C. Humphreys.

The council has also created a War Inventions Committee, comprising H. W. Buck, A. M. Greene, Jr., and E. B. Kirkby, which will cooperate with the Naval Advisory Board and other departments at Washington, if desired, in the promulgation to engineers of war problems now before the government and for which there are opportunities for solution by means of inventions. In addition, a committee comprising George J. Foran, E. B. Sturgis, A. S. McAllister, and A. D. Flinn has been appointed to collect and compile such information regarding engineers of the country as will enable the committee to cooperate with the different departments of the Federal government on request and to assist in supplying the government's need for engineering services. While the council comprises only members from the four founder societies and of course can claim no right to speak for members of other societies nor for engineers at large, the members feel that the body will not have accomplished the results for which it was created unless it early establishes means of cordial cooperation with engineers, organized or otherwise. Every effort toward this end is contemplated.

* * *

The workshops of the South Manchuria Railway have recently built locomotives for the French railways in Cochin, China. They are of the ten-wheel type and weigh 103,000 pounds, with the tender.

HOW THE NIGHT SCHOOL CAN HELP

BY C. S. COLER [1]

Education is a basic need for the development and growth of an industrial nation, plant, or worker. The education at present provided in this country comprises fundamental knowledge, mental training, and manual skill required as a foundation for practically any line of work; that required as a foundation for work in a certain profession or industry; and the specialized knowledge, mental training, or skill required in the performance of a special line of work in a certain profession or industry. The last is supplied by apprenticeship courses and corporation schools.

In every industry, there is a surprisingly large number of workers who have valuable inherent characteristics that have not been made highly productive through education. Statistics show that fifty out of every hundred students who start in the public schools drop out before completing the sixth grade, and that only about nine out of every hundred complete high school. The night school offers an opportunity for those who have had insufficient training, but who possess an ambition to rise through merit, to make up their deficiency in education.

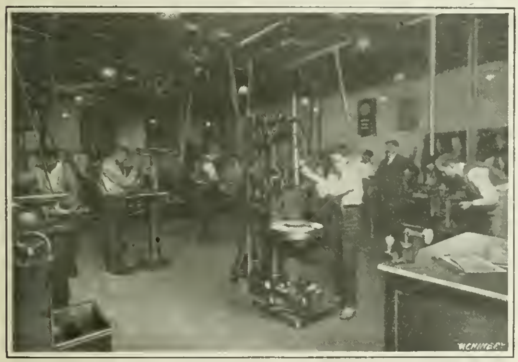

Fig. 1. Class in Machine Shop Practice

The Casino technical night school, located in the midst of the Westinghouse industries at East Pittsburg, Pa., shows what a night school can do to help both the worker and the industry. The courses cover the fundamental principles underlying manufacturing and engineering, but for those who have not sufficient elementary education to take up this engineering course, a brief preparatory course is offered in grammar-school subjects; also a course in English is provided for those of foreign birth. A separate department is conducted for women, which offers courses in commercial subjects and household arts.

The Casino school was established fifteen years ago, with two instructors and a few students who wanted to learn drawing; this year, 1100 students have registered, and the faculty numbers sixty-three. The expenses of the school are borne by those primarily interested; *viz.*, the students, through a small tuition charge; the local industries, through annual appropriations; and the local communities, through annual appropriations in proportion to the number of students in the school residing therein.

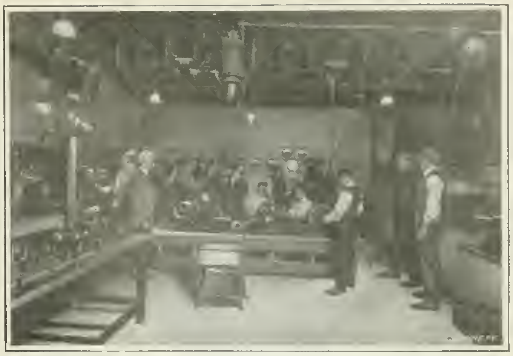

Fig. 2. Test in Electric Laboratory

The school is conducted in the local school buildings, which are rented from the school boards. The classes meet from 6 to 9 P. M., Monday, Wednesday, and Friday evenings, from early in September to about the first of June. Special shops and laboratories have been constructed in the basement of these buildings to take care of subjects not taught in the public schools. The instructors are men and women from the local industries. The strength of the school, in fact, lies in the ability of its faculty to interpret correctly and quickly the demands of the industries. Te instructors assign tasks, set the standards of work, inspire the students to effort, and check their work. The students learn by doing. There is little difficulty with discipline, as the students pay their money and spend their time to receive a definite benefit.

Besides the class-room subjects, students handle all of the outside student activities through their own organizations. In this way they receive experience in organizing and dealing with men, and those students with special abilities soon get into positions where they have an opportunity to make use of them.

The engineering course, open to those who have successfully completed eight years of grammar school or the equivalent, is the nucleus around which all the activities of the school are grouped. This course aims to cover, in four years of night school, the fundamentals of the subjects taught in high school and college. The work in this department may be grouped under three headings: (1) Science, which deals with the material things used in engineering and the laws that govern them; (2) mathematics, which supplies the tools to be used in analyzing conditions and applying laws; (3) expression, which includes the various means of making engineering useful to the world. The subjects taught are as follows: Science—physics, chemistry, metallurgy, electricity, and steam; mathematics—shop problems, algebra, geometry, trigonometry, and mechanics; expression—drawing, pattern-making, foundry, machine shop, physics laboratory, chemistry laboratory, metallurgy laboratory, steam laboratory, electrical laboratory, and English. Problems are used throughout the course as a means of imparting knowledge and developing originality in application.

Each student is graded in judgment, thoroughness, personality, reliability, initiative, and health; besides his term grade in each subject is taken. Every effort is used to keep in close touch with the students and with the local industries with the view of ultimately placing each student in the kind of work which he is best suited to perform.

The growth of the Casino technical night school indicates that it fills a need in industry. It is probable that schools of this nature could be profitably started in connection with many of the industries of the country.

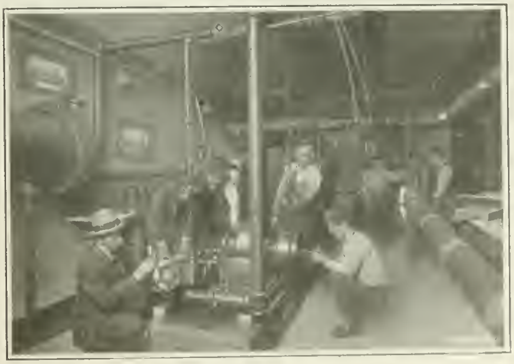

Fig. 3. Test in Steam Laboratory

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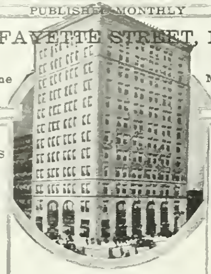

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MACHINISTS AND TOOLMAKERS IN WAR

The exemption boards that pass on our drafted men will be well advised if they excuse high-class machinists and toolmakers employed by machine tool builders, aeroplane makers, small tool manufacturers, gage-makers and concerns having government contracts for guns, gun carriages, motor trucks and other equipment. These men are vitally necessary for the equipment and maintenance of our soldiers at home and abroad. Without guns, shells, aeroplanes and equipment in unstinted numbers, an army cannot be highly effective, and these cannot be furnished without the assistance of the machine tool builder, the skilled machinist and the expert toolmaker. Our allies learned this in the early days of the war, when they found it necessary to recall such men to their industrial pursuits, as their products were vitally necessary for the support of the armies in the field.

* * *

THE MAN WHO STUDIES EVENINGS

The editorial department of MACHINERY receives many requests for information and advice from men engaged in mechanical work. These correspondents ask for guidance in their efforts to improve their condition by studying mechanical literature in spare time. While many of the letters require definite replies, according to the conditions in each individual case, there are two general principles involved in all study that every man educating himself should understand. These are the necessity for a definite purpose and for a definite plan in the study. A great many men who have not had the advantages of a technical school training, or even of an apprenticeship, are ambitious to secure better positions by self-education, but are perplexed to know where to begin and what to study. The result is that much energy and time are wasted. Frequently, machinists take up mechanical drawing with the idea that the draftsman has a better job. Perhaps he has, but it is also true that many machinists who study to become draftsmen might ultimately have obtained better positions if the same amount of time had been devoted to the study of general manufacturing methods and shop practice, with a view to becoming shop foremen or superintendents. Many other examples of misguided effort, due, usually, to a misapprehension of the conditions, could be cited to prove that the best opportunity is often the one nearest at hand. The machinist or machine operator is frequently allured by the prospect of clean work in the drafting-room; but, in many cases, he has only a vague idea of what a competent draftsman needs to know. Generally speaking, it is more difficult to obtain, by self-education, the amount of knowledge required for advancing very far as a designing engineer than it is to obtain the knowledge required for an equally good position in practical shop work.

A definite plan is as important as a definite purpose. In the building of a machine, a definite order of procedure is essential. In the case of a new mechanical development, the designer or inventor must first know the requirements. The general type of mechanism or machine which is expected to meet these requirements is first roughly sketched, and is then carefully designed. Detail drawings are then made, and the parts are shaped from iron and steel in accordance with these drawings. Finally these parts are assembled and the finished machine is tested. The entire procedure follows a definite plan. When studying the principles of machine design or construction, it is equally important to proceed in an orderly and systematic manner. While it may be possible to acquire considerable knowledge by haphazard reading, it is obvious that the same information may be obtained with an expenditure of less effort and time if the student takes up the different subjects in their proper order. In fact, unless a systematic method of reading were adopted, it might be almost impossible to obtain a clear understanding of many important branches of engineering and machine manufacture; hence the necessity of studying text-books which are logically arranged, in addition to reading current mechanical journals. The text-books will supply the fundamental principles, while the mechanical journals will keep the reader posted on the constant advance made in the mechanical field.

* * *

PROGRESSIVE INSPECTION AND ASSEMBLY

The inspection and assembling of parts of motor cars, shells, fuses and other products manufactured in large quantities has been revolutionized by the use of belt and chain conveyors. Progressive inspection and assembly facilitates the passage of work through the factory and sets the pace for the workers. It seems destined to become common in manufacturing plants in which the parts made are of a nature that permits them to be handled advantageously in this manner. Briefly, the general scheme is to provide a moving belt or chain set at a convenient working height on which the parts to be inspected or assembled are carried slowly by the workmen who stand or sit beside it. As a part passes a given station the workman at that station inspects it, using gages for making the test required. If the part is defective it is permitted to pass no farther and is cast into a rejection box beneath or beside the conveyor. The rejected parts are thus separated according to the nature of their defects, and if they can be saved by remachining, they are sent to the machines for drilling, reaming, threading or whatever operation is required. The inspected parts that pass all tests proceed to the assembling tables, where they are united with their components. In the case of the progressive assembly of motor car engines it is necessary to provide transverse conveyors for bringing the parts to the assemblers at the points required. These are usually placed overhead when the nature of the parts permits them to be hung on the conveyor, and picked off as wanted.

Among the advantages of progressive inspection and assembly are: concentration of workers and increase of production in a given area, regularity and uniformity of product, elimination of inefficient and lazy workers, general increase of workers' efficiency and intensive production. The principal disadvantages of the system are initial cost of installation and lack of flexibility when changes of routing become necessary. The latter in many cases can be overcome by building the conveyors in comparatively short units with means for interlocking with other units and transferring the work from one belt to the next. The system can be used effectively, of course, only when the output is of sufficient volume to warrant the installation of costly conveyors and the training of workers.

LUBRICATION

BY E. N. P.

In designing machinery the one point that seems to be generally neglected is provision for lubrication. After the machinery engine or motor has been completed, advertising matter has been prepared, and the photographer has departed, someone asks: "Where shall we drill the oil-hole?" Someone else recollects that lubrication has to be provided for in some way—any old way to get the oil in will do. Perhaps a more than usually careful designer will recollect from his technical school training that certain types of bearings should be subjected to pressures not in excess of 50 pounds per square inch on account of lubrication limitations, and he designs accordingly. Strange as it may seem, this matter is overlooked, in spite of the fact that mechanism of any kind is absolutely dependent upon lubrication for its operation and ceases to operate when lubrication ceases.

Experiments by such authorities as Michell, Parsons and Kingsbury have attracted comparatively little attention from designers, in spite of the vast changes in design possible because of their researches. After extensive experiments with high-pressure lubrication, Kingsbury at one jump raised thrust bearing pressure from 50 to 1000 pounds per square inch, through his advanced understanding of lubricating films, and designed a thrust bearing based on this knowledge. He eliminated the old-fashioned thrust, with its multiplicity of horseshoes and manifold troubles, and substituted a single ring thrust of approximately one-twentieth of the surface. This was done by a design based on geometrical principles, which enabled the thrust bearing surfaces to align themselves automatically with the thrust ring. Michell accomplished much the same result with his marine thrust bearing, based upon wedge-shaped films of oil in which the oil entered at the large end of the wedge and progressed toward the small end by the dragging action of the bearing. Both inventors were able to increase pressures, simplify designs and economize in weight. Experiments by the Westinghouse Machine Co. with Kingsbury thrust bearings have demonstrated that pressures as high as 7000 pounds per square inch could be carried at full speed without breaking the oil film. In fact, babbitt was forced out of the bearing without breaking the oil film. Furthermore, the babbitt did not extrude from the bearing on the exit side, but on the leading side, at the point where the motion of the journal was against such extrusion. The reasons for this suggest a wide field for research.

Thesis work at Stanford University in California has demonstrated that journals rotating in lubricated bearings float on the oil film in a position eccentric to the bearing itself. This position is dependent upon attendant conditions, such as speed, pressure, character of lubricant, etc. Various investigators have shown that a bearing has a pump-like action, taking in oil at the point of least pressure and delivering it, when possible, at the point of highest pressure. If a bearing is carrying a load of 400 pounds per square inch, it will be seen, by attaching a pipe and connecting it to a pressure gage, that it will deliver oil at the point of highest pressure at 400 pounds per square inch. This principle has been made use of by the Westinghouse Machine Co. in connection with its reduction gears. High-pressure lubrication has been used for a step-bearing of vertical turbines. The pressures carried vary from 400 to 1000 or more pounds per square inch. The writer has heard of cases where two inches of the step-bearing would be ground away in fifteen minutes when the lubrication failed for that length of time. The success of extremely high-speed engines, such as the aeroplane or racing automobile type, is almost entirely dependent upon lubrication. In view of the tremendous possibilities that have been barely touched upon by these few investigators, would it not be profitable for institutes of research to specialize to some extent upon lubrication? It cannot be done by manufacturers of lubricants, because they have no facilities for machine design or experimental work. It can be accomplished, however, by institutions of learning, and by large manufacturers of engines, automobiles, etc.

There is reason to suppose that an aeronautical engine or automobile engine whose design was based primarily upon scientific lubrication could outstrip anything of its kind known at the present time in efficiency, smoothness of operation, silence and dependability, and other desirable features. For instance, the light radial type of aeroplane engine used on high-speed planes today cannot run over six to twelve hours without thorough overhauling and rebuilding. Few technical men are aware of this, because of the highly specialized character of aeronautical design. The maximum pressure on aeronautical engines exceeds in some instances 1000 pounds per square inch. Automobile engine bearing pressures exceed 400 to 500 pounds per square inch. All these engines are lubricated by circulating oil systems or oil splash systems. Some are called forced feed, but, speaking scientifically, there is no such thing as a full forced feed system of lubrication, unless the pressure per square inch exceeds the maximum bearing pressure per square inch. In other words, in order to guarantee that the surfaces of an aeroplane engine be held separate by the oil film, it would be necessary to maintain that film under a pressure exceeding 1000 pounds per square inch. This is possible and is well within the limitations of what has been accomplished with pumps, but it cannot be done with geared pumps, rotary pumps or other devices of this kind. The oil-pump should be preferably a slow-running triplex plunger pump geared to the engine. It should not have large capacity nor be excessively heavy. It is probable, however, if such a lubricating system were carefully designed and the engine built around it, that an aeroplane engine could be constructed that would run indefinitely without wearing out.

The writer knows of a cheap automobile that had to be overhauled about every 10,000 miles. It was equipped with so-called "forced feed" lubrication at 12 pounds pressure. The owner finally fitted the engine bearings very close and built a pump capable of delivering oil in ample quantities at 250 pounds pressure. While this did not comply with theoretical requirements, it was a great improvement. The car has been running about 65,000 miles and as yet needs no attention to bearings, pins or cylinders. Another owner has obtained remarkable results by having pistons cast in the rough with deep relief between the rings. After the ring grooves were turned, babbitt was cast between them and turned to 0.002 inch clearance. This automobile has been running for a good many months now and has given the greatest satisfaction. The cylinders when measured recently showed no measurable wear. The pistons have worn slightly, but hardly enough to measure. If they do wear, it will simply be necessary to sweat on more babbitt, turn them up again and replace them in the engine.

The mechanical efficiency of automobile engines varies from 75 to 95 per cent. This 5 to 25 per cent loss is almost exclusively a question of lubrication. In order to get a racing engine, designers will cut pistons down to mere skeletons, lighten up cylinders, lighten up all movable parts and increase the size of valves to the maximum. All of this is done to derive the advantage of a slight increase of mechanical efficiency, which could be fully realized by improving the lubrication. Would it not be worth while to first carefully design a lubricating system based upon research and then build the engine around it?

The hardest part of an automobile engine to lubricate is the wrist-pin, and it is the part that needs lubrication the most. Manufacturers will go to considerable expense to install an oil-pump that pumps from the bottom of the crank-case to the upper pan, or that pumps from the bottom of the crank-case to the bearings, from the bearings to the crankshaft, and through the crank web to the crank-pins; there they will stop, because it is too expensive to provide means for the oil to travel from the crank-pin to the wrist-pin. The wrist-pin, cylinder and piston are left to the uncertain splash system. It is probable that the splash system and other features of cheap lubrication are responsible for 90 per cent of the guaranty expense of automobile manufacturers. It would be far cheaper, both in initial cost and in the long run, to build a cheap engine around a high-grade lubricating system than to build a high-grade engine around a cheap lubricating system.

There are probably not one hundred men in the United States today who know what lubrication is or what it means.

How many technical men or engineers know the character and dimensions of the lubricating oil film? How many know the principles of surface tension and capillarity as applied to oil films? How many have seen the oil film under the microscope? How many know what machine finished surfaces are like under the microscope, with their ragged and torn furrows, ripped and made jagged by the finest finished tools or abrasives? What should be the thickness of this film under various conditions of speed, pressure and temperature? One side of this film is anchored to the journal and the other side to the bearing. The tremendous shearing to which the film is subjected under these circumstances can better be imagined than described. What becomes of the great amount of heat generated by the agitation of the film? What effect has it on the oil? What oils can best stand up under this treatment?

An investigator recently was much astonished to find that the lubricants in the crank-cases of automobiles, tractors, aeroplane and other high-speed engines contained from 25 to 75 per cent of condensed fuel. The writer was so amazed and incredulous at this statement that he made a private investigation and found it to be the case. Another investigator, who wholly failed to realize the importance of his discovery, found that a part of the dark color of lubricants that have been in use for a short time is due to particles of metal of colloidal fineness. This can be demonstrated by grinding up bright silver by certain scientific methods until it is so fine that it will hang in water without falling to the bottom, when it will be seen that the water will appear black and not silver colored.

The importance of a deeper and more far-reaching study of lubrication will be realized when one considers that if lubrication were perfect, no bearing would ever wear out. It is the occasional failure or partial failure of lubrication that causes bearings to wear. The most unpleasant feature of modern automobiles is the necessity of periodical overhauling. This overhauling is confined almost entirely to the motor. The other parts of the car have roller or ball bearings on which the wear amounts to practically nothing. There is a difference of opinion about the use of roller bearings in the motor, but the majority of manufacturers use plain bearings and pins and depend upon lubrication for results. The annual overhauling of such a motor costs anywhere from $25 to $150. The average purchaser is not advised that this financial calamity is impending when he purchases the car. He finds this out after the first year or two, and the majority of purchasers become disgusted, thinking it a weakness of their particular make of car rather than the common ill of all cars. The average purchaser has no realization of the fact that these motors are contracted for by the thousands, and that many different cars have the same motor, just as one can buy a hundred different cigars all made from the same tobacco. As a matter of fact, the writer has never yet seen a bearing wear out that was oiled under extreme high pressure, say in excess of 400 pounds per square inch, unless the lubrication failed. It is probable that much expensive construction, high-priced bronzes and other expensive details, could be modified, if not entirely eliminated, by the development of scientific methods of lubrication.

* * *

SIMPLE RELIEVING ATTACHMENT

BY [illegible] AUX SEGUINS

The writer was interested in an article published in the March number of MACHINERY in which Warren H. Dunbrack described a fixture for relieving the teeth of milling cutters. During the early days of the war the factory in which I am employed required a number of thread milling cutters for use in [illegible] shell and fuse bodies, and the accumulation of work which all toolmaking plants had on hand made it impossible to have this work down outside. Consequently, we were forced to turn the order over to our own toolroom, and as we had only one universal lathe equipped with a relieving attachment, it was necessary to provide some special form of equipment. In a back number of *La Machine Moderne* I found a description of a patented apparatus for relieving the teeth of milling cutters and adapted the principle of this apparatus in working out the design of a relieving attachment which gave very satisfactory results. As this type of apparatus is new to me, I thought it might prove of interest to the readers of MACHINERY.

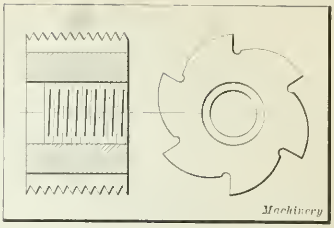

Fig. 1. Thread Milling Cutter to be relieved

Fig. 1 shows the type of thread milling cutters that we had to relieve, and Fig. 2 shows three views of the relieving attachment finally developed for this purpose. The design may be modified according to the requirements of the work or to meet the ideas of different tool designers. The most unusual feature of this attachment is that both the master cam *A* and the cutter *B* which is to be relieved are carried on the same arbor. It will be seen that the steel block *C* that runs in contact with cam *A* is carried at the end of a square bar *D* which is a sliding fit in the relieving attachment. Near the opposite end of this bar there is a horizontal slot into which a short lever *E* projects, which is carried on a pivot *F*. Relieving tool *G* is also carried by a sliding bar shown at *H*.

In operation, bar *D* is pushed back through the action of cam *A*, thus causing lever *E* to rotate about pivot *F*. The short end of lever *E* runs in contact with block *I* carried on tool-holder *H* and thus causes the tool to be advanced toward the work. Spring *J* resists this movement, thus taking up all lost motion in the attachment. Final adjustment of the position of the relieving tool *G* is obtained by a screw actuated by handwheel *K*; and it will be apparent that the relative sizes of master cam *A* and tool *B* are the same as the ratio of the long end of lever *E* to the short end.

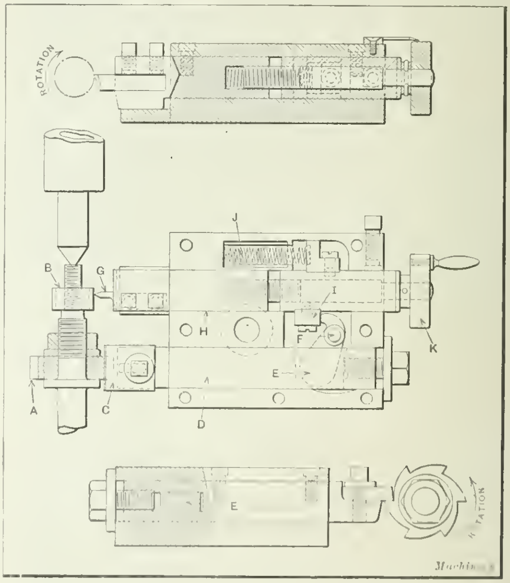

Fig. 2. Attachment designed for relieving Cutters of Type shown in Fig. 1

* * *

The "Pertinax" pipe, which is one of Germany's latest metal conserving devices, is formed of paper which has been wound spirally around a core and then secured in that form with a synthetic gum. Tests have shown that these pipes will stand the same internal pressure as copper pipes of the same weight and three or four times as great an internal pressure as lead pipe nine times their weight. They are to be used for gas or oil, and for insulating electric wires, and are also being tried out for carrying hot water under pressure.

[illegible]

GRIDLEY TURRET LATHE EQUIPMENT—2

TURNERS, DRILLING ATTACHMENTS, DIES, TAP-HOLDERS, AND TAPER-TURNING ATTACHMENTS

BY DOUGLAS T. HAMILTON [1]

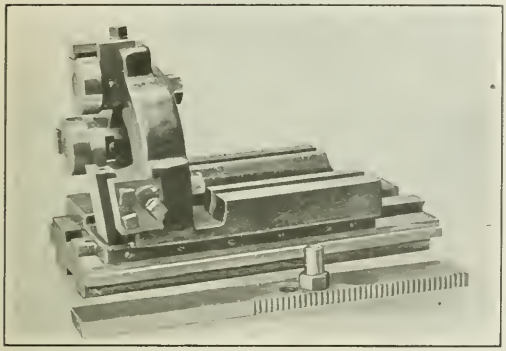

Fig. 20. Special Turner for Use on Gridley 4¼-inch Automatic Turret Lathe

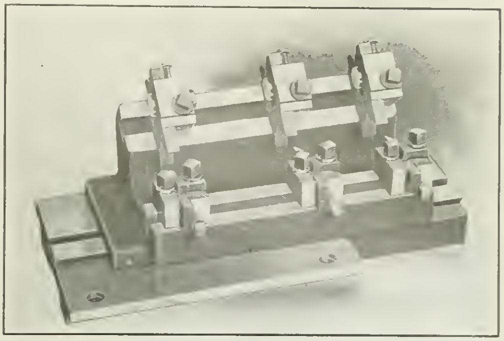

Fig. 21. Finishing Slide for handling Long Turning Operations on Gridley Automatic Turret Lathe

THE standard turning tools described in the August number of MACHINERY are adapted for the average run of work. However, when the work is of such length that the distance to be turned is greater than eight inches—the standard travel of the turret slide—a special type of turning tool is necessary. Two different turning tools for handling long turning operations will be described in the following, as well as additional tool equipment and attachments adapted for use on the single-spindle type of machine.

Special Turner for Use on 4 1 4-inch Machine

A special turner for handling long work is shown in Fig. 20. This turner, it will be noticed, is provided with two slides. One slide occupies the same groove in the turret face as the regular tool-slide, the latter being removed when using this special tool. The top slide, which carries the turning tool and supports, is attached to the turret face, and is operated through a pinion and rack; the latter is shown in the foreground of the illustration. The rear part of the top slide has two grooves in it. These are for attaching auxiliary turning tools, when such are necessary. The turning tool used is of the dovetail type, working on the end instead of the side of the bar. This tool is held in a slide, which provides for adjusting for diameter. Roller supports are used, and these are also held in the adjustable slide, as illustrated.

Finishing Slide

Another type of turning tool, known as a 12-inch finishing slide, is shown in Figs. 21 and 22. This slide will handle a turning operation of 12½ inches. It is not constructed for taking heavy roughing cuts, as these can be more satisfactorily handled with the regular turners placed one behind the other on the turret slide. This slide is operated in a similar manner to that shown in Fig. 20, but differs slightly in construction. With the arrangement shown in Fig. 20, the tool-holders and supports can be independently adjusted to the desired position. This feature is of especial advantage when finishing shafts having a series of shoulders of various diameters.

Fig. 22 shows the 12-inch finishing slide in operation on a handle, 14 inches long. In this case, the work is of such shape that only two turning tools can be used to advantage. The rear tool is used for reducing the end of the handle, whereas the forward tool finishes the straight portion.

High-speed Drilling Attachments

When it is necessary to drill a small hole in a large diameter bar, the best results can be secured by driving the drill at its proper cutting speed. This, of course, cannot be done without arranging a special driving mechanism for the drill, as the tools on the Gridley turret lathe are not rotated, but are held stationary. Fig. 23 shows the standard high-speed drilling attachment on the machine, and Figs. 24 and 25

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[1] Address: Fellows Gear Shaper Co., Springfield, Vt.

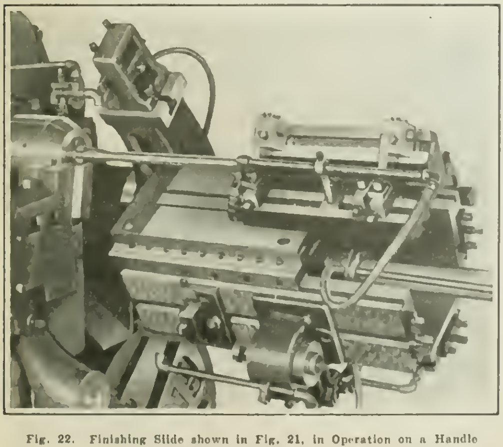


Fig. 22. Finishing Slide shown in Fig. 21, in Operation on a Handle that is 14 Inches Long

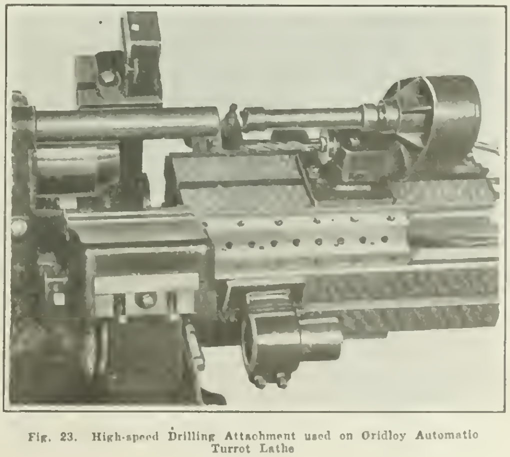


Fig. 23. High-speed Drilling Attachment used on Gridley Automatic Turret Lathe

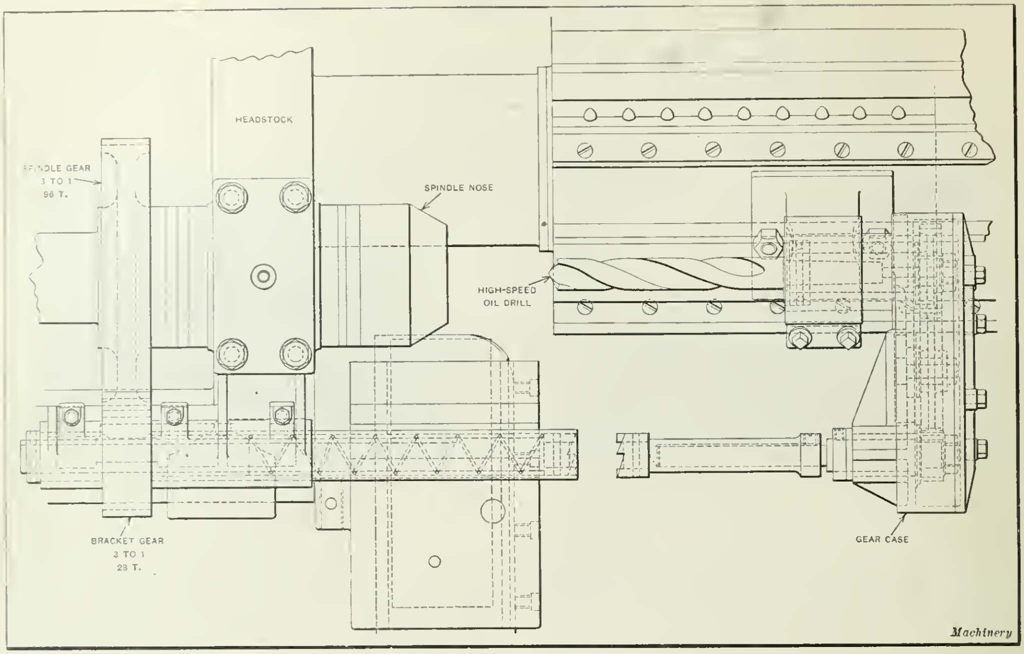


Fig. 24. Detail View of High-speed Drilling Attachment shown in Fig. 23

show a plan and an end elevation view, respectively, of the same device. This attachment is designed for use on the different sizes of automatic turret lathes. Reference to the illustrations will show that it consists chiefly of a bracket, which is clamped to the front of the machine and carries a gear meshing with the spindle gear. The spindle gear has ninety-six teeth and the gear on the drill-driving spindle, twenty-eight teeth.

The driving spindle is provided with a jaw clutch, which is pinned to it and is kept out by an open-wound spring. When the turret slide advances to the drilling position, this clutch engages with a similar clutch member on the drill-driving mechanism proper, which is fastened to the holder carried on the tool-slide. As the turret-slide advances, the clutch on the main driving shaft is forced back into the sleeve against the tension of the open-wound spring mentioned above.

The driving mechanism in the attachment held on the tool-slide consists of three gears, the driver, intermediate and driven gear, running inside an enclosed case. The driven gear is held on the spindle that carries the drill, the latter being supported in a regular tool holder on the tool-slide. The arrangement of the driver, driven and intermediate gears can be more clearly seen in Fig. 25, where a sectional view of the driving spindle and drill-holder is shown; this view also indicates the relation of these members to the holder and the tool-slide.

The ratio between the number of teeth in the main spindle gear and the gear on the clutch shaft is 3 to 1. As shown in Fig. 25, the driving and driven gears can be interchanged, and when this is done four different drill speeds can be obtained with only two work-spindle speeds.

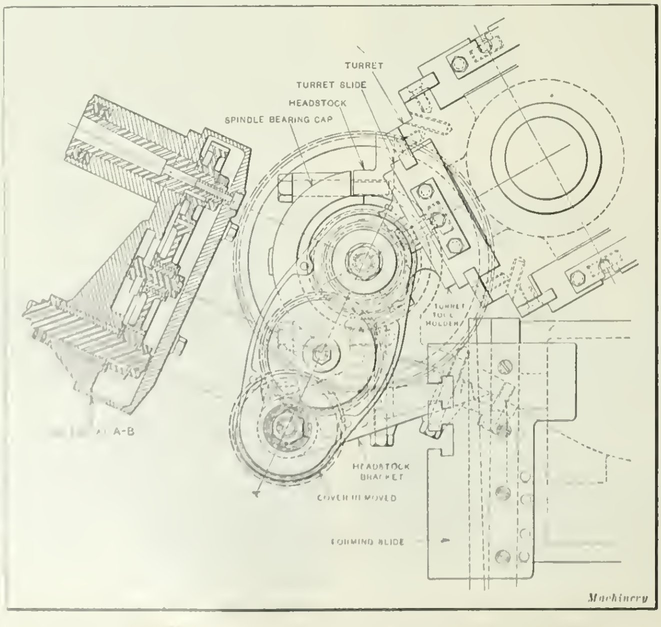


Fig. 25. End Elevation and Sectional View of Attachment shown in Fig. 23

Automatic and Solid Dies

Several different types of automatic dies can be used on the Gridley automatic turret lathe. Some of these are shown in Fig. 26. As a general rule, it is advisable to use an automatic opening die on this machine, but there are cases, of course, when it is necessary to use the solid spring die or the adjustable chaser die shown in Fig. 26. These particular dies will be described in connection with the multiple-spindle type of machine and will not be dealt with further at this time.

Automatic Die-opening Attachment

The automatic die-opening attachment used on the Gridley

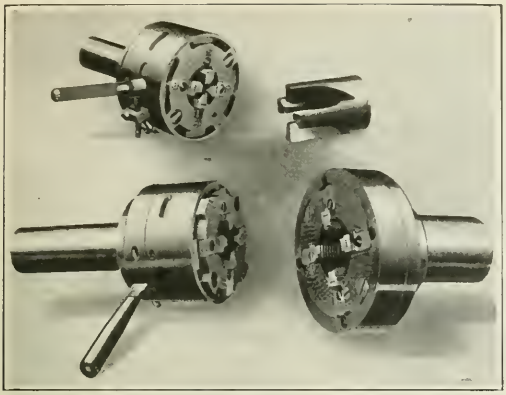


Fig. 26. Automatic Opening Dies, Adjustable Chaser Die and Spring Screw Die used on Gridley Automatic Turret Lathes

automatic turret lathe consists of a lever and cam operating the chasers in the die-head. This attachment is shown assembled and mounted on the tool-slide in Fig. 27, and dismantled in Fig. 28. Referring to the latter illustration, it will be noticed that it comprises a holder and two operating cams or brackets. The arm to which the bellcrank lever is attached is, in turn, fastened to a rod, which can be operated upon by the front bracket attached to the turret-slide for returning the die-head; whereas the cam fastened to the rear part of the slide is used for closing the chasers. The die opens on the forward stroke, and closes on the return stroke of the tool-slide.

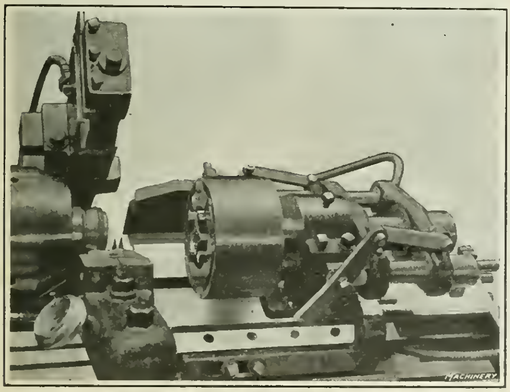


Fig. 27. Automatic Die Fixture in Operation on Gridley Automatic Turret Lathe

Releasing Tap-holder Attachment

When using a tap of the collapsible type on the Gridley automatic turret lathe, it is necessary to use a special attachment in connection with it, as shown in Fig. 29. This attachment does not differ materially from that used for the self-opening die, except in the method of operating the tap. As shown in the illustration, the chasers are collapsed by means of the operating handle on the collapsing tap-holder coming in contact with a pin that is held in a bracket on the tool-slide. The chasers are reset by the bellcrank lever coming in contact with the adjustable screw shown, which is held on a bracket on a corner of the turret. Both these brackets are adjustable, and the one on the tool-slide is set so that the chasers will collapse at the desired point, that is, when the tap has advanced to the desired depth. This illustration also shows a good view of the opening cam for operating the automatic die-head.

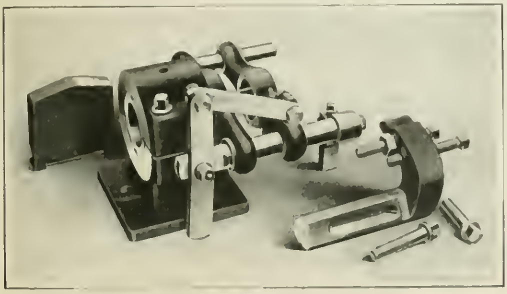


Fig. 28. Details of Automatic Die Fixture shown in Fig. 27

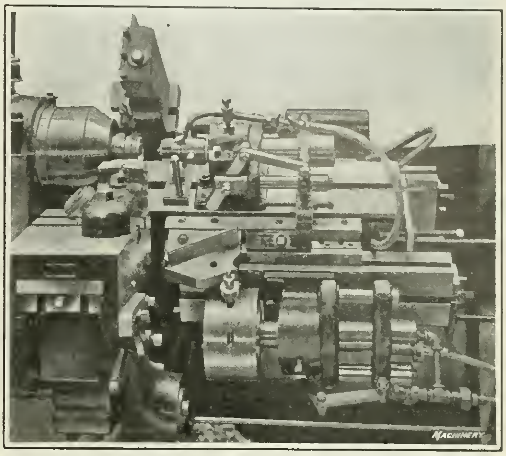


Fig. 29. Collapsing Tap Fixture in Operation on Gridley Turret Lathe

Fig. 31 shows a tapping attachment for carrying a tap that is not of the same design as the one illustrated in Fig. 29. In this case the tap floats and is held in a collapsing holder in which a large collar is used for collapsing the chasers. This collar comes in contact with the arm fastened to the corner of the turret, and is so placed that the rod illustrated prevents the tap-holder from rotating with the work. The holder used is of the releasing type, and is drawn out against the tension of a spring when it advances into the work.

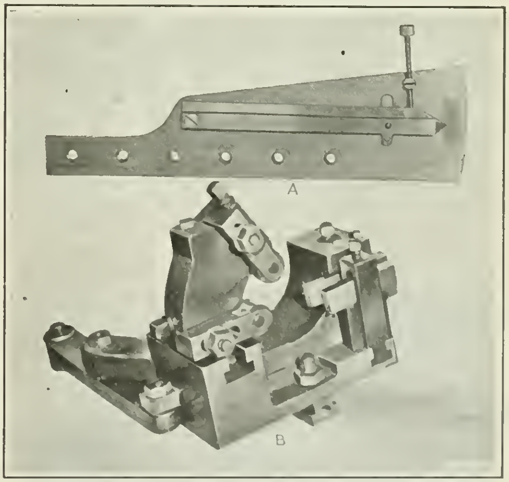


Fig. 30. Taper-turning Tool and Guide used on Gridley Turret Lathe

Taper-turning Attachments

Taper turning can be accomplished on the Gridley automatic turret lathe by the use of a simple attachment, shown at *A* and *B* in Fig. 30. The taper guide, which is capable of being adjusted as shown, is fastened by screws to the turret, whereas

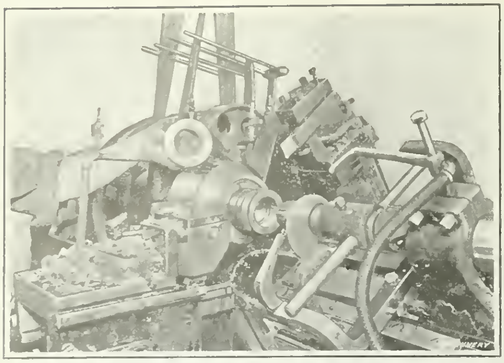


Fig. 31. A Different Design of Tap Fixture from that shown in Fig. 29

the turner proper is fastened to the tool-slide. A rod passing through the tool-holder and connected to a bellcrank lever, which carries a roll on its rear end, is operated by the adjustable taper guide. This particular taper turner carries two turning tools, and roller supports which are set in advance of the front turning tool.

Fig. 32 shows one of the standard taper-turning tools in use on the machine, and also a special taper turner, this particular job requiring the use of two taper-turning tools. The standard turner in this case is not provided with roller supports, the work being guided by a bushing support instead. It is operated in the same manner, however, as the taper turner shown in Fig. 30. The special turner, shown in back of the other, requires the use of a special tool-slide, which is cut away as shown to permit the insertion of the operating lever. This turner is operated by an adjustable taper guide, which is held on the turret as shown, and operates the holder carrying the tool through a lever that is fastened to a rock-shaft, held in the tool-slide.

* * *

An order for half a million scythes for Russia was recently handled by a large American export company. It is of interest to note in this connection that in the past there has been no market for American scythes in Russia on account of a lack of knowledge on the part of American manufacturers of the exact requirements of the Russian mower. A peculiar custom of the Russian farmer is to "hammer-sharpen" a scythe, making a special grade of steel necessary in its manufacture. The Russian scythes in the past have been supplied by Austria. Russian inspectors appointed by the Russian Ministry of Agriculture inspect these scythes in this country before shipping to Russia. It is likely that this market might have been obtained before the war had our manufacturers taken pains to discover the peculiar requirements placed by the Russian farmer on scythes.

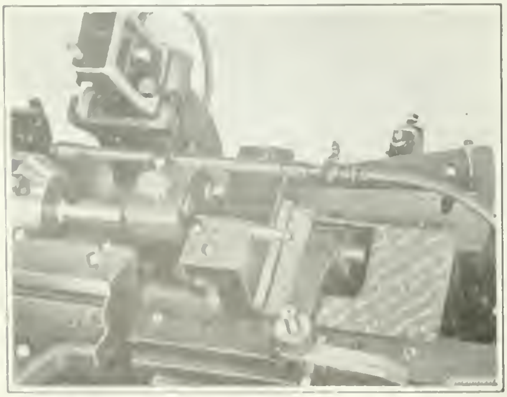
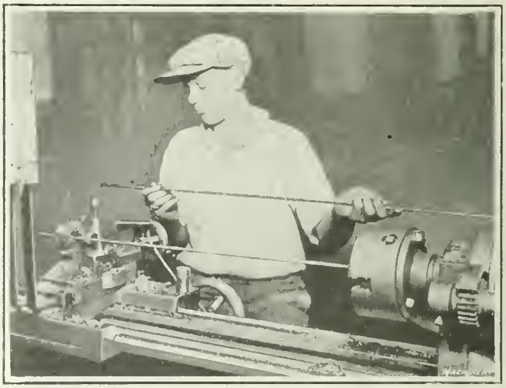


Fig. 32. Two Taper-turning Tools in Operation at the Same Time

MAKING AIRPLANE TIE-RODS

In the design of airplane parts, every precaution is taken to remove superfluous material. This applies not only to the larger units, such as the engine, main framework, etc., but to every part, however small. For example, a tie-rod, 55 inches long and 5/16 inch in diameter is threaded on both ends for a distance of 4 7/16 inches; as the weakest part of this rod is the bottom diameter of the thread on each end, which is practically ¼ inch, the entire section of the rod between the threaded parts is turned down to ¼ inch diameter at quite an expense in order to lighten the rod. This section is approximately 46 inches long.

It is interesting to note how the W. W. Oliver Co., Buffalo, N. Y., performs this operation on an ordinary engine lathe. After the rod is cut off it is held in an ordinary three-jaw chuck, with a little more than half of the rod protruding from the chuck. On the cross-slide ways of the lathe is clamped a special casting, which is bored out in line with the headstock and tailstock of the lathe so as to accommodate a split tool-steel bushing in which there is a hole that is just a running fit for the 5/16-inch rod. In the toolpost is held a small turning tool, set as close as possible to the front of the split bushing. In turning, the carriage is moved as near the chuck as possible, and after setting the tool to turn the rod to ¼ inch in diameter, the carriage is fed by power away from the chuck. The carriage is fed in this direction to within 4 7/16 inches of the end of the rod. This completes practically one-half the length of the rod, after which it is turned around in the chuck and the operation repeated on the other end.



Turning down Airplane Tie-rods

This method of turning long, slender rods is a good one but unless there is a short piece on the end of the rod that does not have to be turned down, it will be necessary to leave a little extra length as a support to be cut off afterward.

* * *

The failure of American firms to place sufficient postage upon their letters to foreign countries has again been called to our attention by a prominent South American firm. It is stated that while the larger firms never refuse mail on account of insufficient postage, many of the smaller firms find it necessary to refuse mail from the United States on which only the regular domestic postage is paid, owing to the heavy total outlay during a year that would have to be met on this account. It should be remembered that when letters are not properly prepaid, the addressee has to pay not only the amount lacking in postage, but double that amount, so that the payment made by the addressee is greater than what would have been the total postage if properly prepaid in the first place. This has been mentioned in the trade press numerous times, but as so many firms still seem to neglect this important matter in extending their trade, especially in the South American countries, it seems proper to call attention to it again.

THE SOLUTION OF EQUATIONS

METHODS USED FOR SOLVING EQUATIONS OF HIGHER THAN THE SECOND DEGREE

BY J. J. CLARK [1]

EQUATIONS may be divided into two classes—algebraic and transcendental. An algebraic equation is one that involves only the arithmetical operations of addition, subtraction, multiplication, division, involution, and evolution; a transcendental equation is one that makes use, directly or indirectly, of either or both of the transcendental numbers e or π. The number e is the base of the hyperbolic system of logarithms, its value being 2.718281828 +, and π is the ratio of the periphery of a circle to its diameter, its value being 3.141592653 +. Any equation, therefore, in which the variable occurs as a logarithm, an exponent, a trigonometric function, or an arc (inverse trigonometric function) is a transcendental equation.

The solution of algebraic equations has engaged the attention of mathematicians for hundreds of years, but no general exact solution for equations higher than the second degree has been discovered. Cardan's formula will solve a cubic equation, provided it has one and only one real root, but it fails if the cubic has three real roots. Descartes' solution will give the roots of the quartic, provided it has two and only two real roots, but it fails if the equation has four real or four imaginary roots. For equations of the fifth and higher degrees, it has been proved that no general exact solution is possible.

It has been proved that neither e nor π can be expressed by a finite number of figures, and that they cannot be expressed by surds, that is, by the use of radicals. Consequently, except in special cases, only approximate values of the roots of transcendental equations can be obtained; this is also true, in general, of algebraic equations higher than the second degree. Such equations, however, are frequently encountered by engineers, machine designers and draftsmen, who are, in most cases, unable to solve them. In practice, every equation has at least one real root; and the method here described, which may be called the method of interpolation, is easily learned and remembered. While in some cases it may entail more labor than other approximate methods, its details are simpler and it may be applied to any equation, which is not true of any other method known to the writer. In order to understand it thoroughly, a few of the leading principles of interpolation must be understood.

TABLE 1.

Argument x	Function $14 + x^3$	Differences First	Second	Third	Fourth
1	15	..	..	..	..
..	..	7	..	..	..
2	22	..	12	..	..
..	..	19	..	6	..
3	41	..	18	..	0
..	..	37	..	6	..
4	78	..	24	..	0
..	..	61	..	6	..
5	139	..	30	..	..
..	..	91	..	..	..
6	230	..	..	..	..
(etc.)					

Machinery

In Table 1, the first column contains a series of numbers in arithmetical progression, the common difference being 1; these numbers are called arguments. The second column contains the values of $14 + x^3$ corresponding to the values of the arguments in the same row; these numbers are called functions. The numbers in the third column (written midway between the functions) are obtained by subtracting the first number in the second column from the second, the second from the third, etc., and are called first differences; thus, $22 - 15 = 7$, $41 - 22 = 19$, etc. The numbers in the fourth column are obtained by subtracting the first number in the third column from the one next below it, the second number from the one next below it, etc. They are written midway between the numbers in the third column, and are called second differences; thus, $19 - 7 = 12$, $37 - 19 = 18$, etc. The numbers in the fifth and sixth columns are called third and fourth differences, respectively, and are found in the same manner as the first and second differences. These subtractions are always downward and are always algebraic, and due regard must be paid to the signs. Thus, in Table 2, the first and third differences are negative and the second differences are positive.

TABLE 2.

Argument x	Function $3 + \frac{1}{x}$	Differences First	Second	Third
1.00	4.00000	....	..	..
....	....	—1961	..	..
1.02	3.98039	....	76	..
....	....	—1885	..	—5
1.04	3.96154	....	71	..
....	....	—1814	..	—4
1.06	3.94340	....	67	..
....	....	—1747	..	—4
1.08	3.92593	....	63	..
....	....	—1684	..	—2
1.10	3.90909	....	61	..
....	....	—1623	..	..
1.12	3.89286	....	..	..
(etc.)				

Machinery

In Table 3, the arguments are represented by x_0, x_1, x_2, etc., and the corresponding functions by u_0, u_1, u_2, etc. The first differences are represented by I_0, I_1, I_2, etc.; the second differences, by II_0, II_1, II_2, etc.; the third differences, by III_0, III_1, III_2, etc. The difference between any two consecutive arguments is always supposed to be constant, and is called the interval; thus, $x_1 - x_0 = x_4 - x_3 = x_2 - x_1 =$ the interval. In most mathematical tables the interval is 1, but in engineering and other tables it may be 2, 5, 10, or any convenient number; in Table 1 it is 1, but in Table 2 it is 0.02.

Now suppose it is desired to find the value of the function corresponding to an argument x that is intermediate between x_0 and x_1. Let $h = \dfrac{x - x_0}{x_1 - x_0}$, and denote the value of the function corresponding to x by u; then:

$$u = u_0 + h \left[\mathrm{I}_0 + \frac{h-1}{2} \left[\mathrm{II}_0 + \frac{h-2}{3} \left[\mathrm{III}_0 + \frac{h-3}{4} \left[\mathrm{IV}_0 + \text{etc.} \right.\right.\right.\right. \qquad (1)$$

The symbol [indicates that the coefficient before it multiplies everything that follows it. In applying this formula, which is Newton's formula for interpolation, x_0 is taken as the

TABLE 3.

Argument x	Function $u = f(x)$	Differences First	Second	Third	Fourth
x_0	u_0				
		I_0			
x_1	u_1		II_0		
		I_1		III_0	
x_2	u_2		II_1		IV_0
		I_2		III_1	
x_3	u_3		II_2		
		I_3			
x_4	u_4				
(etc.)					

Machinery

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argument next smaller than x and the various differences are found until they become zero (as in Table 1) or negligible (as in Table 2); then h is calculated and the formula worked backward, that is, from right to left. Thus, if the fourth difference is neglected, the third difference III_0 is multiplied by $h - 2$, the product divided by 3, the quotient added to the second difference II_0, the sum multiplied by $h - 1$, the product divided by 2, the quotient added to the first difference I_0, the sum multiplied by h, and the product added to the function represented by u_0.

Example 1—What is the value of $14 + 1.6^3$? Table 1 shows that the value of the argument next less than 1.6 is 1; hence, $h = \frac{1.6 - 1}{2 - 1} = 0.6$. Here $x_0 = 1$, $u_0 = 15$, $I_0 = 7$, $II_0 = 12$, and $III_0 = 6$; since the fourth difference is 0, the third difference, or 6, is multiplied by $h - 2$, or $0.6 - 2 = -1.4$, obtaining $-1.4 \times 6 = -8.4$. Dividing this by 3, the quotient is -2.8. Adding this to the second difference gives $12 + (-2.8) = 9.2$, which multiplied by $h - 1$, or $0.6 - 1 = -0.4$, gives -3.68. Dividing by 2 and adding to I_0, or 7, the sum is 5.16, which multiplied by h, or 0.6, gives 3.096. Adding this product to u_0, or 15, the sum is u, or $18.096 = 14 + 1.6^3$, as may be proved by direct multiplication. The calculation for the foregoing, as it would be ordinarily performed, is shown herewith.

$$\begin{array}{rr}
 & 6 \\
h - 2 = & -1.4 \\ \hline
 & 3|\underline{-8.4} \\
 & -2.8 \\
II_0 = & 12 \\ \hline
 & 9.2 \\
h - 1 = & -0.4 \\ \hline
 & 2|\underline{-3.68} \\
 & -1.84 \\
I_0 = & 7 \\ \hline
 & 5.16 \\
h = & 0.6 \\ \hline
 & 3.096 \\
u_0 = & 15 \\ \hline
u = & 18.096
\end{array}$$

Example 2—Find the value of $3 + \frac{1}{1.049}$. Table 2 shows that $x = 1.049$ lies between 1.04 and 1.06; hence, $x_0 = 1.04$, and $h = \frac{1.049 - 1.04}{1.06 - 1.04} = 0.45$. Here $u_0 = 3.96154$, $I_0 = -1814$, $II_0 = 67$, $III_0 = -4$, and the fourth difference is negligible. Consequently, $h - 2 = 0.45 - 2 = -1.55$, and $h - 1 = 0.45 - 1 = -0.55$. The calculation is shown herewith.

$$\begin{array}{rr}
 & -4 \\
h - 2 = & -1.55 \\ \hline
 & 3|\underline{+6.20} \\
 & 2.1 \\
II_0 = & 67 \\ \hline
 & 69.1 \\
h - 1 = & -0.55 \\ \hline
 & 3455 \\
 & 3455 \\ \hline
 & 2|\underline{-38.005} \\
 & -19 \\
I_0 = & -1814 \\ \hline
 & -1833 \\
h = & 0.45 \\ \hline
 & 9165 \\
 & 7332 \\ \hline
 & -824.85 \\
u_0 = & 3.96154 \\ \hline
u = & 3.95329
\end{array}$$

No attention is paid to the position of the decimal points in the differences, which are treated as integers, as is usually the case in calculations of this kind. Since, in general, when the tabular functions are not exact, we can obtain only as many figures correct as there are figures (or decimal places) in the tabular functions, the decimals are rejected each time before adding, as shown in the calculation. By actual division, $3 + \frac{1}{1.049} = 3.953288+$, or 3.95329 to six significant figures, the same value as was obtained for u by the method of interpolation.

Finding the Argument for an Intermediate Function

Having shown how to find the function for an intermediate argument (and the method may be applied to any table when the differences become 0 or are negligible), it is necessary to show how to find the argument for an intermediate function. If the interval $x_1 - x_0$ is represented by m, $h = \frac{x - x_0}{x_1 - x_0} = \frac{x - x_0}{m}$, from which:

$$x = x_0 + mh \qquad (2)$$

Consequently, if h is known, x can be found by substituting in Formula (2). The value of h may be determined in the following manner: From Formula (1),

$$h = \frac{u - u_0}{I_0 + \frac{h - 1}{2}\left[II_0 + \frac{h - 2}{3}\left[III_0 + \text{etc} \right.\right.} \qquad (3)$$

Since h occurs in the denominator of Formula (3), a series of approximate values for h, which will here be designated by h_1, h_2, h_3, etc., is calculated by means of the following formulas, all of which are derived from Formula (3):

$$h_1 = \frac{u - u_0}{I_0} \qquad (4)$$

$$h_2 = \frac{u - u_0}{I_0 + \frac{h_1 - 1}{2} \times II_0} \qquad (5)$$

$$h_3 = \frac{u - u_0}{I_0 + \frac{h_2 - 1}{2}\left[II_0 + \frac{h_2 - 2}{3 \cdot}\left[III_0 \right.\right.} \qquad (6)$$

When applying these formulas, find the value of h_1 to two decimal places, substitute in Formula (5), and calculate h_2 to four decimal places. If the difference between h_1 and h_2 is greater than five units when both are expressed to two decimal places, apply Formula (5) again, using the new value for h_1. If the difference between the two values of h_2 is greater than five units when both are expressed to three decimal places, express h_2 to three decimal places, and substitute in Formula (6); otherwise, express h_2 to four decimal places and substitute in Formula (6). The value obtained from Formula (6) will usually be correct to four or more decimal places; but if the difference between h_3 and h_2 is greater than five units when both are expressed to three decimal places, apply Formula (6) again, using the new value for h_2 expressed to three decimal places. The method is best explained by an example.

Example 3—Using Table 1, find the cube root of 41.305. Here $x^3 = 41.305$, so $14 + x^3 = 55.305 = u$. According to the table, this value of u falls between $41 = u_0$ and $78 = u_1$; therefore, $x_0 = 3$, $I_0 = 37$, $II_0 = 24$, $III_0 = 6$. Substituting in Formula (4):

$$h_1 = \frac{u - u_0}{I_0} = \frac{55.305 - 41}{37} = \frac{14.305}{37} = 0.39$$

Applying Formula (5):

$$h_2 = \frac{14.305}{37 + \frac{0.39 - 1}{2} \times 24} = 0.4820, \text{ or } 0.48 \text{ to two decimal places}$$

Since $48 - 39 = 9$, a number greater than 5, Formula (5) must be applied again, substituting 0.48 for h_1, when $h_2 = 0.4651$ is obtained. Since $482 - 465 = 17$, a number greater than 5, 0.465 is substituted for h_2 in Formula (6) and:

$$h_2 = \frac{14.305}{37 + \frac{0.465 - 1}{2}\left[24 + \frac{0.465 - 2}{3} \times 6 \right.} = 0.4556$$

Since $465 - 456 = 9$, a number greater than 5, Formula (6) is applied again, using 0.456 for h_2; this gives $h_3 = 0.4568$. Since $4568 - 4556 = 12$, it is doubtful if 8 is the correct fourth figure for h_3; hence, substituting 0.4568 for h_2 in Formula (6), $h_3 = 0.45674-$. Substituting this value for h in Formula (2), $x = 3 + 1 \times 0.45674 = 3.45674$. The value of $\sqrt[3]{41.305}$ correct to seven significant figures is $3.4567466+$.

Although this may appear tedious, it is the only practical method that can be used in certain cases. This example is particularly difficult of solution, because the interval is very large as compared with the arguments. When the arguments are given to two or three figures, the work is much easier.

Practical Applications of Method

Example 4—In the December, 1916, number of MACHINERY, there is a request for a solution of the equation $3 \sec \phi + \text{cosec } \phi = 5.7142857$. The equation is first written as $f(\phi) = 3 \sec \phi + \text{cosec } \phi - 5.7142857 = 0$. It is known that ϕ is in the neighborhood of 45 degrees; hence, substituting in the equation, $f(\phi) = -0.057431$; for $\phi = 46$ degrees, $f(\phi) = -0.005453$. It is evident that for $\phi = 47$ degrees, $f(\phi)$ will be positive; that is, it passes through a root between 46 and 47 degrees. Now, assuming that as ϕ increases from 45 to 46 degrees, $f(\phi)$ increases from -0.057431 to -0.005453 at a uniform rate, and that it increases from -0.005453 to 0 at the same rate, it will become 0 at $46 + 1 \times \dfrac{0 - (-0.005453)}{-0.005453 - (-0.057431)}$ $= 46 + 1 \times \dfrac{5453}{51978} = 46.1$ degrees, nearly, = 46 degrees, 6 minutes, which is, probably, the value of ϕ to the nearest minute. If a more exact value is required, a table should be made up, as shown herewith, making the interval 3 minutes, say, to

ϕ		$f(\phi)$			
Degrees	Minutes				
46	6	+ 0.000036			
			— 2750		
46	3	— 0.002714		+ 11	
			— 2739		+ 4
46	0	— 0.005453		+ 15	
			— 2724		
45	57	— 0.008177			

reduce the labor of calculation. The third differences are so small that they will have no effect whatever on the calculation, and may be neglected.

Applying Formula (4), $u = 0$, $u_0 = 36$ (neglecting the decimal points), $I_0 = -2750$, $II_0 = 11$, and $h_1 = \dfrac{0 - 36}{-2750} = 0.01309$. Applying Formula (5), $h_2 = \dfrac{-36}{-2750 + \dfrac{0.01309 - 1}{2} \times 11} =$ 0.01307. The interval is —3 minutes, since 3 minutes — 6 minutes = —3 minutes; hence, by Formula (2), ϕ = 46 degrees, 6 minutes + (—3 × 0.01307) = 46 degrees, 5.96079 minutes = 46 degrees, 5 minutes, 57.65 seconds.

Example 5—Some years ago, the following problem was submitted to the writer by a machinist. Fig. 1 represents a flat ring from which a section *ABCD* is to be cut out. *AD* and *BC* are parallel to the middle radius *OE*. If *OB* = 6 inches, *OC* = 4 inches, and the area of the piece cut out is exactly 6 square inches, what is the length of *AB*? Let $AB = x$, $AD = y$, $AOE = \beta$, and $DOE = \gamma$. If x is known or assumed, $\sin \beta = \dfrac{AE}{AO} = \tfrac{1}{2}x \div 6 = \dfrac{x}{12}$, and $\sin \gamma = \dfrac{x}{8}$, from which β and γ can be found. $AD = 6 \cos \beta - 4 \cos \gamma$; area of segment $AEB = \dfrac{r^2}{2}(2\beta - \sin 2\beta) = 18(2\beta - \sin 2\beta)$; area of segment $DFC = 8(2\gamma - \sin 2\gamma)$; and area of $AEBCFD = AD \times AB +$ segment AEB — segment $DFC = (6 \cos \beta - 4 \cos \gamma) \times x + 18(2\beta - \sin 2\beta) - 8(2\gamma - \sin 2\gamma) = 6$. The equation may be written $f(x) = (6 \cos \beta - 4 \cos \gamma)\, x + 18(2\beta - \sin 2\beta) - 8(2\gamma - \sin 2\gamma) - 6 = 0$. It would be practically impossible to solve this equation by any method other than the one here described. The first step is to assign a value to x; next find β and γ, then substitute in the equation and find $f(x)$. A brief inspection of the illustration will show that x must be nearly equal to, but less than, 3. Assume that $x = 2.9$; then $\sin \beta = \dfrac{2.9}{12}$, from which β = 13 degrees, 59 minutes, 6 seconds, and $\sin \gamma = \dfrac{2.9}{8}$, from which γ = 21 degrees, 15 minutes, 14.5 seconds. Substituting these values of x, β and γ in the equation, $f(x) = -0.11150$. For $x = 2.92$, $f(x) = -0.06981$; for $x = 2.94$, $f(x) = -0.02780$; and for $x = 2.96$, $f(x) = +0.01410$. It is not likely that the last figures of these results are correct, because of the multiplications and the use of five-place tables. Hence, dropping the last figures, arrange the results as shown in the table. Here the second difference is so small that it may be neglected, and $h = \dfrac{0 - 141}{-419} = 0.3365$. Since the interval is 294 — 296 = —2, x = 296 + (—2 × 0.3365) = 295.327, or 2.95327 inches, when the decimal point is restored. This problem is one of the most difficult of solution that the writer has ever encountered, and shows what an engineer is likely to meet with in practice.

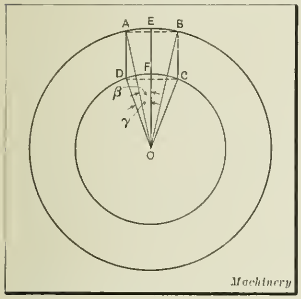

Fig. 1. Diagram illustrating Problem of cutting Exact Area from a Flat Ring

x	$f(x)$		
2.96	+ 0.0141		
		— 419	
2.94	— 0.0278		— 1
		— 420	
2.92	— 0.0698		+ 3
		— 417	
2.90	— 0.1115		

Example 6—In Machinery for July, 1916, the following cubic equation occurs: $1.0472s^3 - 6.2832s^2 + 12.5664s - 0.233 = 0 = f(s)$. To solve this equation by the interpolation method, it is first necessary to find an approximate value of s. To do this, assume that in Fig. 2 $d = D = 4$; whence, $\dfrac{\pi}{12}(D^2 + Dd + d^2)s = \dfrac{\pi}{12} \times 3 \times 4^2 \times s = 4\pi s = 0.233$, from which $s = 0.0185$, nearly. Substituting this value of s in the given equation, $f(s) = -0.002666$. For $s = 0.0187$, $f(s) = -0.000198$, and for $s = 0.0189$, $f(s) = 0.002267$. Forming the table in the usual manner, the second difference is so small it can be neglected; whence, $h = \dfrac{0 - 2267}{-2465} = 0.9197$. Since the interval is —2, s = 189 + (—2 × 0.9197) = 187.1606, or 0.01871606, when the decimal point is restored. The root correct to eight figures is 0.01871607 +.

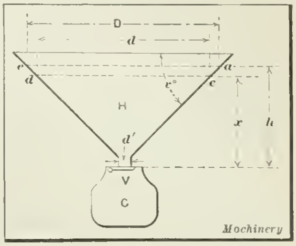

Fig. 2. Illustrating Size of Valve Opening for Discharging 0.233 Cubic Foot of Water per Second

s	$f(s)$		
0.0189	+ 0.002267		
		— 2465	
0.0187	— 0.000198		— 3
		— 2468	
0.0185	— 0.002666		

It may here be stated that if the calculated (tabular) functions are not exact, but are limited to a certain number of significant figures or decimal places, as in the last three examples, the second and all higher differences may be neglected if less than 4, and third differences may be neglected if less than 8. It is also well to note that the value obtained for h is always positive—it can in no case be negative.

The greatest difficulty in finding the root of an equation lies in the determination of the first and second figures; when these have been found, the rest of the work is merely a matter of detailed calculation. In all practical problems, the first two figures can usually be determined quite accurately by exercising good judgment (as in Examples 4 and 5), by an approximate formula (as in Example 6), or by actual measurement from an accurate drawing; the latter is illustrated in the following example.

Example 7—In Machinery for January, 1917, a root is required of the equation $256y^4 + 6656y^3 + 43664y^2 - 1225 = 0 = f(y)$. By making an accurate construction of the diagram

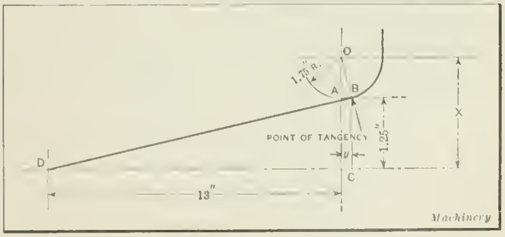

Fig. 3. Problem in designing Dies

shown in Fig. 3 and carefully measuring, y will be found to be about 0.15 inch. Substituting 0.15 for y in the equation, $f(y) = -220$; for $y = 0.16$, $f(y) = -80$; and for $y = 0.17$, $f(y) = +70$. Forming the table as usual, the second difference is 10, and must be considered. By Formula (4),

$$h_1 = \frac{0-(+70)}{-150} = 0.47;\quad h = \frac{-70}{-150 + \frac{0.47-1}{2} \times 10} = 0.46.$$

Therefore, $y = 17 + (-1 \times 0.46) = 16.54$, or 0.1654 when the decimal point is restored.

y	$f(y)$		
0.17	$+70$		
		-150	
0.16	-80		$+10$
		-140	
0.15	-220		

In obtaining the foregoing values of $f(y)$, the calculations were all limited to one decimal place, in order to save labor. Now substituting 0.1654 for y, $f(y) = -0.1677$; and for $y = 0.1655$, $f(y) = +1.3322$. These results show that the first four figures of y are 1654; it will not be necessary to calculate a second difference, since at least three more figures can be obtained by using first differences only. Hence,

$$h = \frac{0-(-1677)}{14999} = 0.1118, \text{ and } x = 1654 + 1 \times 0.1118 =$$

1654.1118, or 0.16541118 after restoring the decimal point. The root correct to nine figures is 0.165411186 +.

y	$f(y)$	
0.1654	-0.1677	
		14999
0.1655	$+1.3322$	

It may here be stated that if the argument has been found correct to three or more significant figures, and the interval is one unit in the last figure, either as many more or as many more less 1 may be obtained by using first differences only.

* * *

AN ANCIENT LATHE

BY GUY H. GARDNER[1]

One sometimes hears the wish expressed that a man of a century ago could return to earth, that we might hear his comments on the surprising changes that would greet his eyes. If such a visitor chanced to be a machinist, with what emotions would he examine the machine tools that have been evolved from the simpler forms with which he was familiar? What would be his standard of comparison and what images of the appliances of his day would their successors bring to his mind? What were the machine tools with which his shop was equipped and how much do we know of the state of our trade a century ago?

In his boyhood, old men told the writer of the chain planers of their apprentice days and of the times of their fathers when lathe carriages were not. Then the skill of the workman was depended on to operate and guide a tool of such proportions that the handle rested on the latheman's shoulder while the working end traversed the T-rest. At a later date there were lathes with a rack feed, for each of which floor space of twice its length had to be provided, one of which it was the writer's privilege some years later to see.

This lathe was credibly reported to have been built just before the war of 1812, and was in daily use seventy years later. It had a swing of twenty inches and its bed was twelve feet long. The bed consisted of three cast-iron pieces, twelve feet long, and four vees of ⅝- by 6-inch flat stock set on edge. The cast iron pieces served as distance pieces, and the whole was united by dowels and tap bolts. The vees were planed to an included angle of 90 degrees.

The headstock was longer than is now usual in lathes of that size, for it was necessary to provide room for a wooden cone pulley of [illegible] steps, there being no back gears. Both spindles were of [illegible], the only round parts of the live spindle being the bearings, the nose, and the projection at the left of the headstock. In this spindle, just inside the front bearing, was a slot for a drift to remove the center, but the tail spindle had a hole through it and a push rod held in place by a pin so that it could not be easily removed. From the enlarged end of this pin battered by the hammer blows of successive generations of workmen, the writer removed a small splinter, which a metallurgist pronounced a pure wrought iron resembling so-called "Norway" (Swedish) iron. The center holes in this venerable relic had been reamed to a modern standard taper, but the original centers were preserved, the tapering portion being about 1½ inch long and tapering more than an inch to the foot; a long teat extended beyond the taper for the drift to act upon. The headstock boxes were of cast iron of somewhat complicated design, each having, besides the holding-down bolts, a pair of screws for raising and lowering the box as a whole and another pair for closing the halves more or less tightly upon the spindle. The writer was told that when the lathe was dismantled for overhauling a few years before, the boxes and bearings were in excellent condition. It was then also discovered that in both the headstock and the carriage bars of wrought iron were "burned into" the castings to add strength and rigidity. The faceplate bore against an unusually broad collar shrunk on the spindle. It had, besides three plain slots, three slots finished by planing and obviously designed to carry chuck jaws, but no one had ever seen the jaws.

Most remarkable of all were the feed arrangements. A rack attached to the under side of the carriage bridge extended beneath the headstock and meshed with a pinion on a horizontal shaft at the extreme left of the lathe. This shaft bore at its front end a handwheel and at the back a sleeve, which formed one member of a jaw clutch. On this sleeve was a wooden pulley that was driven by a belt from a pulley on the live spindle, two idlers being provided to guide and tighten the belt. When a change of feed was desired, the operator had to change the pulleys and adjust the idlers; and to reverse the direction of feed, he had to shift the quarter-twist belt. At the time of the writer's visit, a six-inch pipe flange had just been bored and was being threaded, pulleys being chosen for the proper lead of thread from a large collection hanging on the wall. The taper was obtained by mounting on the cross-feed screw a wooden disk, from the periphery of which a leather strap extended to a bracket at the right-hand end of the bed.

Something more than a hundred years ago, a settler in what was then a wild part of New England, far up the Connecticut River, brought by boat and installed in his log-cabin shop a lathe similar to that just described, and with its aid constructed rifles of such excellence that tales of their accuracy were current in the neighborhood within the writer's memory. To one of these, said to have been the maker's masterpiece, a descendent added a telescopic sight, all the metallic parts of which were made on the old lathe; but whether the grinding of the lenses was done by the same machine, tradition does not reveal. While we are not told how this maker did the rifling, the manner of boring the barrels has been preserved. He kept among his tools a well-seasoned beech log that was bored to fit the outside of the barrels. Driving the barrel into this, after turning its exterior, he mounted the log on the lathe centers and ran a truing cut over it; then carrying the log in several homemade beech steady-rests, he bored the barrel with a "hog-nosed" drill.

Machine tools have changed vastly since those days, but men are still men. If the old workmen could return, they would soon be able to do good work with modern appliances. If obliged to employ the tools and methods of a century ago, we should find more difficulty, but if we are real machinists, not mere runners of machines, we should soon learn to do as our fathers did, for, in spite of what some people say, the skilled eye, hand and brain are of far more importance to good work than any machine, invaluable as the improved machine is, and indispensable to rapid work.

* * *

At the suggestion of the War Department, the manufacturers are now trying to make the parts of motorcycles for use in war as completely interchangeable as possible. The War Department desires large numbers of motorcycles for dispatch work and transportation of machine guns, an official of the motorcycle engineers explained. The department has suggested to the engineers that ultimately the United States will have one standard war motorcycle and also one standard truck.

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[1] [illegible]

PRODUCTION OF ACCURATE THREAD GAGES

METHODS USED IN MAKING THREAD-CUTTING AND RADIUS-FORMING TOOLS AND ANGLE-GRINDING FIXTURE

BY J. R. MACINTYRE[1]

THIS article has been written because little has been published on the actual making of thread gages, though most publications intended for toolmakers and machinists have published formulas from time to time, for measuring and inspecting these gages. Undoubtedly many firms are producing accurate thread gages both quickly and efficiently, but the average tool- and gage-maker has still to learn how this work is done.

The most varied experience on thread gages, aside from working for one of the firms that manufacture them is to be had in the arms and ammunition plants that are making rifles for the different foreign governments. The production and inspection of the modern military rifle requires many sizes and forms of thread gages. Some of the thread angles and elements are strange to the American-trained toolmaker, for instance the Loewenherz thread, which has an angle of 53 degrees, 8 minutes, and the French and Russian metric threads, which are rounded at the bottom of the thread in the screw, and at the top in the nut.

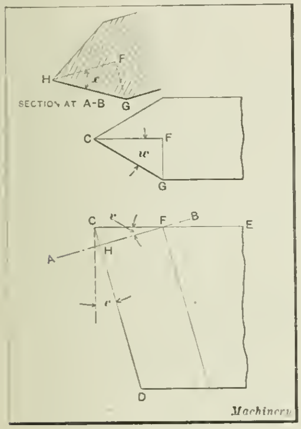

Fig. 1. Diagram for calculating Angle of Thread-cutting Tool

It is seldom that any two tool-rooms approach the problem of thread-gage production in exactly the same manner. Some plants mill their thread gages, while others cut them in either a bench or an engine lathe; and after hardening, some prefer to grind and lap the gages, while others finish them to size by lapping only. The success of thread-gage making depends, as does all other accurate work, on a thorough understanding of the requirements, machine equipment, personal element, raw materials, and so forth; but unless the work is started along the proper lines and these lines are strictly adhered to, the gages will meet neither the expectations nor the inspection limits.

The tools and devices here described are representative of the current practice in the thread-gage department of the Remington Arms Co., Bridgeport, Conn., where thread gages of the various types for gaging rifle parts have been satisfactorily produced. The writer's part of the job was the origination and production of the various angle-testing bars, radius bars, grinding fixtures, thread tools, wires, laps, etc., the calculation of micrometer readings over wires for threads of any angles, change-gears for metric and special threads, and work of a similar nature. In the production of the necessary tools, etc., the first thing required was the origination of a master single-pointed thread tool, Pratt & Whitney style, for each particular type and pitch of thread gage. For example, in the case of the French 60-degree thread gage with round top and root of thread, one tool was made for each radius; similar gages were required for the 53-degree thread gages with rounded top and root, and so on. Simultaneously with the different steps in the making of the master tool, and often preceding some of the steps, came the origination of the necessary fixtures or test-bars for making the tool.

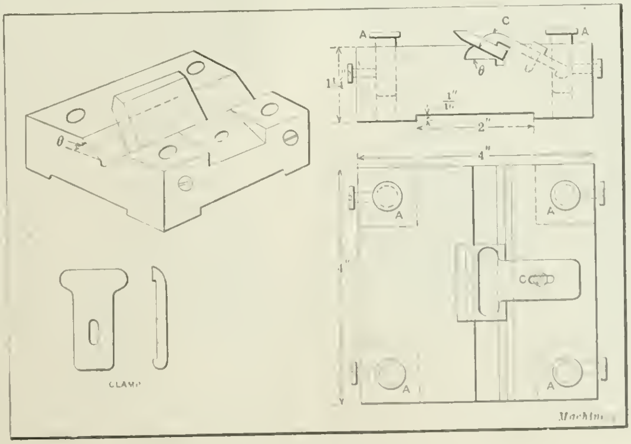

Fig. 2. Angle-grinding Fixture

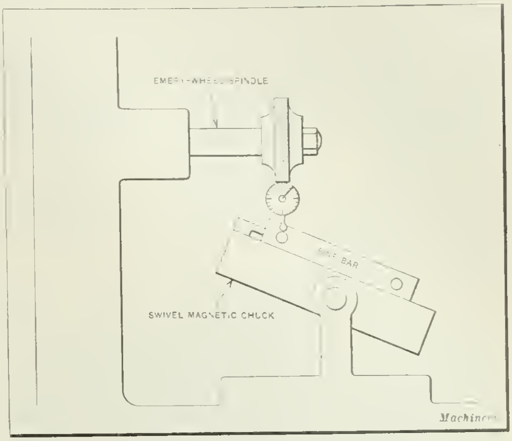

Fig. 3. Diagram for calculating Angle of Magnetic Chuck

The thread-tool blanks are cheaper to buy than to manufacture, if one is not engaged in gage-making as the principal business. When one considers the long life of these types of thread tools, which only need grinding on the top to restore them to first-class condition, it is evident that the blanks should be seasoned as thoroughly as possible, but as time is at a premium at present, the blanks are often finished while in a state of molecular strain, which tends to add to the somewhat inherent instability of such tools.

Some attempt should be made to so plan the work that, after each operation on the thread tool, some other part of the job can be taken up, so as to give the tool some chance to relieve itself of the strain caused by machining. When the tool is being ground, there is a great danger of overheating the thin edge, causing it to be too soft; a soft, coarse wheel with light cuts will give a good finish that will not need much lapping, and at the same time reduces the chance of overheating the edge.

Fixture for Grinding Thread Angle on Tool

When making the fixture for grinding the thread angle on the tool, it must be borne in mind that the angle ground on the thread tool in a plane at right angles to the sharp edge of the tool is greater than the angle that will be cut on the gage by the tool. The excess amount is dependent on the amount of front clearance of the tool; 15 degrees is universally accepted as the most efficient clearance angle.

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The method of calculating the angle of the thread tool is as follows: Let the clearance angle be v, and half the actual thread angle, w, as shown in Fig. 1. The thread-tool angle, which is greater than the actual thread angle, is measured at right angles to line CD, or in the plane AB. Angle w is measured in plane CE. Angles v and w are known. The angle in plane AB that is to be found is called x. This is half the included angle, corresponding to angle w. Then, referring to Fig. 1,

$$CF \cos v = FH$$
$$CF \tan w = FG$$

Hence,

$$\frac{FG}{FH} = \tan x = \frac{\tan w}{\cos v}$$

For a 60-degree U. S. thread:

$$\operatorname{Tan} x = \frac{\tan 30 \text{ deg.}}{\cos 15 \text{ deg.}} = 0.597748$$

$$x = 30 \text{ degrees } 52 \text{ minutes } 6 \text{ seconds}$$

If this angle is multiplied by 2, the answer will be the required angle on the thread tool in a plane at right angles to the thin edge of the tool; hence 2 × 30 degrees, 52 minutes, 6 seconds = 61 degrees, 44 minutes, 12 seconds, the required angle.

This angle, of course, is different for every class of thread. For a Whitworth 55-degree thread it would be:

$$\operatorname{Tan} x = \frac{\tan 27 \text{ deg. } 30 \text{ min.}}{\cos 15 \text{ deg.}} = 0.538946$$

x = 28 degrees 19 minutes 20 seconds, or the full angle, 56 degrees 38 minutes 40 seconds

It will be plainly seen from the foregoing calculations that the angle to which to grind the thread-tool fixture will be 30 degrees, 52 minutes, 6 seconds for a 60-degree thread angle. The fixture is shown in Fig. 2. The block is made of machine steel and pack-hardened; the approximate dimensions are given. The base is cut away so as to allow the block to rest on the four corners. First the block is shaped all over and the angles shaped out, with clearance groove, as shown, so that when the angles are ground, there will be enough clearance for the grinding wheel to cut right across the angle. The slot for the tool-holding clamp C is also shaped out; then the four 3/8-inch holes for the round lapping pins A are drilled, also the four small screw-holes for clamping the lapping pins in position and likewise the screw-hole for the tool clamp.

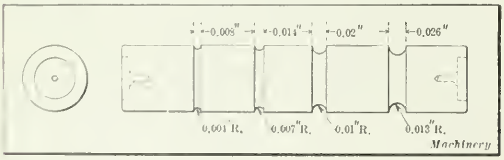


Fig. 4. Master Bar for testing Radius on Point of Thread Tools

The fixture, after hardening, is ground square and flat all over and, in this instance, is put on a Walker surface grinder that is equipped with a universal swiveling magnetic chuck. A sine bar is held on the face of the chuck by the current, and a dial indicator is held between clamping washers on the wheel-spindle; the chuck is then swiveled until the correct angle is obtained, as shown in Fig. 3. As a 5-inch sine bar is used, angle θ = 30 degrees, 52 minutes, 6¼ seconds and $X = 5 \times \sin \theta = 5 \times 0.51307 = 2.56535$ inches. By the use of the micrometer readings on the elevating-screw handwheel and the dial indicator, the difference in height of the two buttons is set to 2.56535 inches, which is the correct angle.

The fixture is now placed upon the chuck and ground on angle θ, and as the surface that the back of the thread tool rests against is at an angle of 90 degrees to the surface just ground, it can also be ground without moving the fixture. The four 3/8-inch holes are then ground, so that they will be perpendicular to the base of the block, in order that the pins, Fig. 2, will not cant out of the vertical line when they are moved up or down, and thus require much grinding to bring all four tops into the same horizontal plane again, this plane being, of course, parallel to the base of the block.

Master Radius Bar and Radius-forming Tool

Upon the completion of the grinding fixture, the master radius bar should be made. This bar is provided with semicircular grooves in the circumference, one groove for each radius required by the respective thread tools for the different pitches of threads; that is, the fine-pitched threads require thread tools with small radius on the point of the tool, whereas the tools for cutting coarser threads will have a larger radius on the point. The bar is made of medium-hard brass, softness not being any detriment to this tool, as it is only used for reference, while the peculiar construction and frailness of the radius-forming tool precludes the use of any hard, tough metal. The bar is made from stock 0.75 inch in diameter and 5 inches long. This bar is centered and placed between centers in a "Pierce" bench lathe, which has a handy vertical slide for adjusting the cutting tools to the exact height of the centers; then the bar is trued up until it is circular.

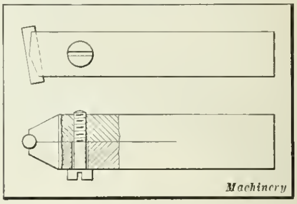


Fig. 5. Radius-forming Tool

At this point there should be constructed the radius-forming tool, similar to that shown in Fig. 5. This tool is made of a piece of 5/16-inch square medium-hard brass; its length is about 3 inches, to suit the toolpost. Assuming that the radius to be cut is 0.009 inch, a hole 0.018 inch in diameter is drilled, with a needle drill, at an angle from the vertical that will provide just enough clearance for the tool to cut and not rub. If this angle of clearance is too great it will alter the size of the radius cut by the tool. A tapped clearance hole is drilled in the side to take the small screw necessary for clamping the round radius tool in position; also a slot is cut in the tool to a depth of, say, ¾ inch. The actual cutting tool is a piece of sewing needle of suitable size that has been lapped truly circular and down to 0.018 inch in diameter.

To cut the grooves in the master radius bar, assuming the desired radius to be 0.009 inch, the bar is held between dead centers, that is to say, the headstock spindle is not revolved, and the radius-forming tool is fastened in the toolpost with the top of the radius tool at exactly the height of the lathe centers. The radius tool is then fed in by the cross-slide screw until it is seen, by the aid of a strong magnifying lens, to just touch the radius bar. The radius bar is then revolved by the finger and thumb of the left hand and the radius tool is fed in exactly 0.009 inch, by the micrometer dial on the cross-feed screw. The bar is then the master female radius gage for testing the male master thread by a "light" test.

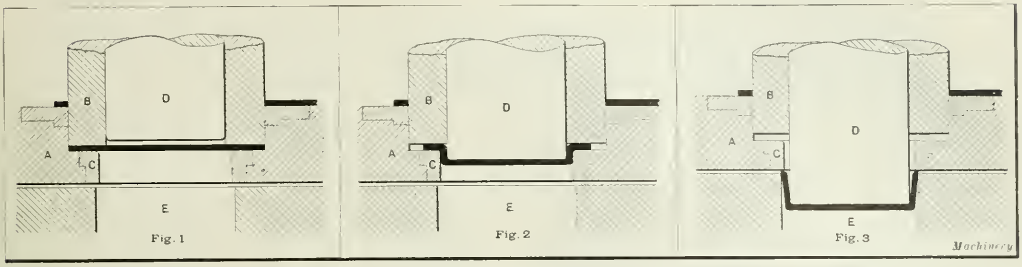
After the master thread tool has been ground and lapped in the angle-grinding and lapping fixture shown in Fig. 2, it is ready to have the radius lapped to size. When the thread tool is mounted in the holder and fastened in the toolpost with the ground top of the tool at the exact center height, the radius should shut out light when the tool is fed carefully into the master radius test-bar and a strong light is coming from underneath.

A master thread tool with a female radius groove is made from the master male radius thread tool and then hardened; with these two tools, master taps and master reference thread gages are made. The master taps are used to make cast-iron laps for finish-lapping the hardened working and inspection thread gages. The master reference thread gages should be left soft; of course, a number of working thread tools must be made along the same lines as the master thread tools, both male and female, to be used in the production of thread gages, as the master male and female thread tools are used only to make the necessary tools and master gages for making and testing the thread tools used to make the thread gages.

CARDBOARD FORMING

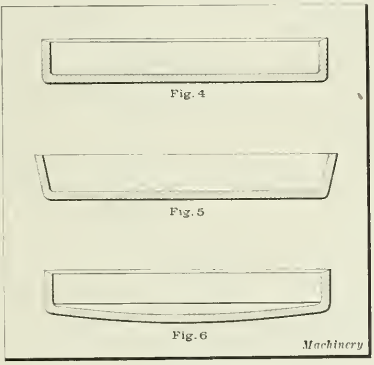
ARRANGEMENTS FOR MOISTENING STOCK, HEATING DIES, AND DRYING PRODUCT—FORCES AT WORK DURING FORMING STROKE

BY R. A. MONTE[1]



Figs. 1 to 3. Blanking and Forming Dies for Double-acting Punch Press, showing Sequence of Operations

THE forming or pressing of cardboard covers, lids or odd shapes is based on the same principles as the drawing of shallow sheet-metal boxes or covers, and the process differs only in such special treatment as is necessitated by the peculiarities of the material. Figs. 1 to 3 illustrate the customary construction and sequence of the blanking and forming dies used in connection with a double-acting punch press. The bolster *A* is screwed down to the press table, or platen, and the outer blanking plunger *B*, actuated by a cam, descends and cuts through the cardboard stock at about 3/10 to 1/2 of its travel. This plunger stops at a height equal to the thickness of the stock, above the face of the drawing die *C*, and dwells there for about one-eighth turn. The inner plunger *D*, driven by a crank or eccentric, is timed to reach the blank soon after the outer plunger *B* has reached its lowest position and draws the rim over the rounded edge of die *C*, converting it into a smooth, solid rim. By descending farther, plunger *D* pushes the finished lid through drawing die *C* into the drying tube *E*, which is slightly larger in diameter than die *C*. As the compressed cardboard rim is still under high tension, it expands until it fills out the larger diameter; this causes it to be stripped from plunger *D*. The blanking and forming dies are hardened, and the drawing die is polished.



Figs. 4 to 6. Cardboard Covers correctly and incorrectly heated and moistened

Moistening Stock

Cardboard varies widely in quality, and its action in being cut, drawn and formed into commercial shapes naturally depends on the nature of the material. It includes the coarse, brittle stock used for milk-bottle caps, which has a resistance to shear of only 35 pounds per linear inch, and tough fiber boards that have a shearing resistance of 200 pounds per linear inch. Thin strawboard may be formed into small shallow boxes or lids without any additions to the dies just described, if there is no objection to a crinkled rim with quite visible folds. A smooth, stiff rim, however, invariably requires the application of moisture, heat and pressure in due proportion and timing; any variation from the experimentally established degrees of moisture, temperature, etc., will affect the final shape of the article.

Fig. 4 shows the shape of a lid that has been correctly moistened and heated for the proper amount of time. Fig. 5 shows a similar lid which was not heated and dried sufficiently; in this case the lid flares. Fig. 6 shows either excess or one-sided moisture, the bottom being too wet on the lower side to dry in the same time as the rim and inside. Each shape and grade of stock must be investigated and treated individually.

For some of the thinner grades of cardboard, the correct degree of moisture can be obtained by simply storing the stock for twenty-four hours in a damp place like a basement. Thicker stock can sometimes be sufficiently moistened by being placed in a pail of water and letting the excess moisture drip off shortly before the cardboard is used. Some manufacturers add starch, dextrine, or other paste stuffs, soapsuds, rosin, etc., to the water.

Fig. 7 represents a combined roll feed and moistening device. Several brass rolls geared to each other carry the water up to the lower surface of the stock. By this arrangement, the lower surface gets an excess of moisture; this is necessary because it is more exposed to the heat of the die than the upper and inner surfaces. Some grades of stock get sufficient moisture by simply being run over the water rolls as shown; others must be run one or more times around the water rolls, thus being fully submerged and thoroughly soaked.

It is very desirable to use stock cut to the proper width. If warranted by the amount of work on hand, the stock roll shown in Fig. 7 should be used, but small orders should be run in the form of strips cut from standard size cardboard sheets. The roll feed, as shown, is operated from the press crankshaft through a small crankpin or eccentric acting on the ratchet on lever *F*. If the stock cannot be obtained in the form of rolls and ordinary card-

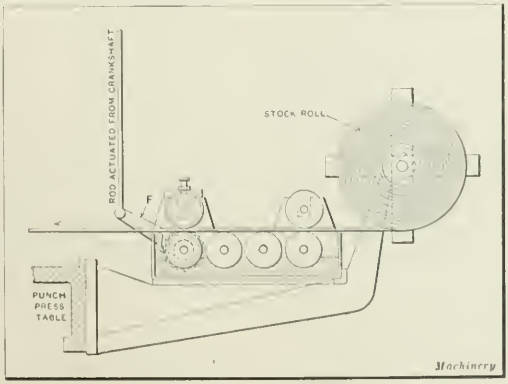


Fig. 7. Roll Feed and Moistening Device

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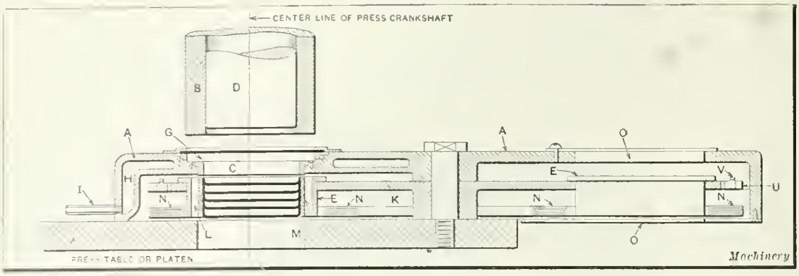

Fig. 8. Sectional View of Drying Table

board sheets must be used, it is more economical to feed these sheets or strips by hand than to attempt to devise a stack feeder. Stack feeders are complicated and costly, and the small increase in output is more than offset by the delays caused through trouble with the stacker. Although the speed of these presses is rather low, about 25 revolutions per minute, it is not advisable to have one operator attend to more than one press, as the product needs constant watching.

Heating and Drying Arrangements

If the steaming moist lid were ejected as it left the die (see Fig. 3), it would not retain its shape; hence a heated drying table is necessary for evaporating the excess moisture and permitting the glue stuffs in the cardboard pulp to obtain a permanent set. Figs. 8 and 11 show the construction of the drying table used in connection with the blanking and forming dies. Fig. 8 is a section on X–X, Fig. 11; B and D represent the double-acting plungers, G, the blanking die, and C, the forming die. The steam-heated bolster A has cored cavities H all around the forming die, the exhaust or other low-pressure steam used enters the cavities at I and the condensed water is piped away at J.

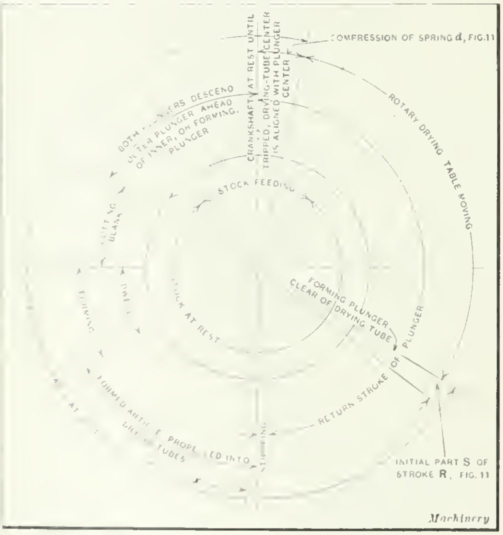
CRANKSHAFT AT REST UNTIL TRIPPED, DRYING-TUBE CENTER IS ALIGNED WITH PLUNGER CENTER
COMPRESSION OF SPRING d, FIG. 11
BOTH PLUNGERS DESCEND OUTER PLUNGER AHEAD OF INNER, OR FORMING, PLUNGER
ROTARY DRYING TABLE MOVING
STOCK FEEDING
CUTTING BLANK
STOCK AT REST
FORMING PLUNGER CLEAR OF DRYING TUBE
RETURN STROKE OF PLUNGER
FORMED ARTICLE PROPELLED INTO DRYING TUBES
INITIAL PART S OF STROKE R, FIG. 11
Machinery

Fig. 9. Timing Circle for Average Type of Punch Press

The rotary drying table K carries a series of drying tubes E, in which vent holes L and M are provided for the egress of pent-up air and vapor given off by the steaming surfaces. These tubes are made of cast iron, the inside, of course, being smooth and highly polished. Electric heaters N supply heat for the drying tubes E. If steam coils were used instead of electric heaters, live steam would be required to transmit a sufficient amount of heat; besides, such coils are prone to leak, and leakage would seriously affect the product. The electric heater, because of its ease of installation and the close regulation that is possible, is superior in every respect.

As shown, the lids are allowed to pile on top of one another in the drying tubes E and are carried around several times before being ejected by the plungers. It is preferable to use as many drying tubes as the available space between the press uprights will permit; that is, not more than four or five pieces should be piled on top of one another in the tubes. Cardboard, 1/8 inch thick, that was thoroughly saturated has come out bone dry when piled four high in presses with sixteen drying tubes on the circumference of the drying table. The openings O in the top and bottom of the bolster are provided merely for inspecting the work.

The intermittent movement of the table is procured as follows: A reciprocating slide P, carrying a pawl Q, is guided in a groove in the bolster and confined by the guide cover T. Its stroke R is the distance between the teeth U on the periphery of the drying table K, plus an excess S. A leaf spring inside pawl Q holds it in engagement with teeth U; the extension W limits the movement of the pawl for correct engagement with teeth U. These teeth need not be machined very accurately, but the stops V on top of the drying table, which stop the table when the tubes are exactly under the plunger, must be closely adjusted for each drying tube. The spacing of drying tubes E, within certain limits, is not very important; the only point needing close attention is the relation of stop V to its tube. The stop can be easily adjusted when setting up the table, by inserting the inner plunger, consecutively, into each drying tube E, and trimming the stop until pawl Y falls into position without any backlash. Stops V should be of hardened tool steel and securely screwed and doweled into position.

The stop-pawl Y should be of hardened tool steel and securely pinned to bolster A so as to have no backlash. The pin should be of ample size and bearing to prevent wear. Any inaccuracy at this point, if more than, say, 1/32 inch, is likely to throw the plunger and the drying table out of register and result in breaking the bolster, die and table. Pawl Y carries at its end a pin Z that is engaged by tappet a on slide P during the first part S of the stroke R. This tappet lifts the pawl Y out of mesh with stop V before pawl Q reaches tooth U. As pawl Q runs up hard against pawl Y when it is stopped by the next stop V, a spring take-up is inserted at the driving end of slide P. This consists of a link b containing a plunger c and a spring d. The lever e

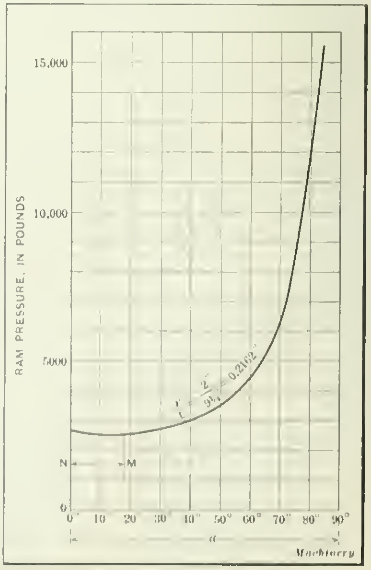

Fig. 10. Force exerted by Inner Plunger while forming

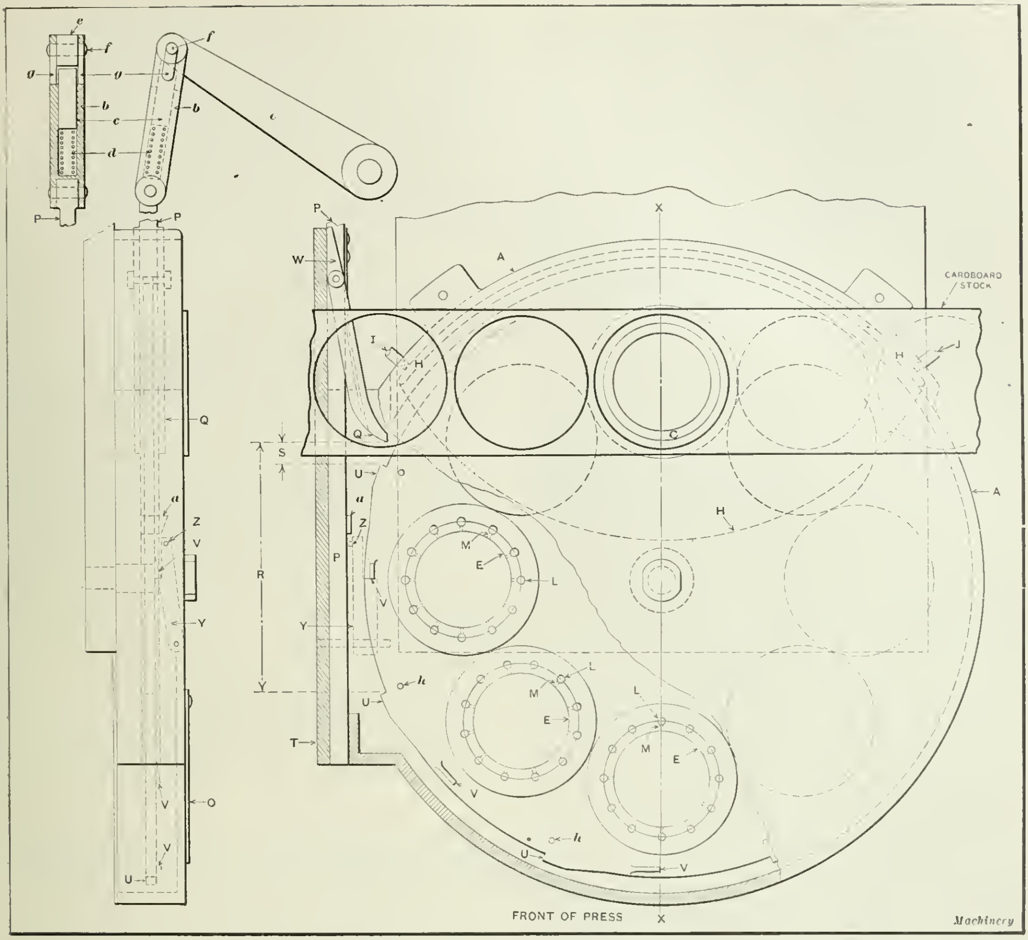

Fig. 11. Plan of Drying Table shown in Fig. 8

is confined by pin *f* to the length of slot *g*, so that at the end of the stroke spring *d* yields, permitting lever *e* to run its full course. Lever *e* is customarily driven by a plain face cam (not shown), which is properly timed to produce the intermittent table motion, while the plunger is clear of the drying table.

Drying Table Safety Device

While spring *d* must be strong enough to overcome the frictional resistance of the table, which, by the way, is very small, the spring cannot be made strong enough to overcome jams produced by pieces of cardboard getting wedged in between the table and the die. Such occurrences invariably produce two

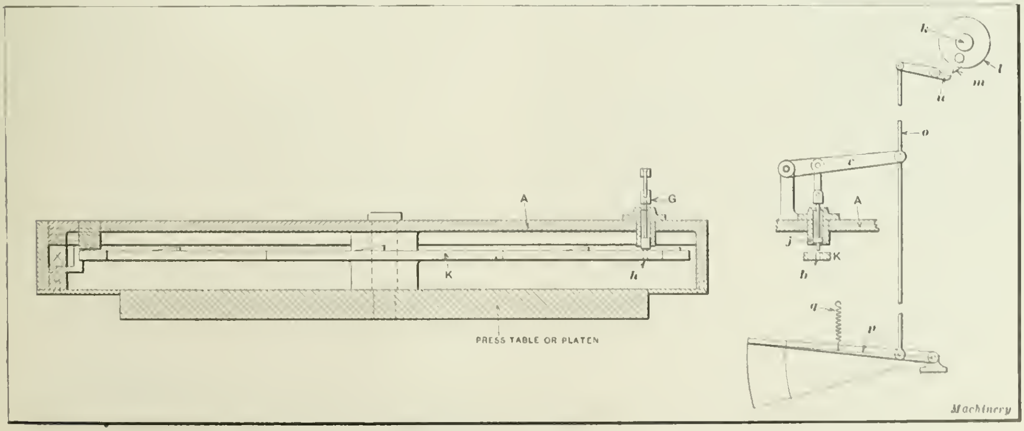

Fig. 12. Safety Catch to prevent Plunger from hitting Table

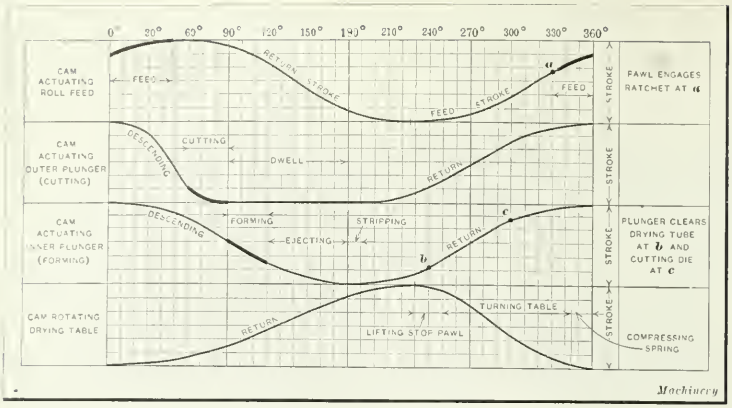

Fig. 13. Cam and Crank Timing Chart

kinds of damage. In one case, the weakest parts of the slide movement give way; in the other, the descending plunger hits the table, instead of registering with a drying tube, and smashes it. The danger of breakage from this cause is overcome by the simple safety device shown in Fig. 12. The drying table has a series of accurately located holes *h*, Fig. 11, exactly midway between each two tubes *E*. The safety-catch pin *j* rides on table *K* on the exact circle of centers of holes *h* and is free to drop into the holes. If everything is perfectly adjusted and in register, pin *j* comes in alignment with a hole *h* and drops into it at the end of each stroke. If for any reason the table gets jammed out of alignment at the end of stroke *R*, Fig. 11, pin *j* will not be aligned with a hole and therefore will stay up. It will hold the clutch *l*, Fig. 12, out of engagement and will prevent the plunger from descending; in other words, it will stop the action of the press and prevent a smash-up.

This safety catch is operated by a treadle as follows: The flywheel pulley crankshaft *k* carries a clutch *l* which is thrown into action when dog *m* strikes stop *n* of the safety catch; the crankshaft then revolves and the plungers descend. A rod *o* connects the stop-lever *n* with the treadle *p*, which is held up by a spring *q*, thus stopping the press automatically after each revolution. If for any reason there is no hole *h* in alignment with pin *j*, the operator cannot depress the treadle, and consequently cannot trip the press until the trouble has been located and attended to. Obviously, with this arrangement, the operator must be instructed to keep his foot off the treadle; that is, he must trip the press for each stroke and not keep his foot on the treadle all the time. However, little trouble is experienced from this one weak point of the safety device.

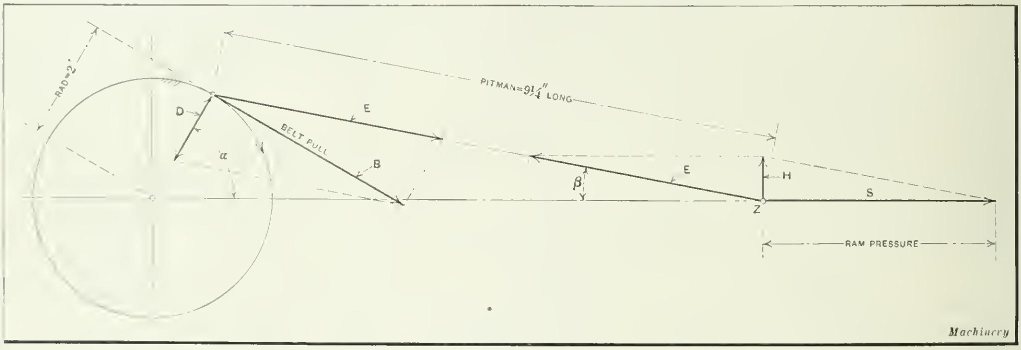

Fig. 14. Analysis of Belt Pull

Determination of Forces at Work during Forming Stroke

The cam and timing diagrams, Figs. 9 and 13, are self-explanatory. The lay-out shown in Fig. 9 is for any standard make of punch press; with a specially designed press, cutting and forming should be done at *x*—at the bottom of the stroke.

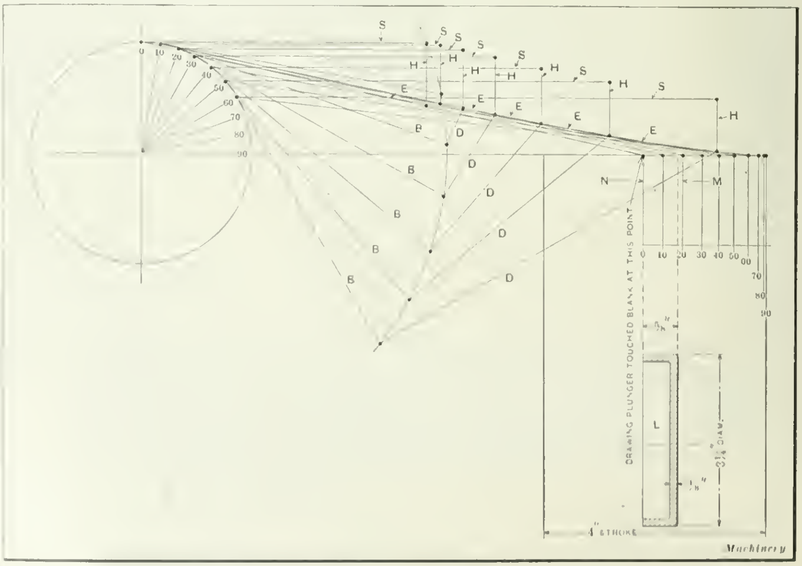

Fig. 15. Available Ram Pressure of Forming Plunger

Figs. 10, 14 and 15 illustrate a method of determining approximately the forces at work during the forming stroke. The article being produced is a fiber board lid *L*, Fig. 15, about 3¼ inches in diameter and ⅝ inch high; the stock is ⅛ inch thick. The double-acting press has a stroke of 4 inches, and is set to start forming at the middle of the down stroke. The press runs at 25 revolutions per minute and has a 35-inch flywheel pulley, 270 pounds rim weight, and a double belt 4½ inches wide. This press was rather weak for this job, so the belt was tightened to its utmost capacity; then the belt pull, when measured, was found to be 300 pounds, or about 66 pounds per inch belt. This produces a torque of

$$\frac{300 \times 17\frac{1}{2}}{2} = 2625 \text{ pounds at the crankpin radius.}$$

In Fig. 14 this belt pull is resolved into the crank-arm pressure and the pitman thrust. The latter, at *Z*, is resolved into the wrist-pin guide pressure and the ram pressure. Fig. 15 shows the same scheme as a composite diagram of the ram pressures exerted during the forming part of the down stroke. Here *B* represents the torques at different crankpin radii, due to belt pull, for various crank-angles; *D*, the corresponding crank-arm pressures; *E*, the pitman pressures; *H*, the wrist-pin strains; and *S*, the ram pressures exerted at the various angles as analyzed.

In Fig. 10, the available ram pressures thus found are plotted as ordinates, with crank-angles as abscissas, for the ratio of crank-radius to pitman length of the particular case under investigation. The forming pressure in this case must have been around 2500 pounds, as shown at *NM*, Figs. 10 and 15.

As already stated, the ordinary run of punch presses of standard make are little suited for the special requirements of this work. The press tables are too close to the ram and do not give sufficient height for a properly proportioned drying table. When the amount of work on hand warrants the expenditure, a press especially designed for each individual case is strongly recommended. The economy in power and in wear and tear will amply repay the trouble of properly proportioning the parts involved.

* * *

TRADE SCHOOLS IN THE PENNSYLVANIA EASTERN STATE PENITENTIARY

BY B 8128

About a year ago Warden Robert J. McKenty of the Eastern State Penitentiary, Pennsylvania, had his attention called to the engineering extension courses conducted jointly by the Pennsylvania State College and the Y. M. C. A. As he had long recognized that one of the main contributing causes to criminal delinquency is the lack of a proper trade training, he arranged with the State College, which for years had been conducting an agricultural correspondence course in the prison, to form a class in which the principles of mathematics and mechanical drawing would be taught. Machine shops, woodworking shops, etc., have long been a feature of the most advanced penal institutions, but, as far as the writer knows, the Eastern State Penitentiary is the first to apply successfully the principle of the continuation school.

The first two classes, with an enrollment of thirty-five men, were started by an instructor furnished by the State College and the Y. M. C. A. in May, 1916. At present the entire instruction is given by an inmate, who has the necessary training to qualify him for the work and who has won the unqualified approval of the State College; a State College supervisor, however, visits the institution weekly. But this was only the beginning. As soon as the men realized how the instruction would benefit them, they were not satisfied until the scope of the undertaking was enlarged. The courses embrace interesting and practical lessons in mathematics and mechanical drawing, as used daily in the shop. The fundamental principles are taught, familiar terms and processes being used and numerous applications to shop problems being given, so as to develop in the student the ability to apply the mathematical and scientific principles in his everyday work. For those who have finished this course, instruction in advanced shop mathematics is provided, as much of algebra, geometry, trigonometry and logarithms being taught as has been found to be of practical value in the shop.

There are now two courses in mechanical drawing. The elementary course is intended to develop in the student the ability to read blueprints and to make drawings and sketches of simple objects. The men are given isometric sketches which they work up to finished mechanical drawings in their cells. This has proved of great value in developing the power of visualization. The advanced course has been developed for men who wish to acquire a good working knowledge of drawing, as practiced in the best drafting-rooms. The text and the problems have been carefully prepared and arranged so as to develop speed, accuracy and neatness.

A large number of men employed at present in the woodworking and machine shops of the institution, who were competent mechanics when they entered, are taking up these courses and are thus fitting themselves for positions of responsibility as toolmakers and foremen. They realize that every man pays for the supervision he requires, and that that supervision represents the supplying by superiors of the knowledge that the untrained man lacks. Others who are classified in the admittance records as unskilled laborers are enrolled in the electrical and the plumbing schools, where they are taught the rudiments of the trades. The apprentices of the electrical school receive practical training by assisting skilled mechanics in the installation and the repair of the elaborate electrical equipment of the penitentiary. The plumbing apprentices work daily with a master plumber, looking after a large plumbing system. Each of the cells (and there are nearly a thousand) is supplied with a self-flushing toilet, running water, and a steam radiator, so that there is ample opportunity to learn every branch of the trade.

The inmates employed in the large power plant of the prison, with its three high-speed automatic engines, direct-connected to 50-kilowatt generators, are instructed in the use and application of the indicator, valve setting, and the care of the numerous boiler auxiliaries. A 25-ton refrigerating machine is also under their care. The men in the boiler room have an equipment of five horizontal return tubular 100-H.P. boilers and are instructed in the theory and practice of boiler-room economy, so that upon their release they may obtain licenses as first-class firemen.

But the thing that counts most in all these efforts to make the trade school a success is the personal element. Without the continual encouragement and interest that the warden shows in his daily intercourse with the inmates, it is doubtful if such excellent results could be obtained.

* * *

Truck manufacturers and users generally advocate the use of solid rubber tires, but evidence shows that the pneumatic tire, properly proportioned to the load, is as advantageous for trucks as for pleasure motor vehicles. The test on a Packard 1½-ton army transport truck was recently made over a distance of 4288 miles from Detroit, Mich., to the Mexican border and back. The truck was fitted with 36- by 7-inch "Nobby" tread U. S. pneumatic tires. The conclusions drawn from the trip are that an average of 40 per cent more mileage per gallon of gasoline can be obtained from trucks equipped with pneumatic tires than from those equipped with solid tires, and that oil consumption is reduced 25 to 30 per cent. The pneumatic tires greatly reduce road shock and lower truck depreciation fully 50 per cent. The average mileage per gallon of gasoline was seven, and the lubricating oil consumption of the trip was one quart of oil per 33.42 miles.

* * *

A movement has been initiated by the Association of British Machine Tool Makers for a greater degree of specialization among machine tool builders. According to the *Yorkshire Post*, some of the firms have arranged among themselves that each shall devote itself to the production of a single type of machine. This policy permits of the production of machine tools being placed upon a manufacturing instead of a "jobbing order" basis. It also lends itself to the appointment of group publicity agents and travelers, both at home and abroad.

AUTOMOBILE SPRINGS

NOTES ON PRINCIPAL TYPES, MANUFACTURE AND TESTING

BY CHESTER L. LUCAS[1]

THE use of leaf springs for horse-drawn vehicles dates back to 1750, but it remained for the motor car industry to put the manufacture of vehicle springs upon a scientific basis. A great deal of credit for this advance is due the Springs Division of the Society of Automobile Engineers, who, of course, have received the cooperation of American spring manufacturers.

Fig. 1 shows the five most important types of automobile springs in common use, though there are many variations in forming and mounting. These are the full elliptic, semi-elliptic three-quarter elliptic, cantilever, and platform types. Each type has an action different from the others and is used in various front and rear combinations by different automobile builders, the practice varying with the demands of the particular car in question.

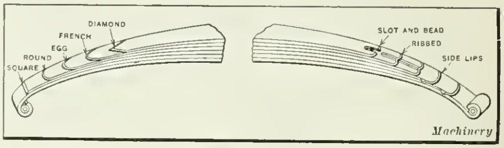

Fig. 3. Varieties of Spring Plate Ends in Common Use

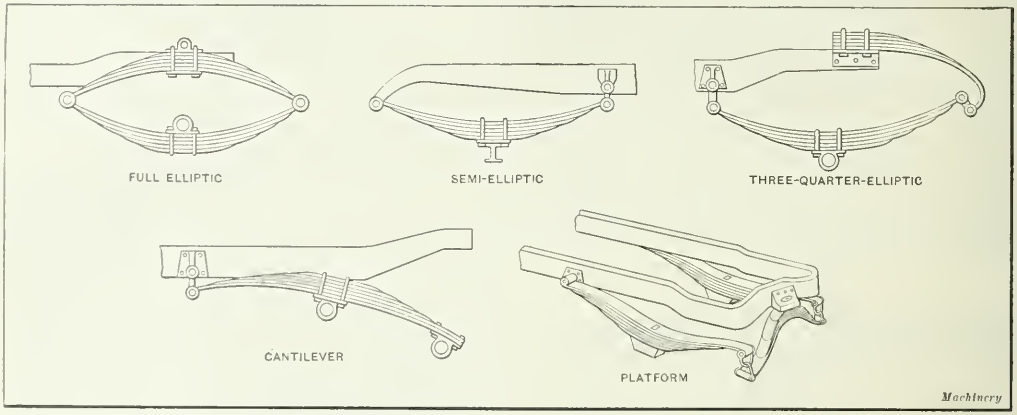

Fig. 1. Principal Types of Automobile Springs

Full Elliptic—This type of spring is probably the most flexible of the standard types, but it is more susceptible to side sway than the other springs. Its easy-riding qualities give it popularity when installed under proper conditions. It is often made with one or both ends in scroll form. A good example of its use is found on the Franklin car.

Semi-elliptic—This spring is not as flexible as the full elliptic, nor is there as much tendency toward side sway. It is more largely used in both front and rear installations than any other type of spring. Among the most common of the cars using it are the Pierce-Arrow and the Chalmers.

Three-quarter Elliptic—This type is a compromise design that is more flexible than the semi-elliptic and still has the side sway well controlled. Almost invariably, this spring has a scroll member at the top, but at times it is used without the scroll. This is a popular spring for rear installations in combination with the semi-elliptic at the front. Among the cars using this type of spring are the Dodge, Studebaker and Oldsmobile.

Cantilever—The cantilever spring is growing in popularity, particularly for rear installations. It permits little side sway, and the action is quite different from that of the regulation elliptic type. It is, in reality, a semi-elliptic spring mounted in cantilever form. On account of the method of mounting the cantilever spring makes the frame take a part of the spring action. It is used as a rear spring, in combination with the semi-elliptic at the front, on the Buick, Briscoe, King, and other cars.

Platform—The platform type of spring is used altogether as a rear spring and is very flexible. The action is much the same as the three-quarter elliptic, due to the fact that a quarter elliptic member is set at right angles to the semi-elliptic member, instead of in line with it, as in the regulation three-quarter elliptic. Good examples of the use of platform springs as rear installations may be found in the Packard and Cadillac cars.

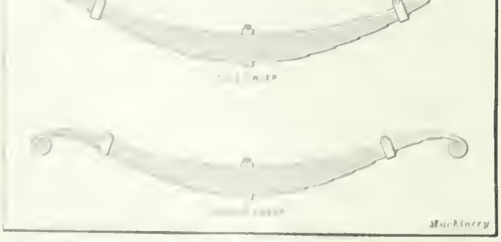

Fig. 2. General Arrangement of Spring Plates, Clips, etc., in True and Double Sweep Springs

A glance at Fig. 1 will show that the semi-elliptic spring member is the basis of all types of automobile leaf springs. Fig. 2 shows two types of semi-elliptic spring members, the upper of which is designated as the "true sweep," while the lower is the "double sweep" type. Of these types, the true sweep spring has by far the better action, as there is less friction in the movement between the leaves of the spring. The double sweep spring is heavier in proportion than the true sweep spring, and its use is confined principally to commercial vehicles.

The average length of a front spring for pleasure-cars is forty inches, and for the rear spring, about fifty inches; but, of course, this varies for different weights of cars. The opening of a semi-elliptic spring, or the distance from a line through the eyes to the center of the inside arc of the spring, is from five to six and one-half inches. The leaves are usually two inches in width, and the number of leaves in the spring varies with the load it must carry; there are generally from six to ten. The larger the number of leaves and the thinner they are, the greater is the flexibility of the spring. The application of this principle is, of course, limited by the impracticability of making springs with extremely thin leaves. The number of leaves and their thickness are points that are usually left to the spring manufacturer.

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[1] Associate Editor of MACHINERY

Detail of Spring Leaves

The first leaf of the spring is called the "master" leaf or "back" plate; the next leaf is the "long" plate; and the shortest leaf is the "short" plate. The usual length of the short plate is three-tenths the length of the back plate, and the spacing is evenly graduated from the short plate to the back plate. In an eight-plate spring, the spacing of the leaves is about 2¾ inches. No. 2 gage steel is most commonly used for the heaviest or back plate of the spring. There are two schools of spring-makers; one advocates that all the leaves of a spring should be of the same thickness; the other favors decreasing the thickness of leaves from a heavy back plate to a thin short plate.

The leaves of the spring are held together with a 5/16-inch bolt at the center; besides, at each end of one of the plates about a third of the way from the eye to the center "rebound clips" are riveted. These clips reach over the back plate, and their purpose is to keep the longer leaves from separating unduly under the rebound action. The rebound clips also help to distribute the load over the spring plates, and without them it is probable a back plate would break when put into service.

There are three methods of forming the eyes at the ends of the back plate. In some cases the ends of the spring plate are rolled upward, as in the right-hand view, Fig. 3, and in other cases they are turned downward, as in the left-hand view. Another form of eye is the "Berlin" type, which is made without bending the metal by forging the eyes solid from the ends of the back plate. The eyes are fitted with bushings to receive the hardened and ground pins.

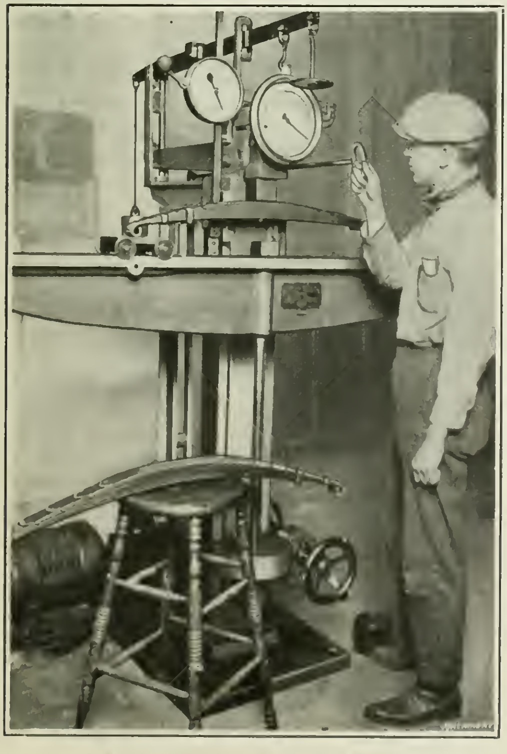

Fig. 4. Capacity Test for Automobile Springs

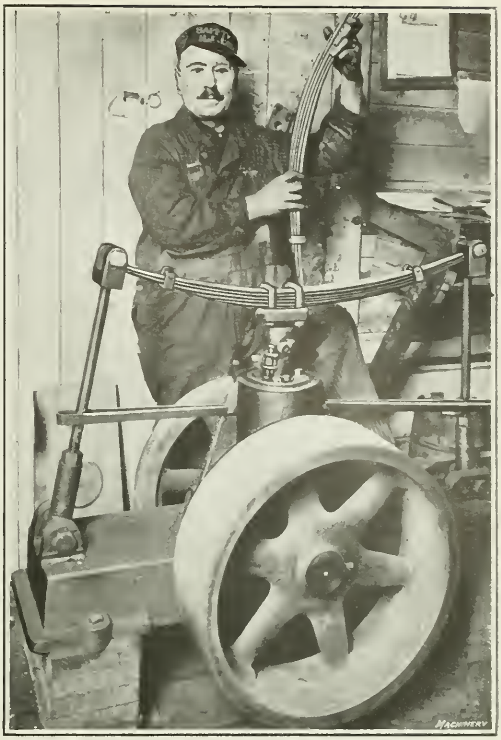

Fig. 5. Vibratory Test for Automobile Springs

In order to make a neater spring and to give a better spring action by relieving the abrupt strain that would be induced if the ends were left full thickness and square, the ends of the spring plates are thinned down and shaped, usually in one of the five ways shown at the left-hand side of Fig. 3. These consist of the square type of plate end, the round, egg-shaped, French, and diamond end. An end similar to the diamond shape, but with the stock left full thickness and not beveled, is also used occasionally.

To prevent the different spring leaves from swinging out of line, each plate is keyed to the one it rests upon. In Fig. 3 at the right are shown three methods of keeping the spring plates in alignment. First is the "slot-and-bead" method, in which each plate is slotted and guided by a pin in the plate beneath. Next is the "ribbed" method, in which a rib pressed in each spring plate meshes with the rib in the succeeding plate. A third method is by means of side lips. In this case the ends of the spring plate are forged out and trimmed to form lips, which are turned over so that they fit closely over the edges of the plate beneath.

Manufacture of Automobile Springs

At present, almost half the springs made in this country are made of vanadium steel. Many are made of chrome-silicon-manganese steel, and some are made of high-carbon steel. There are no unusual operations performed in the manufacture of automobile springs unless it may be the fitting, or cambering, of the spring plates. The stock comes in long strips and the first step is to shear these strips into the right lengths for the various leaves, or plates. In the case of the back plate, the eyes are formed; the other plates are thinned down at the ends, either by rolling or grinding, and the ends are trimmed to the proper shape. Each plate is then punched with a center hole for assembling and goes to the fitting department.

For years the method of shaping, or cambering, the plates of a spring has been to form them while hot to approximately the desired shape in bending dies. Following this operation, each plate is carefully fitted, by hand, for the position in the spring into which it is to go. After one set of spring plates has been fitted, a temporary bolt is put in to keep the leaves of that individual spring together until they are hardened, ground, and finally assembled. The operators at the fitting fires become very proficient in their work, but at best the operation is a slow one.

The modern method of cambering spring plates is by means of spring-forming machines. These machines differ in design, but the principle of action is essentially the same in all, it being the bending and hardening in one heat. The Lewis machine carries a heavy forming turret, having two working faces, each of which is fitted with a pair of forms composed of adjustable fingers. The spring plate, after being heated to a hardening heat, is placed between the forms on the upper turret face and quickly shaped by the dies. Then while the plate is firmly held, the turret revolves and quenches it in the hardening tank beneath, thus forming and hardening the springs in one progressive operation. The pressure of the dies is maintained during hardening, thus preventing the spring from losing its shape. While the spring plate is cooling, the other turret face is presented and another spring plate is placed between the dies and the operation repeated. This method of spring-plate forming has an advantage over hand forming in that the original fiber structure of the plate is not disturbed by hammering. Moreover, this method is very rapid, as the machine will form and harden 1800 plates per day.

When spring plates are fitted by hand, they are hardened at the same time by the fitter, each plate being treated separately. The hardening heat ranges from 1650 to 1750 degrees F. The plates are quenched in oil, and in many shops are tempered by flashing off the oil. This is an uncertain method, however, as the flash points of oils vary greatly. The best practice consists in drawing the spring plates in a salt bath, as the temperature can be accurately controlled and the results are far more dependable.

The eyes of the back plate are now fitted with bushings for the pins and the rebound clips are riveted to the ends of the proper spring plate. The ends of each spring plate are ground and polished to give them a finish and to permit better sliding action, and then they are assembled with the proper center bolt. In some spring-making plants high-grade graphite paste is smeared between the leaves of the spring to reduce the sliding friction. The spring is now complete and ready for testing.

Testing Automobile Springs

Automobile springs are commonly given two tests—the capacity and the vibratory test. At the testing laboratory of the Penn Spring Works of Baldwinsville, N. Y., through whose courtesy these testing data are given, every spring manufactured is subjected to a capacity test, as shown in Fig. 4. The testing machine is made by the Tinius Olsen Testing Machine Co., and is provided with a beam that carries two roller blocks on which the ends of the spring to be tested are supported. This is necessary in order that the springs may lengthen easily as the testing pressure is applied. It will be noticed that there are two dials on the machine. The smaller of these registers the amount of deflection of the spring, while the larger indicates the load. The spring is first mounted on the roller blocks and the plunger of the machine brought lightly down against the short plate. After the plunger has been set against the open spring, the pointer of the smaller dial is turned to zero. Pressure is now applied on the back of the spring and it must register on the capacity dial at the rate of 175 pounds for each inch of deflection, in the case of the particular spring shown being tested. This spring is one-half of a full elliptic spring and the specifications call for carrying a normal load of 1580 pounds at a four-inch opening of the spring. As the full opening of the spring is 13 inches and at 4 inches opening the spring is deflected 9 inches, it will be seen that 1580 pounds represents about 175 pounds for each of the 9 inches of deflection, which is as desired. All springs are set so that a tensile stress of not over 80,000 pounds per square inch will be developed in one-half the spring, at 6½ inches deflection.

The vibratory test is a test to destruction, and is performed at the Penn Spring Works on a machine like that shown in Fig. 5. In this case the spring selected is held firmly at the ends while the center is fastened to a plunger that, by means of an eccentric crankshaft, is given rapid vibrations of 3 inches in length. A spring is put on the machine and vibrated until it gives out by a plate breaking or in some other way, an accurate count of the number of vibrations being kept.

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ELIMINATING WASTE IN MANUFACTURING AND ASSEMBLING

BY H. D. MURPHY[1]

The compilation of data on factory transportation which Edward K. Hammond presented in the July and August numbers of MACHINERY is instructive, and although applying more particularly to the handling of materials on a large scale, these articles contain suggestions that can be modified for the use of the small plant. The writer was particularly interested in the paragraphs in which Mr. Hammond pointed out the loss entailed through having men waste their time at the stock-room door. The necessity for having a comprehensive system for giving out parts for assembling was brought home to us, however, in another way. The assemblers had contracted a habit of accumulating more parts than were needed for any given job and hiding the surplus under their benches. This condition was brought to light shortly after a reliable cost system was inaugurated, when it was discovered that orders were being placed in the machine shop for parts of which there were really sufficient on hand. The first step taken to overcome this was to issue positive orders to the stock clerk that no claimed shortages of the assembling department were to be filled without the sanction of the office.

However, another difficulty arose in that certain parts often were not ordered until actually needed by the assemblers. This, of course, meant failure to keep the shipping date promised to the customer. The following system was therefore evolved. The stock-room was given a card showing each part and the quantity that went into every assembled unit. Whenever an order was issued to the assembling department, a copy was sent to the stock-room. Upon receipt of this copy, the stock clerk consulted the card for the particular unit covered by the order and put all the necessary parts in a tote box. This box was put on a shelf subject to the call of the foreman. At the same time, a list of the missing parts was sent to the office and the necessary orders for making these were, in turn, issued to various machine shop departments. When the assembling foreman was ready to proceed with an order, he would notify the stock clerk, and if all the parts were completed, the tote box would be carried to the bench of the assembler by a stock-room helper. If parts were still needed to complete that particular order, the stock clerk would notify the foreman, who would then designate the next most important order.

This arrangement has accomplished four desirable objects: it has enabled the stock clerk to anticipate the wants of the assembling department; it has removed the slightest excuse for the workman leaving his bench or machine for a friendly visit at the stock-room door; it has done away with the secreting of parts under the bench; and it has also, and this is by no means least in importance, enabled the cost department to show what is actually made and used instead of simply reporting what should be used. The latter can be determined from any intelligently made drawing, but the former is knowledge which is vital to the success of the business.

* * *

An example of a variable standard and the confusion that arises from lack of general agreement is found in the perch used for measuring stone work. The perch is legally defined in some of the older states as 24¾ cubic feet, but the standard is not universal, as in some states it varies from 16½ through 20, 22, 25, to 27 cubic feet. In other states it is defined as equivalent to 2200, 2500, 2700, 2800 and 3000 pounds. The danger of using a variable standard like this is obvious, as contracting parties might have in mind entirely different conceptions of the value of the unit.

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FORMING MILK-CAN HANDLES ON A POWER PRESS

DESIGN OF DIES FOR COMBINED DRAWING AND BENDING

BY ERNEST A. WALTERS[1]

THE making of a milk-can handle is one of the many difficult power-press operations that require the exercise of much patience and good judgment to obtain the proper development and to get the dies into perfect working order. One of the difficult operations in press work is deep bending and drawing, because the blank has a tendency to shift before it is forced to the bottom of the die, which results in imperfect work. Another difficult operation is cross bending, when a large radius is greatly reduced, thereby making it necessary to upset the stock and condense the material without wrinkling or distorting the piece. In designing the dies for these handles, these difficulties were met, and the dies developed produce the desired number of perfect handles per day without much labor. The second and third operations, Figs. 5 and 6, have been arranged so that they may be performed with tandem dies in a single press, if so desired, thus requiring only two presses for the job. This arrangement also eliminates the labor required in handling the work between two presses.

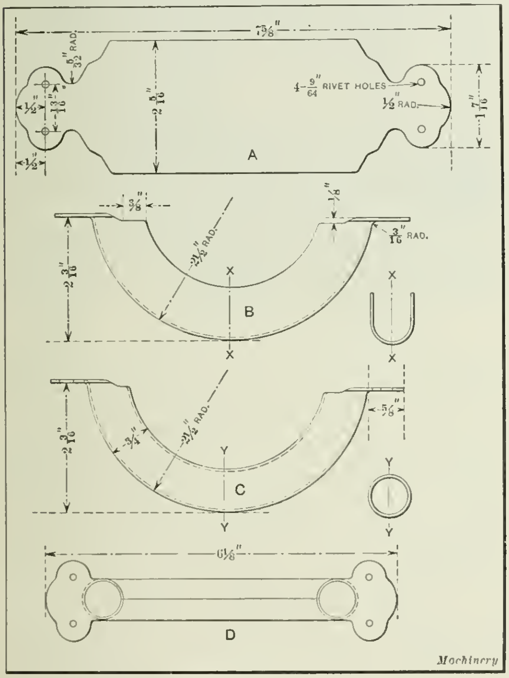

Fig. 1. Operations in forming Milk-can Handle

Fig. 1 shows the blank, which is made of No. 18 cold-rolled deep-drawing steel. The piece *A* is blanked on the progressive punch and die shown in Fig. 2. The punch *A* is made of tool steel and is hardened and dovetailed in the cast-iron holder *B*. The tool-steel perforating punches *C* are hardened and ground to size and are held in position by set-screws *D*. The blanking die *E* is made in two sections with the proper shear. It is hardened and ground and is held in the cast-iron die plate *F* by fillister-head screws *G* and dowel-pins *H*, which are shown in the plan view of the die, Fig. 3. The blanking die *E* and plate *F* are sunk in the cast-iron bolster plate *I* and are held in position by screws *J*. The stripper *K* is made of machine steel and is held in position by cap-screws *L* and dowel-pins. The spacing gage *M* is made of tool steel and is hardened and ground. Fig. 3 shows the guide plates *N*, finger-gage *O*, and spacing gage *M*. When straight strip steel is used, a die of this design will be found accurate enough. When a high degree of accuracy is essential, a compound blanking and perforating die is recommended.

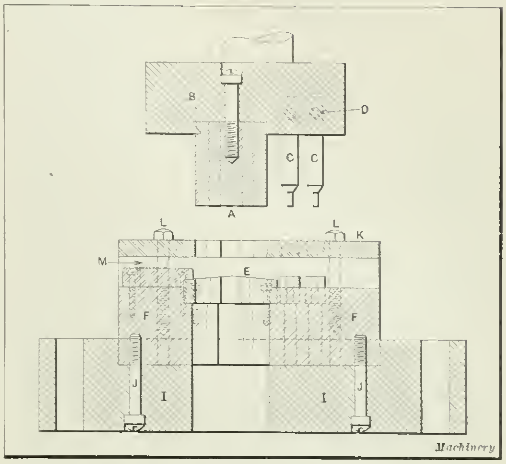

Fig. 2. Front View of Progressive Blanking Punch and Die

Fig. 4 shows the strip of steel and the method of gaging. The sheet of steel *P* is first held against the side *R* of the finger-gage *O*, Fig. 3, and a slight cut *S*, Fig. 4, is taken at the first stroke of the press. Gage *O* is then withdrawn to clear the sheet of steel, which is pushed forward against spacing gage *M*, bringing the gage points *T* and the sheared edge *S* together. Blank *A*, Fig. 1, is then cut. When the first blank is removed it is obvious that the stock will fit over gage *M*, and blanks can be produced continuously.

In the second operation the blank is bent in the die shown in Fig. 5 and formed to U shape as indicated at *B*, Fig. 1.

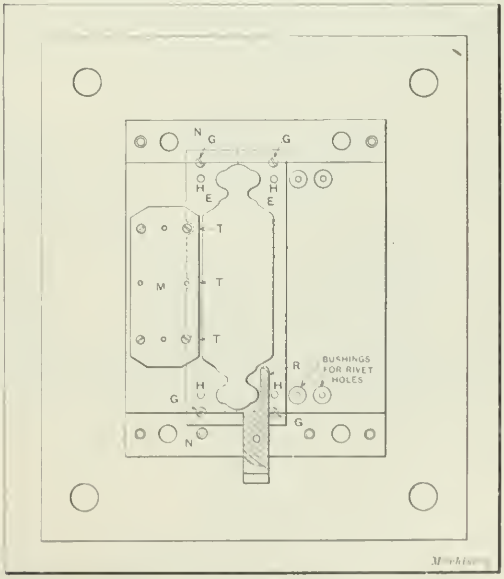

Fig. 3. Plan of Progressive Blanking Die, showing Gages, Bushings, and Die Sections

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[1] Address: 231 W. Buena Vista, Highland Park, Mich.

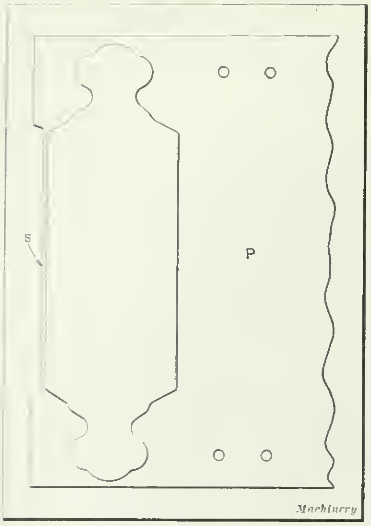

Fig. 4. Blanking Strip after Second Stroke, illustrating Manner of gaging

The punch *A* is made of tool steel and is backed by a hard plate *B*, so that the ends of the handle will be flattened when the die closes. Punch *A* and plate *B* are fastened to the cast-iron punch-holder *C* by screws *D* and dowel-pins *E*. The die *F* is made of tool steel and is hardened and held to the cast-iron plate *G* by screws *H*. Gages *I* are held in place by screws *J* and dowel-pins.

The square pressure bar *X* is slightly hollowed at the top *K*; it is made of tool steel and is hardened and ground to a sliding fit. The punch *A* is knurled at *O*, and with the proper tension on the pressure bar *X* from the rubber bumper *Y* and the adjusting nuts *Z*, will grip the blank and hold it from shifting while it is being bent to shape. The side gages *L* are made of tool steel and are hardened in oil; they prevent the blank from shifting sideways. The gages are held in position by bolts *M* and have the necessary clearance at *N* when closed.

The handle is formed to its completed shape as shown at *C* and *D*, Fig. 1, in the die shown in Fig. 6, which is designed to operate in tandem with the forming die, Fig. 5. The die *A* and the punch *B* are made of tool steel and are hardened in oil because of the strain developed when closing the handle. If this die and punch are hardened under ordinary conditions, they will crack and chip and cause trouble. The punch *B* is held to the hard flattening plate *C* and the cast-iron punch-holder *D* by screws *E* and dowel-pins *F*. The die *A* is set into a cast-iron plate *G* and is held in position by screws *H*. The forming and the closing dies must be kept polished and free from scratches to produce the best results.

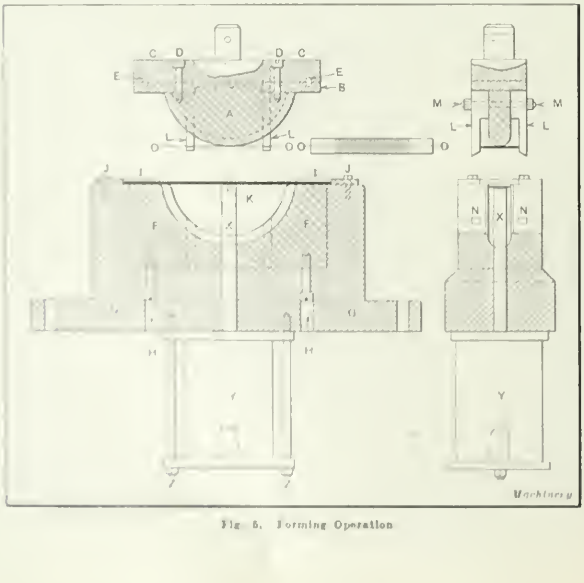

Fig. 5. Forming Operation

WOMEN IN BRITISH MACHINE SHOPS

The Ministry of Munitions in Great Britain recently exhibited at Leeds an extensive collection of work done by women in the mechanical industries. The exhibition indicates the extent to which women have taken men's places in England. There were fourteen separate groups of exhibits. One of the most interesting, to a mechanic, was a group of gages, including thread, ring, and plug gages, made to limits of 0.0003 inch. The plug gages made to these limits were completed entirely by women, including cutting off the stock, turning, casehardening, grinding, lapping, inspection and final corrections. One hundred and sixteen specimens of twist drills, milling cutters, reamers, drill chucks, chasers, etc., many of which were made entirely by women, were exhibited in another group. In some works, the women do all the machining operations, except the hardening, tempering, sand-blasting, and final grinding, while in other shops these operations are also done by women.

The group containing dies and punches for cartridge making is of peculiar interest on account of its intimate relation to the war. Sets of dies for this work are made entirely by women, except the backing off and hardening. Projectiles produced entirely by women were shown in another group, including among other exhibits 4.5-inch howitzer cartridge cases made entirely by female labor. In addition, there were exhibits of aeroplane engines, "tanks," motor cars, internal combustion engines, large and small guns, machine guns, and rifles, many of the parts of which are made by women. In the aeroplane industry, particularly, the women have taken an important place, doing much of both the wood work and the machine work, including the welding.

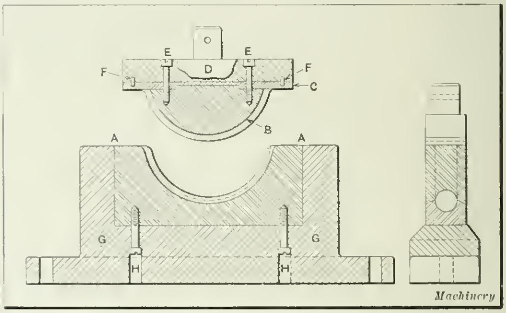

Fig. 6. Closing-in Operation

Photographs were also exhibited showing the women actually at work, and these indicated that the women have taken the place of men in many industries requiring heavy labor, in which it would ordinarily be thought that their lack of physical strength would prevent them from engaging. Women, for instance, were seen working at coke ovens, discharging and quenching coke, stacking and loading it in railway cars, handling it in connection with aerial rope-ways, etc. In rolling mill work, they were seen handling steel rails, punching spike holes in light rails, and charging the rail-mill furnaces. In steel works, they were seen working around furnaces and handling billets, operating hydraulic presses, and doing a variety of similar work. In the foundries, they are making cores both by hand and by machine, machine molding and general labor.

Judging from this exhibition, one would be inclined to draw the conclusion that the war is fought just as strenuously by the English women as by the men, and that the credit for the results that will be achieved will be equally divided between those who are fighting valiantly at the front and those who are fighting equally courageously at home.

IMPROVING A MOLDING MACHINE

BY S. W. PALMER[1]

Fig. 1 shows what is known as the "Modern" arcade molding machine. A number of these machines gave satisfactory service on certain lines of work, but on others they proved so unsatisfactory that it was decided to rebuild several to suit the work. The object of the change was to increase the pressure exerted by the machine on the surface of the mold, so that patterns of a relatively large area could be suitably molded with less hand ramming. In the machine furnished by the manufacturer, compressed air is admitted to the head end of an air cylinder anchored at *A*. The force of the air acting against the piston is transferred through a piston-rod to pin *B* in a bellcrank that is free to rotate about point *D*. As the bellcrank rotates in a clockwise direction, head *E* is drawn down by the connecting-rod attached to pin *C*. The original position of these parts is indicated in Fig. 2 by the solid lines connecting points *A*, *B*, *D* and *C*. When the machine is in the squeezing position, the moving points *B* and *C* have taken the positions B_1 and C_1. This mechanism is the same on both sides of the machine.

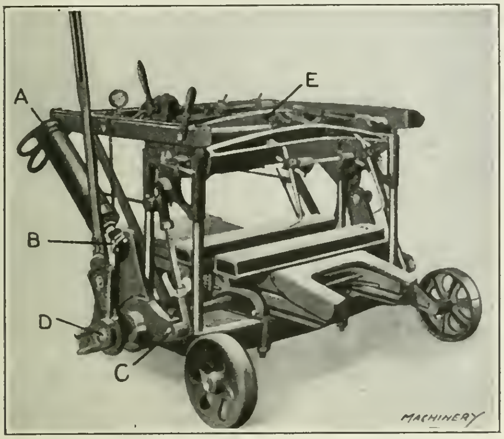

Fig. 1. Molding Machine as furnished by Manufacturer

The change consists in replacing the cylinder on the left-hand side of the machine with one of larger diameter and shorter stroke, and that on the right-hand side with one of larger diameter but the same stroke. The position of the points *A*, *B*, *C* and *D* on the improved machine when the squeezing head *E* is up, as in Fig. 1, is shown in Fig. 4. The left-hand side of the machine is indicated by the solid lines joining points *A*, B_1, D_1 and the dotted line to C_1, and the corresponding parts on the right-hand side of the machine take the positions *A*, B_2, D_1 and C_1.

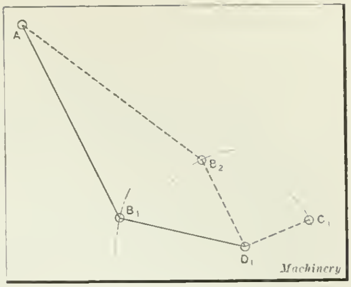

Fig. 4. Position of Air Cylinders, Pistons, and Bellcranks before Operation on Improved Machine

After the air has been turned into the cylinders and the machine has reached the position of squeezing, the squeezer head being down on the flask in the final position, the cylinder and attachment on the left-hand side of the machine occupy the position shown in Fig. 3 by *A*, B_3, D_1 and C_2. Those on the right-hand side occupy the position *A*, B_4, D_1 and C_2. It will be noted that the arrangement of the moving parts of the left-hand cylinder, crank and connecting-rod is such that, at the bottom of the stroke, when the maximum pressure is required on the squeezing head *E*, the angle AB_3D_1 is much more nearly a right angle than is the angle AB_4D_1, which is the angle of the new parts on the right-hand side of the improved machine and on both sides of the old machine. It will also be noticed that the pressure on the line AB_3 is working on a radius B_3D_1 which is of considerably greater length than that of the cylinder working on the line AB_4, with a radius B_4D_1.

In order to show the advantage gained by the greater turning effort thus produced, the following mathematical calculation is necessary. The original machine is equipped with two double-acting 4-inch cylinders of 15-inch stroke. For each mold made, each cylinder must be filled twice with compressed air at 80 pounds pressure, thus requiring $2 \times 2 \times 2 \times 2 \times 3.14 \times 15 = 754$ cubic inches of air. The improved machine is equipped on the right-hand side with one double-acting 5-inch cylinder of 15-inch stroke, and on the left-hand side with one single-acting 5-inch cylinder of $8\frac{1}{2}$-inch stroke. The arrangement is such that for most work the 15-inch cylinder is sufficient to return the squeezing head to the original position after the mold has been finished. However, the short cylinder on the left-hand side of the machine is so arranged as to take air during the last two inches of the return stroke and thus help out the right-hand cylinder when very heavy patterns are being molded.

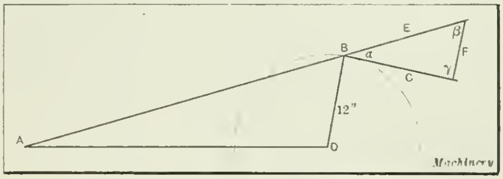

Fig. 5. Force Diagram of Original Machine

By computing the turning effort exerted by each machine on shaft *D*, it is possible to get a fair comparison of the two machines, as the power from this point is transmitted to head *E* in the same way and through the same angles in both machines. The turning effort of the original machine with 80 pounds air pressure is $2 \times 2 \times 2 \times 3.14 \times 80 = 2010$ pounds, which is exerted along line *E*, Fig. 5. The effective effort of this force is represented by the tangent *C*, which equals $E \cos \alpha$, or $2010 \times 0.891 = 1791$. As the radius is one foot, this gives 1791 foot-pounds as the turning moment about point *D*.

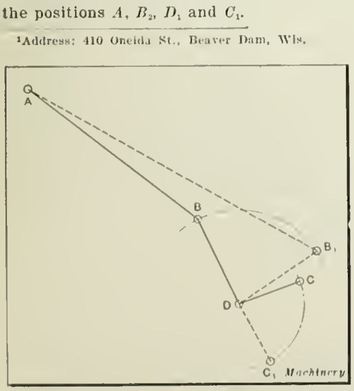

Fig. 2. Relative Positions of Air Cylinders, Pistons and Bellcranks before and after Operation on Original Machine

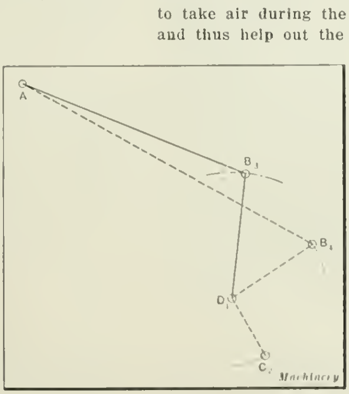

Fig. 3. Position of Air Cylinders, Pistons and Bellcranks after Operation on Improved Machine

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[1] Address: 410 Oneida St., Beaver Dam, Wis.

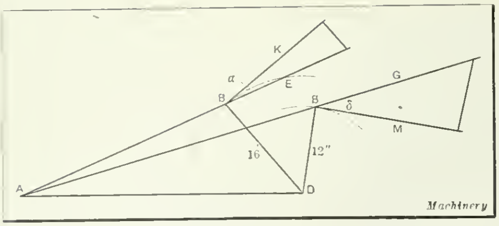

Fig. 6. Force Diagram of Improved Machine

The corresponding effort on the improved machine with the same pressure in the short cylinder is $2.5 \times 2.5 \times 3.14 \times 80 = 1570$ pounds; this is exerted along line E, Fig. 6. The effective force equals the tangent K, which is equal to $E \cos \alpha$, or $1570 \times 0.961 = 1509$ pounds. This pressure, acting on a radius DB of 16 inches, or 1 1/3 foot, equals $1509 \times 1.333 = 2011$ foot-pounds turning effort exerted about point D by the left-hand cylinder only. On the right-hand side of the machine the effective effort is the tangent M, which equals $G \cos \delta$, or $1570 \times 0.891 = 1399$ pounds. As the radius DB is 1 foot, this gives 1399 foot-pounds for the long cylinder only. The total turning moment about point D is the sum of the turning effort exerted by each cylinder, or $2011 + 1399 = 3410$ foot-pounds, as compared with 1791 foot-pounds in the original machine, or almost twice the effective pressure. This turning moment is obtained by the use of the following amount of air. First, assuming that the mold is of such size that the long cylinder alone can lift the squeezing head to its original position, the original machine requires both cylinders to be filled with air twice for each complete mold, or $2 \times 2 \times 2 \times 2 \times 3.14 \times 15 = 754$ cubic inches of air. The improved machine requires $2 \times 2.5 \times 2.5 \times 3.14 \times 15 + 2.5 \times 2.5 \times 3.14 \times 8.5 = 756$ cubic inches of air, or two cubic inches more than the old machine.

If the pattern is so heavy that the short cylinder is required to complete raising the squeezing head E to its original position, the amount of air required is $2 \times 2.5 \times 2.5 \times 3.14 \times 15 + 2.5 \times 2.5 \times 3.14 \times 8.5 + 2 \times 2.5 \times 2.5 \times 3.14 = 795$ cubic inches, as against 754 cubic inches in the old machine. In both cases the improved machine is exerting a pressure to squeeze the mold of 3410 foot-pounds, as against 1791 foot-pounds on the original machine. After gaining this extra power it was, of course, necessary to brace and strengthen a number of the parts of the machine to withstand the increased strain without excessive deflection. Several of these machines have been used for some time on heavy work and are giving satisfactory results.

* * *

REVENUE FROM MOTOR CARS

According to the Department of Agriculture, in 1916 there were 1,067,332 more motor cars registered in the United States than in 1915, an increase of 43 per cent. The gross total of registered cars, including commercial cars, was 3,512,996; the number of motorcycles registered was 250,820. The several states collected in registration and license fees, including those of chauffeurs and operators, a total gross revenue of $25,865,369. Of this amount, 92 per cent, or $23,910,811, was applied directly to construction, improvement or maintenance of the public roads in forty-three states. The figures for 1916 correspond closely with the annual percentage increase of motor-car registration of the last three years. This yearly increase has averaged 40 per cent in the number of cars and 50 per cent in revenue. In 1906, the total state registrations were approximately 48,000 cars, and the several states collected in fees and licenses $190,000, only a small part of this was applied to road work.

* * *

The British minister of munitions has fixed the selling price of aluminum ingots of ordinary commercial purity, 98 to 99 per cent, at £225 (about $1090) per ton and the maximum selling price of remelted aluminum scrap and swarf ingots of 98 to 99 per cent purity at £210 (about $1020) per ton.

THE HEART OF THE FACTORY

BY ARTHUR JENNER[1]

As the heart is to the human system so is the tool department to the modern factory. If that department is not operating as it should, the condition is reflected in decreased or inefficient production. Quantity manufacturing of interchangeable parts requires that the necessary tools be produced as economically as possible and upon schedule time. Economy means not necessarily cheap tools, but such as are fitted for their intended functions and made as good as possible and on time. The provision of plenty of relatively inexpensive accessories is positive economy, not only in dollars and cents, but also in increased production due to the psychological effect on the toolmakers or machinists. Many jobs take more time to set up than to machine.

Illustrations are not rare in the advertising pages of technical journals that show the lack of common necessities for holding down work. Bolts six or more inches longer than necessary are often used, the extra length requiring the use of large nuts, collars, old hubs, washers, etc. Dividing heads and tailstocks are robbed of the proper bolts, and even small carriage bolts and such substitutes are used at the risk of spoiling the job through inefficient holding power. But the search for better facilities would cost much more in time and temper than the value of the missing equipment. One of the worst results of this condition is the effect upon the men. Order and neatness are not encouraged, so that when these men get into a shop where better conditions exist, they cannot immediately change their habits, and to some extent the well-equipped shop suffers.

This fact was brought forcibly to the writer's attention some years ago when taking charge of a tool-room that had not received the proper attention. The machines were good, but the important, though less expensive, details were lacking. Casehardened bolts and nuts of sizes to suit the various machine T-slots, and from 2 to 10 inches long, were provided, also casehardened U-straps, 3, 5 and 7 inches long, and soft plate straps, 3/4 inch by 2 1/2 inches by 8, 10 and 12 inches. Small hardened and ground parallels, 1/4 by 3/8 inch to 1/2 by 1 1/8 inch, and large cast-iron ones were made. Every man was supplied with a surface plate, and a few spare plates were kept on hand for extra help; true angle-irons in several sizes were also made. All lathe centers were marked to denote the make of lathes they fitted, were rehardened and ground, and spare ones made, together with half centers. Tap sets, with the proper drills and counterbores fitted to hardwood blocks, were made in ample quantity, and every toolmaker was supplied with a set of drills, in blocks, from No. 1 to 60. Lapping plates for gage-makers were provided, replacing die-shoes and other odd-shaped castings required for specific purposes. Cast-iron lap blanks and suitable adjustable holders for use in lapping plug gages, etc., were carried in the tool crib in various sizes, as also were small lead laps, cast on cold-rolled steel centered arbors ready to turn, for use in lapping jig bushings, ring gages, etc. Wrenches were supplied and marked for use on certain machines, the originals having been used for other purposes. The tool crib was rearranged to enable the mechanics to observe at a glance and thus select odd-shaped and special tools, cutters, etc. Also the tools most in demand and small supplies were placed as near as possible to the point of distribution, resulting in much better service from the tool crib. Reflectors and shades for electric lamps were supplied, and many other details received attention along the line of general betterment. The establishment of the foregoing system was inexpensive as compared with the resultant all-around improvement.

Once in a while a man would be employed who did not fully appreciate the fact that it was to his advantage as well as that of his employer to have the equipment kept in proper order and care was required to see that he got into the spirit of this system. This was not due so much to want of thought as to his having been employed in shops that did not possess any carefully studied plan of caring for the upkeep of the means of quantity production.

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BALL BEARINGS[1]

FACTORS GOVERNING DESIGN — METHODS OF DETERMINING OVERLOADING OF BALLS — GYROSCOPIC EFFECTS

THE ball bearing of today could never have been made a commercial success but for the high degree of accuracy attained in its manufacture. With a load of 130 pounds, a half-inch ball is compressed 0.001 inch. Hence if one of the balls in a thrust bearing is 0.001 inch larger than the rest, the ball will have 130 pounds more load upon it than the others. As the total load that may be put on a half-inch ball running at very low speeds on a curved track is about 250 pounds, an error of 0.001 inch in the diameter of the ball, or a place in the race 0.001 inch high, will increase the load to such an extent that failure of the ball is certain to occur. With a one-inch ball, the safe load is about 1000 pounds, and the effect of 0.001 inch error, 200 pounds.

Except in the smaller sizes, balls in a properly designed bearing hardly ever break into pieces when overloaded, but the surface chips or peels off. The safe-working load of a ball depends on the strength of its surface to withstand the continual compression and expansion under load, or, in other words, on the elastic limit of the surface. It does not follow, however, that the ball with the highest crushing load will have the highest safe-working load. The safe-working load of a bearing depends not only on the quality of the ball, but on the design of the bearing and the accuracy with which it is ground. At high speeds, the safe loads per ball are much less than at low speeds; hence, with a fast-running bearing, it is of much greater importance to get extreme accuracy of workmanship than in a slow-running bearing. Balls running on a curved track will carry from 2 to 2½ times as much load as those on a flat track. Why the load-carrying capacity of a ball bearing diminishes with the speed is not altogether clear. It is sometimes said that the diminished capacity is due to the increased load on the balls caused by centrifugal force; but on calculating the amount of this force it will be seen that the increased load due to this cause is so small as to be negligible except at very high speeds. With balls running in a properly fitted cage with flat ball-races, it is difficult to see how the centrifugal force of the balls can have any effect on the load-carrying capacity of the bearing. The speed effect on the balls has possibly some relation to the well-known effect of very rapid reversals of stress.

All authorities agree that the effect of speed is much more marked in thrust bearings than in radial bearings. In a thrust bearing the balls are always under the same load, but the direction of their line of loading is always changing. In a radial bearing, however, the balls are gradually loaded for a fraction of a second, and then gently released from stress; at least half the time they get a complete rest, as regards supporting any load, which appears to enable them to withstand higher loads at a given speed than they are capable of doing when in a thrust bearing.

Curvature of Tracks and Mounting

Prof. W. Schwinning has stated that a curved track is the best shape for races of radial bearings intended for heavy loads. Hertz's theory shows that for a given load the maximum stress in the material is smaller the greater the extent of contact between the balls and the races, and therefore it is desirable, in order to maintain the maximum bearing capacity, to make the radius of the groove of the inner ball path from 4 to 5 per cent, and that of the outer ball path from 10 to 15 per cent larger than the radius of the balls.

With grooved races, the normal continuous load, in kilograms, can be taken as $W = 15\dfrac{n}{5d^2}$,

in which n = number of balls;

d = diameter of balls, in 1/8 inch.

This relation is suitable for medium speeds of, say, 800 revolutions per minute, assuming absence of shock. If shocks are probable, the normal load on the bearing must be reduced. The races should contain as many balls as possible.

In the case of a nearly perfect roller or ball bearing the frictional resistance of the bearing is practically independent of lubrication. For a single-row, radial bearing, having a diameter of outer ball track, 2.75 inches; radius of curvature of outer race, 0.275 inch; diameter of inner ball track, 1.75 inch; radius of curvature of inner race, 0.2625 inch; diameter of ball, 0.5 inch. If the ball deflects so as to approach the race by 0.0001 inch, the area of contact on the outer race is 0.00057 square inch, and the area of contact on the inner race is 0.00063 square inch.

Creep in journal bearings is due to the slight difference in diameter between the shaft and the bore of the inner race of the bearing, so that the revolving shaft rolls around the bore of the inner race as it rotates. If the diameter of the shaft is 0.001 inch smaller than the bore of the bearing, its circumference is approximately 0.003 inch less, and in each revolution a point on its surface will travel 0.003 inch less than a point on the bore of the bearing. If the shaft makes one thousand revolutions per minute, the surface of the bore will, theoretically, creep forward three inches in each minute. The only way to prevent this creep is to make certain that the revolving races are a tight fit, and are clamped endwise on the shaft. Grub screws or keys are not satisfactory. There is no tendency to creep between the outer race and its housing where these are both stationary, or between the shaft and inner race if these are both stationary. This is because the load remains continually in the same direction; when the load revolves, the outer race will tend to revolve in the opposite direction to the load.

A journal bearing that has to withstand pure end thrust and no journal load has the end thrust evenly distributed over all the balls. When the bearing is subjected to combined journal and thrust load, the journal load is carried on two or three balls which are held by this load in the bottom of the tracks. A side thrust coming on this bearing at the same time will be carried by the same two or three balls, and therefore the load per ball will be greater. The balls that are not subject to the journal load, and are therefore slack in their races, will not be carrying any of the side thrust.

Method of Determining Overloading of Balls

The wear of properly made ball bearings is practically nil when run at suitable loads and speeds. A new ball, straight from the makers, when examined shows slight defects; but after running a few weeks under a moderate load, the surface improves. When, however, the ball is overloaded it appears to be covered with tiny flakes of snow, which are specks where crystals have broken away from the surface of the ball. Such specks can be seen only with a lens magnifying about 300 to 400 diameters. As soon as these specks appear, it is a sure sign that the ball has been overloaded; and if the test is continued at this load the balls and races will ultimately fail. The races must be perfectly smooth and free from chatter and scratches; otherwise the load on the balls will be increased.

Prof. Schwinning says that when two balls are pressed together, the load at which the first fissure occurs is a measure of their tenacity; the breaking load does not depend only on this fissure-load. The first crack is a circular fissure surrounding the point of contact and often occurs at less than one-tenth of the breaking load; circumferential cracks occur much later. The first circular fissure cannot be seen with the naked eye, or even with a microscope, but it can be made visible by etching the balls, preferably with warm hydrochloric acid. Not infrequently criss-cross scratches, due to too rapid grinding, occur on the cylindrical surfaces of the races, especially where the tenacity of the surface has been reduced through defective hardening. These scratches are rendered visible by etching.

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[1] Abstract of a paper by A. Marshall Arter, read before the Society of Engineers of Great Britain, April, 1917.

Permissible Loads for Ball Bearings

Taking the foregoing considerations into account, the author has evolved the following formulas for the permissible loads of ball bearings of the best materials and workmanship, and with curved tracks, giving approximately the same area of contact for the inner and outer races of journal bearings, which will be found to conform closely with generally accepted practice.

Thrust bearings:

$$W = 770nd^{1.45}\sqrt{\frac{320d}{ND}}$$

Radial bearings:

$$W = 900nd^{1.45}\sqrt[3]{\frac{320d}{ND}}$$

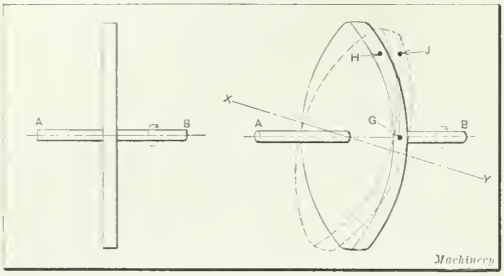

Fig. 1. Diagrams showing Effect of Gyroscopic Torque

in which W = load, in pounds;
n = number of balls;
d = diameter of ball, in inches;
N = revolutions per minute of shaft;
D = diameter of ball track (thrust bearings, center to center of opposite balls; radial bearings, diameter of inner track) in inches.

In the case of thrust bearings, all the balls carry the load simultaneously; in radial bearings, only one-fifth of the balls take the load at one time. But in the latter case the area of contact of the balls is greater than in the former, and consequently their load-carrying capacity is greater, due to the cylindrical formation of the outer race and the smaller radius of track of the inner. In thrust races, a satisfactory permissible load has been found to vary inversely as the cube root. The effect of shock is extremely important and with hardened steel surfaces in metallic contact the inertia of the moving parts subjects the bearing to an extra load, which must be taken into consideration when determining the size of a bearing.

Gyroscopic Effect

When the axis in a ball bearing about which the balls rotate is not parallel to the axis of the bearing, there is a gyroscopic couple, due to the action of each ball as its axis of rotation "precesses" in a radial path. Suppose a disk to be rotating in a clockwise direction when viewed from the end of spindle B, Fig. 1, and spindle AB to be precessed about an axis at right angles to AB, so that the end A rises vertically from the surface of the paper while B descends below it. Then, by the principle of "conservation of angular momentum of aspect," any point G on the rim of the disk will tend to run in its original aspect of rotation, and a gyroscopic force will ensue, acting at right angles to the plane of precession.

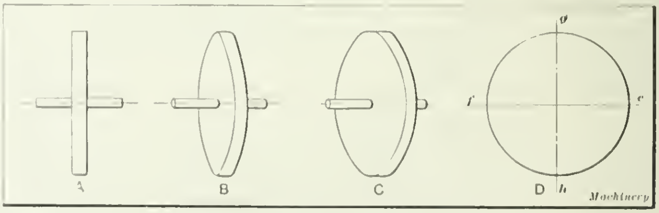

Fig. 2. A, Position of Edge Aspect; B and C, Successive Positions; D, Diagram showing Condition with Mass concentrated at Four Points

In Fig. 2, A represents a disk in edge aspect, and, when its spindle is precessed as shown in the previous illustration, it will assume positions B and C successively. Each of these positions is a different "position of aspect." Now, imagine that for an infinitesimal period of time the mass of the disk is equally divided and concentrated at four points e, f, g and h, as shown at D. Now, considering point G, Fig. 1, as representing point e, Fig. 2, on precession, its rotation will cause it to travel to a position shown at H, Fig. 1, but, owing to the precession and its original momentum of aspect in a plane at right angles to the surface of the paper, as shown at position A, Fig. 2, it actually travels to a point indicated by J, Fig. 1. A gyroscopic torque results, which tends to move the disk to the position shown by dotted lines in Fig. 1. Point f, shown at D in Fig. 2, acts in a similar manner. If the action of points g and h be examined, similar reasoning will show that a torque is set up in opposition to the precession, but this torque is counteracted at the commencement of precession, and is soon reduced to zero.

Owing to the new aspect of rotation taken by the disk represented by XY, tending to conserve the instantaneous angular momentum of aspect of points g and h, on termination of the precession, the reverse condition will be observed. The constraint by which each ball is made to change the direction of its axis is due to a frictional driving contact of the two races between which it runs. If this frictional restraint is greater than the gyroscopic couple, the balls will roll properly in their races; if the frictional restraint is insufficient, the balls will not roll in the correct manner, and skidding will take place, resulting in some loss of power and unnecessary wear and tear.

The value of the gyroscopic torque T is given by the following equation:

$$T = IWV$$

T = gyroscopic torque;
W = angular velocity of ball in radians per second;
V = precessional angular velocity in radians per second;
R = radius of ball in inches;
K = radius of gyration of ball in inches;
I = moment of inertia of ball = $K^2 \times$ mass;
d = weight of material in pounds per cubic inch.

$$K^2 = \frac{2R^2}{5}, \text{ and}$$

$$\text{Mass} = \frac{4}{3}\pi R^3 d$$

Hence:

$$I = \frac{2R^2}{5} \times \frac{4}{3}\pi R^3 d = \frac{8}{15}\pi R^5 d$$

In this particular case, where the "axis of spin" is at right angles to the "axis of bearing," the precessional angular velocity V equals $2\pi r$, where r is the number of revolutions per second of the ball around the axis of the shaft = ½ shaft revolution per second. Therefore:

$$T = \frac{8}{15}\pi R^5 d \times 2\pi r \times W = \frac{16}{15}\pi^2 R^5 d r W$$

The maximum restraining couple due to frictional contact = $2wnR$, where w = weight sustained by each ball in poundals, and n = coefficient of friction between the ball and race, that is, that proper to rolling contact under the conditions in question. This value is not known with accuracy, but may be taken as 0.1. Therefore, the limiting conditions under which a bearing will function properly are given by the expression:

$$2wnR > \frac{16}{15}\pi^2 R^5 d r W$$

Let S = speed of revolution of shaft per second;
l = radius of circle containing balls;

then:

$$W = \frac{lr}{R}\text{; but } S = 2r$$

Therefore: $W = \dfrac{lS}{2R}$, and $V = 2\pi r = \pi S$

Therefore: $T = \dfrac{8}{15} \times \pi R^5 d \times \pi S \times \dfrac{lS}{2R} = \dfrac{4\pi^2 R^4}{15} \times lS^2 d$

Thus the limiting condition is given by the following:

$$2wnR > \frac{4}{15}\pi^2 R^4 lS^2 d \qquad w > \frac{2\pi^2}{15n} \times R^3 lS^2 d \text{ poundals}$$

Let us apply this to the following numerical example: suppose a bearing has balls 1 inch in diameter, a ball circle 6 inches in diameter, and that the shaft runs at 30 revolutions per second.

$$w > \frac{2\pi^2}{15n} \times 0.125 \times 3 \times 900 \times 0.28$$
$$w > 1250 \text{ poundals}$$
$$w > 38.6 \text{ pounds}$$

The meaning of this result is that if a thrust bearing is designed according to the preceding data and the load on any ball falls short of 38.6 pounds at any time, that ball will begin to skid, owing to the effect of its gyroscopic torque. It is evident that under conditions of practice at full load, no slippage will take place if in a well-designed bearing a 1-inch ball is loaded up to many times the slipping limit. It would appear, however, that at light loads there is some danger that gyroscopic slippage may take place. In a motor car, the maximum load for which a bearing has to be designed is very often many times greater than the ordinary working load, which, in its turn, is considerably above the load frequently existing. From this, it will be seen that there is a minimum load at which any thrust bearing may be run at a given speed, and it is established that the higher the speed the lower the maximum load that can be carried. From this, it may be inferred that there is an absolute limit of speed at which any bearing may be run; namely, when the permissible maximum and minimum loads coincide.

* * *

FALSE EDGE ON CUTTING TOOLS

BY WILLIAM S. ROWELL[1]

Frank Richard's analysis of the action of cutting tools in the June number of MACHINERY is interesting, but does not seem to be final. The writer would like to hear from someone who has studied tool action with special reference to the formation of a new edge (shall we call it false edge?) on cutting tools almost as soon as cutting begins.

Though all observing men in the shop have noticed this action since their first metal-cutting experience, it is much more in evidence today than before the introduction of high-speed steel. It may also be noticed that lathe-men grind their tools with far more top rake than was the custom when slower speeds were in use; is this to provide a less abrupt curling of the chip? This false edge forms on drills and other tools almost instantly in many cases; it may be seen where the cut is intermittent or where it is alternately deep and shallow. It is the writer's belief that this edge, in many cases, changes its form slightly while in action, and that it actually comes as near cutting as metal-cutting tools usually do. High-speed steel tools are peculiarly active in forming a false edge; in fact, it would almost seem that one is rarely in use without that curious addition to its edge. This is probably the reason that high-speed steel is of little use for finishing tools.

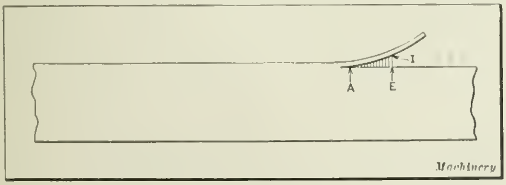

Fig. 1. Cutting Action of Steel

The writer's theory of the formation of the false edge is that the chip is torn from the work, and in tearing parts slightly ahead of the tool edge. The edge then trims off the rough surface left in the tearing and the minute particles of metal trimmed from this rough surface are imprisoned and compressed in the space *IAE*, Fig. 1. This addition to the tool is much harder than would be expected; so hard that its irregularities impress themselves on both chip and work. A proof of this is the hair-like curled shavings, shown in Fig. 2, formed while turning high-speed steel with a high-speed steel tool. The cutting conditions were normal for a 16-inch lathe removing ¼ inch diameter from 1¼-inch stock. But for a short time these perfectly straight helices were split from the chip near its inner edge apparently by some slight projection from the false edge.

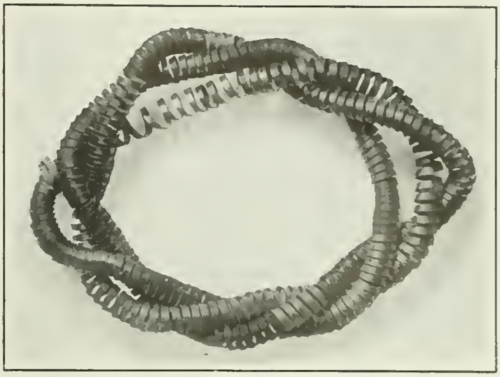

Fig. 2. Effect of varying Rate of cooling a Lathe Chip

This false edge prevents the formation of a smooth surface, but appears to help in the removal of the chip. The action is similar to that of a tool with a slight cutting angle and much top rake, and the chip is curled slowly. One may often note, in lathe work, the effect of false-edge action on the surface of the work in the form of a regularly repeated building up and partial breaking away of the false edge. When built up to its maximum, the work surface begins to roughen and its diameter to diminish slightly, thus showing that the false edge overhangs the tool proper. This goes on until it is too weak to stand the pressure, when it crumbles away and a smoother surface and normal diameter are again produced. This cycle is repeated with singular regularity in some cases, the resulting work surface being regularly alternating bands of fairly smooth and rough surfaces. In the direction of tool traverse, the roughness appears gradually and changes abruptly to smooth. No one would suppose that opening *IAE*, Fig. 1, is as large at the beginning as the accumulation of false edge is after the first few seconds of cutting. It rather seems that this accumulation starts infinitely small and the metal opening ahead of it gives it a chance to grow; but in growing it becomes weak and crumbles, resulting in a constant slight change.

The chip reproduced in Fig. 2 shows interesting variations in color. The different colors were produced by blowing on the shaving as it left the work; the light colored parts are the sections that were cooled by being blown on, and the dark parts are the sections that cooled slowly.

* * *

The back yards of some manufacturing plants are filled with piles of rusting scrap that are both unsightly and wasteful, and are permitted to remain in this disgraceful condition. Light sheet metal and wire scrap rust rapidly and lose a large percentage of value in a few months. In these times of high scrap prices and general need of all available metal, it is deplorable to let large quantities of valuable scrap waste away in unsightly piles. The careful manufacturer is known by the back yard of his plant; he will not permit an accumulation of piles of waste materials even if they represent comparatively little value. They reflect disorderliness and wasteful methods, and are an eyesore. This is no time for waste, and disorderliness is always out of order.

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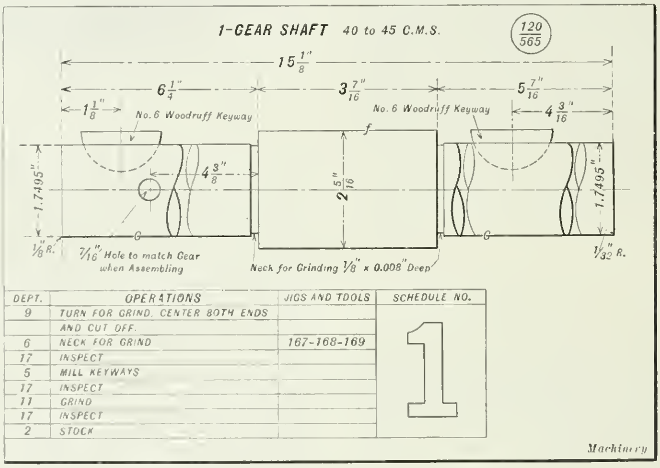
PRODUCTION MANAGER'S GUIDE AND SELF-SCHEDULING WORK

CHART THAT RECORDS PROGRESS AND COST OF WORK

BY ROBERT A. ENDEBROCK[1]

IN these days when progress depends so much upon individual and organized efficiency, we have probably organized societies of every branch of the industrial world except that branch pertaining to the production and routing of parts in process. The American Society of Mechanical Engineers frequently has papers referring to this important work, but until some individual, or group of individuals, organizes the American Society of Production Engineers, men interested in this work must be content to learn from one another by contributing to the various trade journals which have, thus far, given them their most liberal support.

Order and system must prevail if we expect to be constructive and approach our goal, and system comes closer to scientific management when production is increased by the use of simple rather than elaborate methods. The routing system here described compiles in one simple comprehensive chart the routing and tracing of work, location of parts in process, time of each operation on each piece, total time and labor cost for each piece, and the time and labor cost of each department for the lot when it is finished. The chart (see Fig. 2) gives the name of every piece, number required for one machine, piece number, drawing number, schedule number, material issued, the departments through which each piece will pass, and total time and cost columns. The number of the lot and the number of machines in the lot are noted at the top, while at the bottom space is provided for totaling the time of each department, as well as for totaling the cost of all parts, giving the total labor cost for producing the parts for the entire lot. The number in the schedule column denotes the order in which the different parts are to be machined. Parts needed first in the assembling department, those requiring considerable machining time and all hardened parts are marked 1, those of next importance are marked 2, and those of least importance, requiring very little machining, are marked 3 or 4. In the department columns, the large figure denotes the number of the operation and the small figure to the right denotes the estimated time for that operation. The guide chart furnishes just the information the supervisor of production wants, and the ease with which it can be read enables one to gather facts quickly and accurately. Another good feature is that all the detail parts for each unit are grouped together, that is, all the parts for the head are listed together and all the parts for the gear box are listed together, etc. This enables one to determine quickly which parts of any unit the material has been issued for and how fast they are moving.



DEPT.	OPERATIONS	JIGS AND TOOLS	SCHEDULE NO.
9	TURN FOR GRIND. CENTER BOTH ENDS		1
	AND CUT OFF.		
6	NECK FOR GRIND	167-168-169	
17	INSPECT		
5	MILL KEYWAYS		
17	INSPECT		
11	GRIND		
17	INSPECT		
2	STOCK		

Fig. 1. Drawing that accompanies Work through Departments

Fig. 1 shows a copy of the work drawing, which travels with the work. On the work drawing is shown the piece to be machined, the number required, piece number, operations and schedule number, which corresponds with the schedule number on the guide chart. Putting the schedule number on the work drawing does away with the uncertain and unsatisfactory method of setting due dates and keeps the work moving through the shop automatically in the order in which it is required by the assembling department. It also relieves the foreman of the responsibility of selecting the work and prevents the work from going through in a hit-and-miss manner, because what one foreman may consider as the part that is needed first the foreman in the next department may consider as being needed last. Relieving the foremen of this responsibility gives them more time for instructing their workmen and also for improving the methods of machining, thus obtaining a larger output. If the operator, whether skilled mechanic or apprentice, has several jobs around his machine at one time, he naturally machines the parts in the order in which they are scheduled.

The manner in which the foregoing is applied can be easily followed by taking one part on the schedule. The chart shows that the lot is No. 42 and contains thirty machines. As there is one piece $\frac{120}{565}$ required for each machine, the stockkeeper issues material for thirty pieces on May 15, as indicated in the Material Issued column; this entry also shows that the department which has the first operation to perform received the material on that date. When an operation is finished, the date is stamped by the timekeeper in the column of the department in which the operation was finished. In this instance, the first operation was finished in the lathe department on May 21, which entry also indicates that the parts were at that time delivered to the milling department, which had the second operation to perform.

The guide chart shows the estimated time for machining one piece on the first operation to be forty minutes. This time multiplied by the number of pieces required for the lot gives the estimated time for machining the thirty pieces, which is twenty hours. The length of time these parts were actually in this department can be ascertained from the date the material was issued and the date the operation was stamped finished. In this instance, a twenty-hour job remained in the department six days. After the lot of machines is finished, the guide chart is sent to the office and the time for each operation is entered. The time for machining any piece complete is easily determined by totaling the individual operation time from left to right and the total time for each department is obtained by adding the individual operation time vertically.

The following summary shows what information the production manager can obtain from the guide chart:

Name of piece, number required, piece number, drawing number, and which assembled unit each piece is for.

Order of operations.

Time for each operation.

Total number of hours required in each department for each machine to be produced.

Length of time parts should remain in each department, obtained by multiplying time for each operation by number of parts in lot.

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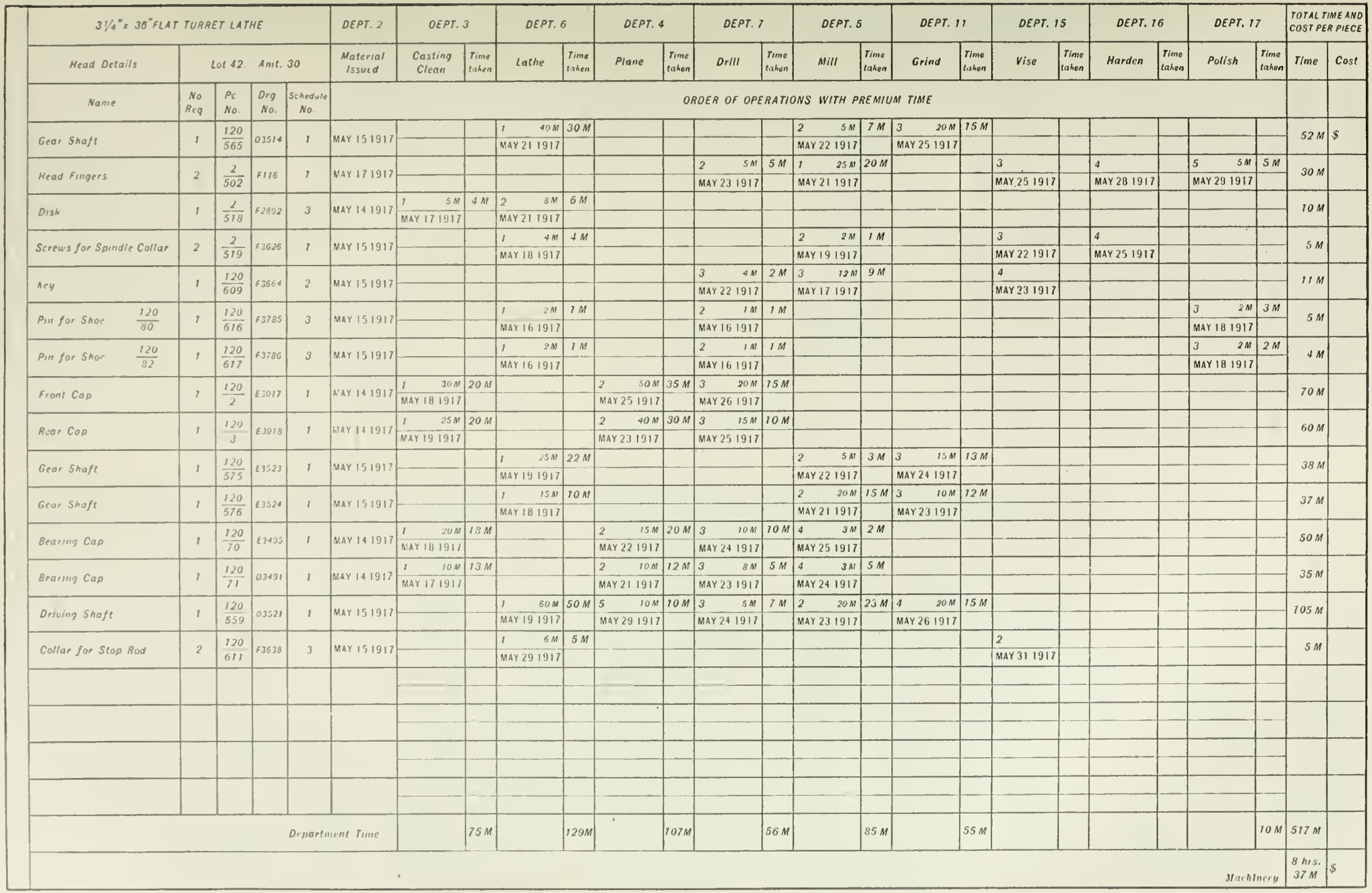
[1] [illegible] Acme Machine Tool Co., Cincinnati, Ohio.



3¼" x 36" FLAT TURRET LATHE					DEPT. 2	DEPT. 3		DEPT. 6		DEPT. 4		DEPT. 7		DEPT. 5		DEPT. 11		DEPT. 15		DEPT. 16		DEPT. 17		TOTAL TIME AND COST PER PIECE	
Head Details	Lot 42. Amt. 30				Material Issued	Casting Clean	Time taken	Lathe	Time taken	Plane	Time taken	Drill	Time taken	Mill	Time taken	Grind	Time taken	Vise	Time taken	Harden	Time taken	Polish	Time taken	Time	Cost
Name	No Req	Pc No.	Drg No.	Schedule No.	ORDER OF OPERATIONS WITH PREMIUM TIME																				
Gear Shaft	1	120/565	03514	1	MAY 15 1917			1 40 M MAY 21 1917	30 M					2 5 M MAY 22 1917	7 M	3 20 M MAY 25 1917	15 M							52 M	$
Head Fingers	2	2/502	F116	1	MAY 17 1917							2 5 M MAY 23 1917	5 M	1 25 M MAY 21 1917	20 M			3 MAY 25 1917		4 MAY 28 1917		5 5 M MAY 29 1917	5 M	30 M	
Disk	1	2/518	F2892	3	MAY 14 1917	1 5 M MAY 17 1917	4 M	2 8 M MAY 21 1917	6 M															10 M	
Screws for Spindle Collar	2	2/519	F3626	1	MAY 15 1917			1 4 M MAY 18 1917	4 M					2 2 M MAY 19 1917	1 M			3 MAY 22 1917		4 MAY 25 1917				5 M	
Key	1	120/609	F3664	2	MAY 15 1917							3 4 M MAY 22 1917	2 M	3 12 M MAY 17 1917	9 M			4 MAY 23 1917						11 M	
Pin for Shoe 120/80	1	120/616	F3785	3	MAY 15 1917			1 2 M MAY 16 1917	1 M			2 1 M MAY 16 1917	1 M									3 2 M MAY 18 1917	3 M	5 M	
Pin for Shoe 120/82	1	120/617	F3786	3	MAY 15 1917			1 2 M MAY 16 1917	1 M			2 1 M MAY 16 1917	1 M									3 2 M MAY 18 1917	2 M	4 M	
Front Cap	1	120/2	E3017	1	MAY 14 1917	1 30 M MAY 18 1917	20 M			2 50 M MAY 25 1917	35 M	3 20 M MAY 26 1917	15 M											70 M	
Rear Cap	1	120/3	E3018	1	MAY 14 1917	1 25 M MAY 19 1917	20 M			2 40 M MAY 23 1917	30 M	3 15 M MAY 25 1917	10 M											60 M	
Gear Shaft	1	120/575	E3523	1	MAY 15 1917			1 25 M MAY 19 1917	22 M					2 5 M MAY 22 1917	3 M	3 15 M MAY 24 1917	13 M							38 M	
Gear Shaft	1	120/576	E3524	1	MAY 15 1917			1 15 M MAY 18 1917	10 M					2 20 M MAY 21 1917	15 M	3 10 M MAY 23 1917	12 M							37 M	
Bearing Cap	1	120/70	E3405	1	MAY 14 1917	1 20 M MAY 18 1917	18 M			2 15 M MAY 22 1917	20 M	3 10 M MAY 24 1917	10 M	4 3 M MAY 25 1917	2 M									50 M	
Bearing Cap	1	120/71	03491	1	MAY 14 1917	1 10 M MAY 17 1917	13 M			2 10 M MAY 21 1917	12 M	3 8 M MAY 23 1917	5 M	4 3 M MAY 24 1917	5 M									35 M	
Driving Shaft	1	120/559	03521	1	MAY 15 1917			1 60 M MAY 19 1917	50 M	5 10 M MAY 29 1917	10 M	3 5 M MAY 24 1917	7 M	2 20 M MAY 23 1917	23 M	4 20 M MAY 26 1917	15 M							105 M	
Collar for Stop Rod	2	120/611	F3638	3	MAY 15 1917			1 6 M MAY 29 1917	5 M									2 MAY 31 1917						5 M	
Department Time							75 M		129M		107M		56 M		85 M		55 M						10 M	517 M	
																								8 hrs. 37 M	$

Machinery

Fig. 2. Production Manager's Guide Chart, by Means of which the Progress of the Work and the Cost can be easily followed

Each department's time compared with the department's time of lots previously finished.

Kind and amount of additional equipment required for a specified output, based on number of hours required in each department to produce one machine.

Location of various departments to eliminate unnecessary trucking, determined from order of operations.

Location record of every piece in progress.

Which parts are started, not started, finished and unfinished.

Which parts move forward each day.

Distance each part travels from start to finish.

Number of operations finished in each department each day.

Checks purchasing of raw materials.

Rapidity and order in which raw material is issued to machine departments.

* * *

DESTRUCTIVE VIBRATION IN MACHINES

BY A. SEARLES [1]

We often read of the dire effect that might be produced on a bridge by a "fiddler" endowed with enough patience and physical endurance to induce, in the structure, sufficient vibration to cause ultimate failure; also, that an army marching over a bridge should break step in order to avoid deleterious vibrations, constant recurrence of which may cause crystallization and ultimate failure of members. Again, we read much of the effects of vibration from running machinery on steel and concrete framed buildings, and how these vibrations may be damped to avoid the inevitable collapse of the building. So much for the troubles of those responsible for the bridges and buildings, but let us look into the effects of vibration on machinery. Here, vibration may cause fatigue and rupture in members under stress; it may cause wear in joints or bearings; and it may cause fracture and wear in parts under comparatively insignificant working stress. The effect of all vibration is that of a succession of blows, and it is that into which vibration resolves itself.

Considering first the case of a member under tensile stress, a tie-rod for instance, supported only at the ends, the stress produced can be calculated by determining the deflection, and the resultant stress may be found by calculating the amount of elongation. This condition, of course, is assumed on the basis of absolute rigidity of the member, or members, that undergoes the compressive reaction and stresses within the elastic limit. The formula for the stress in a catenary uniformly loaded is:

$$S = \frac{wl^2}{8D}$$

where w = uniformly distributed load per unit of length;
l = length;
D = deflection.

An analysis of this formula will give some idea of the enormous stresses that may be produced by vibration, especially of small amplitude. These high stresses, coupled with high frequency, may soon produce a crystallized condition, with resulting failure.

The resistance of the member to bending, if sufficiently great, however, may overcome the tendency to vibration. For this reason tie-rods subject to vibration of a serious nature should be supported frequently throughout their length or should be of sufficient rigidity to resist vibration. The stretching of bolts also comes under this class, and if bolts are permitted to become loose, the nuts may work off or destroy their threads. Lock nuts are not a sure remedy. Even lock-washers, while apparently as suitable as any locking devices, will not obviate the difficulty entirely. This is shown by the necessity for the railway repair gang to inspect each joint periodically and tighten the bolts which are secured by lock washers.

In the case where vibration produces wear in the joints and bearings, we have the direct effect of impact. Since the force of a blow is proportional to the travel of the member producing the blow, it is necessary to maintain minimum clearances and to use materials capable of resisting as much as possible permanent deformation. Of course, while materials and construction permitting proper resilience might cure the evil, it is oftentimes impracticable to resort to such means, with the result that the next best remedy must be applied. This is admirably illustrated by the present-day tendency in rolling-mill spindle construction. The older practice was to use rough-cast spindles and couplings, with resulting large clearances. These not only produced excessive wear on the parts immediately concerned, but also produced excessive vibration in other parts of the mill. As a result, the cost of maintenance of the equipment as a whole was greatly increased and the production was affected through lost time incurred by repairs. The more recent practice is a construction that permits the machining of the spindle and coupling joints, thus reducing the clearances. The same trend is being followed in rolling-mill gear-drive practice for the same reasons. Where it was formerly general practice to use cast gears, with their attendant evils on account of the necessarily large clearances, there is a growing tendency toward the use of cut gears.

Numerous interesting results have come to the writer's attention through an extended experience with stamp mills, toggle swagers, and vibrating screens. In the case of one type of stamp mill, which weighs approximately six tons and strikes 1300 blows a minute with stamps weighing approximately 150 pounds and dropping five or six inches, the hammer shafts wear, purely from the effects of vibration in their guide bearings, from an original diameter of 2½ inches down to 1½ inch. Cam-shafts in babbitted bearings soon pound out the babbitt linings, and plain cast-iron bearings give much better results. Originally, open-hearth cut steel gears of ½ diametral pitch, twenty-four teeth, three-inch face, were used to transmit approximately one horsepower, with the result that the teeth rapidly wore to a knife-edge and frequently broke. When these were replaced by rough cast gears of 1¾-inch circular pitch, twenty-one teeth, and six-inch face, the gears wore almost indefinitely. While this result is apparently contrary to past statements, it is possibly explained by the superiority of cast iron operating under these conditions. It might be mentioned that these gears ran at a speed of only eighty revolutions a minute. The superiority of cast-iron gears is also shown in rolling-mill practice, where it has been found that cast charcoal-iron pinions are superior to those of cast steel, both of which have cast teeth.

That excessive wear can be produced by vibration only is shown by the case of a one-inch shaft, eighteen inches long, that supported, aside from its own weight, a part weighing not over ten pounds. This part was supported in cast-iron bearings, 1½ inch long, and was infrequently operated, yet it soon wore into an elliptic section approximately ¾ by 1 inch. At the same time the bearings were worn from ⅛ to ¼ inch out of round.

To maintain tight joints and prevent hammering, some toggle swaging machine makers find it necessary to incorporate springs in their machines. These springs are so applied as to maintain compression on the toggles when the machine is running freely. If these springs become loose or are not adjusted tight enough, the whole machine soon starts on the road to destruction. Bearings pound out, bolts stretch in their threads and wobble, wearing out the threads, and even anchor bolts break, again showing the necessity of keeping close clearances in joints. This has occurred in machines weighing eight or ten tons with moving parts that weigh not more than two tons and consume, on an average, not more than ten horsepower.

As an example of vibration causing the fracture of materials under comparatively insignificant stress, may be mentioned the cast-iron driving pulleys that operated the stamp mill just mentioned. These pulleys were thirty inches diameter, had a six-inch face, transmitted two horsepower, and were run at a speed of eighty revolutions a minute, yet they were soon fractured and had to be replaced by paper pulleys.

Because of the necessity of providing for vibration, the experienced designer does not proportion his machine elements too close to the calculated working stresses. This provision is especially necessary when the duty of the machine is such as to produce vibration to any great degree. Also, it is desirable to provide the maximum flexibility and resilience in the proper place, to absorb vibration compatible with practical results; this is the foundation of success in the design of agricultural machinery and the modern automobile.

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[1] [illegible]

MASTER WHITWORTH THREAD GAGES

BY W. T. ILER, JR.[1]

Thread gages with the Whitworth form of thread are the most difficult thread gages that the toolmaker is called upon to make. The Whitworth thread has seven elements, an error of 0.0002 inch in any of which will cause the gage to be rejected. These elements are the full or outside diameter, the core or root diameter, the effective or pitch diameter, the pitch, the angle, the form at the top of the thread or crest, and the form at the root of the thread.

The first step to be taken when making Whitworth master thread gages is to determine the maximum diameter, the pitch diameter, the root diameter. the size of wires used for measuring by the three-wire system, the dimension measured over the wires, the single and double depth of the thread, the radius at the top and bottom of the thread, and the distance between the sharp point of a 55-degree thread and the top of a thread properly rounded, which is equal to the amount that the tool point is shortened in order to obtain the proper radius on the tool. Fig. 1 shows a master Whitworth thread gage with dimensions as given to the gage-maker. In this case, the full or outside diameter is 1.9960 inch. The diameter of the rough blank is made a certain amount larger, this amount being equal to about twice the radius at the top of the thread.

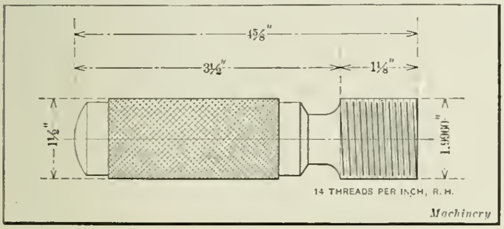

Fig. 1. Thread Gage to be made

When measuring a Whitworth master thread gage, two sizes of wires should be used, one of larger and one of smaller diameter. In this way, it is possible to obtain a check on the angle of the thread. The sizes of the wires may be obtained as follows:

Diameter of small wire = 0.52 × pitch
Diameter of large wire = 0.78 × pitch

To obtain the dimensions measured over the wires, use the formula given on page 1032 of MACHINERY'S HANDBOOK, modified as follows:

$$\text{Diameter over wires} = D - \frac{1.600825}{N} + (3.16567 \times d)$$

in which

D = full or outside diameter of gage;
N = number of threads per inch;
d = diameter of wires used.

The root or core diameter is obtained from the formula:

$$\text{Root diameter} = D - \frac{1.28066}{N}$$

in which D and N denote the same values as in the preceding formula.

The depth of the thread, radius and double depth of the thread may be obtained from the table on page 1004 in MACHINERY'S HANDBOOK.

Probably the most important and least understood matter in the making of Whitworth master thread gages is the making and use of the thread-cutting tools. After the blank has been roughed out, a thread having the correct lead is cut with an ordinary sharp-pointed tool having a 55-degree angle. This thread is not cut quite as deep as required for the finished thread. Tools for cutting the finished radius at the top and root of the thread are then made as follows: A drill with a diameter equal to twice the root or top radius is used to drill a hole in a piece of soft tool steel. as shown in Fig. 2. This piece of tool steel is then cut straight across the diameter of the drilled hole, along line *A–A*. After this, it is cut to the shape of a thread tool with an angle of 55 degrees, as shown in Fig. 3. The tool is then hardened, ground and lapped. The 55-degree angle and horizontal cutting surface should be lapped. If taken directly from the grinding wheel and used, the angle of the tool may be correct and the radius, which is the most important part in cutting the thread, may be in error, due to deformation during grinding. The length of this female radius tool is not of importance. After grinding and lapping the surfaces of the tool, the radius is lapped to a gage.

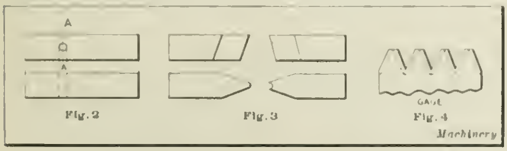

Fig. 2. Blank for Female Radius Tool. Fig. 3. Male and Female Radius Tools. Fig. 4. Thread of Rough-threaded Gage

AMOUNT TO SHORTEN THREAD TOOL TO OBTAIN CORRECT RADIUS

Threads per Inch	Shortening, Inch	Threads per Inch	Shortening, Inch	Threads per Inch	Shortening, Inch
40	0.0040	20	0.0080	10	0.0160
36	0.0044	19	0.0084	9	0.0178
32	0.0050	18	0.0089	8	0.0200
28	0.0057	16	0.0100	7	0.0229
26	0.0062	14	0.0114	6	0.0267
24	0.0067	12	0.0133	5	0.0320
22	0.0073	11	0.0146	4	0.0400

Machinery

The male radius tool for the root of the thread, Fig. 3, is made as follows: A high-speed tool bit is ground perfectly sharp to a 55-degree angle. The bit is then ground and lapped on all surfaces. This is done to make it interchangeable with the female radius tool in the same spring tool-holder. The length of the bit from the sharp point to the opposite end is measured carefully with a micrometer. The accompanying table gives the amount the tool is to be shortened to form the male radius. The amount of shortening is equal to one-quarter of the depth of the thread. The radius is then carefully stoned to size, using the female radius tool as a gage. If the shortening and forming of the radius is carefully done, it ought to require very little further modification to adjust the tool finally so as to bring both the root diameter and the pitch diameter simultaneously to within the limits allowed. The horizontal surface of this tool must also be lapped, for the same reason as given for the female radius tool.

When the gage-maker is ready to use the male radius tool, the gage looks like that shown in Fig. 4. The dotted lines in this illustration show the part cut by the male radius tool.

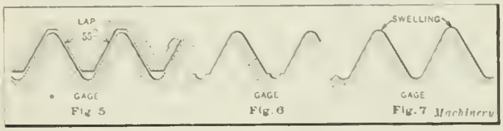

Fig. 5. Lap for Angle of Thread. Fig. 6. Exaggerated Thread Form after lapping Top of Gage Thread. Fig. 7. "Swelling" on Top of Thread

The female radius tool replaces the male tool and the radius of the top of the thread is then cut. All dimensions should be cut to about + 0.0003 inch on a plug gage and − 0.0003 inch on a ring gage. This 0.0003 inch is the amount allowed for lapping.

The next step is to lap the gage to the proper size. This requires four laps. The first is made as shown in Fig. 5. In this lap the angle must be absolutely correct. There need be no top or bottom radius on the lap thread. The root must be cut away so that it does not touch the top radius of the gage. The top of the lap thread should be cut away so that it does not touch the root radius of the gage. The form of the gage thread (exaggerated) after this lap has been used is shown in Fig. 6. The next lap is used to lap the root radius of the gage to size. The angle of the thread of this lap is 54 degrees. The root of the lap is cut away and the top is cut with the female radius tool used in cutting the top radius of the gage. This gives a perfect top radius, so as to lap the root radius of the gage to the proper form and depth. Another lap with a 54-degree angle thread and with a perfect root radius is made by using the male radius tool used to cut the root radius of the gage. The top of the thread of this lap is then cut away. This lap finishes the top radius of the thread of the gage. It will be noticed that the laps, if made as stated above, will lap only one part of the thread at a time. This method will enable the gage-maker to control the various dimensions so as to spoil very little work.

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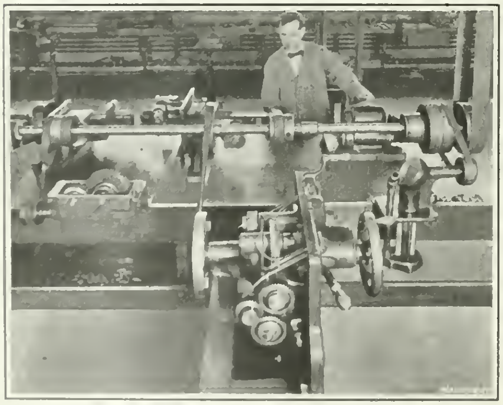
[1] Address: Care of Slocum, Avram & Slocum Laboratories, Inc., 531 W. 21st St., New York City.

It has been found by experience that after lapping the angles and root radius of the thread, a swelling is formed near the top of the thread by the distortion of the metal, as shown enlarged in Fig. 7. The ridges are removed from the thread by means of a lap cut with a very shallow thread, that is, using the top male radius tool to cut a lap just as deep as the radius of the curve at the top of the thread.

* * *

TESTING BENCH FOR MACHINE UNITS

An important factor in the successful performance of a machine after it leaves the factory is the degree of thoroughness with which the component parts are run in before the machine is finally shipped. With this in mind, the Fitchburg Grinding Machine Co., of Fitchburg, Mass., builder of the Fitchburg "six-twenty" grinding machine, attends to this part of the work by testing the different units of the machine on a special bench like that shown in the accompanying illustration. This view shows six of the units of a grinding machine undergoing the running-in operation before assembling.



Bench for testing Units of Grinding Machines

Referring to this illustration, the units on the rear side of the bench are the work drive gear-box; the table traverse gear-box; the head-stock; the cross-feed gear-box on the front side of the bench; the apron; and the lubricant pump. These component units are belted to the drive-shaft, with pulleys to give the correct running speeds, and the inspector goes over them carefully while they are running to ascertain that everything runs right before the machine is finally assembled. In order to make sure that the operation of each unit will be correct under all conditions, the units are run first at the lowest speed and then at the highest speed that will be required in actual operation. If they pass both tests, the units are O.K.'d for assembling. C.L.L.

* * *

The magneto coils for Ford cars are assembled progressively by girls who wind and put each coil in place on its pole as the disks slowly travel past them on a conveyor. The object of the progressive assembly is to set a pace, as each girl must wind a coil and place it in position in order that the sixteen coils shall be finished at the end of the conveyor.

OXY-ACETYLENE WELDING AND THE SCRAP PILE

In ordinary times the scrap pile is the source of a considerable loss of profits. Now that war has pushed up the prices of raw material to unprecedented heights, the American plant owner and factory man have begun to analyze their scrap heaps. They often find huge accumulations of damaged or worn machinery, tools, "short ends" and other material that represents considerable profit thrown away. Face to face with labor shortage, metal shortage and the time factor, plant owners are reclaiming these worn and damaged machines and broken tools and putting them back to work earning profits. Recently an engineer for an oxy-acetylene concern made an investigation in a western mining field. At one large mine he found in the scrap piles, dollies and dies for drill sharpening worth \$9 each, which could be welded and put into service at a cost of about \$1 apiece. At the same time, the mining company was anxious to get more new material. It was found that the scrap heap would yield a three months' supply of good material in a year's scrap accumulation. At another time the engineer found a year's supply of tram buckets, worth \$40 each, with broken bottoms, which could easily be repaired by welding at a slight cost. In addition, he found a three months' supply of stamp stems and short ends of tungsten steel, which could be welded to give a year's supply. He found crusher plates of manganese steel worth \$20 each, slightly too big for the machines then in use, but which could be cut down by the oxy-acetylene process at small cost, and put into service again at a great saving. The various processes of welding have made it possible to reclaim a great number of metal machines and tools that formerly were sold as waste, and at a fraction of the original cost. Nowadays any kind of metal—steel, iron, both cast and malleable, brass, bronze, copper, aluminum, sheet iron and precious metals such as gold, silver, and platinum—can be welded and made as good as new. A railroad company had a large accumulation of scrapped driving wheels for locomotives, most of which had cracked spokes. The demand for more rolling stock caused the company to reclaim these wheels, and they were welded by the oxy-acetylene process, saving the road several thousand dollars and yielding much more in profits through putting discarded engines to work.

* * *

COAL GAS AS A SUBSTITUTE FOR GASOLINE

By using coal gas as a substitute for gasoline, English motor bus companies are said to have succeeded in reducing their fuel cost per mile from 8 to 3.3 cents, with gasoline selling at 61 cents a gallon and gas at 61 cents per 1000 cubic feet. The only change made in the motor is the fitting of a butterfly valve in the air-intake pipe for the regulation of the air supply, which allows the engine to draw the gas in the correct quantity according to load and speed. It is claimed that when using gas the engine is cleaner and the valves do not require grinding so often. The gas is drawn from the main into a canvas bag with an inner layer of rubber, shaped like a mattress, which is strapped to the top of the motor omnibus or to the rear of the automobile. This bag is connected with the induction pipe, and the engine is worked by the suction process in the same manner as the ordinary gasoline vapor induction. Because of the bulky container necessary for the gas, this fuel has proved unsatisfactory for small cars.

* * *

Because of the stoppage of tin imports, Germany is reported to have prohibited the use of solder containing more than 30 per cent tin, and the tin so used must have been recovered from dross or scrap. The making of soldered joints is restricted to cases where lapping, riveting, and electric or autogenous welding are impracticable. It is stated that a usable solder can be prepared from ten parts tin, eighty parts lead, and ten parts cadmium. Although the cadmium is three times as expensive as tin, the extra cost is considered of no consequence because of the necessity of using sufficient tin as raw material.

LETTERS ON PRACTICAL SUBJECTS

WE PAY ONLY FOR ARTICLES PUBLISHED EXCLUSIVELY IN MACHINERY

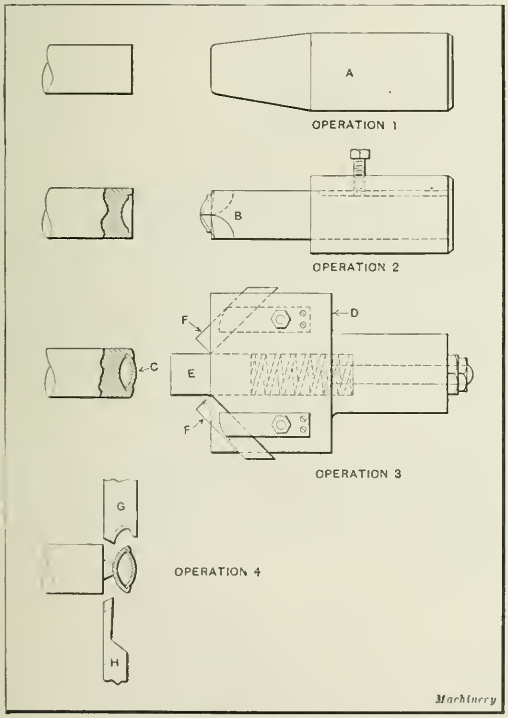
MACHINING EXPANSION SEATS FOR AUTOMATIC SPRINKLER HEADS

In the accompanying illustration is shown a quick and easy method of machining expansion seats for automatic sprinkler heads. These seats are made of 11/16-inch brass rod. To save time on the set-up, two sets of tools can be used in the turret of the screw machine. When a piece is cut off, the stop will be in position for the next piece.

Operation 1—Feed stock to stop; a solid stop *A* can be used, being set about 3/4 inch from the face of the collet.

Operation 2—Cup and face the end of the bar with the combination two-lip tool *B*. Cut the relief about 1/64 inch deeper than the thickness of the sheet-brass disk *C*, which is about 1/16 inch. This disk can be formed and cut out on a punch press in one operation.

Operation 3—Spin disk *C* into place with the burnishing tool *D* shown. The disk *C* is put in place while the machine is in motion and is held there by the plunger *E* while the tools *F* are turning over the edges.



Machining Expansion Seats for Automatic Sprinkler Heads

Operation 4—Form the seat and the round edge with the forming tool *G*. The cutting-off tool *H* should be ground so that no burr will be left when the piece is cut off.

Aurora, Ill. JOHN J. BORKENHAGEN

VERNIER ATTACHMENT FOR MICROMETER

The vernier attachment shown in Fig. 1, which the writer made for his micrometer, while not as accurate as a fixed vernier, is better than the eye for judging fractions of thousandths. It is bored to suit the sleeve of the micrometer and is split to provide enough spring to hold it in place. Lack of space on most micrometers makes a narrow ring necessary. The writer has one 3/16 inch wide and of the same diameter as the thimble, which he always uses when the location of the thimble will permit. A small flat is milled, as shown, on which is a line to coincide with the line on the sleeve of the micrometer; 3/25 of the circumference from this the graduations begin, ten spaces being equal to 9/25 of the circumference. The graduating can be done with a dividing head on a milling machine. The first space will be four turns and twenty holes on the twenty-five-hole circle; the other spaces will be one turn and eleven holes on the same circle. In use, the micrometer is opened to the nearest thousandth of the desired size. Then the ring, having been placed on the sleeve as shown in Fig. 2, is slid up against the thimble and turned so that the lines coincide. Fractions of thousandths may now be read as with micrometers with fixed verniers. A. F. H.

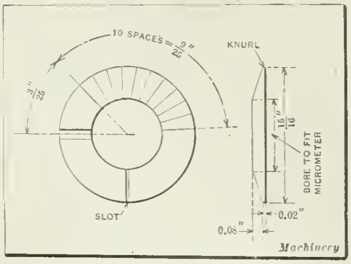


Fig. 1. Micrometer Vernier Attachment

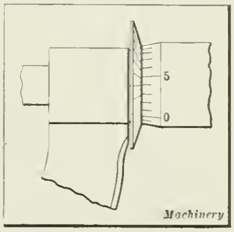
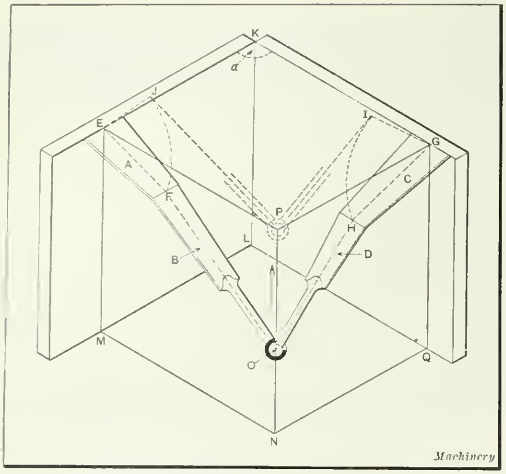


Fig. 2. Micrometer with Attachment in Place

A TWO-PLANE STRAIGHT-LINE MOTION

The linkage known as Peaucellier's exact straight-line motion is composed of seven links with two fixed centers of motion, as described in MACHINERY, August, 1916. If these links are represented by straight lines, the arrangement may be described as a one-plane motion, since all the elements are contained in the same plane. The question naturally occurs: Is it possible to design a straight-line motion having elements in different planes? This result may be attained by four moving pieces with two fixed axes of motion. The figure is an isometric drawing of the combination, which illustrates the simple geometrical theorem that any two planes intersect in a straight line. The planes *EKLM* and *GKLQ* intersect at *KL*, and the moving pieces *A* and *B* are hinged at *E* and *F*, respectively. The broken center line *EFO* (broken at *F*) is constrained to move in the plane *EPNM*, which is perpendicular to the plane *EKLM*. Similarly, the moving pieces *C* and *D* are hinged at *G* and *H*, respectively; and the broken center line *GHO* (broken at *H*) is constrained to move in the plane *GPNQ*, which is perpendicular to the plane *GKLQ*. The pieces *B* and *D* are united by a ball-and-socket joint *O*, the center of which is at the intersection of the center lines *FO* and *HO*. As the center lines *EFO* and *GHO* will remain in the planes *EPNM* and *GPNQ*, respectively, in whatever positions the moving pieces may be placed, the locus of the point of intersection *O* will be at the intersection of the planes containing them; that is, the path of the point *O* will be the straight line *OP*. The broken center lines *EFO* and *GHO* are shown dotted in the positions they reach when the point *O* is at *P*. It



A Two-plane Straight-line Motion

should be noted that the pieces *A*, *B*, *C* and *D* may be of any length, equal or unequal; that *E* and *G* may be in any positions on the lines *EK* and *GK;* and that the planes *EKLM* and *GKLQ* may be assumed at any angle α.

Hartford, Conn. FREDERIC R. HONEY

DESIGNING A MOVEMENT

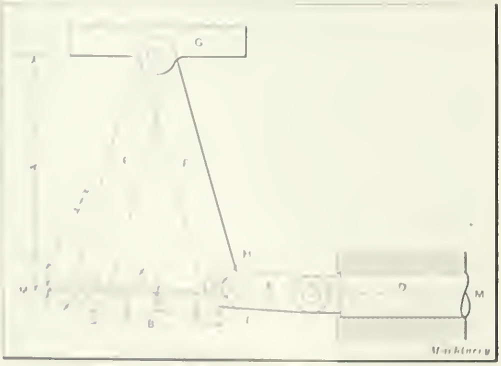
In designing a motion of the type shown in the illustration, it is necessary to have link *E* vibrate equally above and below the center line *MM*. A mathematical solution of this problem is not treated in any books the writer has seen. One book that showed a graphic solution added that "the mathematical way is a very extensive process." In the cut-and-try method of the graphic solution, in which *X* is taken as slightly less than one-half *HI*, fairly good results are obtained, which, however, are not satisfactory to the mathematical mind. At first the problem looked somewhat difficult, but upon investigation it proved to be quite simple. The quadratic equation becomes one of the first degree, as the solution shows. The parts are as follows: *G* is the machine frame; *F*, a lever shown in the extreme positions; *E*, a link; and *D*, a slide. The distances *A* and *B* are fixed and the problem is to obtain $A + X$, for the required length of the lever. In the right triangle:

$$A + X = \sqrt{(A - X)^2 + \left(\frac{B}{2}\right)^2}$$

Squaring, we have:

$$A^2 + 2AX + X^2 = A^2 - 2AX + X^2 + \frac{B^2}{4}$$

$$4AX = \frac{B^2}{4}$$



Designing a Movement

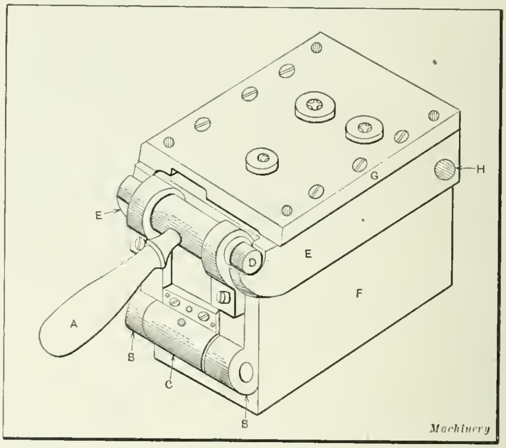
$$X = \frac{B^2}{16A}$$

$$A + X = A + \frac{B^2}{16A} = \text{length of lever.}$$

Prince Bay, N. Y. LOUIS WRAY

QUICK-LOCKING DEVICE FOR BOX JIGS

In the accompanying illustration is shown a handy quick-locking device for box jigs, etc. The handle *A* is threaded into an eccentric shaft *D*, which hinges on two straps *B*. These, in turn, hinge on a support *C* secured to the front of the jig *F*. Arms *E*, fastened to the cover plate of the jig, project beyond the front of the jig to provide a socket for the action of eccentric shaft *D*. They also give side support to the jig cover and are hinged on pin *H*. Lever *A* is pulled up and out to open the cover and given the reverse motion to close it.



Quick-locking Device for Jigs

E. EDWARDS

SCRATCHING OUT LINES ON THIN PAPER

For one reason or another, drawings are sometimes made on thin paper, such as typewriter paper. If after the lines are inked in, a mistake is found that necessitates scratching out even a short line, it is difficult to make this erasure without making a hole in the paper. If the work of correcting can be left until the drawing is removed from the board, and two or three sheets of the same stock are laid under the drawing before the work of scratching out is begun, there will be little risk of tearing the paper. A sheet of thick drawing paper can be used instead of the extra sheets of thin paper.

Middletown, N. Y. DONALD A. HAMPSON

HEIGHT OF CHIMNEY

In the March, 1917, number of MACHINERY, directions were given for determining the height of a chimney by the old process of measuring the shadow cast upon the ground. While this method of measurement is theoretically correct, there are many practical objections to its use.

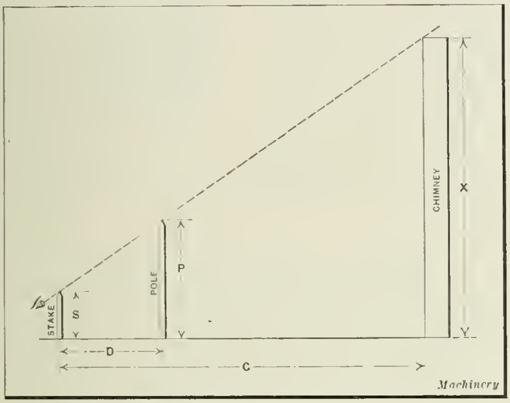
Select the most convenient place in sight of the chimney top and erect a short pole, as shown in the accompanying illustration. At a convenient distance from the pole, say eight or ten feet, drive a stake in line with the pole and the chimney; the tops of the stake and the pole may be bluntly pointed. See that both the stake and the pole are plumb. Drive the stake into the ground until the tops of the stake and pole are in line with the top of the chimney, or if more convenient, mark the stake at the point that is in alignment with the pole top and the chimney top. Mark a ground line on the stake level with the ground line of the pole. Measure the distance *C* from the chimney to the stake, the distance *D* from the stake to the pole, the height P of the pole, and the height S of the stake. Then the height X of the chimney is:

$$X = \frac{C}{D}(P - S) + S$$

For the formula as given, the ground line at the pole and stake must be level with the base of the chimney. If the base of the pole is above or below the base of the chimney, add or subtract this difference from the calculated height X. If C is 160 feet, D is 8 feet, P is 7 feet, and S is 2 feet, 4 inches, we have, substituting the values and reducing all measurements to inches:

$$X = \frac{1920}{96} \times (84 - 28) + 28 = 1148 \text{ inches} = 95 \text{ feet, } 8 \text{ inches}$$

If the ground line at the pole is 2 feet above the base of the chimney, the total height of the chimney will be 95 feet, 8 inches plus 2 feet, or 97 feet, 8 inches.



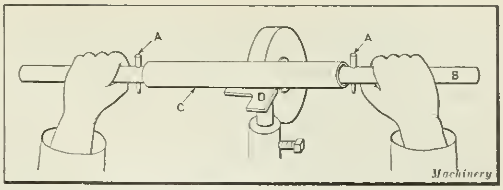
Method of finding Height of Chimney

This method will give accurate results that can be verified at any time; it can also be varied to suit conditions. For instance, a mark on the corner of a building will often serve in place of the pole. The measurements may be made on a sloping roof if necessary, taking into account all differences of level.

Barberton, Ohio FRED B. COREY

REMOVING SCALE FROM SHORT BOILER TUBES

A rush job which came to the shop one day was a small vertical boiler that required a set of new tubes. The tubes were very short, less than 18 inches long. So some long used tubes were cut to length by being caught in the chuck of a hollow spindle lathe and the required length of tube cut off with the pipe cutter, an ordinary hand tool being used; the lathe rotated the tube while the pipe cutter remained stationary. The pipe cutter upset the ends of each tube slightly, but enough so that the tubes would not pass through the holes in the tubesheet of the boiler. The burr was filed off a couple of the tubes, but even then they would not go into the holes on account of a thin layer of hard scale. Neither could the tubes be driven in, because the tubesheets would be cut by the scale. As no tumbling barrel was available, the scale was removed by grinding.



Scaling Short Boiler Tubes

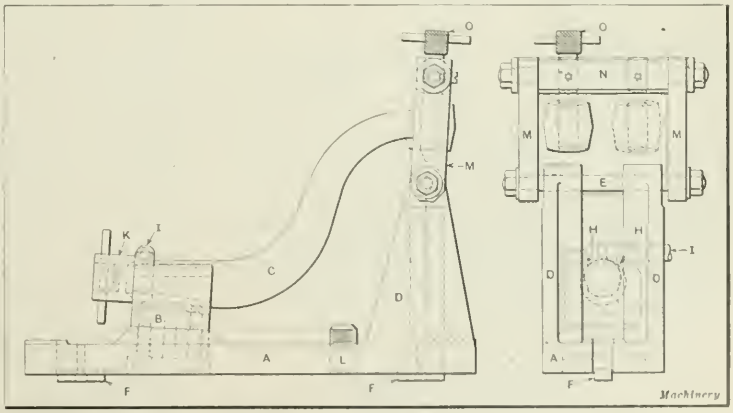
At first, one of the tubes was rolled around in front of a water emery grinder, which removed the scale, but it required some time to bring all parts of the tube against the grinder wheel. The apparatus shown was then rigged up, and the set of tubes scaled easily and quickly. Two holes for taper pins A were drilled and reamed in a piece of 7/8-inch cold-rolled rod B, these holes being about 1/8 inch farther apart than the length of the tube C. When the rod had been placed through the tube and the pins inserted, the tube was applied to the wheel of a dry grinder as shown. The tube was placed on a rest D, but so lightly that when the weight of the bar was lifted the grinder wheel caused the tube to revolve slowly. It only required a few minutes for a helper to acquire the knack of holding the bar in such a manner that the tube would revolve slowly against the grinder wheel; then the tube was traversed slowly endwise until it had entirely passed over the grinding wheel. In a short time, the helper was able to remove all the scale during a single passage of the tube past the grinding wheel. The burr was removed at the same time.

Indianapolis, Ind. JAMES F. HOBART

SPLINING FIXTURE FOR GASOLINE TRACTOR STEERING ARMS

In the accompanying illustration is shown a fixture used when cutting a spline 1/4 inch wide, 1/8 inch deep, and 2 1/4 inches long in the tapered shank of the steering arms of a gasoline tractor. The center line of the spline must lie in a vertical plane through the axis of the tapered shank and parallel to one containing the axis of the hole. The finished faces of the boss and the location of the hole are not required to be accurate, so that the only constant location is the taper. The floating locating device allows the locating plug to float in every direction, but keeps its axis in a vertical plane parallel to the plane containing the axis of the taper. It thus secures the accuracy required without exacting accuracy in the finished faces of the boss or the location of the hole.

The construction of the fixture is as follows: A cast-iron base A, which is clamped to the milling-machine table, provides a seat for the steel piece B in which the tapered shank of the steering arm C is located. It also has two vertical arms D, in the ends of which the rod E carrying the floating locating device slides and rotates. This base is provided with the usual tongues F and screws for fastening it to the table.



Splining Fixture for Tractor Steering Arms

The hardened steel seat *B* that locates the tapered shank of the steering arm is provided with two ground surfaces *H;* the splining cutter *I* is set in position for cutting by placing a 3/8-inch set-block against the larger of these surfaces. Both right- and left-hand steering arms are located in this seat by the tapered part of the shank; a 1-inch groove in the seat provides clearance for the cutter and an outlet for the chips. A hand-nut *K* is screwed onto the threaded part of the steering-arm shank and thus locks the tapered part of the steering arm in the locating seat *B*. This hand-nut is countersunk and its threaded part is only 3/16 inch long; the other part fits over the outside diameter of the threaded shank of the steering arm, thus making it easy to remove and replace rapidly. When this nut is not in use it is screwed upon a stud *L* to prevent it from being lost.

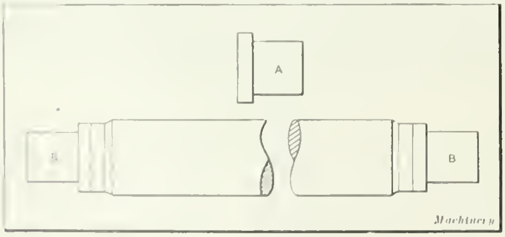
The floating locating device consists of a hardened and ground steel rod *E* that rotates and slides in the bearings in the cast-iron base *A*. The side bars *M* are clamped by nuts and washers to rod *E*, and are reamed to provide bearings for a cross-bar *N* that has two 5/8-inch holes for the locating plug *O*. Plug *O* is used in one hole for the right-hand steering arm and in the other hole for the left-hand arm. Thus the plug is free to rotate about the axis of the cross-bar *N*, and also about the axis of the bottom rod *E*, as well as to move 3/16 inch each way horizontally; yet its axis is always in a vertical plane parallel to a plane containing the axis of the taper. This plug is prevented from being detached from the cross-bar *N* by a screw, which is turned down on the end to a sliding fit in the keyway in the plug. The side arms should be drilled and reamed together so that the center distances of the holes are exactly alike.

In operation, the locating plug *O* is swung back of the fixture out of the way and the tapered part of the steering arm is inserted in the tapered hole in the seat *B*. Plug *O* is then swung into position and pushed into a hole in the boss of the steering arm and the hand-nut *K* is screwed on, thus locking the steering arm in position. One steering arm is splined at a setting. In changing from right-hand to left-hand steering arms, or *vice versa*, the locating plug is transferred from one hole to the other in the cross-bar; this is the only change. This fixture has been the means of avoiding much trouble in manufacturing and assembling, and is a rapid producer.

Hartford, Conn. JOHN J. WOFFINGTON

POWER HACKSAW ON LATHE WORK

The writer had to make several small steel pieces like that shown at *A*, out of bar stock on an engine lathe. To obviate changing tools, both ends of the stock were turned up as shown at *B* with one tool. The ends *B* were then cut off in a power hacksaw while turning similar ends on another piece of stock. Of course full-length bars of stock could not be used, as the time and trouble saved in not having to change tools and cutting off in the lathe would be lost in turning the long bars from end to end, but bars from two to three feet long can be handled this way without much trouble.



Power Hacksaw on Lathe Work

Worcester, Mass. C. ANDERSON

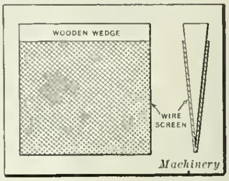
COUNTERSINK SLEEVE

Although the countersink sleeve described in the August number of MACHINERY is satisfactory in certain respects, it has one disadvantage: No matter how tightly the set-screws may be fastened, there is always a tendency for the sleeve to move upward upon the tool if it is brought in contact with the work with any shock. This trouble may be overcome by threading the upper part of the countersink and the sleeve and depending on the set-screw only to prevent rotation of the sleeve. In place of the screw, a thin lock-nut may be used. Tools of this type have been successfully used by the firm by which the writer is employed.

Buffalo, N. Y. CHARLES A. KUHN

FASTENING HAMMER HEADS

The method of fastening hammer heads here shown has proved very satisfactory, and is neater than that described in the May, 1917, number of MACHINERY. Fit the handle to the head in the ordinary way and cut the slot for the wedge slightly wider than usual. Cut a hardwood wedge and bend around it a piece of fine-mesh iron-wire gauze, as shown in the accompanying illustration. Drive the wedge and the gauze in securely and soak the hammer head in water over night. The wood of the handle and the wedge will swell into the mesh, making a good, secure job.



Using Wire Gauze to fasten Hammer Heads

G. E. H.

CUTTING MULTIPLE THREADS

Many devices and methods have been proposed from time to time for the purpose of cutting multiple threads. Multiple faceplates capable of being indexed to various positions have been made and prove useful where much of this work is done. However, these devices are of no avail for multiple internal threading; for this, various methods must be devised for relocating the carriage in relation to the work to obtain the desired result. Where the lathe has a compound tool-block with a graduated dial, it is only necessary to move the compound tool-block into a position at right angles with its normal position, when upon completion of the first cut of a multiple thread the tool can be advanced the correct distance and each thread completed in its turn. This method lends itself to either outside or inside threading. Many lathes, however, are not fitted with compound blocks or graduated dials, so that this method cannot easily be used.

The following simple way of cutting multiple threads can be used on any lathe for either outside or inside threading; it calls for no special faceplates, etc., and is quickly available for an occasional job of this kind. It requires merely a collar to slip over the spindle nose. The width of this collar will be one-half the pitch of the thread on the spindle nose, in the case of a double thread, thus advancing the faceplate or chuck, as the case may be, just one-half turn. When the first thread is completed, removing the collar allows the next thread to locate properly on the work. By the use of two collars triple threads can be cut, one being one-third the spindle-thread pitch in thickness, and the other two-thirds. Assuming a spindle-nose thread of four per inch, the collars would be 0.0834 and 0.1667 inch, respectively; or with a double thread to cut, the collar would measure 0.125 inch in thickness. A perfectly satisfactory job results with ordinary care, and little time is wasted in getting ready to start. F. E. L.

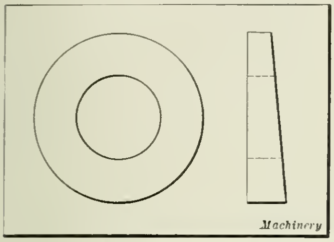
REPAIRING A BROKEN FOLDING RULE

Allow me to take issue with the statement, on page 806 of the May number of MACHINERY, that glued breaks in a folding rule last only a short time. If pianomakers' glue is used, thin and hot, the surfaces to be glued being heated and the pieces clamped together until the glue has set, the wood will break in a new place before the joint will part. One might just as well use flour paste as to use cold glue.

New York City ROBERT GRIMSHAW

TOOLPOST COLLAR

The toolpost collar and shoe ordinarily furnished with an engine lathe has a spherical bearing that allows a wide range of vertical adjustments. While this form has the advantage of very slight adjustments, it is not as rigid as might be desired. The Du Bois toolpost collar and shoe, described in the May number of Machinery, having notches on the shoe and the collar, gives a much more rigid hold on the tool, but does not allow the slight adjustments that can be obtained with the plain shoe. In one shop in which I worked, the collars were made plain, and adjusted by inserting shims of varying thickness under the tool. This gave a rigid setting, but necessitated a trip to the tool-room for every lathe job, and where a very small vertical adjustment was required, it was often difficult to find the right combination of shims. To overcome this, the form of collar shown in the accompanying illustration has been adopted. This is simply a plain ring, faced true with the axis on one side and at an angle with the axis on the other. By rotating the collar around the toolpost, the tool can be elevated through its whole range. The bearing of the tool upon the collar is always flat, thus making it very rigid. If a greater range of adjustment is required, a flat shim may be inserted under the tool. A collar of this form allows a wide range of very close adjustments and still holds the tool much more rigid than the spherical form.



Toolpost Collar that permits Close Adjustments

Lomax, Ill. P. H. White

USELESSNESS OF THE INTERMEDIATE MEASURES OF LENGTH

The announcement of the organization of the American Institute of Weights and Measures is pleasing news. Although he has nothing to add to the vast amount that has been written on both sides of the metric controversy, the writer is sure most fair-minded men will agree to the statement that we are not giving the units of weight and measure we now use a fair chance to serve us. Even if we were not threatened by the metric menace, would it not be the reasonable thing for us to use the present units with the least expenditure of mental energy? One glaring example of the worse than useless burden the metal workers carry is the practice of using on the same drawing six binary and one decimal subdivision of the inch, and these seven subdivisions are none too easily translated and compared one with another; they are halves, fourths, eighths, sixteenths, thirty-seconds, sixty-fourths, and thousandths.

Theoretically, the yard is the unit of linear measure; and linear measure only need be considered, as it is the basis of most standards of measure, whether time, weight, or extension. In several kinds of linear measurements, however, the yard is wholly ignored and some multiple or fraction thereof is used, because more convenient. For instance, the woodworker has adopted the inch in describing sections of lumber. He knows that the inch is the thirty-sixth part of a yard and the twelfth part of a foot, but he never describes a piece of material as 1/18 by 1/6 yard, or as 1/6 by 1/2 foot; rather, he describes this piece as 2 by 6 inches. By so doing, its relation to a 2 by 4 inch piece is instantly seen. How would it be if he were to describe the pieces as 1/18 by 1/6 yard, and 1/18 by 1/9 yard; or as 1/6 by 1/2 foot, and 1/6 by 1/3 foot? In describing a section of timber, the inch is the unit even beyond twelve inches, as the wood-worker speaks of a 2 by 16 inch joist; not a 2-inch by 1-foot, 4-inch joist. In a word the inch, being as small a unit as he is likely to use often in such measurements, is made the unit; just as everyone uses the cent and its multiples in naming values up to a dollar, ignoring the dime, which was undoubtedly intended as an intermediate unit between the cent and the dollar.

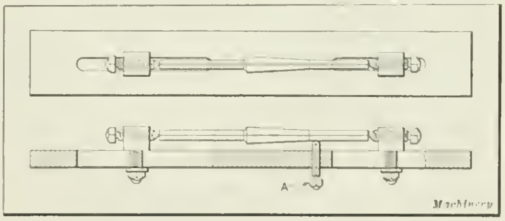
A tool crib of the writer's acquaintance is served by one man, who is often changed. He is always a green man to start with, and his efforts in realizing the size relation between a 5/8-inch drill and a 39/64-inch drill are distressing. Why not decide that 1/64 inch is the smallest unit we are likely to need in designating drills above a certain size and give all sizes below the inch in sixty-fourths? Here, again, the practice of wood-workers furnishes something of a guide. In the old days of heavy framing, augers varied by 1/4 inch and were known as two-quarter, three-quarter, four-quarter, five-quarter, and so one, and today, wood-workers' brace bits vary by 1/16 inch and are marked with numbers indicating the number of sixteenths of an inch each is in diameter. This not only is much simpler, but makes possible the use of larger characters in stamping sizes on the limited areas available. If drills, reamers, and taps were marked in the same reasonable way, what an amount of mark-hunting and eye strain could be saved, not to mention the easily realized relation between a 40/64-inch (5/8-inch) and a 39/64-inch, or a 41/64-inch drill?

Of course drawings should be dimensioned in the same way, possibly thus avoiding part of our many errors in adding and subtracting dimensions. Protests against the use of binary and decimal fractions on the same drawing were published many years ago. The same complication and source of error exists today. Huge wall charts, designed to help translate one into the other, appear at frequent intervals wherever such drawings are in use—everywhere in the metal-working industries in this country. The introduction of decimal fractions in the metal-working industries, while still retaining the partial use of binary fractions, always was, and always will be, the source of endless error and a great progress retarder. In the case of the micrometer we seem to have been far more reasonable. We entirely ignore the chance to introduce fortieths and in almost all cases we forego fourths and halves, naming sizes in multiples of the smallest unit that is frequently used, 0.001 inch. Who can say why we burden ourselves with seven fractions of an inch when one or two would serve much better? Here's for a start at relieving us of part of our present burden; at the same time we take the big stick from the man who would saddle us with more.

Wilkinsburg, Pa. William S. Rowell

STRAIGHTENING HIGH-SPEED STEEL REAMERS

Several high-speed steel reamers about 14 inches long, with a pilot ⅝ inch in diameter and 3½ inches long, were sprung in hardening so that they would not finish to size; so the simple device here shown was made and clamped in a vise close to the hardening furnace. The reamers were heated and placed in position in the fixture; then a little pressure was applied with a screw A at the point of greatest error. This device also is used for testing by rotating the reamer on the centers and observing the space between it and screw A. The advantage of the device for high-speed steel is apparent, because, after hardening, the steel may be heated sufficiently to correct it without injuring its temper.



Device for straightening High-speed Steel Reamers distorted by hardening

Springfield, Vt. F. H. Whitney

WHY DIDN'T IT EXPLODE?

In the August number of MACHINERY, W. S. R. asks why a can of milk did not burst or show signs of escaping steam while immersed in boiling water. The explanation is very simple. There was no steam escaping from the can because the milk did not boil, and the milk did not boil because it was not sufficiently heated. The boiling point of milk is 215 degrees F., and that of water is only 212 degrees F. The bulging of the ends of the can was caused by the contents becoming heated and expanding.

St. Louis, Mo. LOUIS A. SCHLOSSSTEIN

The title "Why didn't it explode?" should read "Why should it explode?" The temperature of the "furiously boiling" surrounding medium was 212 degrees. The pressure due to this temperature is 14.7 pounds, or atmospheric. The temperature in the interior of the can is, therefore, at most 212 degrees and the pressure atmospheric. As the internal and external pressures exactly balance, why should any explosion be expected?

Holyoke, Mass. W. M. FLEMING

The reason the can of milk did not explode is easily given. In the case of all canned foods, the surplus air is exhausted before the small vent hole in the can or cap is sealed. The general method is to place the cans in steam-heated ovens so that the food will expand and force out the surplus air. Then when the cans are sealed and cooled, what air they may contain is below the atmospheric pressure, with the result that if the cans are over-exhausted or underfilled, the sides will collapse. Foods that are packed cold are subjected to a temperature of 160 to 180 degrees F. for from one to three minutes. Foods, like corn and tomatoes, that are partly cooked when packed are packed hot and so do not require the exhausting process.

After the vent is "tipped," or sealed, the foods are sterilized, or cooked, to prevent fermentation and to destroy bacteria. Berries and fruits are subjected to a temperature of 212 degrees F. for ten or fifteen minutes; tomatoes are subjected to a temperature of 240 degrees F. for from twenty-five to forty minutes; while salmon is subjected to this temperature for one hour. Subjecting a can of milk to a temperature of 212 degrees for twenty minutes, therefore, hardly overcomes the partial vacuum in some food cans.

The art of soldering tin cans is known to only about a hundred men in the United States. A No. 3 tomato can will not burst under a pressure of 75 pounds per square inch nor will it spring a leak at 50 or 60 pounds. A No. 2 corn or pea can will burst if subjected to a pressure between 90 and 120 pounds, and a milk can will resist pressures up to 125 pounds, as they are lighter as well as smaller in diameter. This strength is secured in spite of the fact that can makers use less solder in making the whole can than the packers use on the cap alone. Cans are tested with an air pressure of 15 to 18 pounds per square inch under water, and the seller guarantees that not over two cans out of each thousand will leak when filled and subjected to cooking strains, and agrees to pay for the cans, the food in them, and the cost of packing if the leaks exceed that amount—which never happens, even when this nation empties 13,000,000,000 tin cans a year.

Wheeling, W. Va W. H BROOKS

BORING A LARGE FLYWHEEL WITH IMPROVISED TOOLS

Modern methods have largely done away with the odd jobs that used to be encountered and that required considerable ingenuity on the part of the machinist. While many of the older men will doubtless recall jobs similar to the one here described, these makeshifts bring out points of interest even to the modern machinist.

A flywheel 12 feet in diameter, and weighing many tons, had to be bored. As no shop in the locality could handle the work, the following method was used. One end of an old piece of shafting was chucked in the lathe, the other end being supported by steadyrests. When trued up, the shaft was turned for a short distance close to the chuck and a 32-pitch thread cut on it, the length of the thread being a little longer than the hole through the hub of the flywheel. About one inch of the shaft close to the chuck was then turned to tap size. This, together with the thread, was polished smooth and the shaft was cut off close to the chuck. A hole was then bored in a hardwood plank to fit the tap size, making a tight fit, and an inside threading tool was run through a couple of times, roughly cutting a 32-pitch thread. Before removing the piece of plank from the chuck, a circle was struck upon it a little distance from the hole; this was used in centering the boring-bar.

This piece of plank was laid between two timbers and suspended below the flywheel; a bearing placed above the flywheel supplied the other bearing for the boring-bar. The lower end of the bar was then centered by measuring from the rim of the flywheel to the circle on the plank and the upper end was centered by measuring to the shaft. The lower bearing was then fastened securely to the floor. A cutter in a collar was placed on the shaft and a lever fastened to a split pulley, which was clamped to the shaft, gave a means for turning the boring-bar. The feed of the bar was derived from the thread traveling through the plank; a clamp prevented the plank from splitting. Three cuts were taken, the first one down, the second one up by reversing the cutter and the direction of the bar, and the third down again. Half a day's work of a laborer supplied all the power required and was cheaper than rigging up for any other source of power.

The balancing of the flywheel was done after it was placed in position. The shaft was raised out of its bearings and rested on large flat bars of steel, care being taken to have them level. Provision for obtaining the balance was made beforehand by casting weights on the inside of the wheel all the way around. These weights were nicked close to the wheel and were easily removed as required.

Scranton, Pa. JOHN H. VAN ARKEL

PAINTING STEEL CEILINGS

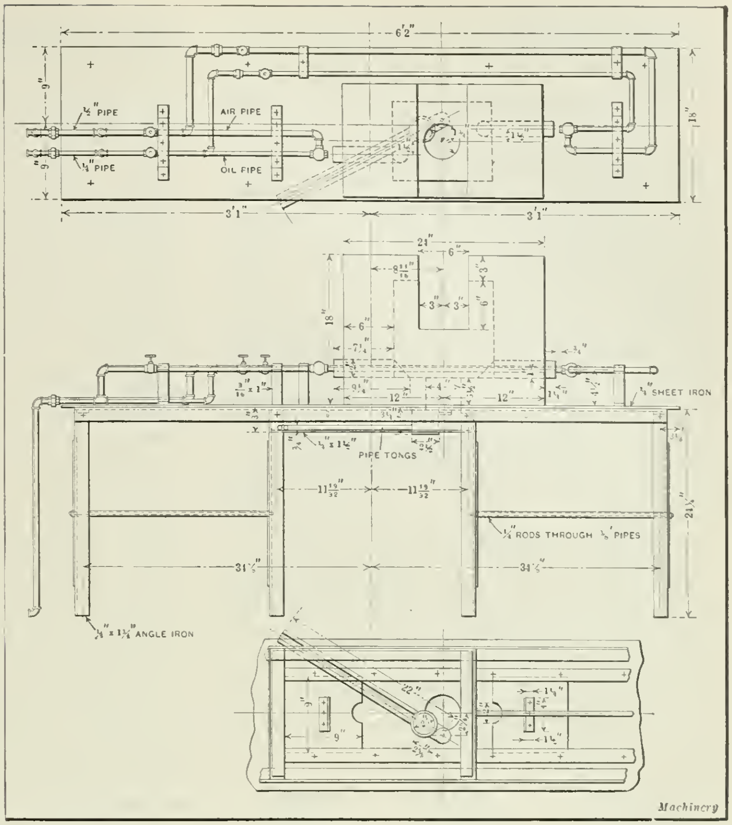
The manufacturers of steel ceilings prepare the sheets with a gloss, as follows: After the sheets are stamped, they are dipped in a mixture of zinc white and varnish that has been thinned down with benzine. Not enough zinc white is added to make the finish opaque, though this is not important, since the finish is applied by a painter who prefers a different prime coat, one quite dead or flat. If the steel sheet has not been primed or coated in the factory, the painter must cleanse it of grease and dirt with benzine, or some alkaline solution. When dry, it should be coated with raw or boiled oil to which a little drier has been added. While the makers of steel ceilings use a primer with a pigment base, zinc as a rule, the best primer is the pure oil, raw or boiled. After the oil priming coat has become dry, any desired paint may be applied; usually a gloss paint is used, though many prefer a soft, rather flattish effect.

Galvanized iron should not be painted until it has been subjected to the weather for a year or so, unless it has been treated with a liquid to cut the so-called "grease" or galvanizing. In many instances, new galvanized work looks well enough without paint, in which case it is a waste of time and money to apply paint to it. But when the finish demands the painting of the galvanized work, it may be prepared by giving it a coat of the following mixture: Dissolve in one gallon of soft water 2 ounces each of copper chloride, copper nitrate, and sal ammoniac; then add 2 ounces of muriatic acid. Mix in a wooden vessel and apply with a broad-bristle brush. When dry, the work may be painted.

Liverpool, England MARK MEREDITH

BRAZING FURNACE

In the accompanying illustration is shown an efficient brazing furnace with two burners, which heats the pipe all the way around. The top of the supporting table is made of 1/4-inch sheet iron, 18 by 74 inches, which is fastened by coun-



Two-burner Pipe Brazing Furnace

tersunk bolts to angle-irons running lengthwise of the furnace. Each leg is made of a continuous piece of angle-iron, and the table is made rigid by ⅛-inch by 1¾-inch plates across the legs and by ¼-inch rods, passed through ⅜-inch pipes, as shown. This furnace will take 4-inch copper pipes, but is used mostly for brazing 2½-inch pipes. As the pipe is placed in a vertical position, the 4-inch hole makes it possible for the pipe to extend below the table top if necessary. Directly beneath the top of the table are two slides, resting on plates running lengthwise; each of these is cut out so that when closed they will make a snug fit around a 2½-inch pipe. Underneath these slides is a pair of pipe tongs, working on a pivot. The ends of the handles are supported by a ¼-inch by 1½-inch iron plate; the tongs are shown pushed in out of the way. By the aid of these tongs, a pipe can be held at any desired height for the flames to work upon.

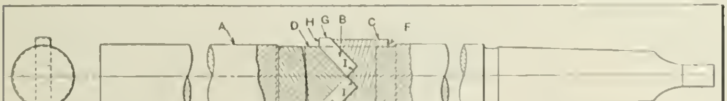
The center lines of the two burners are 3 inches apart; this makes a quick heating arrangement and at the same time heats a good portion of the pipe. A ¼-inch oil line and ½-inch air line are run from the tanks to a T near the furnace; from there on, there are two oil and two air lines, one of each for each burner. The piping is supported by 3/16- by 1-inch iron supports, and all valves are placed close together so they can be conveniently and rapidly operated.

The box is 24 inches long by 13½ inches wide, and is made of ⅛-inch sheet iron, which is lined with firebrick, covered with fireclay. Each side is cut out 6 inches wide and 9 inches deep; the inside is shaped as shown by the dotted lines. A small plate can be laid over the hole in the bottom, through which long pipes are passed to retain the heat when the pipes are laid horizontally or when short pipes are being worked upon. M. K.

SOLID ADJUSTABLE BORING-BAR

The boring-bar of the solid adjustable type here described has given excellent satisfaction. This particular bar is for a drill-press fixture having guide bushings above and below the cut, and the bar is therefore shown with pilot sections above and below the cutters and with a taper shank. However, the same principle can be used for a turret-lathe bar. The cutters *B* are of standard section of high-speed steel, the same as that used for tool-holder bits. The holding piece *C* is a nice fit in the slot in the bar *A* and is centered in the customary manner by being fitted up over a flattened part of the bar at *F*. The cutters are held in place by the piece *D* and key *E*. The edge of key *E* bearing against part *D* is made slightly rounding to take up any inaccuracy in the cutter stock. All parts except the cutters are made of machinery steel and pack-hardened, the pilot sections and taper shank of the bar being then ground. The cutters are ground to size on the surface *G* without clearance, being cleared only from the cutting edge *H*. When the bar begins to cut under size, the cutters can be packed out at *I* and reground. This bar has the advantage of having high-speed cutters without the expense of making them up special. Besides, it ties up the minimum amount of high-speed steel, thus reducing the waste far below that of the ordinary solid or adjustable cutters.

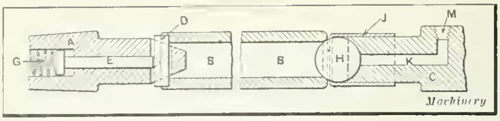
Orange, Mass. W. R. Stults



Solid Adjustable Boring-bar for Drill-press Fixture

TURNING PISTON-PINS

The accompanying illustration shows a method of turning piston-pins in which it is not necessary to stop the machine when removing or inserting the work. By the old method, the pins were turned on ordinary centers at high speed. In the headstock center *A* is a cross-key *D*, which engages a slot milled in one end of the piston-pin *B*. Key *D* is backed by a plunger *E* and spring *G*. The end of the headstock center is threaded for an Allen set-screw, by means of which the spring tension against plunger *E* and key *D* is adjusted. These pins are made from steel tubing, which is rounded and centered on one end and then cut off, rounded and centered on the other end; these operations are performed on Brown & Sharpe automatics. The slot is then milled in the end, after which they are ready to be turned. When turned by the old method, the pins revolved at high speed, causing the tailstock end of the pins to wear rapidly, with the result that they were turned out of round, so that in the grinding operation after hardening,



Turning Piston-pins using Steel Ball on Tailstock Center

many were found that would not "clean up." Another disadvantage of this method was that white lead was used as lubricant, and if it was not all removed from the pins it would prevent the places covered from being properly carburized. Then, too, the tailstock center, after being used a short time, became worn and raised a burr on the inside of the pin, which caused considerable trouble when the pin was ground.

The new method produced a round pin without any burr in the end and entirely eliminated the use of white lead. The special feature of this device was the use of a hardened steel ball *H* revolving with the pin, on the hardened concave end of tailstock center *C*. Ball *H* is held in place by a piece of brass tubing *J*. Cross-holes *K* drilled in the tailstock carry the lubricant to the ball *H* from the grease cup screwed into the tapped hole *M*. By the old method, it was necessary to run one machine day and night to get the desired production; by the new method the production is obtained in ten hours.

Flint, Mich. Thomas J. Rothe

RIGHT- AND LEFT-HAND TOOLS

There seems to be a diversity of practice among the different makers of machine tools and lathe tools as to the use of the terms "right-" and "left-hand" and "right-" and "left-bent," with reference to tools and tool-holders. The question may be considered under three heads: First, right- and left-hand tools, with reference to the cutting edge of the tool; second, right- and left-bent tools, with reference to the shank of the tool, which is bent to allow for clearance for different kinds of work; and third, right- and left-hand tool-holders, which ought properly to be called "right-" and "left-bent."

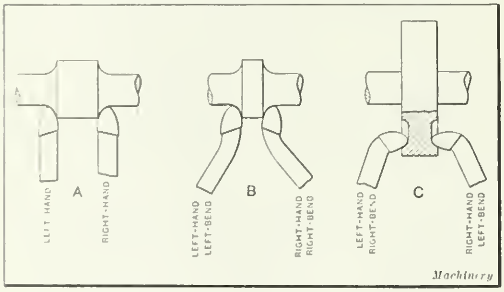


Fig. 1. Names of Commonly Used Types of Lathe Tools

It is the writer's opinion that in machine shop practice it is practically settled that a right-hand tool is one turning toward the headstock, and a left-hand tool is one turning the opposite way, or toward the tailstock.

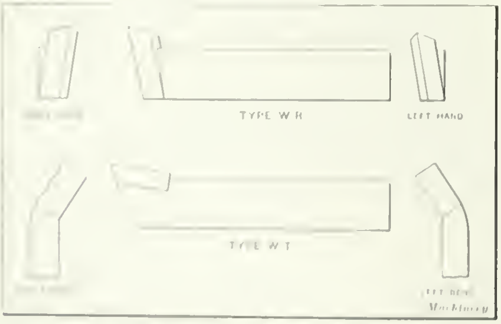


Fig. 2. Welded Lathe Tools made by Ready Tool Co.

There seems, however, to be no general agreement as to the use of the terms "right-" and "left-bent." The writer believes that the majority would call a right-bent tool one with a shank bent toward the right, and a left-bent tool, one with a shank bent toward the left. Fig. 1 shows at *A* a left-hand and a right-hand tool, and at *B* a left-hand, left-bent tool and a right-hand, right-bent tool. These are tools that are commonly used. Tools that are also used a great deal are left-hand, right-bent and right-hand, left-bent tools, which are illustrated in operation at *C*.

It seems to have been the general custom to designate tool-holders as "right-hand offset" if the shank is bent toward the left, and as "left-hand offset" if the shank is bent toward the right. The only reason that can be seen for this is that a right-hand offset tool, although bent to the left, has the cutting edge, generally, on the right-hand side of the cutter and is used for turning toward the tailstock, or toward the right, while a left-hand offset tool has its cutting edge on the left-hand side and turns toward the headstock.

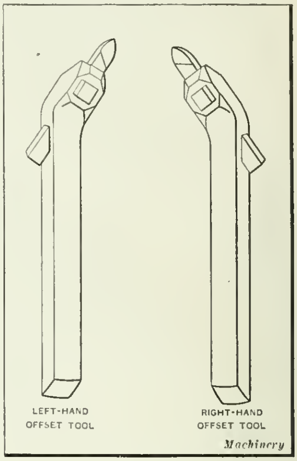


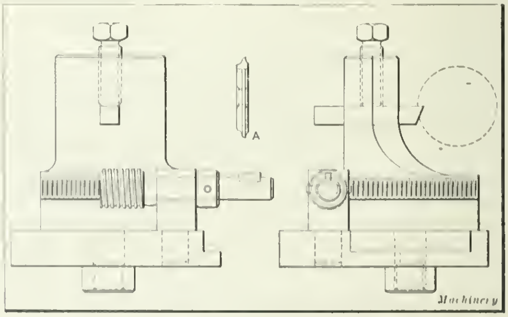
Fig. 3. Offset Tool-holders made by Ready Tool Co.

The Ready Tool Co. has decided to adopt for its welded stellite tool the words "right-hand" and "left-hand" for its Type WR tool, which is a modified diamond-point tool, and the terms "right-bent" and "left-bent" for the bent Type WT tools, in which the stellite is on the top. It is believed that this designation will cover all the various questions encountered and that it would be a great help if these terms were universally adopted.

Thomas Fish,
Bridgeport, Conn. President, Ready Tool Co.

RADIUS TURNING FIXTURE FOR MAKING FORM CUTTERS

It was necessary to make twenty-four form, corner-rounding cutters *A* for a Brown & Sharpe automatic screw machine, the corner-rounding grooves being of different radii. As the shop had no regular forming or circular-turning device, the simple mechanism here shown was made. It is adapted for the Hendey lathe tool-slide after the compound slide is removed.



Radius Turning Fixture used in making Cutter A

The blanks to be finished are held on a threaded arbor inserted in the headstock spindle or on a plain nut arbor caught in a scroll chuck. The tailstock is shoved back out of the way, and the tool is fed against the blank by hand, using the crank of the compound rest to rotate the toolpost through the worm drive. The cutter-holding block is cleared ⅜ inch back of the center of rotation, giving a definite measuring point for setting the tool for a given radius. The tool slot is located at the right position for describing a true circle. Circular cutters with radii from 0 to 1½ or 2 inches can be generated.

Springfield, Vt. O. S. MARSHALL

RADIUS OF SMOKE ARCH

The following is a simple, accurate way of laying out the radius of a smoke-arch fit for a pair of cylinder saddles: Have the carpenter make two templets out of dry ¾-inch boards, making one fit the smoke arch at the front and the other at the back of the cylinder saddles. Obtain the height of the saddle, from those removed or the blueprint, measuring from the frame fit to the lowest point of the smoke arch for the distance *F* and place a center-punch mark *A* at the top point of this distance. Fasten the wooden templets to the cylinder saddle with wooden clamps, making the middle point of the templets coincide with the center-punch mark *A* on the saddle. With a small trammel and any radius and with point *A* as a center, draw arcs cutting the arc of the templets at *C* and *D*. Take any point *B* on the center line of the cylinders and strike an arc to *C*. Then with the trammel and the distance *BC*, check up the distance *BD*, raising or lowering the templet to make the distances *BC* and *BD* of equal length, being careful that the middle point of the templet and *A* coincide. Then scribe off the radius onto both the front and back of the cylinders.

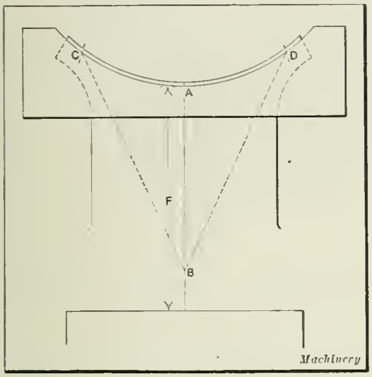
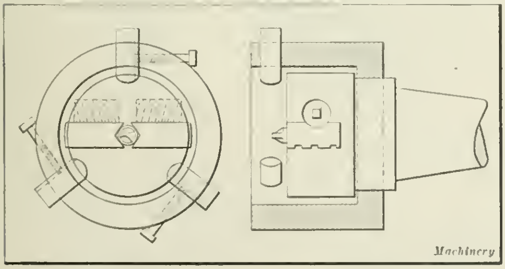


Diagram for determining Radius of Smoke Arch

Scranton, Pa. ERNEST A. KOSCHINSKE

CENTERING TOOL

The accompanying illustration shows a device that has been found quite useful in a shop doing considerable screw-machine work that is too slender to center without some form of support. While made for this class of work, this device may also be used in the lathe where a steadyrest would otherwise be required. As shown it is a cast-iron hood, carrying jaws, that is made a press fit on the body of a drill chuck. The round drawn brass jaws seat in reamed holes in the hood.

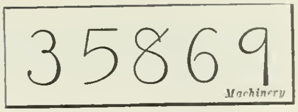


Centering Tool

Cincinnati, Ohio H. M. BOGART

PLAINER FIGURES FOR THE SHOP

The article in the July number of MACHINERY advocating the use of plainer figures on steel stamps used for marking in machine shops agrees with the writer's ideas, but while we are about it, why not cut out the nine that is an inverted six, and why make the three as nearly like the five as possible? In a word, why not give each numeral character and individuality, and make it so distinctive that no figure can be mistaken for any other though standing alone and inverted? Should it not be beyond discussion that each numeral should be as different from all others as possible and still retain the necessary simplicity? It would seem that the only excuse for a three with a horizontal top and a lower curved line that duplicates the same line in a five, is that the three will thus be less likely to be mistaken for an eight; but with such an eight as is shown in the article referred to, there is small chance of the two-cusp three being confused with it. Why not numerals like those here shown?



Plainer Figures for the Shop

Wilkinsburg, Pa. WILLIAM S. ROWELL

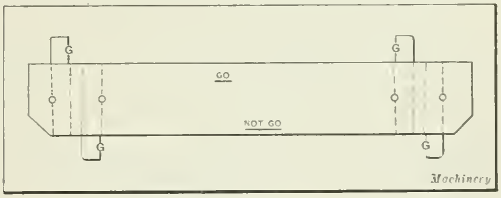
A MICROMETER TIME-SAVER

Most of the Slocomb micrometers, except the 1-inch size, will measure ± 0.100 inch. Hence, if a measurement of 3.075 inches is to be made, it is unnecessary to go to the tool crib to exchange a 2- to 3-inch micrometer for a 3- to 4-inch size, as this measurement may be made with the extra capacity of the micrometer at hand.

Bridgeport, Conn. JAMES MCINTYRE

LIMIT GAGE

The accompanying illustration shows a very simple and inexpensive device for the close gaging of various kinds of large quantities of manufacturing parts. The writer has used it for over two years with the best economic results. It has no complicated parts for machining or hardening. It consists simply of a cold-rolled steel bar and standard Brown & Sharpe taper pins, tool steel, hardened. A worn-out gage can be repaired by replacing one pin and regrinding and lapping the gage.

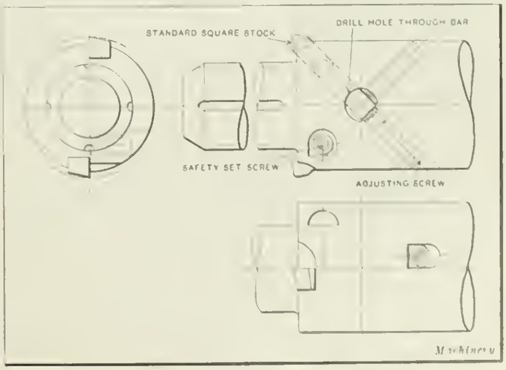


A Simple, Inexpensive Limit Gage

New York City MAX T. VOIGT

BORING-BAR

The accompanying illustration of a boring-bar needs no explanation. A thorough test has shown that it is a good sub-



Boring-bar using Standard Square Stock

stitute for the flat-tool type of bar, and is cheaper, standard square stock being used, which avoids the fitting and grinding all over that is necessary with the flat tool. The same idea has also been carried out in single tool bars.

Jackson, Mich. M. E. Stock

CHASING 100-PITCH THREAD WITH 50-PITCH CHASER

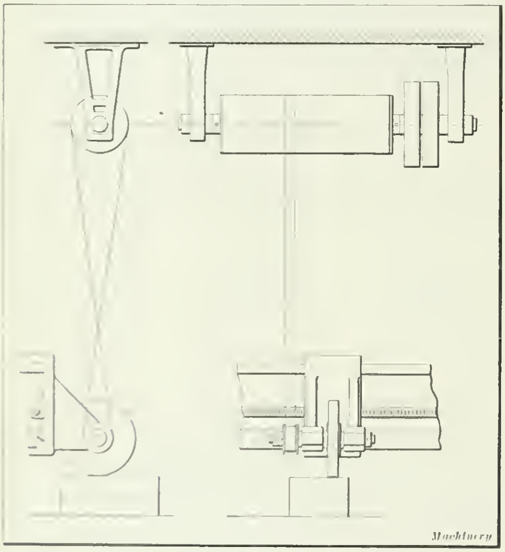
The chasing of a 100-pitch thread with a 50-pitch chaser described by Eric Lee in the May number of Machinery is similar to the work done by front and back V-tools. These are set first to cut diametrically opposite each other; then one is backed off, run along 2½ pitches, and run in to cut the third groove while the other cuts the first. But the chaser would do the better job of the two. Similarly, a 50-pitch chaser with six teeth can be made to cut a 150-pitch thread, with a lathe geared for 150 threads per inch.

New York City Robert Grimshaw

GRINDING CASTINGS WITH A PLANER GRINDING FIXTURE

A small New England shop received an order for some rectangular castings 15 by 7 by 5 inches. As the castings reached the shop with rather rough surfaces, while the job called for smooth, though not finished, surfaces, it was decided to grind the castings to bring them to a more satisfactory condition. A 10-inch emery wheel, with a 1-inch face, was mounted on a bracket, as shown in the accompanying illustration, which was placed on the cross rail of an old Gray planer, from which the tool-slide had been removed. The wheel was operated by a belt passing over a flanged pulley, on the bracket and a drum on the countershaft. The results obtained were satisfactory.

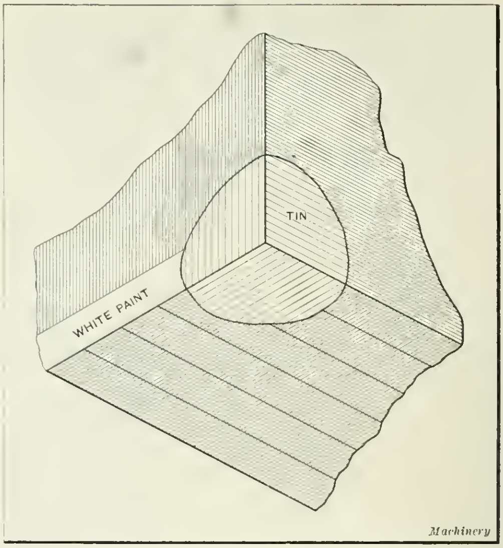
H. E. G.



Planer Fixture for Surface Grinding Castings

CLEAN AND SAFE CORNERS

Dark corners attract, magnetically, dust and trash that seem to be unaffected by the neighborhood of light places. The moral of this is: pay more attention to the dark places, as they are likely to breed disease, general disorder and slothfulness as well as to cause "spontaneous" fires. While it is seldom practicable to give these dirt pockets special illumination, it is perfectly feasible to paint them white, as well as to run a white strip along the wall, next the floor line, on the dark side of the room, as shown in the illustration. Further, if a trihedral piece of sheet tin, about 15 to 18 inches on a side, is fitted into such a corner, when sweeping, the dust and scraps can be collected with ease.



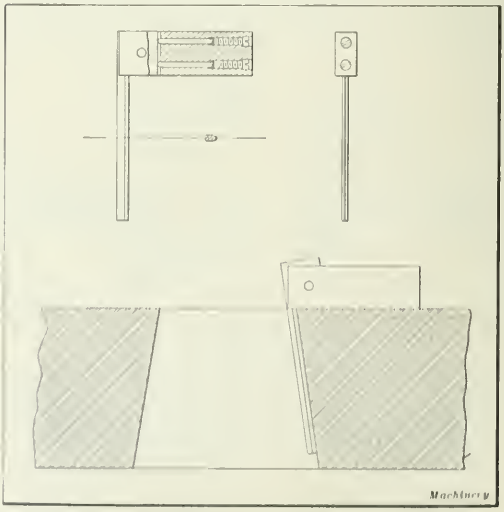
Aids toward obtaining Clean and Safe Corners

New York City Robert Grimshaw

SMALL-ANGLE PROTRACTOR FOR DIEMAKERS

The tool here illustrated was especially designed for use in backing the hole in a die away from its working edge. The blade may be moved over and set to any angle needed in this class of work—which rarely exceeds 5 degrees either way—by means of two screws in the end of the base. These screws engage with sliding pins that act on a projecting arm of the blade on opposite sides of the fulcrum pin, and thus firmly lock the blade in position. The narrow blade is beveled on its inside edge to almost a knife-edge, as shown in the sectional view. This form renders its use in gaging surfaces, especially concave surfaces, very convenient.

Ambridge, Pa. August J. Lejeune



Convenient Small-angle Protractor

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

TRIGONOMETRIC FUNCTIONS FOR ANY ANGLE

R. B.—I do not quite understand the latter part of your answer to the question concerning the trigonometric functions of any angle as printed in the August number of MACHINERY. You say that cos 685 degrees = cos 7 × 90 degrees + 55 degrees = cos 3 × 90 degrees + 55 degrees. How do you get 3 × 90 degrees + 55 degrees? It also seems to me that cos 3 × 90 degrees + 55 degrees should be — sin 55 degrees instead of + sin 55 degrees, as you have it.

A.—Near the bottom of the first column of page 1107, it is stated that if the angle is greater than 360 degrees (= 4 × 90 degrees), subtract 4 (or some multiple of 4) so that n will be less than 4, but not negative. In the present case, 685 degrees = 7 × 90 degrees + 55 degrees. Here $n = 7$; hence, subtracting 4 leaves 3 × 90 degrees + 55 degrees for the angle. The four quadrants subtracted do not affect the result, for after the revolving radius passes the 360-degree mark, the sequence of signs and values begins over again. The sign is plus, because the revolving radius stops in the fourth quadrant between D and A. The three quadrants (3 × 90 degrees) bring the radius to D, and the 55 degrees in addition carry it beyond D toward A. The angle may also be written 8 × 90 degrees — 35 degrees; in this case, subtract 2 × 4 quadrants, obtaining cos 8 × 90 degrees — 35 degrees = cos — 35 degrees = cos 35 degrees. The name of the function does not change, because the number of quadrants is even; and the sign is +, because the revolving radius stops in the fourth quadrant between A and D. In this latter case, the negative sign indicates that the revolving radius moves from A toward D instead of from A toward B.

J. J.

MEASURING A 65-DEGREE V-THREAD

P. L. N.—I would like to have a formula for measuring a 65-degree thread of sharp V-thread form by the three-wire system.

A.—Referring to the accompanying illustration showing a 65-degree sharp V-thread, let:

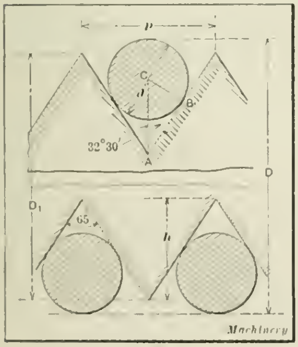
D = diameter measured over wires;

D_1 = theoretically correct diameter over the tops of the threads;

d = diameter of wire;

h = depth of thread;

p = pitch of thread.



Measuring 65-degree V-thread

The dimensions D_1 and p are known; diameter d is assumed; it may be made equal to about $0.6p$; h equals $\frac{1}{2}p$ × cot 32 degrees, 30 minutes.

By referring to the accompanying illustration, it will be seen that $D = D_1 - 2h + 2AC + d$.

But $AC = BC$ ÷ sin 32 degrees, 30 minutes = $\frac{1}{2}d$ ÷ sin 32 degrees, 30 minutes.

Hence, $2AC = d$ ÷ sin 32 degrees, 30 minutes.

Inserting this value in the formula above we have:

$D = D_1 - 2h + (d$ ÷ sin 32 degrees, 30 minutes$) + d$.

MOVEMENT OF V-REST

L.E.S.—What should be the horizontal movement of a 90-degree V-rest to keep in contact with the work while the tool moves horizontally 1⅝ inch? The tool and the back-rest are to be moved by the same screw, but the threads are left and right, respectively. If the pitch of the one that moves the tool is ⅛ inch, what should it be for moving the rest?

Answered by F. Webster Brady, Scranton, Pa.

The illustration shows the lay-out of this problem. It will be seen that the rest must move horizontally a greater distance than the tool, that is, the horizontal distance AB is greater than the radial distance AC. The distance AB may be calculated as follows:

$AB = AC$ ÷ cos 45 degrees, or 1⅝ ÷ 0.707 = 2.298 or 2 19/64 inches.

If a pitch of ⅛ inch moves the tool, then the pitch for the rest must be greater in the following proportion:

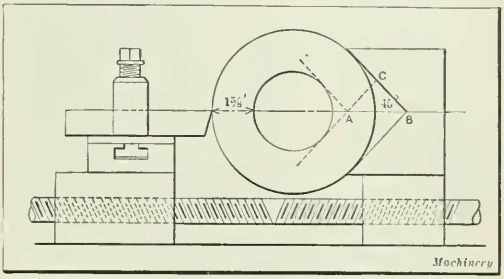


Diagram showing Relative Movement between Cutting Tool and V-rest

(2 19/64 ÷ 1⅝) × ⅛ = 0.177 or 11/64 inch.

A simple arithmetical solution of the problem, because of the angle of the jaws being 90 degrees, may be made as follows:

$$2 \times AC^2 = AB^2, \text{ and}$$

$AB = \sqrt{2 \times 1⅝ \times 1⅝} = 2.3$ or 2 19/64 inches (approximately).

If the jaw angle is not 90 degrees, then the general solution given above may be applied to all cases.

STRESSES IN WIRE ROPE DUE TO BENDING

H. A. J.—In a work relating to hoisting, I note the statement that the diameter of the sheave should be not less than 100 times the diameter of a rope having 6 strands, 7 wires to the strand, nor less than 60 times the diameter of a rope having 6 strands, 19 wires to the strand. How are the numbers 100 and 60 obtained, and why does the number of wires in a strand make such a difference in the diameter of the sheave?

A.—The actual value of these numbers is somewhat arbitrary, but their ratio should be about as you state, that is, 100:60. The following will make this clear. The strength of a wire rope is equal to the strength of one of the wires composing it multiplied by the number of wires in the rope. When a wire is bent around a cylinder, as shown in the illustration, the upper half is lengthened and the lower half is compressed, while the length of the center line is unaltered. Let R = radius of sheave, r = radius of wire, and D and d = corresponding diameters. The topmost element of the wire will then be lengthened by the bending an amount equal to $\pi(R + d) - \pi(R + r) = \pi r$, when the two parts of the rope are parallel, as shown in the illustration. The length of the wire that forms the semicircle is $\pi(R + r)$; hence, the unit elongation, or unit strain, is $s = \frac{\pi r}{\pi(R+r)} = \frac{r}{R+r} = \frac{r}{R} = \frac{d}{D}$, when the r in the denominator is dropped, as having no appreciable effect on the ratio. Let P = force required to bend wire, A = area of cross-section of wire, and S = unit stress;

then, $S = \frac{P}{A}$. The coefficient of elasticity E is defined as the ratio of the unit stress to the unit strain, or $E = \frac{S}{s}$ from which, $S = \frac{P}{A} = Es = E\frac{d}{D}$. This expression for the stress due to bending applies only to the topmost element of the wire; and as the various elements are located nearer the center, the stress in each becomes less. According to MACHINERY'S HANDBOOK, page 401, a prominent wire-rope manufacturer recommends the formula $S = \frac{Ed}{D} \times 0.45$, which is probably sufficiently close to actual conditions for practical purposes. Since the value of E is practically always the same for the same material, a change in S can be produced only by a change in the ratio $\frac{d}{D}$, and since this ratio is independent of the length of the arc of contact, it follows that the same bending stress will be produced when the rope is bent around a small arc as when it is bent around an entire circle. It is also evident that if D remains the same, the smaller d is the smaller will be the bending stress and, *vice versa*, the larger d is the greater the bending stress S.

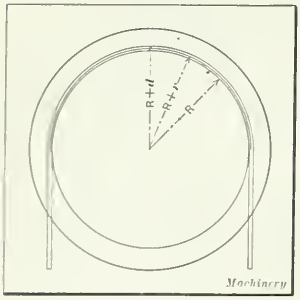


Diagram Illustrating Stresses in Wire Rope.

A 6 by 7 rope contains 6 × 7 = 42 wires, and a 6 by 19 rope contains 6 × 19 = 114 wires, therefore, for ropes of the same diameter, the wire in a 6 by 7 rope will be larger than in a 6 by 19 rope. Referring to pages 402-404 of MACHINERY'S HANDBOOK, $d = 0.106 \times d'$ for a 6 by 7 rope; and $d = 0.063 \times d'$ for a 6 by 19 rope, d being the diameter of the component wire and d' the diameter of the rope. The ratio of the right-hand members of these two equations is $\frac{0.106 \times d'}{0.063 \times d'} = \frac{0.106}{0.063} = \frac{1}{0.594} = \frac{100}{59.4}$, which is almost exactly the same as the ratio of 100:60. Some manufacturers permit the ratio $\frac{D}{d}$, to be as low as 80 for a 6 by 7 rope and as low as 48 for a 6 by 19 rope, but the values given in the question tend to greater safety. For a 1-inch 6 by 7 steel rope, $d = 0.106 \times 1 = 0.106$ inch and the stress due to bending is $S = \frac{30{,}000{,}000 \times 0.106}{100} \times 0.45 = 14{,}310$ pounds per square inch, since for steel $E = 30{,}000{,}000$ and $D = 100 \times 1 = 100$. The area of the cross-section of the wires of a 1-inch rope is 0.3706 square inch; hence the total stress P due to bending is $14{,}310 \times 0.3706 = 5303$ pounds = 2.65 tons. For a 1-inch 6 by 19 steel rope, $D = 60$ inches and $d = 0.063$ inch; hence, $S = \frac{30{,}000{,}000 \times 0.063}{60} \times 0.45 = 14{,}175$ pounds per square inch; the area is 0.3554; whence $P = 14{,}175 \times 0.3554 = 5038$ pounds = 2.52 tons. These values are a little over one-third of the safe working load of extra-strong crucible-steel wire rope. J. J.

ANGLE OF REST OF SHELLS

I. J. F.—Please give me a formula for finding the angle x from the dimensions given in the accompanying illustration. This problem has to do with the angle of rest of shells, and a simple solution will be appreciated.

A.—This problem is difficult of solution, and there is no formula easily applied that will give the value of x to any degree of exactness. Evidently, angle $CQD = CAH = AOB = x$. $CE = 6 - (DQ - CF) = 6 - (56 - 56 \times \cos x) = 6 - 56\,(1 - \cos x)$. $CH = CE - (OB - GA) = 6 - 56(1 - \cos x) - 48\,(1 - \cos x) = 6 - 104\,(1 - \cos x)$. $HA = 60 - (QF + AB) = 60 - (56 \times \sin x + 48 \times \sin x) = 60 - 104 \times \sin x$. Also, $\tan CAH = \frac{CH}{HA} = \frac{6 - 104\,(1 - \cos x)}{60 - 104 \times \sin x} = \tan x$. This formula may be made general by substituting a for the dimension 6, b for 60, and R and r for the two radii, thus obtaining $\tan x = \frac{a - (R + r)\,(1 - \cos x)}{b - (R + r)\sin x}$. This equation can be solved only for particular cases, the best method of solution being the following: Write the equation in the form:

$$f(x) = \tan x - \frac{6 - 104(1 - \cos x)}{60 - 104 \times \sin x} = 0$$

Now assume values of x and substitute in the formula until the function becomes 0, or as near 0 as is desired. The work will be greatly facilitated by using the principles of interpolation. It is plain that $\tan x$ is a little greater than $\frac{DI}{BI} = \frac{6}{60} = 0.1 = \tan 5$ degrees, 40 minutes, nearly. Assume $x = 6$ degrees; then, using a four-place table and limiting all results to four decimal places, $f(x) = 0.1051 - \frac{6 - 104\,(1 - 0.9945)}{60 - 104 \times 0.1045} = 0.1051 - \frac{5.428}{49.132} = 0.1051 - 0.1105 = -0.0054$. Assume $x = 6$ degrees, 30 minutes; then $f(x) = 0.0033$. Since the function has changed sign, x lies between 6 degrees and 6 degrees, 30 minutes. Arranging the results in the form of a table and subtracting the upper function from the lower, the difference, neglecting the decimal points, is 87; subtracting the upper function from 0, the difference is 54; the interval is 30 minutes; hence, x is nearly equal to 6 degrees $+ \frac{54}{87} \times 30 = 6$ degrees, 18.6 minutes.

x Deg.	Min.	$f(x)$
6	00	−0.0054
		.87
6	30	0.0033

If a more accurate value is desired, use a six-place table, and obtain results as shown in the margin. Here it is seen that x lies between 6 degrees, 18 minutes and 6 degrees, 19 minutes; the interval is 60 seconds. Subtracting the upper function from 0, the difference is 161; hence, $x = 6$ degrees, 18 minutes $+ 161 \div 294 \times 60 = 6$ degrees, 18 minutes, 33 seconds. This value of x substituted in the formula gives 0.000002 for $f(x)$.

x Deg.	Min.	$f(x)$
6	18	−0.000161
		294
6	19	0.000133

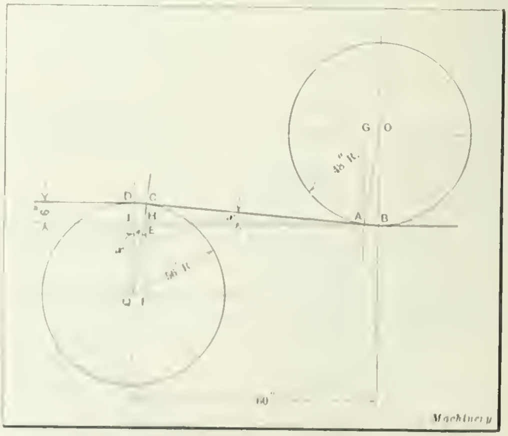


Diagram Illustrating Angle of Rest of Shells

The same problem, but with different dimensions, was sent in by B. V. D., one inquiry coming from Cleveland and the other from Buffalo, the dates of the letters being two days apart. The dimensions given by B. V. D. are $a = 0.050$, $b = 0.160$, $R = 0.125$, and $r = 0.045$. This problem can be solved in exactly the same manner; the work can be made a trifle easier by first multiplying all dimensions by 1000, thus obtaining $a = 50$, $b = 160$, $R = 125$, and $r = 45$. J. J.

STRENGTH OF CONDENSER TUBE PLATE

N. G. H.—Can you give me a method of calculating the unbalanced pressure which a condenser tube plate, such as that shown in Figs. 1 and 2, is capable of withstanding? In the present case, it is proposed to increase the pressure of the cooling water from slightly above atmospheric pressure to 15 pounds gage. The vacuum carried is 22 inches, the barometer being 26 inches (high altitude).

Answered by John S. Myers, Philadelphia, Pa.

Probably the most direct method of treating such problems is to calculate the thickness of a solid plate which would have the same strength as the perforated tube plate, so that the well-known formula for flat plates may be applied; then, since the pressure only acts upon the net area of the plate, *i. e.*, that between the tubes, increase the allowable pressure so calculated in the ratio of the gross area to the net area.

Fig. 3 shows the section of material between any two tubes. Referring to Fig. 3:

Area of portion a is $0.1 \times 0.875 = 0.0875$
Area of portion b is $0.35 \times 0.625 = 0.2187$

Total area of section is 0.3062

Taking the moment of section a about the center of section b and dividing this moment by the total area, we find the location of the center of gravity g of the section as follows:

$$x = \frac{0.0875 \times 0.75}{0.3062} = 0.214 \text{ inch}$$

The moment of inertia of the section is found by taking the sum of the areas a and b multiplied by the square of their distance from the center of gravity g, plus their moments of inertia about their own axis. Thus:

$$0.0875 \times 0.536^2 = 0.0252$$
$$0.2187 \times 0.214^2 = 0.0100$$
$$\frac{0.1 \times 0.875^3}{12} = 0.0056$$
$$\frac{0.35 \times 0.625^3}{12} = 0.0071$$
$$\text{Moment of inertia } I = 0.0479$$

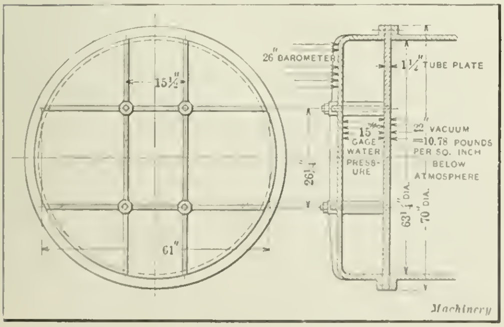


Fig. 1. Arrangement of Water Head and Tube Plate

$$\text{Section modulus for tension} = Z_t = \frac{I}{c_t} = \frac{0.0479}{0.526} = 0.091$$

The section modulus of a rectangle of breadth c and depth or thickness t is:

$$Z = \frac{ct^2}{6}; \text{ hence } t = \sqrt{\frac{6Z}{c}} \qquad (1)$$

Substituting in Formula (1) the value of Z just found and the center distance c between the tubes of 1.1 inch, we have:

$$t = \sqrt{\frac{6 \times 0.091}{1.1}} = 0.705 \text{ inch}$$

as the thickness of a solid plate equal in strength to the tube plate.

To obtain the net area of the plate over which the pressure acts, calculate the area of an equilateral triangle the length of the sides of which is c:

$$A_g = 0.433c^2 = 0.433 \times 1.1^2 = 0.524 \text{ square inch}$$

From this is to be subtracted the area of 3/6 = 1/2 of a circle of diameter d. This area is $A_n = \frac{0.7854d^2}{2} = 0.393 \times 0.75^2 = 0.221$ square inch.

The net area between any three tubes, such as the shaded portion in Fig. 2, is then:

$$A_n = A_g = 0.433c^2 = 0.433 \times 1.1^2 = 0.524 \text{ square inch}$$

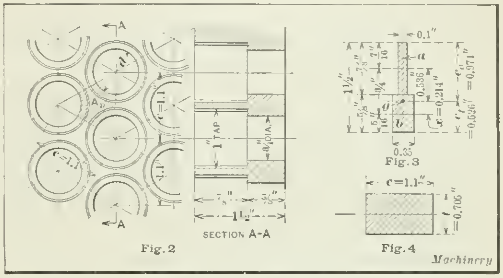


Fig. 2. Tube Spacing. Fig. 3. Section between Tubes. Fig. 4. Section of Equal Strength to that in Fig. 3

The ratio of gross area to net area is then:

$$\frac{A_g}{A_n} = \frac{0.524}{0.303} = 1.73$$

Most flat plate formulas are approximate only, and present the further difficulty that the case in hand is often dissimilar to that experimented upon, and for which the available formulas apply. Those formulas representing the cases studied by Grashof and Bach are probably the most reliable. For a rectangular plate such a formula accredited to Grashof is:

$$S = \phi \frac{B^2b^2}{B^2 + b^2} \times \frac{p}{t^2} \qquad (2)$$

from which

$$p = \frac{St^2}{\phi} \times \frac{B^2 + b^2}{B^2b^2} \qquad (3)$$

where S = stress in pounds per square inch;
p = pressure in pounds per square inch;
B = longest side of plate in inches;
b = shortest side of plate in inches;
ϕ = a coefficient determined by experiment.

When firmly secured at all four edges,
$\phi = 0.38$ for cast iron;
$\phi = 0.24$ for steel.

When supported at the edges but not restrained,
$\phi = 0.57$ for cast iron;
$\phi = 0.36$ for steel.

For our case we may consider a strip across the tube sheet of a breadth $b = 26.25$ inches, and average length, $B = 61$ inches, as indicated in Fig. 1. Now the ends of this strip, at the flange, are held firmly only at the sides; at the stays the plate is only partially restrained by the plate beyond it. For our purpose we may therefore take a mean value of $\phi = (0.38 + 0.57) \div 2 = 0.475$. With this value of ϕ and the value of $\frac{A_g}{A_n} = 1.73$, the coefficient for Formula (2) will become $\frac{0.475}{1.73} = 0.275$, and the similar coefficient for Formula (3) will be $\frac{1.73}{0.475} = 3.65$. For our case, we then have the approximate formulas:

$$S = 0.275 \frac{B^2b^2}{B^2 + b^2} \times \frac{p}{t^2} \qquad (4)$$

$$p = 3.65\,St^2 \times \frac{B^2 + b^2}{B^2 b^2} \qquad (5)$$

In Formula (4) the value of the unbalanced pressure in our case is $p = 15 + 10.78 = 25.78$, and $t = 0.705$. Substituting, we have for the stress in the tube plate:

$$S = 0.275 \times \frac{61^2 \times 26.25^2}{61^2 + 26.25^2} \times \frac{25.78}{0.705^2} = 8290 \text{ pounds per square inch.}$$

With cast iron having an average ultimate tensile strength of about 16,000, this would give an apparent factor of safety of $\frac{16{,}000}{8290} = 1.92$, which would be entirely too small a margin of safety, especially in view of the necessarily approximate methods of analysis which must be resorted to for such problems.

* * *

CODE OF SAFETY STANDARDS FOR POWER TRANSMISSION MACHINERY[1]

A tentative draft of a code of safety standards for power-transmission machinery states that the use of properly designed, constructed, and installed individual motor-driven equipment with electrical power distribution not only eliminates many of the hazards demanding this code, but also gives an uninterrupted distribution of natural and artificial light, and a greater flexibility and range of speeds than is possible with mechanical power-distributing systems.

The specifications describe standard guards for all power-transmission equipment later mentioned, and apply to all main shafting, jack-shafting, drive-shafting, and counter-shafting, and their belts and other attachments up to but not including belts actually driving machines. Belts actually driving machines are considered machine belts, and therefore a subject for machine codes.

Class A Guards—Class A guards are those used when the clearance between the guard and the guarded part is less than five inches. They consist of a metal guarding material that will not admit objects larger than one-half inch in diameter, and is strong enough to withstand loads to which it may be subjected, durable enough to withstand ordinary wear and tear, substantially fabricated and erected, and free from sharp points and edges.

Class B Guards—Class B guards are used when the clearance between the guard and the guarded part is five inches or more. They consist of a metal guarding material that will not admit objects larger than two inches in diameter, and is strong enough to withstand loads to which it may be subjected, durable enough to withstand ordinary wear and tear, substantially fabricated and erected, and free from sharp points and edges.

Hand-rails—If the clearance between the guard and the guarded part is fifteen inches or more (measured horizontally from extreme parts within six feet of floor), a hand-rail forty-two inches in height with at least one intermediate rail, supported at least every eight feet, substantially fabricated and erected, and with no sharp points or edges may be used. If constructed of pipe, the rails and posts shall be at least equal in strength to 1½-inch standard-weight pipe. If constructed of structural metal, the rails and post shall be at least equal in strength to 2- by 2- by ¼-inch angles. If constructed of wood, the top rail shall be 2 by 4 inches, the center rail 1 inch by 4 inches, and the posts 4 by 4 inches, all straight-grained lumber dressed on four sides, or other construction of equal strength.

Toe-boards—When power-transmission equipment extends through floors or into pits, the standard guards shall extend to the floors, or toe-boards six inches in height shall be provided around the floor opening in addition to the standard hand-rails.

Auxiliary Bases—The standard guards, for power-transmission equipment not extending through floors, shall enclose exposed sides to two inches below the bottom of the lowest moving part when the clearance between that part and the floor is less than eight inches. When the clearance is eight inches or more, the guards shall be closed on the bottom, or extended on all sides down to six inches above the floor.

Gears and Sprockets—All power-driven gears and sprockets shall be completely enclosed on exposed sides with standard guards, except where the design and operation of the parts to be guarded make a complete enclosure clearly impracticable. In this case the face of the gears or sprockets shall be covered with a band guard surrounding all exposed teeth, with flanges on both sides extending inward beyond the roots of the teeth, and there shall be a continuous smooth web cast or fitted between the hubs and rims of the gears or sprockets.

Vertical and Inclined Belts, Ropes, and Chains—All vertical and inclined belts, ropes, and chains used for transmitting or distributing power (except belts traveling less than 120 feet a minute, or transmitting so little power that accidental contact can cause no accident) shall be provided with standard guards six feet high on exposed sides, or on exposed sides and top, or with a standard hand-rail on exposed sides.

Horizontal Belts, Ropes, and Chains—All horizontal belts, ropes, and chains used for transmitting or distributing power (except belts traveling less than 120 feet a minute, or transmitting so little power that accidental contact can cause no accident) shall be guarded as follows: If the upper part of the belt is less than six feet above the floor or working platform, it shall be provided with standard guards six feet high on exposed sides or on exposed sides and top, or with a standard hand-rail on exposed sides. If the upper part of the belt is more than six feet above the floor or working platform and the lower part of the belt is less, it shall be provided with standard guards, six feet high on exposed sides, or with a standard hand-rail. If the lower part of the belt is more than six feet above the floor or working platform and lower than seven feet, it shall be provided with standard guards on exposed sides and bottom, or with a standard hand-rail. Where a horizontal belt is located over a driveway or passageway, the highest floor of any wagon or truck passing beneath the belt shall be considered a working platform.

Belt Fasteners—All belts not provided with standard guards and within seven feet of the floor or working platform shall be free from metal lacings and metal fasteners.

Belt Shifters—Belt shifters shall be provided for all tight- and loose-pulley belts. These shall be so designed and constructed that ordinary vibrations or accidental contact will not alter the set position; they shall also have a controlling handle conveniently located.

Pulleys—Pulleys belted from above or from the side in such a way as to allow passage beneath them, and within seven feet of the floor or working platform and not completely enclosed by standard belt guards or hand-rails, shall be guarded to the top of the pulley or to a height of seven feet above the floor or working platform on exposed sides and beneath by standard guards or shall be enclosed on exposed sides by standard hand-rails. Pulleys without belts shall be guarded as though belted, or removed from revolving shafts.

Bearing Clearance—The clearance on shafting between pulleys and bearings or between pulleys and fixed objects shall be not less than thirty-six inches or the width of the belt, or the pulleys shall be guarded on the near side with standard stationary guards, and all revolving objects in the clearance shall be smooth, cylindrical, and concentric with shafting.

Belt Clearance—The clearance on shafting between pulleys and pulleys, collars, couplings, or other revolving attachments shall be wider than the widest belt used, or the pulleys shall have flanges or guards to prevent the belt from dropping into the clearance.

Clutches—Friction, jaw, and compression clutches within seven feet of the floor or working platform or within thirty-six inches of a bearing shall have their operating mechanism completely enclosed in standard stationary guards, or in smooth, concentric, revolving guards of solid construction with no projecting parts or attachments.

Couplings—All couplings within seven feet of the floor or working platform or within thirty-six inches of a bearing shall be guarded as follows: Sleeve and flange couplings shall be cylindrical and concentric with the shafting and with no parts or attachments projecting beyond the largest periphery of the coupling or its projecting flanges. Flexible and universal couplings shall be completely enclosed in standard stationary guards, or in smooth concentric revolving guards of solid construction. Clamp couplings and makeshift devices of irregular shape or unknown strength are prohibited on power-driven shafting.

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[1] Submitted by the subcommittee on the Protection of Industrial Workers to the American Society of Mechanical Engineers in Cincinnati, Ohio, May, 1917.

Collars—Assembled collars shall be smooth, cylindrical, and concentric with shafting, with no projecting parts or attachments.

Set-screws—All set-screws in revolving parts not enclosed by standard guards shall be flush with or countersunk below the periphery of the part retaining the set-screws.

Keys—All keys or keyways in revolving shafting not enclosed by standard guards shall be made flush with the end and periphery of the shaft or enclosed by smooth, cylindrical, concentric guards.

Vertical Shafting—Vertical shafting with or without collars, couplings, clutches, pulleys, or other attachments shall be enclosed on exposed sides with standard guards to a height of six feet above the floor or working platform, or with a standard hand-rail.

Horizontal Shafting—Horizontal shafting with or without collars, couplings, clutches, pulleys, or other attachments, including dead ends, within seven feet of the floor or working platform, shall be enclosed on all exposed sides with standard guards, a standard hand-rail, or freely revolving tubing. Where horizontal shafting is located over driveways or passageways, the highest floor of a wagon or truck passing beneath the shafting shall be considered a working platform.

Emergency Stop Stations—A station, or stations, shall be provided in each room, section, or department to stop immediately all power-transmission equipment therein. Such station, or stations, shall be properly marked, easily accessible, and provided with means for locking in the "stop" position.

Bearings—Where possible, bearings shall be of a self-oiling type with reservoir capacities for at least twenty-four hours' running or they shall have methods of oiling that do not bring the oiler into the danger zone. They shall also have necessary drip-cups and pans securely fastened in position.

Lubrication—Oiling that brings the oiler into a danger zone shall be done only by an authorized person and while the machinery is not in motion. The oiler must not wear loose or flowing clothing, and shall be provided with a lock and key or with a key to the locks at the emergency stop stations. He shall also have a warning sign. He shall be required to lock a station in a "stop" position and display the sign before going to work, and shall unlock and remove the sign when the work is completed and all men have left dangerous places.

Starting Signals—Ample notice should be given, by means of an effective alarm or signal, in all departments before power-transmission equipment is started.

Inspection—All power-transmission equipment should be carefully inspected at frequent and regular intervals by foremen or authorized inspectors, and defective equipment should be reported for repair and records kept of inspections.

Repairs and Adjustments—Repairs and adjustments to power-transmission equipment or guards shall be made only when the power is shut off from that equipment, and guards shall be replaced in protective position before the power is turned on.

Removing Guards—Guards installed in accordance with this code shall not be removed or rendered ineffective.

* * *

DISPOSAL OF METAL CHIP WASTE

BY MARK MEREDITH[1]

Metal chips, in the shape of borings, turnings, and planing scrap, often amount to 10 per cent of the total production of machine shops; and it is not an easy matter to dispose of this waste material to advantage. The most economical way is to use it in place of other materials in furnace mixing, but it is difficult to charge a furnace with loose chips. The forced draft blows away a large proportion, and a large part of that which remains is subjected to violent combustion and goes at once into the slag as ferric oxide. When loose chips are charged into a furnace, it is safe to say that at least half the total weight is wasted, and the large amount of viscid slag produced interferes with the efficient working of the furnace.

Some years ago it was suggested that the metal chips might be packed in wooden or metal cases before they were added to the furnace mixture, but taking everything into consideration, this method is far from economical. Another method that was advocated was to expose the chips to the atmosphere, so that they might rust into a solid form, but this was found to be expensive. The proposal to feed the chips into the furnace with a low-power blast also has been found unsatisfactory. Some engineers have added binding material to the chips and pressed the mixture into bricks, but in almost every case the binder disintegrated the moment it was exposed to heat and the briquets simply broke into free metal dust. There was then a great loss due to oxidation, under the action of the binder, besides the ordinary furnace loss.

For many years German engineers have been trying to develop a method of using low-grade ore and waste metal in their country. As a result, that nation has become the largest user of waste steel plate, and solved the problem of utilizing metal chips to the best advantage some time ago with almost complete success. In all German metal-working shops, the chips are saved and sheltered, as far as possible, from atmospheric influence. If the shop has not the necessary facilities for dealing with the chips, they are stored until a sufficient quantity has accumulated to justify sending them to a works that can handle them efficiently. The method adopted is to load the metal scrap into a press and subject it to a very high pressure, thus compressing it into briquet form without the aid of any binding material. These blocks are then charged into the furnaces and practically no loss results through burning or through particles being blown away, so that this waste may be used instead of expensive grades of pig iron in the production of high-grade cast metal. In steel foundries it has been pointed out that these briquets might be substituted for the low-phosphorus white iron that is now in such demand. In fact, they can be economically used in any place where steel scrap is used, whether it is in the foundry or the steel mill, as briquets of steel or wrought iron are a good charging material. Chips from hard rolls, projectiles, and the like may be mixed with gray-iron chips, so as to make a uniform charging material.

Chips from copper, brass, bronze, and white metal have also been pressed into briquets, with a considerable saving in cost. This is due to the fact that the cost of pressing the chips is much less than the savings that are effected in other ways, such as in the oxidation of the metal in remelting, the easier methods employed in handling the chips, and economy in space required for storing.

* * *

The iron ore mined in the United States in 1916 reached a total of 75,167,672 gross tons, the greatest annual output ever made. There were shipped from the mines 77,870,553 gross tons, valued at $181,902,277. The quantity mined was over 19,600,000 tons more than in 1915; the quantity and value of the ore shipped were increased 40 and 80 per cent, respectively. The average value per ton at the mines was $2.34 as against $1.83 in 1915. These figures do not include iron ore containing 5 per cent or more of manganese.

The production of pig iron, including ferro-alloys, was 39,434,797 gross tons in 1916, compared with 29,916,213 gross tons in 1915, an increase of 32 per cent. The pig iron, exclusive of ferro-alloys, sold or used in 1916, amounted to 39,126,324 gross tons, valued at $663,478,118, compared with 30,384,486 gross tons valued at $401,409,604 in 1915, a gain of 29 per cent in quantity and 65 per cent in value. The average price per ton at furnaces in 1916 was $16.96, compared with $13.21 in 1915, an increase of 28 per cent. The increase from January to December, 1916, in the prices of standard grades of pig iron at the large iron centers ranged between 45 and 68 per cent, but this increase was confined almost entirely to the last two or three months of the year and does not affect the average greatly.

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[1] Address: 67 Dale St., Liverpool, England.

METAL PLANERS AND METHODS OF PRODUCTION[1]

The problem of providing the increased speeds and power to develop the possibilities of high-speed steel and to meet the increasing necessity for greater production has been a comparatively simple one in machines in which the cutting is continuous and the motion of the tool is in one direction only. It has meant merely adding power and strengthening parts. The speeding-up process introduces, however, a vastly different problem in machines in which the cutting is not continuous and which have a return motion of the tool. The principal limitations of machines of this class, especially the planer, are the inertia of the moving mass at the moment of reverse and the speed at which the tool enters the work. The problem of overcoming these limitations has had the attention of quite a number of engineers, yet, while considerable progress has been made, the complete solution does not seem to have been reached.

The evolution of the planing machine has followed along the lines of increased table speeds. The earlier demands were for a higher return speed, in the belief that great savings could be effected by reducing the idle time consumed in the return of the table. Then it was found that further gains could be made by increasing the cutting speed, owing to the fact that this part of the cycle consumes the greater part of the time involved; the advent of high-speed steel can be credited largely with the marked advance in this part of the development. Next there came the demand for variable cutting speeds; for to operate a planer having only one cutting speed was both wasteful and detrimental to the best methods of increased production.

This constant change of conditions and the desire to obtain the highest possible speeds in both directions led to serious difficulties for which a change in design became imperative. One of the objections to the speeding-up of the planer was the difficulty encountered at the reverse, namely, the inertia of the moving parts. Tests established the fact that the greater part of the trouble was caused by heavy machine pulleys and their high speeds, so various types of clutch drives were designed in which the pulleys were not reversed; but these developed the objectionable features inherent in friction clutches. The use of an aluminum alloy for the pulleys instead of cast iron, however, not only overcame most of the objections to the heavier pulleys, but made higher speeds possible and thus increased the number of cutting strokes, as less time was consumed in the reverse. These pulleys also effected quite a saving in power.

Electric Planer Drives

The subject of individual electric motor drive for planers has received considerable attention in the past few years. One type that has been successfully developed is the 2 to 1 variable-speed motor, coupled direct to the top driving shaft of the planer. Its speed is controlled by two separate sets of resistance, which are automatically operated by a master switch connected to the shifting mechanism of the planer. The cutting speed can be varied from 25 to 60 feet per minute, while the return speed can be varied without affecting the cut. The controller handles are set to a predetermined speed before starting and the planer is operated in the usual manner from the tumbler, the master switch automatically varying the speed of the motor at each reversal.

Probably the most interesting motor application to planers is the reversible motor drive. While the application of this type of drive is not new, the drive approaches more nearly the ideal planer drive than any method heretofore used. The motor is an adjustable-speed motor, having a speed range of 1 to 4, so that a large range of cutting speeds from 25 to 60 feet per minute can be obtained. A double set of resistance makes it possible to vary either the cutting or the return speed independently of the other. This arrangement has also simplified the problem of variable speeds in connection with this drive. The operating mechanism is handled in exactly the same manner as is the standard belt-shifting type planer. Two predominating features are the total absence of belt slippage under heavy cutting and the lower peak loads at the moment of reverse. The superiority of this drive is shown in that in one test the travel of the cutting stroke was increased from 24 feet per minute, by either a single or double belt drive, to 35.8 feet by this drive; and the travel of the return stroke was increased from 66.6 feet to 85.7 feet per minute.

Value of Jigs and Fixtures in Planer Work

As a general rule, comparatively little thought is given to the subject of handling work on the planer. If the same amount of time and study were devoted to providing jigs and fixtures for the planer that is given other machining operations, the saving in time would be astounding. With planers, as with any other machines, we depend on the operator to a large extent for the best results. The question of chucking the work is left to his discretion, and he proceeds to the best of his ability with the equipment allotted him, which usually consists of an assortment of bolts, clamps and blocks, instead of jigs and fixtures. In innumerable cases the chucking time alone almost trebles the cutting or machining time. Add to this the time lost in changing tools and measuring work, and it is found that on an average the total actual time required to complete a piece of work is from four to five times the theoretical time necessary to plane the piece, the theoretical time being based on the number of square inches to be planed and the cutting and return speed used. In the greater number of cases, a holding fixture with screw adjustments can be devised so that it is only a matter of dropping the piece into this fixture and applying the clamps, which should be part of the fixture. Hardened steel plugs can also be incorporated in the jig to indicate the various heights and angles of the piece without using scales or referring to a drawing. Gang tools and double-end cutters also assist greatly, as they save considerable time in getting correct sizes without measuring.

For instance, when short-wall coal-cutting machine main frames were planed by clamping and stopping them on the planer table, the average time required for each frame was twenty-eight hours. Since the proper jigs and fixtures have been provided, these frames are now being planed complete in four hours. On this jig, bosses are planed on which hardened blocks are placed for setting the tools. Another good result obtained by time studies has been the planing of locomotive cylinders complete in one setting. As a general rule, these cylinders are planed one at a time and several settings are required. After a careful study, fixtures have been devised by which the four surfaces can be planed at one time, using four tools for the cutting instead of only one. The saving in time on a pair of these cylinders is about 100 per cent.

* * *

American manufacturers of gasoline farm tractors will produce about 50,000 tractors this year to meet a demand for about 100,000. Last year they built about 39,000 tractors, and it was hoped to produce about 70,000 this year, but the shortage of labor and materials and lack of standardization has cut the figure to a possible 50,000. It is estimated that there is a field for a million of these tractors in this country. Great Britain has found it necessary to standardize farm tractor construction, and America faces the same problem. The Society of Automotive Engineers, which embraces in its membership the engineers representing such industries as automobiles, motor tractors, farm tractors, aeroplanes, motorcycles, motor boats and stationary gas engines, has started the work of tractor standardization. The society was responsible for the standardization work accomplished in connection with American automobiles, and its engineers are now standardizing aviation motors and planes.

* * *

The United States consul at Hong Kong says that China's increased demand, at the close of the war, for machinery like pumps, rice mills, gas engines, etc., will be much smaller than is generally anticipated, because of the growing tendency to manufacture such machinery in the Far East.

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[1] Abstract of a paper by [illegible] read before the American Society of Mechanical Engineers at Cincinnati, Ohio, May, 1917.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

ROBSON & SORENSEN TWO-PART BALL BEARING

In the construction of many types of machinery, need has been felt for a split ball bearing which could be applied on lineshafts and other equipment without the necessity of taking down the shafting, and on automobile crankshafts, etc., where the form of the machine member would make it otherwise impossible to apply a ball bearing. It is a generally accepted axiom in the manufacture and operation of ball bearings that as soon as a bearing raceway or the balls carried by that raceway begin to show wear, the life of the bearing will soon come to an end. Bearing this fact in mind, inventors who have turned their attention to the development of a split ball bearing have endeavored to overcome the inevitable joint between the two halves of the races by machining the joints to such a degree of perfection that the balls could run over the joints without appreciable shock and therefore with no consequent damage.

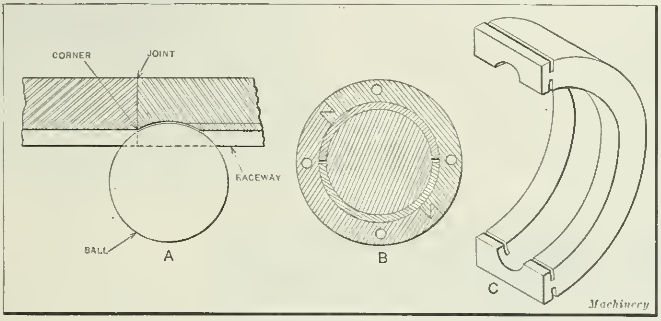


Fig. 1. A, Diagram showing Effect of Distortion on Two-part Ball Bearing Races with Close Joints; B, Two-part Lock Nut Construction; C, Outer Raceway of Robson & Sorensen Two-part Ball Bearing

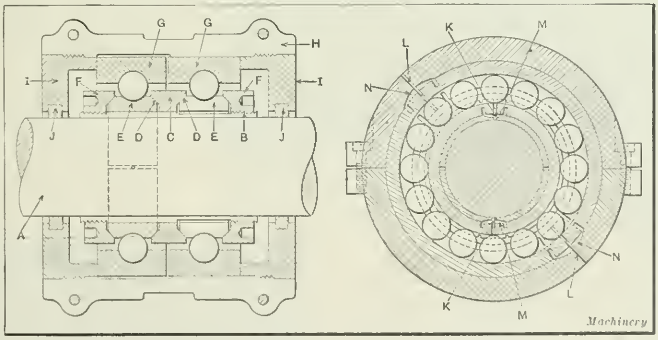


Fig. 2. Longitudinal and Cross-sectional Views of Robson & Sorensen Two-part Ball Bearing

Those who worked on this principle overlooked the important fact that steel is an elastic material and is subject to considerable distortion when placed under the stress introduced by heavily loaded balls running in the raceways. Where the attempt is made to produce a satisfactory two-part ball bearing by the use of highly finished joints between the raceway segments, satisfactory results will not be obtained for the reason which is shown diagrammatically at *A* in Fig. 1. Here it will be seen that as the loaded ball approaches the joint, distortion of the steel depresses half of the raceway below the other, with the result that each ball strikes a sharp corner or step as it passes over the joint. This will soon cause wear in the balls and raceways, and when such wear has started it means that complete destruction of the ball bearing will take place in a comparatively short length of time.

Upon this principle of the elasticity of steel, Robson & Sorensen, 430 Bridge St., Spring City, Pa., have developed the two-part bearing, best understood by referring to the illustration of half of an outer raceway for this bearing shown at *C* in Fig. 1, and the longitudinal and cross-sectional views of the bearing shown in Fig. 2. In a well-designed bearing the balls are all made of exactly the same size—this accuracy being held within 0.0001 inch—in order that the load may be uniformly distributed over the balls. It is apparent that a heavily loaded ball running over a joint in a divided ball bearing raceway would result in considerable damage being done to both the raceway and balls; if, on the other hand, the load could be relieved from the balls as they pass over the joints in the raceways, practically no damage would result. Realizing the importance of this point, it was decided to provide means for relieving each ball in the bearing of its load as the ball passes over one of the joints in the raceway. This result is accomplished by cutting transverse slots across the outside and inside of the raceways at points adjacent to the joint, this idea being shown at *C* in Fig. 1 and in Fig. 2.

As a ball reaches the section of the raceway immediately adjacent to the joint, this part of the raceway is deflected by the pressure of the ball, which results in the ball dropping below the circle formed by adjacent balls running on the solid sections of the raceway, and as a result, the ball is practically relieved of load—just enough load remaining to keep the end of the raceway slightly deflected. As a result, the ball runs over the joint with practically no load upon it, and so the tendency toward wear of the balls and raceway is eliminated. The criticism may be offered that this slotting of the raceways would have a tendency to cause them to break, but this point has been given careful consideration and the cross-section of the metal at the bottom of the slots is ample to prevent trouble from this cause. It will, of course, be realized that the deflection of the end of the raceway segments is only 0.001 or 0.002 inch.

The type of shaft mounting shown in Fig. 2 is the original design, which is rather complicated and expensive. Now it is the practice to mount the inner raceway directly on the shaft by means of two two-part clamps fitted into annular grooves on each side of the ball groove. It will be possible, however, to gain a clear idea of the bearing construction by referring to Fig. 2, where the shaft to be supported by the bearing is shown at *A*, and on this is mounted a two-part sleeve *B*, which carries a flanged collar *C* loosely mounted upon it. This collar has a beveled under-cut portion *D* at each side, against which bear the segmental inner bearing races *E*, which are beveled at each side to conform to the contour of the collar at *D*. At the outside, these inner races are secured by two-part nuts *F*, which are suitably beveled to engage the races and threaded on the inside to enable them to be screwed onto either end of sleeve *B*. Nuts *F* and collar *C* are

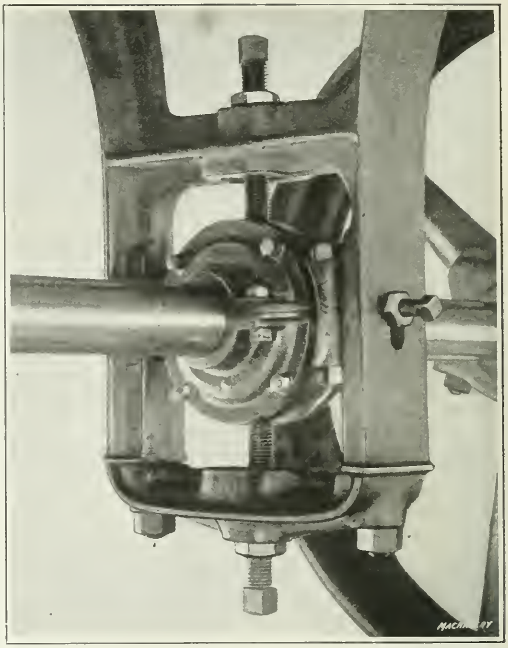


Fig. 5. Rebsen & Sorensen Two-part Ball Bearing mounted in S K F Hanger

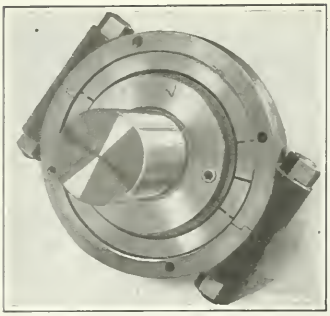


Fig. 3. Close View of Assembled Bearing with End Plate removed

of split construction, as shown at *B* in Fig. 1. Consequently, when assembled in this way, the two-part nut is practically a single piece, and as this nut is screwed onto sleeve *B* (Fig. 2), it draws the sleeve firmly onto the shaft while the bevel on the outside of the nut draws the bearing race down onto the sleeve.

In assembling one of these bearings it has been found desirable to have the inner races *E* arranged so that the divisions of one bearing raceway are out of line with the divisions of the other raceway or raceways which comprise the bearing. In Fig. 2 is shown a bearing with two sets of balls and raceways, but bearings of this type may be arranged with a greater number of raceways if so desired. Also, it will be apparent from Figs. 3, 4 and 5 that the design of these bearings does not depend for successful performance on having two or more bearings assembled directly opposite each other, as illustrated in Fig. 2. Tests have shown that this is nonessential. In Fig. 2 the outer bearing raceways are shown at *G*, and it will be seen that these raceways fit into a casing *H*, which is also made in two sections that are secured in the present instance by transverse bolts or by some other suitable design. Heads *I* are screwed into the threaded ends of casing *H*, and the ends of these heads bear against the outer bearing raceways *G* and hold them in proper alignment with the inner raceways. It will be apparent that these heads have openings considerably larger than the diameter of the shaft, and annular grooves are provided to receive packing rings *J*.

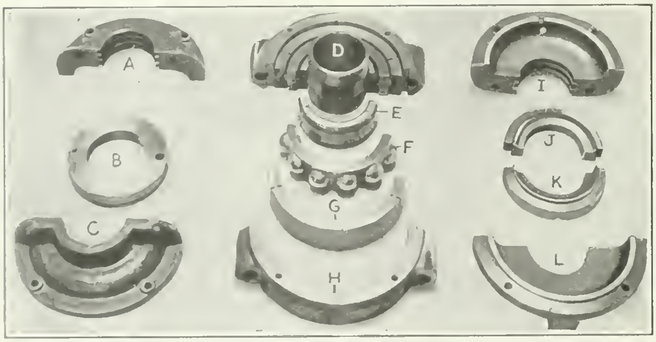


Fig. 4. A-C, Upper and Lower Halves R. H. End Plate; B, R. H. Lock Nut; D, Upper Half Complete Bearing with Upper Cap and Shaft Adapter; E-G, Lower Half Inner and Outer Raceway; F, Lower Half Ball Cage; H, Lower Cap; I-L, Upper and Lower Halves L. H. End Plate; J-K, Upper and Lower Halves L. H. Nut Lock

In order to prevent the inner bearing raceways *E* from turning on sleeve *B*, flat pins *K* are provided, which project up from sleeve *B* and extend into the spaces between the ends of the bearing raceways *E*. Similarly, it is necessary to prevent the outer bearing raceways *G* from rotating independently of casing *H*, and this result is accomplished by flat pins *L*, which extend from the joints in casing *H* into the spaces between the ends of the outer raceways. It will also be noticed that in order to allow the ends of the inner and outer raceways to be deflected by the ball pressure in the manner to which reference has already been mentioned, clearances are provided at *M* and *N*. The exterior of the casing can be formed in any suitable manner to accommodate the type of hanger to be used. In Fig. 5 one of the Robson & Sorensen bearings is shown mounted in an S K F lineshaft hanger. From the preceding description it will be apparent that this type of ball bearing construction makes it possible to apply a ball bearing at any point on the lineshaft or any continuous shaft without the necessity of taking down the shaft to enable the bearing to be slipped over the end. Similarly, the two-part ball bearing can be mounted on crankshafts or other machine members which are of such a form that it would be impossible to support them in one-piece ball bearings of standard design.

BREWSTER "ETCHOGRAPH"

In all shops where small tools, milling cutters, saws, etc., are used, the occasion frequently arises for applying various marks. This may be for the purpose of branding the tools with the name of the shop in order to

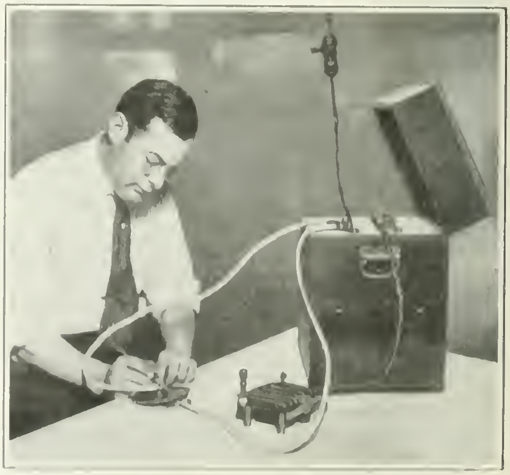


Fig. 1. Brewster "Etchograph" engaged in marking Tools

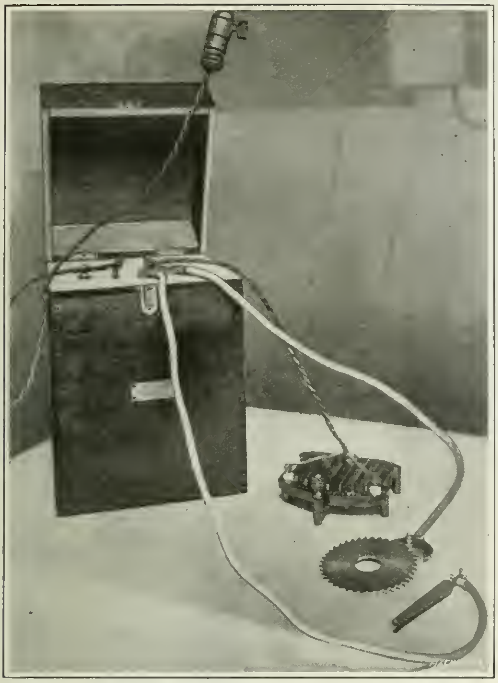


Fig. 2. Electric Marking Machine known as the "Etchograph," made by William Brewster & Co., Inc.

avoid theft; it may be found necessary to designate the size of a tool or the operation for which it is employed, and numerous other occasions may arise which make it necessary for a tool to be marked. To meet the requirements of this work, William Brewster & Co., Inc., 30 Church St., New York City, has developed an electric marking machine which is known as the "etchograph." It consists of a transformer for connection with an ordinary electric lighting circuit to provide for obtaining the required current and voltage for operating the etchograph. Two leads are taken off from the secondary of the transformer, one of which runs to a steel plate of considerable size upon which the work to be marked is placed. The transformer used is made by the Adams-Bagnall Co., Cleveland, Ohio.

The other lead runs to what is known as the "pencil" of the etchograph. This pencil has a hardened rubber handle and a clamp at the end to which is secured the lead from the transformer. This clamp also carries a small copper point, made from an ordinary piece of wire, with which the marking is performed. As this point is drawn over the surface of the work, the higher electrical resistance of the iron or steel to be marked results in producing a burn on the surface of the work, leaving a dark oxide mark on the metal. This machine is adapted for use in connection with standard alternating current of 110 volts, 60 cycles, and the consumption of current from the line is from 1½ to 2 amperes. When alternating current is not available, a D.C.-A.C. converter can be furnished at low cost. This current is stepped up so that when delivered from the secondary of the transformer, there are 20 amperes of current at a potential of 2 volts available for marking. To provide for obtaining the desired depth of marking, a rheostat is furnished which provides for adjusting the amount of current delivered to the pencil of the etchograph. This pencil is used as an ordinary lead pencil would be handled, and provision may be made for either writing free hand script or for printing, according to the class of marking which may be desired. The etchograph is adapted for marking either iron or steel, and all classes of high-speed carbon and machine steel may be marked with equal facility, no matter whether it is in the hardened or soft condition.

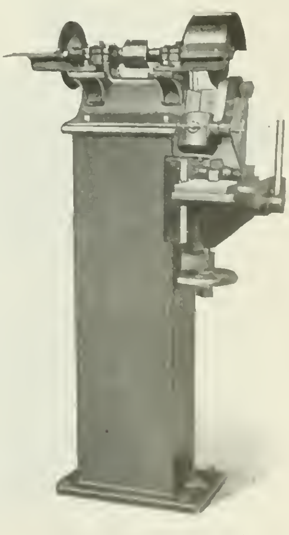
RUSS FORGED DRILLS

There has been a question as to whether it was possible to forge a twist drill from a solid steel blank and make the operation a commercial success, both as regards the cost of production and quality of workmanship. It is claimed that the practicability of securing satisfactory results in this way has been proven by the A. E. Russ Forged Drill Co., Cleveland, Ohio, and this firm is now manufacturing and supplying the trade with its "Drill Far" forged twist drills, one of which is shown in the accompanying halftone illustration. In carrying out this manufacturing operation, a round bar of high-speed steel is forged down to the desired diameter, after which it is subjected to a second forging operation to form the flutes. It is claimed that these two forging operations tend to give the steel a more compact structure and that the forging operation compels the fibers of the steel to follow the spiral instead of running straight from end to end. Greater strength should be obtained in this way, because the different fibers in the metal would afford each other mutual support when the drill was placed under strain, and so there would be less tendency toward breakage. This would make it practicable to use high speeds and heavy feeds.

A. E. Russ Forged Twist Drill

SLEEPER & HARTLEY NAIL DIE GRINDING MACHINE

To meet the requirements of firms operating automatic nail making machinery for a grinder for use in sharpening the dies used on such machines, a die grinder of this type was brought out by Sleeper & Hartley, Inc., 68 Prescott St., Worcester, Mass. The machine was primarily designed for use in connection with Sleeper & Hartley nail machinery, but is now offered to nail makers using other types of equipment. It will be seen that the machine is provided with two wheels mounted upon a double-ended spindle, one of these wheels being used for squaring the dies, while the other has a V-shaped formed edge for grinding the pointing dies. Below this wheel there is a table mounted on the machine frame for vertical travel and made adjustable to and from the wheel with a screw actuated by a handwheel. This table carries a support adapted to receive the holder in which the die is mounted for grinding. This support is adjustable in a lateral direction in order to bring the die into line with the wheel, while the die-holder itself may be rotated in the support to locate the die in any one of three grinding positions. When positioned, the die is reciprocated to and fro past the wheel, while the whole table may be fed to or from the wheel as desired. Equipment of the machine includes one die-holder made according to the customer's specifications, and a countershaft for driving the machine. This machine occupies a floor space of 16 by 22 inches in size and has a net weight of 350 pounds.



Nail Die Grinding Machine built by Sleeper & Hartley, Inc.

WESTINGHOUSE INDUCTION MOTOR CONTROL PANELS

Where it is desired to combine in one unit the complete control equipment for wound-rotor induction motors, a neat, safe and convenient means either for starting or for speed variation is provided by Type RF control panels, manufactured by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. By their use, motors are provided with complete protection from injury due to overloads, failure of voltage and improper starting. Panels are suited to all applications where drum controllers may be employed. Each outfit consists of a pipe-mounting slate panel, on which is mounted an oil circuit-breaker for the primary circuit, a drum controller for the secondary circuit, and, when desired, one or more meters mounted on the panel. Resistors are separately mounted. One of the most interesting features of these panels is an interlock between the oil circuit-breaker and the drum controller, which renders it impossible for the operator to start the motor without all the resistance in the secondary. These panels are recommended for service in which reversing is seldom or never required.

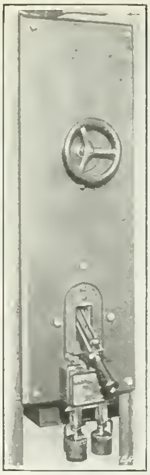


Fig. 1. Westinghouse Control Panel

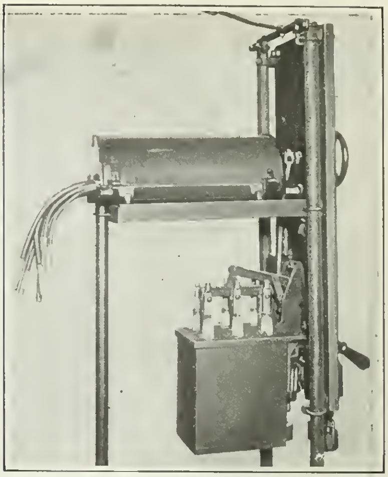


Fig. 2. Opposite Side of Westinghouse Induction Motor Control Panel

TRIUMPH RADIAL DRILL

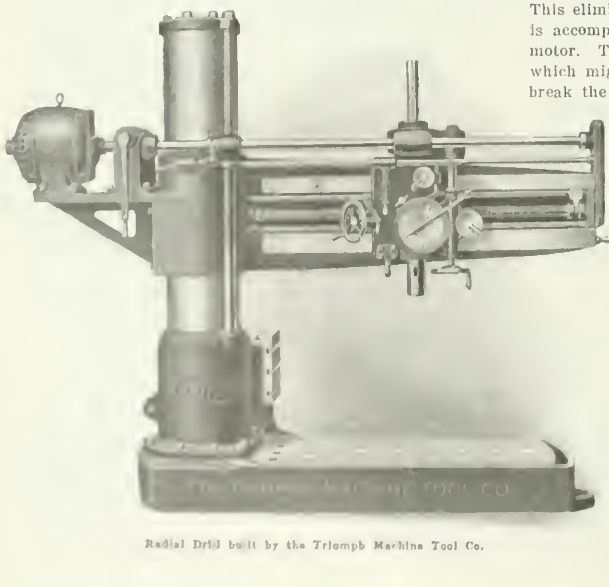
The Triumph Machine Tool Co., 1276 E. 55th St., Cleveland, Ohio, is now building the 6-foot radial drilling machine which is illustrated and described herewith. It will be apparent that the machine is furnished with individual electric motor drive, making it possible to place this radial drill in any position in the shop to suit existing conditions, regardless of the position of lineshafts, etc. Space under traveling cranes or in out of the way corners may be utilized in this way. On this machine all controls are placed in the spindle head, making it possible to lock and unlock or raise and lower the arm, lock the sleeve to the column, change the speed of the spindle, run in the forward or reverse direction, or stop the spindle, move the head along the arm by power, and change the rate of feed to the spindle without requiring the operator to change his position. By mounting the variable-speed motor on the arm, the number of driven parts required is lessened.

The arm of this radial drill is made of a heavy section and is adequately ribbed at both the top and bottom. It is provided with liberal sized gibs and its bearing upon the column is of ample length. The spindle head is supported by three gibs on the arm and may be moved to any position by means of a power-driven rapid traverse screw mounted in the arm. This screw may be engaged, disengaged or locked as required. A handwheel provides for making minor adjustments. The spindle is made of high-carbon crucible steel and is supported in phosphor-bronze bearings, the thrust being taken by a ball bearing. Drive is accomplished by a worm and wheel, the worm having a 30-degree pressure angle, and although ample power is provided, the drive is perfectly noiseless. This is the only driving mechanism located in the head.

Automatic return of the spindle is accomplished in such a way that when the drill has reached a predetermined depth the feed is knocked out and the spindle automatically returned to the upper position. The gear-box is located at the rear of the machine in front of the motor and contains gears furnishing three ratios—one speed for heavy tapping, etc.—and is provided with an accelerated speed to provide for the use of small drills. Under normal conditions of operation there are no gears in mesh, as the motor drives direct through the shaft which carries the worm, thus eliminating all noise and providing an efficient transmission of power to the spindle head. The gears are of steel and submerged in an oil bath.

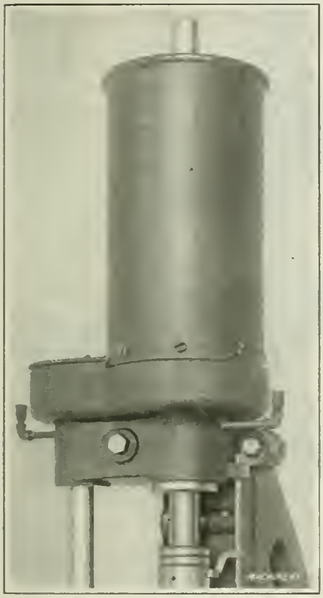
Reversal of the direction of rotation is accomplished by reversing the motor, the start, stop and reverse lever being located on the spindle head within easy reach of the operator. This eliminates all shock when tapping, as the braking effect is accomplished electrically by reversing the current in the motor. This eliminates the necessity for reversing clutches, which might give trouble through slippage or a tendency to break the tap or drill. Feeds are instantly available at the spindle head by the use of an indicator, and available rates of feed are 0.006, 0.009, 0.015 and 0.024 inch per spindle revolution. This range meets the requirements of all ordinary conditions, and changes of feed are obtained by merely setting the indicator.

The column is made in two sections, the inner portion or mast being attached to the base, while the sleeve is mounted upon this column and provided at the top and bottom with roller bearings to make the movement of the arm easy and to take the thrust load. The outer sleeve extends almost to the base of the machine and is provided with means of clamping to the inner column. The motor control is located on the spindle head and gives twenty-one speeds in either direction, without the operator being required to change his position. With the geared transmission, the number of available speeds in either direction is increased to sixty-three, and constant speed is maintained at any given speed


Radial Drill built by the Triumph Machine Tool Co.

Principal dimensions of this machine are as follows: height of base, 9 inches; working surface of base, 4 feet by 6 feet, 8 inches; vertical movement range of arm, 4 feet; horizontal movement range of head, 4 feet, 2 inches; minimum and maximum distance from base to spindle, 8½ inches and 6 feet, 2 inches; minimum distance from base to center of head, 39 inches; minimum distance between column and spindle, 24 inches; capacity in plane of base is to drill to center of circle of 6-foot radius; range of motor drive speeds for 5-horsepower motor, 775 to 3100 revolutions per minute; range of spindle speeds, 15 to 260 revolutions per minute; least diameter of spindle at driving section, 2 9/16 inches; vertical traverse, 19 1/2 inches; and net weight of machine complete with motor, approximately 16,500 pounds.

COLBURN TAPPING HOOD



Tapping Hood for Colburn Drilling Machines

To provide for relieving the strain on the side of the keyway in spindles of its drilling machines while the machines are engaged in the performance of heavy boring and tapping operations on work of large diameter, the Colburn Machine Tool Co., Franklin, Pa., is making a tapping hood in various sizes to fit different types of Colburn heavy-duty drilling machines. Power from the driving gear is transmitted through a cross bar, which is keyed and held rigidly to the spindle by means of a clamping screw. The outer extremities are slotted to form a slidable fit with square keys seated into the inside surface of the drum. This drum is attached directly to the spindle driving gear, so that there is no sliding contact in the keyway of the spindle, such a contact taking place on the double keys inside the drum. This tapping hood is machined inside and out and is claimed to be in perfect balance. It can be used when the machine is run up to the highest speeds without the least danger of introducing vibration.

DETROIT BELT LACER

In lacing a belt it is essential to obtain strength and durability, and to do the work by a method which enables it to be handled rapidly in case of emergency. These features are obtained through the use of machine-closed wire belt lacing which gives the added feature of smoothness of operation under all conditions. The Detroit Belt Lacer Co., Hubbard Ave. and A St., Detroit, Mich., is now making the "Bulldog" belt lacing and a machine for lacing up belts in this way. It is claimed that "Bulldog" lacing applied with this machine gives a perfect staggered grip on the belt and shows a minimum reduction of cross-sectional area on any cross-section for a given size of wire. "Bulldog" belt lacers are put up 84 hooks to the section, which is full 12 inches long, and 12 sections are packed in a box which contains slightly in excess of 144 inches of lacing with six full-length sections of rawhide pins. These lacers are made in four sizes known as Nos. 3, 4, 5, and 6 for lacing thin, medium, heavy and extra heavy belts, respectively. Rawhide pins are sold in 12-inch lengths and are also made in four sizes, 3/32, 7/64, ⅛ and 9/64 inch in diameter for use in connection with respective sizes of lacers to which reference has just been made.

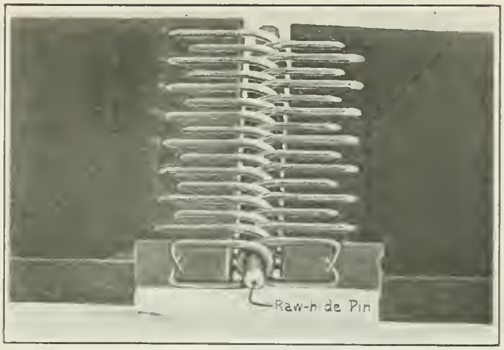


Fig. 1. Belt laced with "Bulldog" Belt Lacing made by Detroit Belt Lacer Co.

The "Bulldog" closing machine shown in Fig. 3 is furnished with two handles, either of which operates the machine leaving the other hand free to hold the belt. Consequently, one man can operate the machine without difficulty. The belt hooks are driven in from both sides and are always central. Fig. 2 shows a removable holder for lacers. The required sections of lacers is put into the holder and the holder is slipped into the closing machine, after which the lacers are driven home by pushing down the hand lever. This holder can also be used for closing lacers in a vise or with a hammer. Features of this belt lacer, to which particular attention is called, are as follows: The detachable holder enables the lacers to be properly arranged before the holder is inserted in the machine. The double handles on the machine enable the operator to pull either handle which is most convenient for him; either handle operates the machine and the operator always has one hand free to hold the belt. The removable holder centers the hooks properly and they are driven in from both sides, the positioning being such that there is a minimum reduction of cross section. Any thickness of belt may be laced in this way and secure a joint which runs over the pulleys almost as smoothly as other sections of the belt.

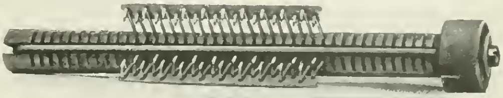


Fig. 2. Removable Holder for "Bulldog" Lacers Ready to be put into Closing Machine

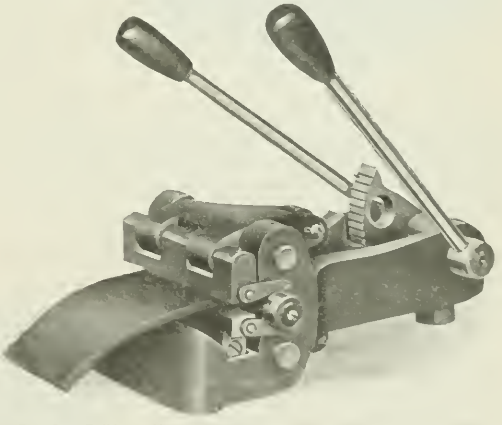


Fig. 3. "Bulldog" Closing Machine for lacing Belts with "Bulldog" Lacing

"RESISTAL" SAFETY GOGGLES

In Fig. 1 are shown what are known as "Resistal" goggles which are well adapted to the requirements of machinists and other workmen engaged in shops where there is danger of having their eyes injured by flying particles of metal, abrasive, etc. The name "Resistal" was adopted because although the crystals can be cracked they cannot actually be broken with a hammer blow. In cracking, there is no flying of splinters to jeopardize the eyesight of the wearer. The crystals are made of two layers of optical glass which may be either flat or curved, and between the two layers of glass there is introduced a layer of celluloid, the whole being cemented into a solid mass. This produces a crystal which has every virtue of glass but none of its drawbacks. The strength and safety features of celluloid goggles is obtained, but the crystals are unscratchable, rigid, and perfectly fireproof; they are not affected by water, heat or cold, and the celluloid layer is said to provide a heat insulating medium which prevents clouding up the glass due to condensation of moisture. Goggles with "Resistal" crystals are made with either clear amber or "euphos" colors and are sold by Strauss & Buegeleisen, 37 Warren St., New York City. Crystals may also be obtained in special forms for use in industrial masks used by welders, sandblast operators, etchers, etc.

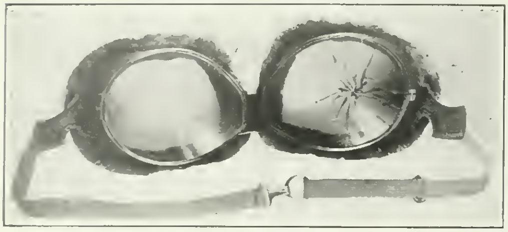


Fig. 1. "Resistal" Goggles made by Strauss & Buegeleisen

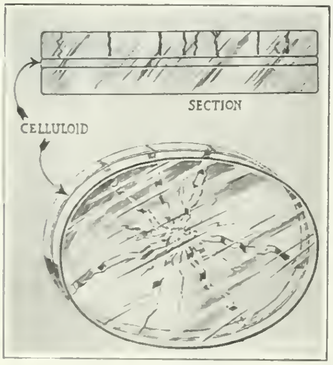


Fig. 2. Broken Crystal, showing Construction

SILVER UPRIGHT DRILLING MACHINE

One of the latest additions to the line of drilling machines built by the Silver Mfg. Co., Salem, Ohio, is a 25-inch upright machine which is illustrated and described herewith. This drilling machine was especially designed to meet the requirements of severe service, but is capable of producing work of high accuracy. Eight spindle speeds are obtainable, four of which are secured with open belt drive and four by transmission through the back-gears, which are fully enclosed and may be quickly engaged by means of a conveniently located lever. Six positive geared feeds are obtained, and any feed may be instantly engaged while the machine is running. The spindle is made of high-carbon crucible steel and provided with an imported ball thrust bearing. Both column and sleeve are accurately ground, and the spindle and sliding head are accurately counterbalanced by means of a weight inside the column. This weight is attached by means of a chain to a notched lever and the sensitiveness of the spindle counterbalance may then be adjusted to suit conditions by simply varying the position of the chain connection on the lever. The sliding head has a wide bearing on the column to which it is rigidly secured and is easily adjusted up and down owing to its perfect balance.

Two quick-return levers are used; the one situated on the right-hand side can be slid back and forth in its bearing, and when withdrawn to its full length it is suitable for hand drilling in light work. The automatic stop for the down feed is set by graduations on the spindle and may be instantly disengaged either by hand or power. This enables holes to be drilled to any desired depth. The swinging table is of rigid construction and is in perfect alignment with the spindle and column. The supporting arm is provided with a wide bearing on the column, and it may be easily raised or lowered by means of a screw. It will be apparent that the frame is symmetrical in design and liberally proportioned to provide the necessary strength and rigidity for heavy work. A tapping attachment provided for use on this machine consists essentially of four bevel gears, one intermediate pinion and two positive clutches, the intermediate pinion being mounted on an eccentric so that it may be thrown out of mesh when the attachment is not in use.

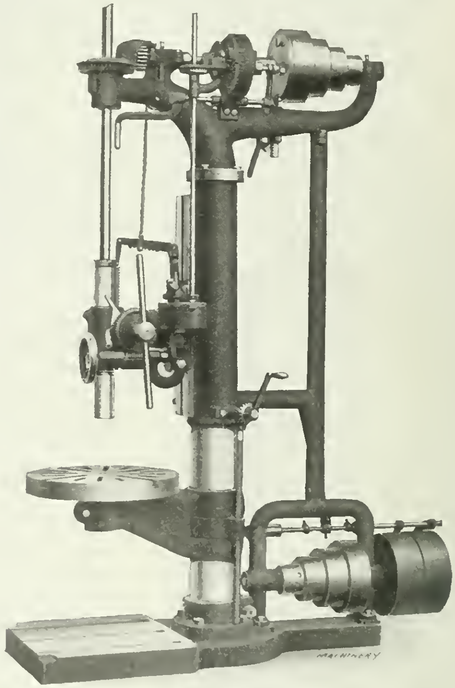


Fig. 1. Silver 25-inch Upright Drilling Machine

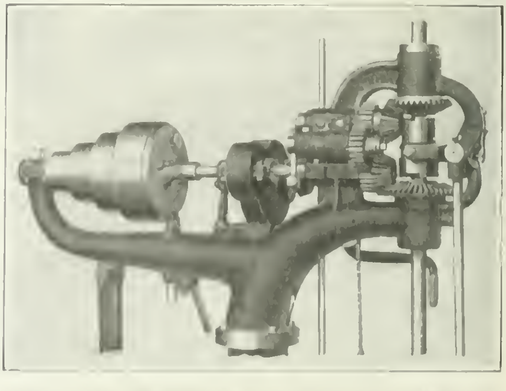


Fig. 2. Close View of Arrangement of Gearing for Tapping Attachment

The principal dimensions of this machine are as follows: height, 7 feet, 3 7/16 inches; maximum distance spindle to base, 48 inches; maximum distance spindle to table, 31 inches; distance from column to center of spindle, 12⅞ inches; traverse of table on column, 16 inches; traverse of head on column, 22¼ inches; diameter of table, 21¼ inches; diameter of column, 6⅝ inches; diameter of spindle, 1⅝ inch; diameter of sleeve, 2⅞ inches; Morse taper hole in spindle, No. 4; maximum feed of spindle, 9¼ inches; ratio of bevel gears, 2 2/11 to 1; ratio of back-gears, 3¾ to 1; size of driving pulleys, 4¼ by 12 inches; diameters of largest and smallest steps on cone, 10 and 4 inches, respectively; face width of cone pulley steps, 3⅛ inches; speed of countershaft, 275 R.P.M.; range of spindle speeds, 14 to 315 R.P.M.; range of feeds, 0.0056, 0.009, 0.012, 0.014, 0.021, and 0.031 inch per revolution; floor space occupied, 22 by 62½ inches; and net weight of machine, 1650 pounds.

SEBASTIAN GEARED-HEAD LATHE

The Sebastian Lathe Co., Cincinnati, Ohio, is now building a geared-head, quick-change lathe in 13-, 14- and 15-inch sizes. These three lathes are all of the same general design. Eight mechanical speed changes are provided in the headstock, ranging from 19½ to 487 revolutions per minute. Two levers control these speed changes, four changes being obtained by the left-hand lever, while this number is doubled by the right-hand lever, which provides for engaging either the direct or back-geared drive. The spindle is made of 40- to 60-point carbon steel, and is carried in bronze-bushed bearings. All shafts are made of steel, and careful provision has been made for lubrication of all bearings.

The entire headstock is packed with grease, which affords constant lubrication to all gears and moving parts. Lathes of this type may be furnished with or without individual motor drive, the top of the headstock being planed to receive a motor where individual electric drive is required, and power is transmitted by either a belt and idler pulley to maintain the desired tension or by a chain and sprocket wheels. The switch for motor control is arranged either at the front of the motor or on the back of the bed, and in the latter case control is obtained from the apron. Any make of motor for direct or alternating current—either constant or variable speed—may be used.

The quick-change gear-box occupies the space ordinarily taken up by the intermediate gear and quadrant. All shifting gears are made of steel, and twenty-four changes of feed are obtained. Eight rates of feed are secured by operating the sliding tumbler, which is locked in position by a pull pin, and these are compounded by placing the knob in any of its three positions. Bronze bushings are provided for all running bearings in the feed-box. A plain change-gear can be furnished, if desired, instead of the quick-change gear-box. This box cuts from five to thirty-six threads per inch, including the 11½ pipe thread. The tailstock has an adjustable side movement to provide for the performance of taper turning operations and is so designed that the compound rest can be swung at right angles.

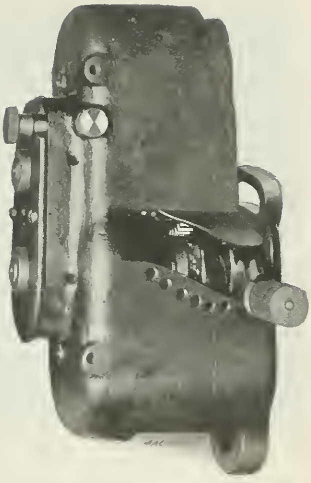


Fig. 2. Quick-change Gear-box

The carriage has long bearings on the ways and is provided with ample means for lubrication; it is gibbed to the bed at both the front and back and provided with T-slots. Both a lead-screw and feed-screw are provided, and the carriage is furnished with power cross-feed. Regular equipment of the lathe includes a compound rest, steady- and follow-rests, large and small faceplates, a plain rest, and a friction countershaft if the lathe is not arranged for motor drive. These lathes are built with a gap bed, the gap being 7¾ inches long and 3½ inches deep, thus increasing the swing of the lathe in the gap by 7 inches. The bed is braced at the gap in such a way that there is no weakness at this point. A bridge block, which may be easily placed in position or removed, may be fitted in the gap, but this bridge cannot be fitted after the lathe is finished.

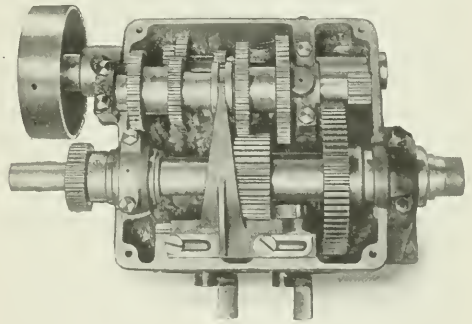


Fig. 3. Arrangement of Gearing in Lathe Head

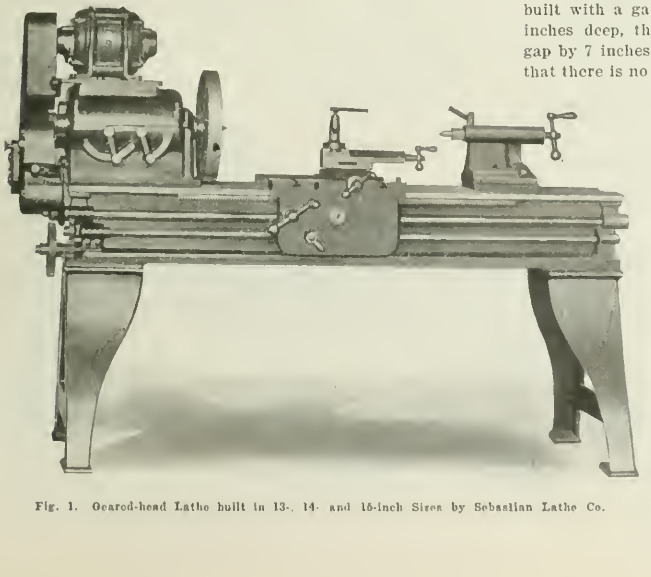
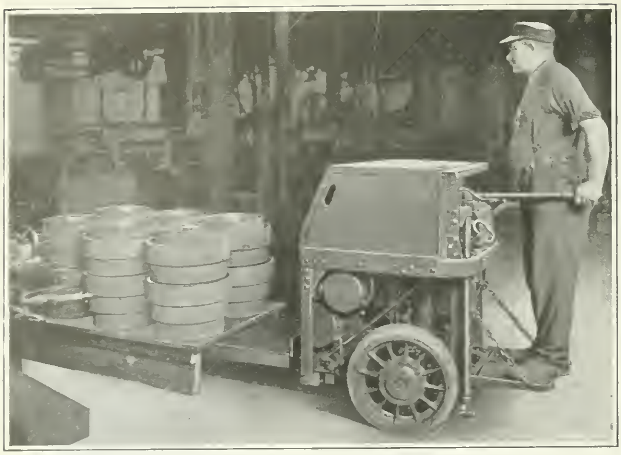


Fig. 1. Geared-head Lathe built in 13-, 14- and 15-inch Sizes by Sebastian Lathe Co.

ELWELL-PARKER TRUCK

Since building its first hand-operated elevating platform on an electric storage battery truck about five years ago, the Elwell-Parker Electric Co., Cleveland, Ohio, has developed two special electric lift trucks. The latest model of this type has incorporated many features and refinements dictated by actual service conditions. Both the electrical and mechanical construction of this type of truck, which is built in two sizes, are completed in their own plants. The tool is operated by two enclosed motors, each especially built to perform work of an entirely different character, i. e., one to propel the truck and the other to electrically



Self-loading Electric Truck made by the Elwell-Parker Electric Co.

drive the elevator. The storage battery is carried in a covered compartment on top, close to the controller and above the vertical propelling motor. This motor is direct-splined to a single worm reduction on a four-pinion bevel differential. A contracting brake is located between the motor and axle and is spring-operated by the driver releasing his weight from one pedal, which forms half of the operating platform. The brake is capable of stopping the truck in its own length under all conditions of load and speed.

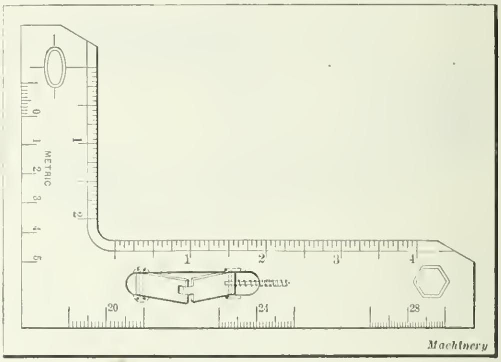
A circuit-breaker or connection between the controller and battery is actuated by the weight of the operator on a second pedal. This circuit-breaker is interlocked with the controller and will not close except when the latter is in the "off" position. Therefore, no fuse is required and the special motor will take the full battery power. The brake and circuit-breaker operate independently, so that the truck can be started on the incline without fully releasing the brake or blowing a fuse. The controller is self-returning to the neutral position whenever the handle is released. Thus the operator is afforded complete protection under both normal conditions or in emergencies. Drive to the axle is of the full floating type, and supports the truck frame of heavy springs. The driving shafts carry no weight and are removable through the wheels with 21½- by 3½-inch tires, which are also demountable.

A lever, which is adjustable for the operator's height, steers all four wheels. The steering tie-rods and knuckles are so located that difference in wheel angularity is compensated for, giving concentric steering when turning to right or left. All levers are bushed, and the pins are hardened and ground and held rigidly in the steering links. The steering knuckles are located over the tire center lines to give easy steering. These features, with independent operation of the brake and circuit breaker with no fuse, are exclusive Elwell-Parker construction details. The truck deck or platform is raised by means of a special enclosed motor which drives a worm lifting device or elevator. This lifting mechanism runs at slow speed in oil and needs attention only once or twice a year. A special switch is closed manually to lift the truck platform after having driven it beneath a separately loaded deck or platform. This results in an instant lift of 4½ inches to the load. This raises the load up above all floor obstructions and proves an advantage in crossing door sills, rails, or uneven floors or grade. When the load reaches the upper or lower limit of travel, an attachment to the platform opens the switch to the motor.

It is possible on this truck for the operator to instantly stop movement of the platform in either going up or down. This is an important improvement, for loaded platforms or loads that catch on obstructions or adjacent machines and do damage unless it is possible to stop at any point when elevating two tons. Storage batteries are furnished of a capacity to perform a day's work when traveling ten to twenty miles. These trucks are made in two heights to suit different conditions. The higher one is provided with larger wheels and is particularly well adapted for yard work. With a worm drive and worm lift, large clearances beneath, larger wheels and a reduced width and length, these trucks meet conditions in practically every industry.

WARE GRADUATED ANGLE SQUARE

R. B. Ware, 101 Northampton Ave., Springfield, Mass., is now making what is known as a graduated angle square, which is shown in the accompanying illustration. This instrument is intended for the use of draftsmen, and it is claimed that it may be used with equal facility by right- and left-handed men. It will be apparent that this is a 30- and 60-degree angle square, because, when placed with the beveled ends on the T-square, 30- and 60-degree angles may be drawn. Using the square with the beveled side down makes it very convenient for inking in—especially for dotted lines. This square is regularly furnished with divisions graduated to 1/16 inch on the inside, centimeters and millimeters at the end, and 20ths, 24ths and 28ths of an inch on the bottom edge. It is provided with the Ware "Pick-up" feature. As previously described in MACHINERY, this consists of a knuckle joint which presses through the slot in the square and pops up on either side through pressure applied by a music wire spring. This pick-up always rises to the upper side of the square, but the square may be placed between the leaves of a book or have other articles laid upon it. In such a case the pick-up drops into the slot and takes no more room than if it were not there. This square is made in 2 by 4, 3 by 6, 4 by 8, and 5 by 10-inch sizes of 30- and 60-degree angles; and in 3 by 3, 4 by 4, 5 by 5, and 6 by 6-inch sizes of 45-degree angles.



Graduated Angle Square made by R. B. Ware

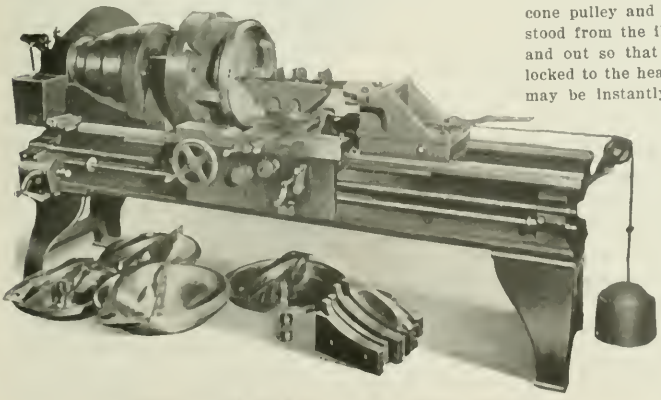
LUSTER-JORDAN LATHE FOR TORPEDO AIR FLASK HEADS

The Luster-Jordan Co., Inc., Franklin Ave. and Washington St., Norristown, Pa., has recently built for the Spanish government a special lathe for turning the air flask heads on torpedoes. It was formerly the practice to turn these heads on a standard lathe, and the required radii of curvature on various surfaces of the work were obtained with radius attachments. Since the inside of one head may have from two to five different curves, it will be apparent that in order to handle this class of machining operations and produce accurate work, it might be necessary to use ten different adjustments of the radius attachment to machine both sides. On the special lathe built by the Luster-Jordan Co., a forming attachment is used on the tailstock, and in some instances a forming attachment on both the carriage and tailstock. In this way the operation is greatly simplified.

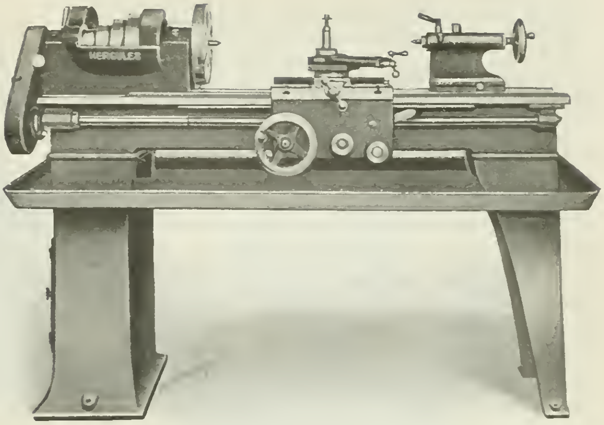
The toolpost on the lathe carriage has been made wider and heavier; and the upper part of the tailstock has been removed to provide for mounting a special forming attachment. This consists of a plate whose edge conforms to the contour of the air flask head to be machined. The toolpost has a straight slot extending across it, and in one side of this slot a cutting tool is carried, and in the other a forming guide, which runs in contact with the formed plate carried on the tailstock. Both the tool and forming guide have on their cutting edge and guiding edge, respectively, an accurate circular point, say ¼ inch in diameter. The distance between the centers of these circles is ¾ inch. The forming plate is marked "Center of Tool" and "Center of Work," and these two centers are ¾ inch apart in order to register correctly.

Due to the fact that it is necessary to use a circular cutting edge in order to follow all around the work and get into the recesses, the condition arises that the form plate must have a different form from the finished air flask head. If, for instance, the curvature of the work conforms to a 16-inch radius at a certain point, the radius of the form plate for use in machining this head will not necessarily be 16 inches for the corresponding point, since the cutting tool does not always cut on the same point, but changes around the circular form of the tool. Therefore, it is necessary to develop each form plate according to the head for which it was made. Some of the heads have a decided transverse curve ending in a longitudinal curve, and it has been found necessary, in order to make the machine operate correctly, to disconnect the toolpost screw and connect with the feed of the carriage, so that when one feed is disconnected the other is thrown in without interruption. This result has been accomplished by splitting the screw operating the toolpost and connecting this attachment with the clutch on the carriage which operates the feed-screw on the carriage, thus making the machine practically automatic in operation.

A counterweight is connected to the carriage which supports the toolpost for boring the center of the torpedo head. The machine is equipped with a progressive boring tool, which is registered by the guide in the center of the form. The heads are gaged by inserting a plug gage into the center of the head, and the inside form of the head is registered from this plug gage by means of a flat gage. The outside form is gaged by another flat gage, which rests on the upper surface of the inner gage, thus gaging the inside and outside form and also the thickness of the head, where inaccuracy might result in serious trouble. By means of this machine it is possible to machine a smaller head 12 inches in diameter in approximately 6 hours, and a larger head 22 inches in diameter in from 10 to 14 hours. These figures were obtained in machining samples made of cast iron; forgings which are used in actual practice were not available. The machine is equipped with an oil pump and progressive feeds in the cross-slide to compensate for the different peripheral speeds.



Luster-Jordan Lathe for turning Air Flask Heads on Torpedoes



"Hercules" 12-inch Screw Cutting Engine Lathe built by Himoff Machine Co.

HIMOFF ENGINE LATHE

The 12-inch screw cutting engine lathe which is the subject of the following description has recently been added to the line of "Hercules" machine tools built by the Himoff Machine Co., 45-53 Mills St., Astoria, L. I. In working out the design of this machine it has been the aim to develop a lathe adapted for handling a wide range of work in tool-rooms and mechanical laboratories, in addition to the performance of manufacturing operations on light commercial work where accuracy is required. This lathe may be furnished with floor legs, bench legs, or mounted on an oil-pan; and it may be equipped for either belt drive from a countershaft or direct-connected motor drive.

The feed motion is positively driven by change-gears through a splined lead-screw, worm and gear, and then through spur gears to the rack. A friction is provided which may instantly be thrown in or out by turning a knob on the apron, and reverse is provided by shifting a lever in the headstock, which will feed the carriage either right or left or disengage the feed as required. The only wear which can occur in the lead-screw threads is when the screw is actually being used in the performance of thread cutting operations. Power cross-feed is provided by pulling out or pushing in a hand knob on the apron. The headstock casting is designed to afford mutual support for the front and rear spindle bearings, and this construction also serves to afford protection for both the cone pulley and back-gears. The idea will be readily understood from the illustration. The cone is finished both inside and out so that it is perfectly balanced, and this pulley is locked to the head gear by an improved locking device, which may be instantly secured or released without the use of a wrench. The hollow spindle is made of 50- to 60-point carbon crucible steel and ground to size. A chain oiling system insures positive lubrication. The thrust is carried by a hardened steel washer, which runs against the rear bearing, and adjustment is provided by a nut.

A wide range of thread-cutting operations may be performed on this lathe, the capacity being for cutting both right- and left-hand threads from 3 to 72 per inch, including the 11½ pipe thread. An index and set of transposing gears may be furnished as a special equipment to provide for cutting screws with metric pitches.

The lead-screw on this lathe is carefully cut in a special lathe equipped with a master screw, which is frequently tested to insure accuracy. If a lathe is desired for cutting only metric threads, a metric lead-screw can be provided. The cross-slide is furnished with a standard compound rest as the regular equipment, but if so desired, a European toolpost may be furnished.

The tailstock is of the extension barrel type, providing clearance over the carriage bridge for turning short work. It is clamped in position by means of a special locking device, and the spindle has a self-discharging center. Side adjustment is provided to adapt the machine for the performance of taper-turning operations. The carriage is gibbed at both front and rear, and a simple locking device clamps the carriage to the bed when using the cross-feed. The cross-feed screw is supplied with a micrometer collar graduated to read to 0.001 inch, and an adjustable stop for the cross-slide is provided for use in screw cutting. The bed is a semi-steel casting, which is harder than ordinary cast iron, to give the required durability. This bed has two vees—one large vee to guide the carriage and the other placed at a lower level to guide the headstock and tailstock and avoid weakening the bridge.

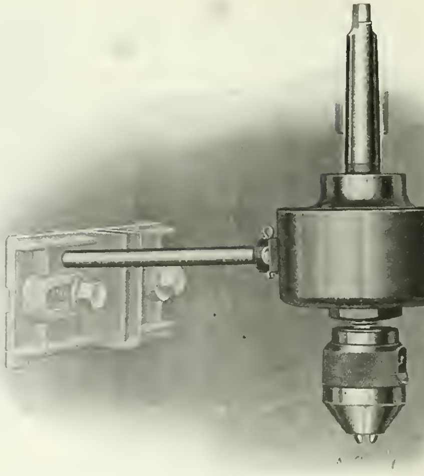
This lathe may be furnished with a taper attachment secured to the back of the carriage and arranged to travel with it. This attachment is always in position, ready for use, and is available for the full length of the lathe bed. It can be used with a plain or compound rest, and a micrometer cross-feed stop may be used on taper work. The swivel guide bar is graduated in degrees and inches, and has accurate adjustments from zero to 3 inches taper per foot, and tapers up to 12 inches in length may be turned at a single setting. This lathe can also be furnished with an automatic draw-in chuck attachment, consisting of a drawn-in tube with handle attached and bushings for collets. These bushings and the collets are made of tool steel, hardened and ground.

Principal dimensions of this machine are as follows: swing over bed, 12¼ inches; swing over slide on carriage, 7¼ inches; standard length of bed, 5 feet; capacity between centers for 5-foot bed, 30 inches; capacity between centers with tailstock overhung, 34 inches; dimensions of front spindle bearing, 1¾ by 4 inches; dimensions of rear spindle bearing, 1⅜ by 3 inches; taper of centers, No. 2 Morse; diameter of hole through spindle, 1 inch; back-gear ratio, 1 to 8.52; diameter of lead-screw, ⅞ inch; threads per inch on lead-screw, 8; countershaft speed, 300 R.P.M.; range of spindle speeds, 808, 500, 326, 214, 95, 59, 38 and 25 R.P.M.; range for thread cutting, 3 to 72 threads per inch; diameter of tailstock spindle, ½ inch; maximum movement of tailstock spindle, 4¼ inches; maximum opening of steadyrest, 3¾ inches diameter; length of carriage, 13½ inches; maximum movement of compound rest top slide, 4 inches; and net weight of machine with 5-foot bed, 760 pounds

BICKNELL-THOMAS TAPPING ATTACHMENT

The Bicknell-Thomas Co., Greenfield, Mass., is now making what is said to be the first friction-driven tapping attachment built to fit any make of drill press. It has a capacity for handling taps from 3/32 to 1/4 inch in diameter, and has a friction mechanism inside the body of the attachment which is automatically adjusted by the amount of pressure the operator puts on the drill spindle when tapping. This makes a very sensitive drive and eliminates the sudden strain at the point of reversal, which is responsible for a large percentage of the taps which are broken in operation. Use of this friction mechanism overcomes the necessity of using a friction chuck, and so this tapping attachment is equipped with a plain chuck.

This company is also making a positive-driven tapping attachment designed for use on standard drill presses to overcome the necessity of reversing the machine spindle for backing out a tap. When the tap has been driven into the work to the desired depth, raising the drill spindle reverses the tap while the machine continues to rotate at full speed in the forward direction. An internal gear drive gives a reverse speed which is twice the tapping speed. All parts are made of steel, and those subject to constant wear are hardened. The clutch pins are made of tool steel, and the clutch dog is a tool steel forging, properly hardened and tempered. This attachment can be furnished with one of the Bicknell-Thomas friction chucks, in which the friction can be set so that in case the tap binds in the hole or is driven to the bottom of the hole, the friction will slip and prevent the tap from breaking. As shown in the illustration, the attachment may also be equipped with a plain chuck. Both styles of chucks are fitted with jaws which grip both the round shank and squared end of the shank, giving a very positive grip. This positive-driven tapping attachment is made in two sizes, with capacities for handling taps from 3/16 to 3/8, and 5/16 to 3/4 inch in diameter, respectively.



Tapping Attachment made by the Bicknell-Thomas Co.

LUFKIN MECHANICS' READY REFERENCE TABLE

Information often required by machinists, toolmakers and other shop men in handling their daily work has been compiled in convenient form on a reference table recently added to the line of tools made by the Lufkin Rule Co., Saginaw, Mich. In order to make it suitable for carrying in a mechanic's pocket, this table, which is known as the Lufkin No. 97 rule, is made of flexible spring steel 1 7/32 inch wide by 6 3/4 inches long. On one side there appear machine screw tap sizes, each followed by the tap drill size number and its diameter in thousandths of an inch, and the corresponding body drill size number and its diameter in thousandths of an inch, *i. e.*, what is commonly known as the "outside diameter size." On the opposite side of the scale is a complete set of decimal equivalents of fractions, and at the foot of the rule a space of 1 inch

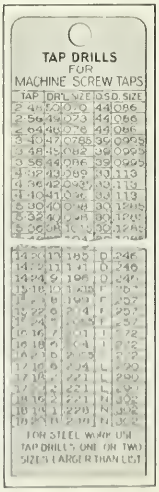


Fig. 1. Lufkin Mechanics' Ready Reference Table

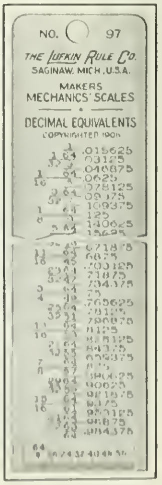


Fig. 2. Opposite Side of Reference Table shown in Fig. 1

graduated to 64ths. This rule has good legible figures, and as the figures and graduations are cut in steel, the rule will prove durable and not easily soiled. Combining in a single table tap and drill sizes and decimal equivalents, makes it unnecessary to refer to two tables, which is now customary. This new Lufkin No. 97 rule should prove a time saver and a thoroughly practical tool for those classes of work for which it is intended.

"SATCO" KEYLESS DRILL CHUCK

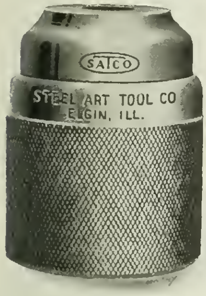


Fig. 1. "Satco" Keyless Drill Chnck

In working out the design of a quick-change keyless drill chuck which has recently been placed upon the market by the Steel-Art Tool Co., Elgin, Ill., attention has been paid to simplifying the mechanism as far as possible, the complete chuck consisting of only eight parts. Another feature is that this is a hand-operated chuck, which makes it possible to change drills while the machine is running at full speed without the operator running any risk of being hurt. The chuck centers the drill automatically and requires no keys or wrenches to tighten or release its powerful grip. It is normally open to its full capacity and can be reduced to the smallest capacity by simply holding the knurled sleeve against rotation of the spindle. In operation, a drill is slipped into the chuck and the knurled sleeve held until the jaws grip the drill; then as the load increases the jaws increase their grip in direct proportion. The chuck is released by striking the knurled sleeve in the direction of rotation, as shown in Fig. 2. There are three jaws in the chuck, which are made of tool steel, hardened and ground, and attention is called to the fact that the chuck is built up without working screws or threads of any kind. The chuck is made in five sizes, known as Nos. 0 to 4, inclusive, and have capacities of from zero to 1/8 inch, zero to 1/4 inch, 1/16 to 3/8 inch, 1/8 to 1/2 inch, and 1/4 to 5/8 inch, respectively.

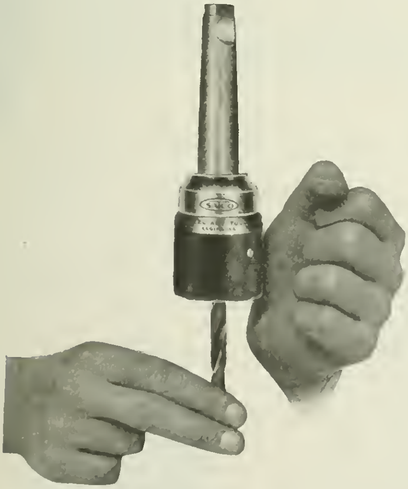
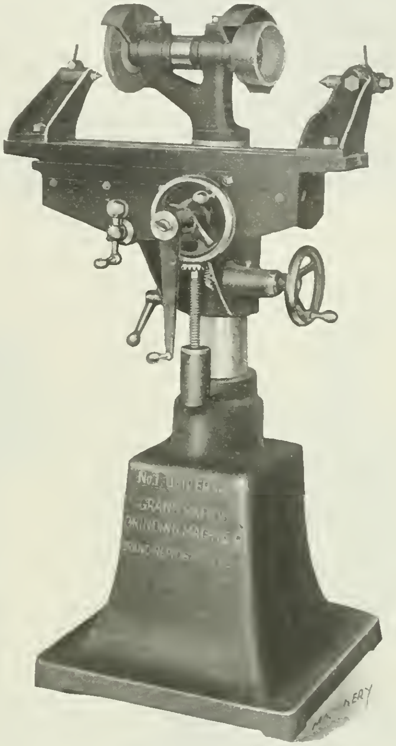


Fig. 2. Method of releasing Drill from "Satco" Keyless Chuck

GRAND RAPIDS UNIVERSAL GRINDER

The Grand Rapids Grinding Machine Co., Grand Rapids, Mich., is now building a No. 1 universal grinding machine which is illustrated and described herewith. This is a companion machine to the Grand Rapids No. 2 universal grinder which was illustrated and described in the March number of Machinery. The No. 1 grinder is adapted for use in those plants where a satisfactory drill grinding machine is already available. This machine swings 9½ inches on centers and has a capacity for work up to 20 inches in length. It has a maximum longitudinal movement of 15 inches, transverse movement of 7 inches, and vertical movement of 6¾ inches. The knee, which carries the saddle, table and sub-table, swivels all the way around the main column, and the table also swivels through a full 360 degrees on the sub-table.

To provide for the performance of taper turning operations, the table is provided with a graduated scale reading to 1/16 inch taper per foot. Both the transverse and elevating movements are provided by means of Acme thread screws running in bronze nuts of liberal size. Both screws are provided with graduated dials reading to 0.001 inch per foot. The spindle is made of hammered crucible steel and is carried in self-oiling bronze bearings with means of easily adjusting for either radial or end wear. The loose pulley is equipped with a bronze bushing; and the column, spindle and similar parts are carefully ground to the required size. The machine is regularly equipped with a chuck, universal vise, internal grinding attachment, and a complete outfit of wrenches, dogs, grinding wheels, etc.



Grand Rapids No. 1 Universal Grinding Machine

NEWTON MULTIPLE-SPINDLE MILLING MACHINE

In the June number of Machinery a description was published of a multiple-spindle milling machine which had just been placed upon the market at that time by the Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa. Recently this firm has built another machine of very much the same design, which is illustrated and described in the following article. The spindle saddles are of similar design, having square lock bearings and adjustments made by taper shoes. The horizontal spindle saddles have the narrow guide construction to provide for controlling alignment, and the rail saddles have hand adjustment, reversing cross-feed and revers-

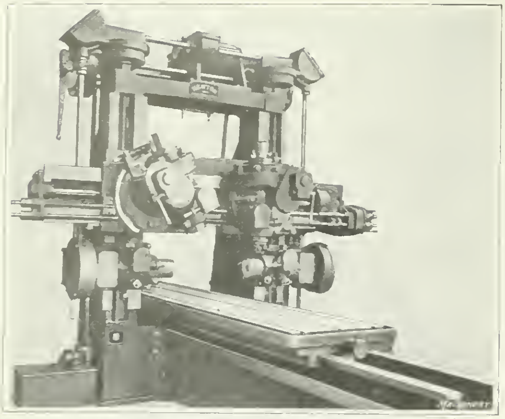


Fig. 1. Newton Multiple-spindle Milling Machine

ing fast cross motion. The saddles on the uprights are counterweighted by weights inside the uprights, and have only hand vertical adjustment.

Provision is made to clamp the rail to the saddles to provide power elevation and also to control alignment when a horizontal cutter-arbor is used and supported at its outer end. The cross rail has square bearings on the uprights, with narrow guide construction to control alignment; it is furnished with reversing power vertical adjustment, and supported by screws having bottom tension bearings. Twelve changes of reversing cross feed are available for the vertical spindles, covering a range of from 0.172 inch to 8½ inches per minute. There is also reversing fast power motion at the rate of 15 feet per minute. Each of these movements is controlled from the table mechanism. The spindles rotate in a clockwise direction unless otherwise specified, and there are nine changes of spindle speed, covering a range of from 16½ to 99 revolutions per minute.

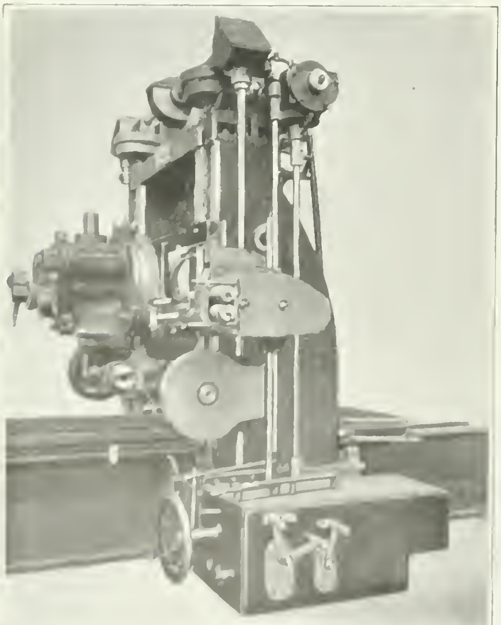
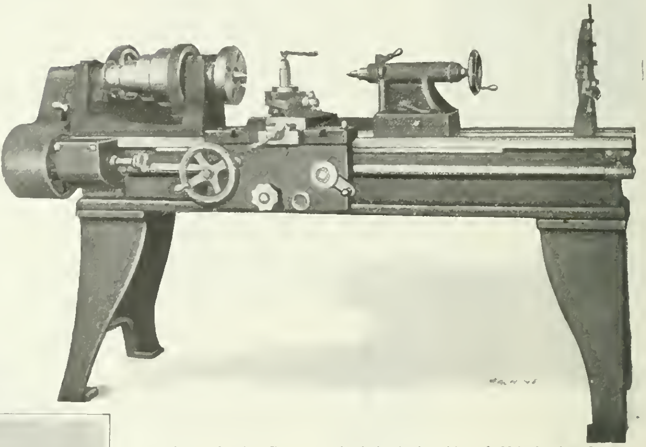


Fig. 2. Side View of Newton Milling Machine shown in Fig. 1

The work-table is of heavy box-type construction, surrounded by an oil pan, and has square bearings on the base. Table feeds are independent of spindle speeds. Twelve feed changes are available, ranging from 0.355 inch to 13 inches per minute in both directions. These changes are obtained through gears in an oil-tight feed-box, cut bronze or steel gears being used, which are mounted on sliding sleeves controlled by latch levers fitted through the cover. The table movement is obtained through an iron or steel angular rack and a steel or bronze worm which rotates in a bath of oil. Provision is also made for hand adjustment of the table. Rapid traverse of the table is independent of the feed movements and spindle speeds, and is available at the rate of 30 feet per minute in both directions. The machine base is of heavy box-type construction, with a solid closed top and double cross ribs. Cheeks for the attachment of uprights are cast solid with the base; and the standard length of the base is 1¾ times the length of work which the machine is rated to mill. In working out the design, all control levers have been placed within easy reach of the operator.



Screw Cutting Engine Lathe built in 14-, 16- and 18-inch Sizes by Canedy-Otto Mfg. Co.

CANEDY-OTTO ENGINE LATHE

One of the latest additions to the line of machinery built by the Canedy-Otto Mfg. Co., Chicago Heights, Ill., is a screw-cutting engine lathe built in 14-, 16- and 18-inch sizes. The 14-inch machine is built with either a 6- or 8-foot bed, and the 16- and 18-inch machines with either a 6-, 8- or 10-foot bed. The spindle on these machines is made of 50-point carbon steel finished by grinding and carried in bronze-bushed bearings. The carriage is gibbed at both the front and back, and all plain bearings on the machine are carefully scraped to surface plates. The gear-box is of the quick-change type, and in working out its design care was taken to combine the features of strength and simplicity. Three changes of feed are available. Regular equipment furnished with this machine includes large and small faceplates, compound-, steady- and follow-rests, two steel centers, change-gears for screw cutting, a double friction countershaft, and the necessary wrenches for making all adjustments.

Principal dimensions of the 16-inch lathe are as follows: swing over bed, 16½ inches, swing over carriage, 11¼ inches; size of front spindle bearing, 2⅜ by 4 inches; size of rear spindle bearing, 1¾ by 3 inches; width of cone pulley belt, 2 1/2 inches; diameter of hole through spindle, 1 5/16 inch; size of cutting tool, ⅝ by 1¼ inch; diameter of nose of spindle, 2⅜ inches; diameter of tailstock spindle, 1¾ inch; length of carriage bearing on bed, 18½ inches; speed of countershaft, 125 revolutions per minute; distance between centers for 6-foot bed, 40 inches; and net weight of machine, 1600 pounds.

HARRIS OFFSET DRILLING ATTACHMENT

The Harris offset drilling attachment, which is illustrated and described in this article, is, as its name implies, an attachment for drill presses to drill, face and counterbore holes and bosses in out of the way places that cannot be reached by usual methods. It is valuable for use on standard lines of manufacture, such as automobile, muntion, railroad work, machine tool work and in jobbing and contract shops in general. This tool is made in eight sizes to fit every standard make and size of drill press or similar machines. It is not only a labor saver on many jobs, by permitting it to be done mechanically and thus avoiding the use of otherwise unhandy methods, but the tool is also said to be conducive to good workmanship. With this attachment, screw holes in pulleys may be drilled without weakening the rim by drilling through the rim, as shown in Fig. 2.

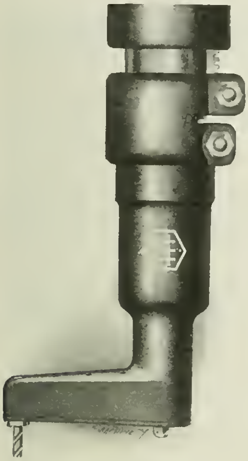


Fig. 1. Harris Offset Drilling Attachment

Oil-cup holes can be drilled by this method to supply lubrication to bearings without using a copper tube to carry the oil from some place where it is more convenient to drill by ordinary means for the oil-cup. Holes may be drilled in engine crankshafts for balancing purposes or for the distribution of lubrication. Bosses in frames, automobile parts, etc., may be faced off by the use of a counterbore, the operation being similar to that shown in Fig. 3, although much more difficult pieces of irregular shapes can be handled than that shown. It also presents a distinct advantage in permitting engineers designing machinery or apparatus to use advantageous designs which are sometimes avoided, due to lack of proper means of drilling in out of the way places.

Fig. 4 shows another use for the offset drilling attachment. These three operations will suggest to the engineer and mechanic the large number of varied uses to which this tool can be applied, thereby effecting economy both in the design of the apparatus upon which it is used, and in the performance of drilling and facing operations. One special use to which this offset drilling attachment has been put, and which may suggest others, is using an end-mill in the attachment on a drill press with a compound slide mounted upon its table for milling in an out of the way place which could not be reached with an ordinary end-mill or facing cutter in a milling machine or a profiler.

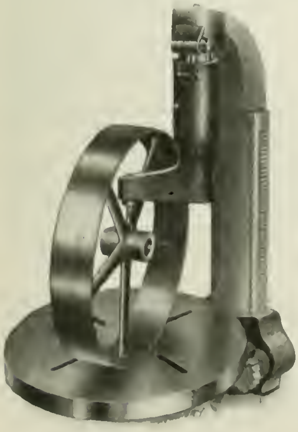


Fig. 2. Drilling Screw-hole in Pulley

If standard sizes of the offset attachment should for any reason not be suitable for the machine or work in hand, a special offset attachment may be made from a large number of special patterns. For instance, in cases where there is not room enough for the regular attachment to be used, or where a longer extension is required, by modifying the standard form an attachment to suit any special need can be supplied. One holder is furnished with each attachment, and the tool or drill is fitted to this holder. In grinding or changing tools, it is not advisable to remove the tool or drill from the holder, but the holder itself, with the tool, can readily be removed from the attachment, and as readily replaced. This attachment is so arranged that it may be swiveled around the center of the drill press spindle in any position which is found most convenient for the operation of the work. The drive is strong and powerful, being driven by a square shaft.

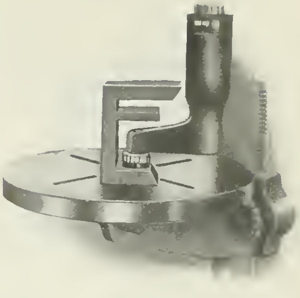


Fig. 3. Typical Work for Offset Drilling Attachment

The construction is rigid and strong, and the attachment will stand up to the work within its capacity. The tool-holder for holding the drill, counterbore or mill has a positive drive and means for holding the tool centrally, so that they will run true, and the change from one tool to another can be readily made without disturbing the set up of the attachment in the drill press. The drill spindle runs in a hardened and ground tool steel sleeve and is provided with a ball thrust bearing. The driving gears in the attachment are made of carefully heat-treated vanadium steel gears, which are tested to a high degree of strength. This attachment is made by the H. E. Harris Engineering Co., 1047 Broad St., Bridgeport, Conn.

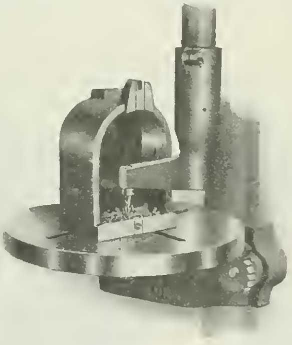


Fig. 4. Another Example of Offset Drilling

UNIVERSAL ELECTRIC TOOLS

The Universal Electric Co., 9 Oliver St., Newark, N. J., is now building the portable electric drill and grinder which are shown in Figs. 1 and 2. The drill is manufactured in three sizes, with capacities for handling drills up to $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{3}{4}$ inch in diameter, respectively, the two latter sizes being made in both single and two-speed types. In working out the design particular attention was paid to the obtaining of strength, durability and efficiency of operation. "Acieral" metal, made by the Acieral Co. of America, 26 Cortlandt St., New York City, was used wherever possible in order to keep the weight down to a minimum. These drills are provided with Cutler-Hammer switches; and the $\frac{3}{8}$- and $\frac{1}{2}$-inch sizes are equipped with Jacobs drill chucks, while the $\frac{3}{4}$-inch size has a Morse quick-release taper socket.

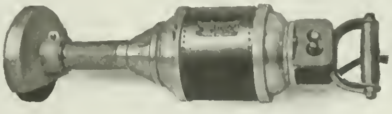


Fig. 1. Aerial Surface Grinder made by Universal Electric Co.

The electric grinder is what is known as an aerial surface grinder and is intended for the performance of heavy grinding operations of the kind that has to be done in foundries,

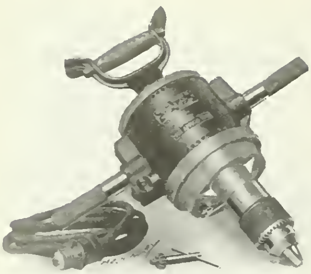


Fig. 2. Portable Electric Drill made by Universal Electric Co.

engine shops, etc. The motor is wound for two- or three-phase alternating current and develops ½ horsepower at a speed of 3575 revolutions per minute. This motor is equipped with SKF ball bearings, and the wheel bearings are lined with bronze and made adjustable for wear. The size of the grinding wheel is 6 inches in diameter by ¾ inch wide, and it is protected by an efficient guard. Care has been taken to place the operating switch in a convenient position to be manipulated by the operator's thumb without requiring him to release his hold upon the handle. As this grinder is often used without being suspended from the ceiling or the workman's shoulder strap, it was important to keep the weight as low as possible. The complete weight of the ½-horsepower grinder is only 31 pounds. After trying out several aluminum alloys, it was decided to adopt the use of an Acieral metal which is extensively used in aeroplane construction.

"SATCO" SAFETY LATHE DOG

With the view of avoiding accidents which sometimes occur through the hands or clothing of machine operators being caught by the usual form of dog used for turning work on lathe centers, the Steel-Art Tool Co., Elgin, Ill., has developed the safety lathe dog shown in the accompanying illustrations. Figs. 1 and 2 show two views of the dog, and in Fig. 3 the dog is shown in operation on a lathe. From these illustrations it will be apparent that the work is gripped by three jaws, and that there are two "tails" to provide for driving the work. As both jaws and tails are adequately protected, there is no chance of accidents resulting from a workman's hands being struck by the dog or from his being drawn into the machine by having a sleeve or other part of his clothing caught.

Fig. 1. Satco' Lathe Dog

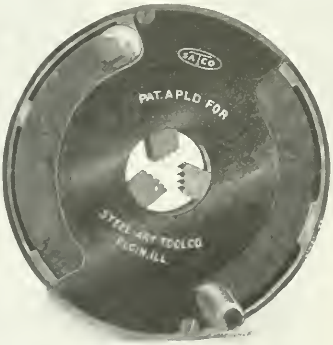


Fig. 2. End View of Dog, showing Arrangement of Jaws

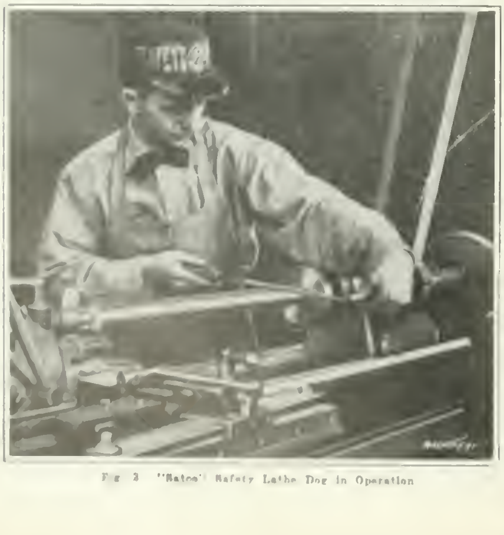


Fig. 3. "Satco" Safety Lathe Dog in Operation

NEW MACHINERY AND TOOLS NOTES

Plain Milling Machine: Cincinnati Milling Machine Co., Cincinnati, Ohio. A 12-inch plain manufacturing miller adapted for the rapid production of small machine parts such as those which have to be machined in shops engaged in making rifles, typewriters, sewing machines, etc.

Journal Truing Machine: W. C. Dunn, 26 Hulbert Block, Cincinnati, Ohio. This is known as the "Pearce" journal truing machine, and although primarily intended for truing car journals it may be employed for numerous other purposes. The range of work handled covers journals from 3¾ by 7 up to 6 by 11 inches in size.

Pneumatic Hammer: Dayton Pneumatic Tool Co., Dayton, Ohio. This hammer is especially adapted for all kinds of chipping on castings, steel billets, boiler plates and structural iron. It is also suitable for use in calking and beading. The hammer has long bearing surfaces and is simply designed, consisting of only twelve parts.

Transfer Truck: Holyoke Truck Co., Holyoke, Mass. A line of transfer trucks of the elevating type. These trucks are made of metal throughout, and are constructed without springs or parts likely to get out of order. Trucks of both the three- and four-wheel types are made, and the wheels are fitted with Hyatt roller bearings.

Axle Drilling Machine: Baker Bros., Toledo, Ohio. A two-spindle axle drilling machine designed for simultaneous drilling of both ends of the front axles of automobiles. This machine comprises two units of the Baker No. 314 standard single-spindle high-speed drill mounted on a bed of sufficient size to accommodate the two machines.

Grinding Wheels: White Heat Products Co., Frazer, Pa. A grinding wheel in which the abrasive grains are fused together to obtain a very strong wheel that will cut fast and last for a comparatively long time. The abrasive grains used in these wheels are imported from France where they are made from a French bauxite and are said to be fast and free cutting.

Expansion Joint: R. D. Nuttall Co., Pittsburg, Pa. A one-piece machined expansion joint which is intended to be used as a substitute for loops and U-bends, and stuffing-box and long sweep expansion joints. The action of this new Nuttall joint is similar to that of an accordion or bellows, limiting bolts being provided to prevent expansion beyond safe limits.

Floating Reamer Holder: Victor Tool Co., Waynesboro, Pa. This holder is intended for carrying reamers used in turret or automatic lathes and on vertical or horizontal boring mills. The design has been developed along simple lines and there are few parts in the tool. These holders are made in standard sizes with either taper or straight shanks; special sizes are made to order.

Drilling Machine: W. W. Machine Works, Chicago, Ill. An upright drilling machine especially adapted for handling small and medium sized pieces. In working out the design of this drill care has been taken to develop a machine possessing ample strength and durability. The machine is 68 inches high; it occupies a floor space 20 by 30 inches in size, and will drill the center of a 15-inch circle.

Grinding Machines: McDonough Mfg. Co., Eau Claire, Wis. Two machines known as the "Sterling" grinders. One of these is a universal tool and reamer grinder, and the other an 18- by 50-inch plain, universal or crankshaft grinder. On the tool grinder a base of the cabinet type is used with a cylindrical column at the top. The swivel frame is bored to fit the column, and the vertically adjustable knee is mounted on a 45-degree slide.

Portable Oil Tank: Gilbert & Barker Mfg. Co., Springfield, Mass. To provide for convenient handling of oil in machine shops, this company is now making a portable pump and tank outfit. The tank is made of sheet steel with the seams oxy-acetylene welded; and the frame and axle are made of wrought iron welded into one piece and mounted on 6-inch malleable iron wheels. The pump can be set to fit any small size container without overflow.

Oil Switch: Crocker-Wheeler Co., Ampere, N. J. An oil switch suitable for use in starting alternating current motors up to 10 horsepower, by connecting them directly to the supply circuit. These switches are also arranged for reversing operations, and are characterized by simple and rugged construction. The switch consists of one set of moving and three sets of stationary contacts, an arrangement which gives a large break on two points for each pole.

Shaper Sawing Attachment: J. A. Moller, New Rochelle, N. Y. A sawing attachment for a shaper, which is intended for use in the manufacture of dies, gages, jigs, fixtures and similar work. Among the advantages claimed for this attachment are provision made for clamping the stock positively in the vise of the shaping machine, the positive control provided for the saw when actuated by the shaper ram, and the ability to adjust the blade in all directions.

Direct-reading Caliper: Fred Todt, 17 Jenks St., Springfield, Mass. This instrument is similar in type to a vernier caliper. Mounted on the slide is a graduated dial on which are two pointers spaced 180 degrees apart, which rotate over a double graduated dial. The outer scale has 500 divisions and the inner scale 32. A ½-inch movement of the slide along the bar causes a complete revolution of the pointers, thus making the instrument read by one thousandths or by sixty-fourths of an inch.

Combination Tool: Hall Mfg. Co., Abington, Mass. A combination counterbore, end-mill, hollow-mill, and boring tool which is adjustable to meet requirements of the work. These tools are made in various sizes and each size has a wide range of adjustment. The blades are ground on all four edges so that the same set of blades serves for counterboring, end-milling, hollow-milling or boring. These blades are clamped in movable jaws to provide for making the required adjustment.

Crane: Champion Crane Co., Guardian Bldg., Cleveland, Ohio. A crane with a 15-ton hoisting equipment designed for operation by either direct or alternating current. The crane equipment is furnished with a number of automatic safety devices to provide for protection of the operator and prevention of damage to the machinery. The hoist mechanism has an automatic switch limiting the upward travel of the hook, while the trolley is designed to permit installation of any standard safety device.

Plate Punching Machine: Ironton Punch & Shear Co., Ironton, Ohio. A large double plate-punching machine built for the Jones & Laughlin Steel Co. This machine consists of two punching machines, each of which cuts a 1⅜-inch hole through soft steel plates 1⅜ inch in thickness, when the two machines are working in unison. The machines are mounted on a bed plate and arranged so that the distance between centers can be adjusted from 5 to 14 feet. Between the two machines is a table for carrying the work.

Band Saw: Napier Saw Works, Inc., Springfield, Mass. This machine is built in three sizes with capacities for handling work up to 6 by 6, 8 by 8, and 10 by 10 inches in size. The base of the machine is of the cabinet type with a flange at the top to retain cutting compound which is pumped from a reservoir in the base. All bearings are lined with either bronze or babbitt. The arm tilts to provide for feeding the saw to the work, and to counteract the possibility of bending, this arm is built up with two channel sections and a truss rod.

Sheet Metal Tester: Pittsburg Instrument & Machine Co., Pittsburg, Pa. A device for testing the drawing, stamping, compressive and folding qualities of sheet steel, iron, copper, brass, aluminum, silver, German silver, nickel, zinc or plated metals. This little machine is furnished with means of working the metal and it has graduations which permit measuring the thickness of material and depth of impression to 0.001 inch. In addition to its use for testing sheet metal, this machine may be used for conducting wire tests if it is furnished with a special die.

Universal Turret Lathe: W. K. Millholland Machine Co., Indianapolis, Ind. In working out the design of this machine, particular attention has been paid to the provision of means for facilitating the setup, obtaining rapid production on bar and chucking work, and to make the machine easy to operate and capable of producing accurate work. To provide power feed to the cut-off and apron, seven gears and a reversing worm and wheel transmit power to the cut-off and longitudinal feed. Feeds to the cut-off and apron are independent and selective, and either one or both of these motions can be engaged or disengaged with automatic stops.

Tapping Attachment: Wahlstrom Tool Co., 5520 Second Ave., Brooklyn, N. Y. A tapping attachment adapted for threading holes up to ⅜ inch in diameter. In working out the design of this tool particular care has been paid to developing a mechanism which is sufficiently sensitive to reduce breakage of taps to a minimum. The attachment is made with either a No. 2 or No. 3 taper shank which fits the drilling machine spindle, and it is furnished with a holding rod to prevent turning, this rod extending to a slide on the column of the machine. This attachment is operated by using the spindle handle on the machine, and reverse motion takes place simultaneously with an upward movement of the drill spindle.

ALUNDUM, CRYSTOLON REFRACTORIES

Alundum, an aluminous abrasive, in its purest form, contains more than 99 per cent aluminum oxide. Its high melting point, 2050 degrees C., high heat conductivity and electrical resistant qualities make it particularly adaptable in the manufacture of refractories. Crystolon, too, gives excellent results for certain work, such as muffles and tubes used under special conditions. Cores, tubes and muffles are used mostly in the construction of small electric furnaces and for general laboratory work; large electrical manufacturers use the tubes in their furnaces for the annealing of tungsten and molybdenum wire. Alundum cores are corrugated to accommodate the resistor; after the resistor is in place, alundum cement is applied around the entire construction. In this way the wire is fully protected and will not corrode under the most severe conditions, since the alundum cement, being of practically the same material as the core itself, is chemically inert.

The interruption of the usual supply of porcelain pyrometer tubes from abroad led to the development of alundum pyrometer tubes, which are guaranteed to be impervious to gases under a wide range of temperatures. They have the added advantage of possessing a surface that does not soften at the temperatures under which they are used and also prevent materials with which they come in contact from adhering to them during their use. They can be supplied, with or without collars, in lengths ranging from 6 to 48 inches. Because of their high thermal-conductivity, the tubes give accurate readings more quickly than a porcelain tube.

Alundum crucibles, cones and dishes are supplied in three degrees of porosity for filtering purposes and have given the greatest satisfaction where the filtration of chemically active solutions is involved. The cones are shaped to fit into the ordinary 60-degree funnel and are held properly in place by stretching a rubber gasket over the top of the funnel before introducing the cone. In steel-plant laboratories, where a great many tests are conducted daily to determine the carbon content in the product, alundum combustion boats have given excellent service.—*Grits and Grinds.*

* * *

HEAT-TREATMENT OF CHAIN CABLE

An exhaustive investigation of the heat-treatment of wrought-iron chain cable was recently presented to the American Society of Mechanical Engineers by Messrs. W. W. Webster and E. L. Patch, the main point under investigation being the causes of the comparative weakness of power-forged wrought-iron cable. The investigation became necessary after the steam-hammer process replaced hand forging, in 1914, in the United States navy yards. The power process was satisfactory to the extent that it effectively and cheaply welded the chain, but unsatisfactorily in that the chain, though apparently perfect, would not meet the breaking-strength requirements, while the hand-welded chain was successful under test, although it was not so thoroughly welded as the hammer-welded. One explanation of this phenomenon is: The hammer-welded link is so stiff, due to the extra work put on it, that the shearing stress can build up in the quarters to such a degree that the link will fail by shearing, whereas the hand-welded link is soft and ductile enough to deform under the shearing stress, failure occurring later, due to a combination of shear and tension when a higher tensile load is applied.

A very thorough and interesting investigation was made to ascertain whether by a simple heat-treatment the power-forged chain could be put into a reliable condition. The material used was refined iron that contained 0.1 per cent of carbon, 0.1 per cent of silicon, 0.008 per cent of sulphur, and 0.085 per cent of phosphorus. The practice of annealing is not commended, but heating to 950 degrees C. and cooling in air decreases the tensile strength and yield point, and increases the ductility of the metal and its resistance to shock. But this treatment increases the strength as well as the ductility and resistance to shock of the link as a whole. Prolonged heating and protracted cooling reduce the resistance to impact. Heating to lower temperatures than 950 degrees C. does not give such good results, and no advantage is gained by going beyond this temperature.

THE NATION'S INDUSTRIES MOBILIZED FOR WAR

PRICE REGULATION OF WAR NECESSITIES—ORGANIZATION OF BOARDS AND COMMITTEES

BY L. J. F. MOORE[1]

IN spite of criticism, it is the fact that the government has made extraordinary progress in mobilizing the great and varied industrial activities of the nation for war purposes. The organization of the War Industries Board was a great step toward centralization and the quick and effective application of executive power. At the head of this great war body is Frank A. Scott, so well known in the machine-tool industry. Associated with him are R. S. Brookings, B. M. Baruch, R. S. Lovett, F. F. Fletcher, P. E. Pierce and Hugh Frayne. This board has real power, while the Council of National Defense, important as it was and still is, was purely advisory in function; and while its recommendations were heeded, so much of its activity went into preliminary organization that its effect was not felt to any great extent in practical results. But the splendid organization and the vast amount of data compiled by the Council are now available for the War Industries Board, which is speeding up every line of war industrial effort and getting results every day. The subcommittee of the Council of National Defense, whose function is to formulate the problem for the War Industries Board to solve, are as given in the list.

These various committees will continue their valuable work and are depended on by the War Industries Board for the information and data it requires. The actual purchasing is under the direction of some individual of the War Industries Board, as, for instance, the purchase of machine tools and gages for government shops and work is under the supervision of Robert S Brookings. This method of purchase will succeed that in which the various firms provided themselves with machine tools and gages. The third step will possibly be the commandeering of machinery for the use of the government under the direction of the War Industries Board, and some means of avoiding this last step will very soon be considered by the War Economies Board under the supervision of A. W. Shaw.

Frank A. Scott's Message to the Machine Tool Industry: "Speed in Accomplishment Should be Our Motto."

(By Telegraph to Machinery, New York.)

Washington, D. C., August 24, 1917.

An important part of the task assigned to the War Industries Board is to study the methods to increase production, including the creation or extension of industries demanded by the emergency, and the sequence and relative urgency of the needs of the government services. It is easy to see how closely these duties are related to the machine tool industry of our country. Modern war is very largely a matter of machinery, and while in our country there exists the greatest aggregation in the world of machine tool equipment, it is not all adapted to war needs. Therefore new equipment and much readjustment will be necessary. It is the hope of the board, and the confident expectation, that American machine tool manufacturers will meet new demands with all possible energy. Speed in war is essential to success. Machinery adapted to our needs is necessary if we are to attain speed in production. While a commission of the War Industries Board will arrange purchases for the government, the actual work of contracting and buying will continue as heretofore in the several departments established by law. It is clearly within the power of the government to take over and operate manufacturing plants necessary for war purposes, but it is not the present purpose of the War Industries Board to encourage the establishment of such a policy. It is obvious that except in special cases the government can be better served through contractual relations with the private owners of factories. The activities of the priority division of the new board will assist greatly in forwarding the work for the government in the order of its importance. Naturally considerations of economy and convenience in the several

Prices and Contracts

In the important matter of price regulation for war necessities, both for America and her allies, Judge Lovett states that the board expects no trouble in dealing with manufacturers, but has considered all phases of the question and has formulated plans to enforce its regulations. No definite declaration is made as to the methods to be adopted, but there is the strongest intimation that drastic steps, even requiring legislation for their enforcement, were considered, and the government may ask for power to commandeer and purchase necessities not included in the Food Control Bill.

The status of existing contracts held by American manufacturers for munitions and war supplies for the Allies is still in doubt. Whether the price regulations to be enforced by the War Industries Board will apply to them or whether the contracts will be abrogated, Judge Lovett has not yet stated. It is understood, however, that in the matter of fixing prices for future war necessities, the "just price" to be determined will be based on President Wilson's public statement of July 12:

> By a just price, I mean a price which will sustain the industries concerned in a high state of efficiency, provide a living for those who conduct them, enable them to pay good wages, and make possible the expansion of their enterprises which will from time to time become necessary as the stupendous undertakings of this great war develop.

Aircraft Production Board, Howard E. Coffin, chairman.

Committee on Coal Production, F. S Peabody, president, Peabody Coal Co., Chicago, chairman

Commercial Economy Board, A W Shaw, president, A W Shaw Co., chairman

General Munitions Board, Frank A. Scott, Warner & Swasey Co., Cleveland, Ohio, chairman

Subcommittee on Army Vehicles, William Butterworth, Deere & Co., chairman

Subcommittee on Armored Cars, Col J H Rice, Ordnance Dept., United States Army

Subcommittee on Emergency Construction and Contracts, W. A. Starrett, Starrett & Van Fleet, chairman

Subcommittee on Optical Glass, Dr R A Millikan, National Research Council

Subcommittee on Machine Guns, B M W Hanson, Pratt & Whitney, chairman

Munitions Standards Board, Frank A Scott, chairman

Subcommittee on Gages, Dies, etc., F. C. Pratt, General Electric Co., Schenectady, N. Y., chairman.

Subcommittee on Army and Navy Artillery, S. M. Vauclain, vice-president, Baldwin Locomotive Co., chairman.

Subcommittee on Fuses and Detonators, E. A. Deeds, Engineering Laboratories, Dayton, Ohio, chairman.

Subcommittee on Small Arms and Munitions, J. E. Otterson, Winchester Arms Co., chairman.

Subcommittee on Optical Instruments, Frank A Scott, chairman

Subcommittee on Army and Navy Projectiles, W. H. Van Dervoort, president, Root & Van Dervoort Engine Co., E. Moline, Ill., chairman

Cooperative Committee on Automotive Transport, Karl W. Zimmerschied, of General Motors Co., Detroit, Mich., vice chairman

Cooperative Committee from National Industrial Conference Board, L. A. Osborne, vice president, Westinghouse Electric & Mfg. Co., Buffalo, N. Y., chairman

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[1] Machinery's Staff Correspondent

Cooperative Committee on Brass, Charles F. Brooker, president, American Brass Co., Ansonia. Conn., chairman.

Cooperative Committee on Copper. J. D. Ryan, president, Anaconda Copper Co., 42 Broadway, New York City, chairman.

Cooperative Committee on Steel and Steel Products, Elbert H. Gary, chairman, United States Steel Corp., 71 Broadway, New York City, chairman.

Subcommittee on Alloys, James A. Farrell, president, United States Steel Corp., 71 Broadway, New York City, chairman.

Subcommittee on Pig Tin, John Hughes, assistant to president of United States Steel Corp., chairman.

The establishment of this just price to the government and its allies, and, if necessary, to the public, will be the first result of the work of the War Industries Board, its Central Purchasing Commission, working with the Federal Trade Commission, which is to determine production costs, the Food Administration in its special field, and the Shipping Board, which will soon control freight rates and all shipping, together with the Export Council. Manufacturers and users of machine tools and other metal-working equipment are deeply interested in this matter of price regulation and in the manner of awarding governmental contracts.

In certain divisions of the work, notably in the case of air-plane production, the contracts are no longer awarded as the result of purely competitive bids. They are placed in accordance with the results of a survey made of the resources and ability of all plants throughout the country. But despite the fact that these contracts have been virtually assigned to the manufacturers on a basis of prices to be adjusted later, the various plants have had to furnish their equipment as private parties. The great difficulty in procuring the necessary additional machinery has had to be solved by each concern. This brings up the question as to how far the government will go in commandeering the production of private plants manufacturing machine tools, but no decision has as yet been announced by the Priority Board, which has this phase of the problem under consideration.

trades involved as well as the necessities of the situation will be elements entering into the priority activities. To "win the war" will be the moving impulse in all the work of the board, and the machine tool industry enjoys to a unique degree the opportunity to contribute to success. Speed in accomplishment should be our motto until the end.

Frank A. Scott

FRANK A. SCOTT,
Chairman War Industries Board.

In the manufacture of field guns, another method has been adopted. The formation, at the suggestion of the government, of companies largely composed of manufacturers of metal-working machinery has resulted in the incorporation of the Wisconsin Gun Co., of Milwaukee, Wis., the Northwestern Ordnance Co., of Madison, Wis., and the Root & Van Dervoort Engine Co., East Moline, Ill. The same suggestion has also been made to the Niles-Bement-Pond Co., and the Otis Elevator Co. It is understood that the Bullard Machine Tool Company, of Bridgeport, Conn., will also operate a gun plant on the same conditions. Although no actual promise has been made, the government has intimated that it will take over ordnance plants that are being financed by these various companies and operated at no profit to themselves in the manufacture of field guns and ammunition.

Subcommittee on Steel Distribution, James A. Farrell, president, United States Steel Corp., chairman.

Subcommittee on Scrap Iron, Eli Joseph, of Joseph, Joseph & Bros., New York City, chairman.

Subcommittee on Production Engineering, Dr. Hollis Godfrey, chairman.

Subcommittee on Construction Engineering, Dr. Hollis Godfrey, chairman.

Committee on Labor, Samuel Gompers, president, American Federation of Labor, Washington, D. C., chairman.

Subcommittee on Mediation and Conciliation, V. Everit Macy, president, National Civic Federation, chairman.

For general contract work, however, an immense amount of which the government will have to let shortly, the recommendations of the Interdepartmental Cost Conference will be adopted. The report gives a comprehensive system for the letting of contracts and recommends very strongly, in preference to all other methods, the straight purchase-and-sale prices wherever practicable. The experience of the British government in the cost-plus-profit plan was considered by the conference, but it decided that the purchase-and-sale contract method was superior. The five forms for the letting of contracts recommended to the War Industries Board by this conference are as follows:

1. Where fair terms can be obtained, contracts should be in the form of straight purchase-and-sale contracts at fixed prices.
2. A standard form of straight purchase-and-sale contract at a fixed price should be adopted for use wherever practicable.
3. In cost-plus contracts, a fixed profit of a definite sum of money per article should be agreed upon instead of a percentage of cost.
4. In cost-plus contracts, the fixed profit agreed on should be subject to adjustment, so that the contractor may share in the saving of, or be charged with part of the excess of, actual cost over estimated cost.
5. A standard form of cost-plus contract should be adopted for use wherever practicable.

The following items were considered in terming what constitutes fair terms: The quality and quantity of the articles purchased. Whether or not the plant is adaptable to business other than war business. The duration of the job and the length of time the contractor's plant and capital will be tied up; also the amount of capital tied up in comparison with the particular output contracted for. The possibility of fluctuations in material and labor costs, with attendant risk to the contractor. Loss in commercial business by taking government work, which must be given precedence; disarrangement in plant organization and labor conditions. Comparison with prices of other manufacturers, competitive bidding, etc The prosperity of the trade and of the particular contractor.

In determining the standard form of straight purchase-and-sale contracts, the following clauses should be incorporated: Method of delivery, storage of production, shipment to point designated; United States to pay for raw material when delivered to contractor; United States to have the right itself to supply material and component parts; United States to adjust price on increased material costs above estimated costs; United States to adjust price on increase in labor costs; liquidated damages; war termination clause.

Cost-plus contracts will be necessary in such cases as: Where the production is novel and the contractor has had no past experience upon which to base a price; for example, steel helmets, large caliber guns and shells for same, aeroplane motors and the like. Where production involves difficult and complicated manufacturing effort subject to changing plans and specifications, or wide fluctuations in material costs; for example, steel and wooden ships, aeroplanes, optical glasswork, and the like. Where the contractor, though deserving of confidence, lacks sufficient working capital and plant equipment to carry through the job. Engineering or building jobs for which the cost-plus contract has for many years been standard.

The application of these well-planned methods will remove obstacles that have blocked the progress of the committees in charge of the production of war supplies and will facilitate the awarding of contracts held up by confusion about prices. Under the Central Purchasing Committee of the War Industries Board the work has been speeded up, and with the vast powers now entrusted to the President, red tape has disappeared and results are quite amazing.

* * *

GUN BUILDERS FOR THE GOVERNMENT

Reports have been received that the following concerns have taken contracts for building heavy guns for the United States Government, or are making plans for that purpose: Northwestern Ordnance Co., Madison, Wis., incorporated with a capital stock of $100,000 for manufacturing 4.7-inch field guns; Tacony Ordnance Corporation, Tacony, Pa., organized with a capital stock of $100,000 to forge 6-inch howitzers; Bullard Machine Tool Co., Bridgeport, Conn., preparing to construct a plant for government gun work. Other plants organized for heavy gun manufacture or contemplating such government work are the Wisconsin Gun Co., Milwaukee, Wis.; the Inland Ordnance Co., Bedford, Ohio; the Symington-Anderson Co., Rochester, N. Y.; the American Brake Shoe & Foundry Co., Erie, Pa.; the Otis Elevator Co., New York City; and the Niles-Bement-Pond Co., New York City. The Wisconsin Gun Co. of Milwaukee was organized and incorporated with a capital stock of $100,000 by officers of the Kearney & Trecker Co., the Cutler-Hammer Mfg. Co., the Northwestern Malleable Iron Co., the Bucyrus Co., and Power & Mining Machinery Co. to build 3-inch field guns.

* * *

PAPER TUBES AND SACKS

Paper tubes for liquids and gases are one of the novelties that the dearth of metals has helped to develop. According to the process of A. von Valois, the paper is rolled to the desired wall-thickness and diameter and the seams are glued together and coated. Tubes kept full of water for weeks have shown no swelling or loss of strength, are not attacked by coal gas, weigh only one-sixth as much as lead pipes, and stand more than three times the bursting pressure. The joints are made by putting sleeves over the tubes and filling some cement into the annular space; the joint, however, will not stand the internal pressures of unjointed sections. They will withstand an external pressure of 400 pounds per square inch, which is sufficient to admit of burying these pipes in the ground.

In another type of tube, known as the "Pertinax," the water is impregnated with synthetic rosin and is rolled under tension. The water tests of these tubes have not been quite satisfactory. There was absorption of water when closed tubes were filled with water and kept standing. As oil does not attack synthetic rosin, however, small oil conduits might be made of "Pertinax" paper, which can be shaped into tubes as small as 0.200 inch in diameter.

Paper yarn sacks for sand are strong enough, when wet, if the dry yarn has been impregnated at 60 degrees C. with a solution containing 24 ounces of glue, 0.1 ounce of tannin, and 0.1 ounce of sodium silicate of density 1.345. The tensile strength of the warp of strips of the dried material is 560 pounds per square inch untreated, and 650 pounds treated; after soaking in water twenty-four hours, the figures are 375 pounds and 480 pounds; and after redrying, 580 pounds and 640 pounds per square inch. The weft figures were a little lower throughout. Favorable results were also realized with successive impregnations, first with cold basic aluminum formate, then with glue, and again with the formate. Mixtures of soap and glue did not answer.

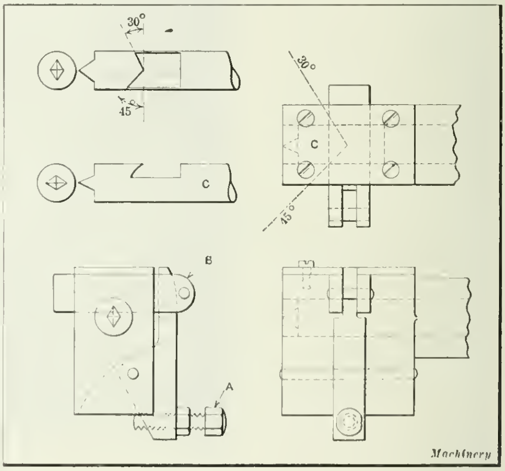
* * *

STOP AND CENTERING TOOL

BY ROBERT GALLAGHER[1]

The combination stop and centering tool here shown is used on a No. 2 Brown & Sharpe automatic screw machine. It is used as a stop when feeding out stock and also for centering a piece that has to be drilled. Where six tools have to be used in the turret, including the facing and centering tool, it is much more economical to use this tool than the old-style facing and centering tool, as no stock is wasted. It is more accurate in securing exact lengths than is the method of feeding stock to the centering and facing tool. On one order for 100,000 pieces, a shop saved $300 on material alone, besides increasing its production. This shop is now using this tool on all brass jobs over ½ inch in diameter.

To operate this tool, an extra lobe is provided on the front cross-slide cam which operates when the tool is advanced for the stock to feed out against it. The tool dwells in this position while the front slide advances and comes in contact with the adjusting screw of lever *A*; this draws out the cross-bar *B* which is notched, the notch having two angles of 30 and 45 degrees. The cross-bar is drawn out against the 30-degree angle, which, in turn, advances the centering tool *C*. When its work is finished, the cross-slide backs away and a spring in the shank draws back the centering tool.



Stop and Centering Tool

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Among the artificial limbs tested by the Verein Deutsche Ingenieure at its testing station in Charlottenburg is the magnet hand invented by Prof. Klingenberg. The attachment of this hand to the arm or shoulder ends in a cup which encloses an electromagnet. This cup has a ball bearing and can be clamped in any position. The electric circuit is closed or opened by the aid of the outer arm or the chin. With this hand, a man may do filing and planing, put metal sheets under a punch, and manipulate shears or pinchers. Tools not made of iron may be handled if they are provided with an iron ring or plate. The hand can also be provided with fingers and a thumb to be opened or closed separately.

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[1] Address, Harrison, N. Y.

AUTOGENOUS WELDS OF BOILER PLATES[1 2]

METHOD OF MAKING WELDS AND THEIR AFTER-TREATMENT, ALSO TESTS TO BE APPLIED AND THE FIELD FOR AUTOGENOUS WELDS

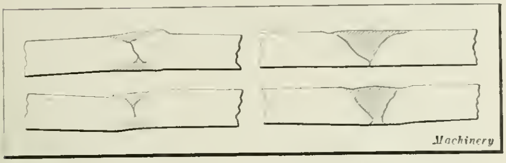

Fig. 1. Welds made with too Sharp an Angle between Surfaces

BECAUSE of the growing importance of autogenous welding, the Swiss Society of Steam Boiler Owners recently conducted a series of tests "to produce exact data on the actual status of the art and to assist in its development." But in these tests, as in all Swiss practice, autogenous gas and electric welding are treated separately, for gas welding alone is known as autogenous. In these tests the most frequent defects were found in the joining of the original metal to the added metal, or between successive layers of the added metal, where it was more nearly "pasted" than welded. The principal cause of these defects was that the edges to be welded were too close together.

The angle of the opening prepared for welding, whether chipped or burned out, should be at least 90 degrees, and the width of the bottom of the V should be at least 3/32 inch for sheets 1/2 inch thick. If the angle is too acute, the flame cannot penetrate to the bottom in an effective manner. It is pushed and frequently blown out so that only the upper edge is welded to the filling material, as shown in Fig. 1. On the other hand, if the slot is wide enough and open at the bottom, the flame reaches all the surface, and fuses the edges of the plate throughout their entire extent. Although the expenditure of time, metal and gas seems greater for a wide opening than for a narrow one, the reverse is true. Properly welded pieces are, without exception, made in widely opened slots, as shown in Fig. 2.

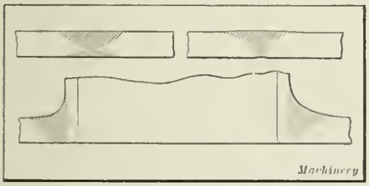

Fig. 2. Welds made with Wide Angle between Surfaces

Whether it is better to weld from one side only or from both sides depends principally on the thickness of the sheet. When welding from one side, the space for the reception of the added metal is greater than if the welding is done from both sides, and it would seem as though the consumption of welding metal would be greater; in practice, however, this is the case only to a slight extent. When welding from both sides, it is of the greatest importance that the welding be finished at a single heat; this is only possible, when welding from one side, in the case of thin or moderately thick plates. When welding thick plates from both sides, the two sides should be welded and hammered simultaneously.

Another cause of poor welding is insufficient preheating of the parts to be welded. This defect arises either from lack of experience or attention, for a welder who knows his trade should know the instant that the pieces of metal to be welded are in a condition to melt or flow together. Examples of this fault are shown in Fig. 3; at *A* is shown a piece of metal stuck on the plate, only the edges of which are welded.

Other grave faults, developed by the etch tests, are blowholes, deposits of oxide, soft (weak) structure, etc.; these defects also arise from lack of skill. There is also the development of oxides during the welding. Iron raised to a high temperature absorbs oxygen rapidly from the air. Since oxygen is used directly to make autogenous welds, the formation of oxides is much greater if the flame carries an excess of oxygen. It is necessary, then, to regulate the mixture of gases in the torch. On the other hand, if the flame has an excess of acetylene, the acetylene will carburize the liquid iron and transform it into steel. One must, therefore, regulate the blowpipe flame exactly right, which will be done when the core of the flame is white, very luminous and somewhat limited in size, but not too short. If the core is short and the flame tinged with violet, oxygen is in excess; and when it is extremely luminous, acetylene is in excess. When the flame is well regulated, the preheating of the oxygen tends to steady the flow, although trouble may arise from the condensation of water which forms in the tubes.

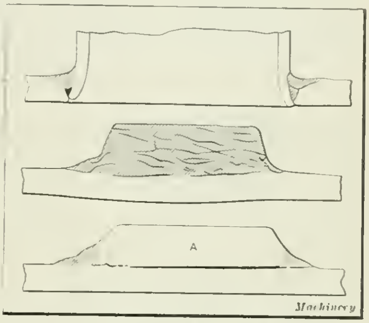

Fig. 3. Poor Welds caused by Insufficient Preheating

Burned metal results from too high a temperature. It is facilitated when the flame carries an excess of oxygen. An oxidation and partial decarburization of the iron is produced, for which the iron itself (by its combustion) furnishes part of the heat. The action of the cutting torch depends also on a greater consumption of oxygen than does the welding torch. In this respect, the distance from the core of the flame to the weld is of great importance. Oxides are eliminated by agitating the molten metal with the welding wire, which brings them to the surface. Powder is no longer used in welding mild steel to reduce the oxides; cast iron presents a different problem. The skilled use of the torch and the welding rod will avoid oxidation. If possible, the welding wire should never make actual contact with the flame, but both should be kept in motion and in such a way as to avoid each other.

The test specimens that broke at the weld possessed on an average only 76 per cent of the strength and 39 per cent of the elongation of the unwelded pieces. The specimens that broke outside the weld had 87 per cent of the original tensile strength and 66 per cent of the elongation. Annealing may have contributed to this result, but as the average elongation fell to 53 per cent of the comparison plate, the conclusion is forced that the quality of the metal suffered. The influence of annealing was further demonstrated by tests by the Brinell process, the results of which, in general, parallel those of the tension tests. While the specimens of the unwelded plate gave a mean value of hardness $H = 115.6$, the mean for plates with autogenous welds fell to 102.8 when measured outside the weld, or 89 per cent of the hardness of the unwelded plate. When measured at the weld, the mean hardness was found to be 108.2, or 94 per cent of the hardness of the unwelded plate. The diminution of 11 per cent in hardness represents

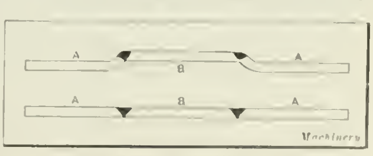

Fig. 4. Welding a Piece into a Plate

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[1] Abstract of an article by E. Hohn printed in "The Locomotive" of October, 1916, and January, 1917.

[2] For other articles on autogenous welding previously published in MACHINERY, see "Welding 18-foot Tube Sheets for Sugar Evaporators" and "Aluminum Welding," August, 1916; "Strength of Oxy-acetylene Welds," June, 1916; "Metal Cutting with Oxy-acetylene Gas," April, 1916, and articles there referred to.

about what could be attributed to the annealing; and although the metal was somewhat harder at the weld than outside it, the difference was only 5 per cent. The softest of the autogenously welded plates had the greatest elongation—101 per cent of the unwelded plates; the hardest had the highest tensile strength—90 per cent. The electrically welded plate was harder than all the others, especially at the weld.

Impact Test

An important addition to the tensile tests is the impact bend test on notched bars. These tests were made on six bars, machined on the top and bottom edges, that were supported at their ends and struck with a ram weighing 116.85 pounds. The impact in every case was applied at the weld and in the longitudinal direction of the joint. The average work of deformation was 32 per cent of that of the unwelded bar and the angle of bending was 22 per cent. Thus the tenacity of the metal was much less than its tensile strength showed. It is worthy of note that the best plate, from the standpoint of the execution of the welds and for elongation and malleability, was the poorest when classed according to its resistance to impact. On the other hand, plates that yielded poor results in the tensile tests did very well under the impact test. It appears that as far as resistance to impact is concerned, some of the less homogeneous and more fibrous welds are superior to those that are of a more uniform structure.

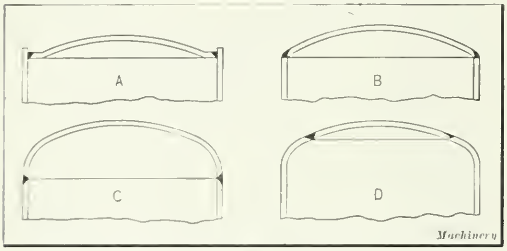

Fig. 5. Proper and Improper Methods of welding Drum Heads

Although they are not provided for in the official specifications for the acceptance of material, impact bend tests should become an important test method for those engaged in autogenous welding, both because the test yields information as to the nature of the weld itself, through the appearance of the fracture, and because, in tensile testing, a weld is recognized as good if the specimen breaks outside the weld. The impact test is the one best adapted to yield information in a very simple manner as to the effect of heat-treatment. Doctor Schmid, of Zurich, recommends this test to determine if steel has been forged at the blue heat; this test has been successful with him when tensile tests, ordinary bend tests, and even microscopic examinations have failed.

Hammering and Annealing

Several test plates were returned out of shape and some with displaced edges, showing that the welders lacked the skill necessary to align and fix the parts to be welded. The melted iron at the joints exerts a tension in cooling, and if the pieces to be welded are not fastened together solidly, their edges are displaced, even during the progress of the welding itself. On cooling, internal stresses cause the plate to buckle. Two firms that measured the effect of the contraction set up in welding have found that for plates 0.4724 inch thick the contraction was from 0.0197 to 0.1299 inch. It is possible during welding to counteract the contraction to some extent by hammering, and then later on a further diminution can be obtained by annealing. Hammering can also be done at the time of annealing. Hammering with small hammers while the metal is red-hot improves it the same as rolling and forging improve structural iron. But if the hammering is done at a temperature lower than a red heat there is danger of working the metal at the blue heat, which must always be avoided.

When welding a square piece *B* into the plate *A*, Fig. 4, the best plan is to raise the interior edges of *A* and after welding, lay back the whole joint while the metal is hot by means of the hammer. By this process, the joint is strongly compressed and the internal stresses relieved; and at the same time the workman retains control of the form of the work.

By annealing after welding, a compensation of the residual internal stress is obtained and the annealing further improves the metal, giving it a finer grained structure. It is not enough to make a sound weld, but the metal must also be submitted to a heat-treatment or a simultaneous heat and mechanical treatment (hammering and annealing), which will give the best possible mechanical qualities and, above all, great toughness or resistance to impact. The annealing temperature for welded plates is between 700 and 800 degrees C. The exact temperature plays an important part; relatively small differences of from 40 to 60 degrees C. may have a considerable influence on the brittleness of the material. When it is necessary to anneal with the welding torch, it is best to give the preference to a short anneal at a high temperature.

Preparation of Materials for Welding

For the most satisfactory welds, the consumption of oxygen, and hence of gas, is most rapid, while the poorest welds are made with the least gas. Whoever tries to economize in gas risks making a poor weld; further, there is no control of the gas. It is well known that the gas should be pure and fresh to get a good weld; above all, it should contain neither sulphur nor phosphorus, for fear of making a weld either hot-short or cold-short. This is why illuminating gas should not be used by welders in place of acetylene; illuminating gas is not pure enough. Only the best pure iron should be used for the welding wire, as, for example, Swedish charcoal iron.

Conditions for a Good Weld

The conditions that are necessary to obtain good welds are: sufficient good, pure, dry, fresh gas; a torch that is correct as to both design and size; pure charcoal-iron wire as added metal; sufficient preparation, in the way of correct chipping or other working of the joints to be welded, both to secure correct angles, correct distance apart, and solid fastening; exact flame mixture; preheating of pieces to be welded; avoiding oxidation by properly managing both the torch and the welding wire; removing the oxide that forms in spite of all precaution; hammering after welding and annealing.

Field of Application

The true field for welds is on objects the joints of which must resist compression, as in furnace tubes, iron fireboxes, etc. The possibility of producing a thickening of the joints, which exists equally for the electric and the autogenous welding, should be considered an important advantage. In the present status of the process, it is recommended that in the construction of steam apparatus use should be made of autogenous welding only with the greatest prudence and that the work should be done by reliable firms and under the supervision of the inspection societies. Even then it is necessary to take account of the fact that, through the heating of the edges in welding and the cooling of the melted metal, there are set up in the iron that sort of tensions that produce accidents. Joints that must resist tension and bending stress through external forces or changes in temperature should not be welded unless it is possible to anneal the piece afterward.

A welded joint always carries something hidden and uncontrollable. It is not desirable to make welded joints where riveting can be done without difficulty. There remain plenty of places where for reasons of construction, for lack of room, or because great strength is not required, autogenous welding will find employment. For objects not under the legislation that applies to boilers, it is possible to go further and permit welds supporting fairly severe tensions; in this, much depends on the intelligence with which such work is carried out. When a head is welded to a drum, as shown at *A*, Fig. 5, it is in opposition to good practice; neither is the weld shown at *B* any better, for it is at the turn or at the edges that the bending strains are set up. Welds like *C* and *D* are recommended. To joint a tube to another or to a plate, the edges should always be relieved.

MILITARY INFLUENCE ON MOTOR TRUCK DESIGN[1]

WHILE American motor trucks have played an important part in the present war, it has not been necessary to make any radical changes in their design to meet military conditions. This has been due to the fact that, on the western front, the armies have been in practically the same positions for two years, so that the trucks have been used mostly on the first-class French roads; in the event of any fighting on American soil, though, much different conditions would be encountered. The trucks would be used on roads of all kinds, and even where there are no roads at all, and under widely varying climatic conditions. The use of motor trucks on the Mexican border has shown that many changes in design must, therefore, be made before the standard commercial truck will satisfactorily meet our military war needs. It is probable that most of the transport work will be done with two-wheel driven vehicles, for where road conditions will permit of its passage this type will haul material in the minimum time and at the minimum operating expense.

One of the first and most important points in connection with the design of a military truck is the absolute necessity for governors on the motors, not only to limit the maximum vehicle speed on high gear, but also to limit the maximum motor speed on any of the gears. This is an important consideration for soft-road operation, where, if a governor that limits only the maximum road speed is fitted, there is a great temptation to the driver to run for long periods on second or third gear in the transmission with the motor racing, a practice that will materially shorten the life of the motor. Governors must be thoroughly enclosed and sealed to prevent their being tampered with without the knowledge of those in authority, and, in order to obtain the best results, should be extremely sensitive, without "surging."

To obtain the best results over soft-road conditions, and without disconnection of governors, the average American commercial truck has insufficient high-gear ability and far too little low-gear ability successfully to pull its load through deep sand or mud or over extreme grades. For American military purposes, the low-gear tractive effort should at least be sufficient continuously to turn the rear wheels of the fully loaded truck on dry asphalt with the truck itself stationary. Using a coefficient of friction between the tires and a drp asphalt surface of 0.6 and a total rear end loaded weight of 7600 pounds for a 1½-ton truck loaded to capacity, the low-gear tractive effort necessary to meet these requirements becomes 4560 pounds. Commercial-truck practice now gives far lower figures. The low-gear tractive effort of what is considered a powerful 1½-ton commercial service truck is only 2600 pounds. To carry safely the low-gear torque required to give 4560 pounds tractive effort, the driving members throughout, from the gear train in the transmission clear back to the rear tires, must be made heavier and stronger, which, of course, will result in an increase in chassis weight.

The heat-dissipating ability of the average radiator was found inadequate, a serious matter at any time and more serious in a country where water is scarce. With the thermometer standing at from 110 to 120 degrees in the shade and the truck using maximum motor power on low gear for long stretches, extraordinary motor-cooling ability is required. Probably an increase of 50 per cent over average commercial practice will not be excessive, and a desirable provision will be a simple means for reducing the radiating area for efficient use in the cooler sections of this country. The radiator mounting should be such as to minimize any strains, in the radiator proper, that are set up as a result of excessive chassis-frame deflection, and the radiator should have large water passages, resist breaking under distortion, and be readily repairable in the field.

Four-speed transmission is more desirable than three-speed for military purposes. If the low-speed reduction ratio in a three-speed transmission is made great enough to give proper low-gear tractive effort, the steps between speeds become so great as to interfere with easy gear shifting. Furthermore, the four-speed gear-box has the very important advantage over a three-speed box, for soft-road service, of always having a gear ratio more nearly adapted to any particular road requirement than can be obtained in a three-speed box. It is probable that the gear ratios in a four-speed box for military trucks will be so arranged that second speed will be used for normal starting on hard-road surfaces, and that the first speed, or low gear, will have a greater reduction ratio than anything that has been built to date. This extra low gear with an extremely high reduction ratio will be used for starting or running in sand or mud or for climbing steep or soft grades.

The control elements should be standardized. Where men must drive different makes of trucks, they should be able to do so with facility, and much time will be saved and better average operation assured if the same motion of the driver's right or left hand or foot produces the same result irrespective of the make of the truck.

Trucks for army service ought to have a specified gage in order that each size or make does not have to break down a new track in the roadway. If all sizes of trucks could be made to the present standard road gage of 56½ inches, such standardization would be of the utmost value from a commercial as well as a military standpoint, as it would facilitate the operation of all trucks over soft country roads.

The best results will be obtained from some form of fully enclosed final drive, which should be so thoroughly enclosed as to retain lubricant and prevent the deposit of fine dust or grit on any of the working parts. Whatever form is used, whether worm, internal gear or double reduction, it should be capable of efficiently and continuously transmitting the maximum low-gear torque of the vehicle without overheating, and give at least a 10-inch road clearance with 36-inch tires.

The development of a braking system suitable for a military truck presents severe problems in regard to cooling. The brakes used on the commercial trucks of today are not well enough cooled to stand up long under some military conditions, as, for instance, handling the fully loaded truck on a three-mile descent on a hard-road surface with grades running up to 25 per cent and averaging 7 per cent. The brakes have sufficient power to hold the truck under such conditions, but will heat up so that the linings char slightly and wear rapidly. Water cooling is undesirable, so it is probable that some type of metal-to-metal brake will be necessary, which, while not as smooth in action as and noisier than the conventional brake and faced with brake lining, will give greater durability under continuous application.

It is essential that thorough means be provided to keep dust and grit out of all working parts. Troubles from dust are more liable to result on trucks in military service than on those in commercial service, due to running in "fleets," or trains, over country roads. The question of road clearance is also of great importance. Not only should a minimum clearance of 10 inches at the center of both the front and rear axles be maintained, but the clearances under the steering-knuckle levers and the steering cross-tube ends must be as great as possible. Furthermore, unusually high road clearance is desirable under the chassis, midway between axles, to prevent contact with the ground when the truck is driven over a bank into a river bed or over a ridge.

To take care of excessive frame distortion, which is unavoidable when operating over rough or soft roads, the radiator, motor, and transmission should be carried on three-point suspensions and with clearances sufficient to obviate any possibility of their being themselves distorted. Provision should be made to protect the steering column from any binding from the same cause, and all connections between the rear axle and frame should be arranged to permit the maximum horizontal misalignment between the two without overstressing or breaking any of the connecting members. The gasoline tank mounting should also be carefully arranged to protect the tank from twisting strains.

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[1] Abstract of a paper read by H. D. Church before the Cleveland Engineering Society.

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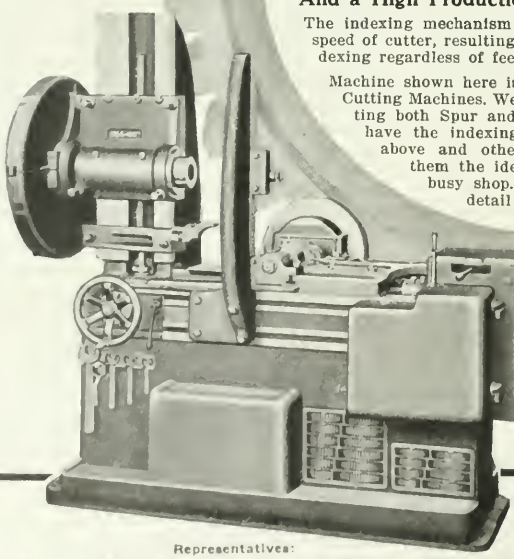

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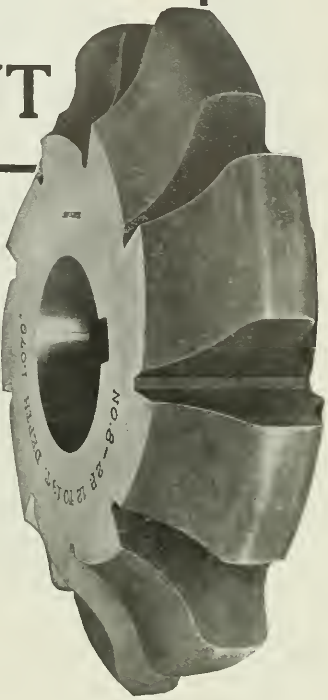

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NEED OF ENGINEERS IN PRESENT WAR

According to Capt. Gustave P. Capart of the general staff of General Pétain, who is at present in this country as a member of the French scientific commission, the old military lines of organization have practically been replaced by a specialized industrial organization whose business is war. The offensive military operations are planned on an engineering basis and the fighting is done, in many branches of the service, by engineering methods. He says that the engineers who go to France as military men in their specialized branches will also be pioneers of American industry in times of peace and will prepare the ground for the economic war that is expected to follow when the military battles are over.

Military operations may be thought of as being conducted in four zones: First, the firing line; second, the military zones immediately surrounding the firing line; third, the avenues and channels of communication between the military zone and what may be called the world-wide zones of supplies to that military zone; and, fourth, the zones of supplies themselves, which include the countries at war and the countries supplying food, machinery and materials to the countries at war. On the firing line, troops in contact with the enemy, engineers are involved in the strictly military operations; mining engineers are planning the executing of trench work, earth work, concrete work, and so on; while other engineers maintain what the French so interestingly explain as a "liason"—the nerves of communication between the various sectors of the armies.

In the military zone, which is entirely in the control of the military and potentially and actually threatened by the enemy, engineers are busy building and maintaining roads, constructing, maintaining and operating railroads, building, rebuilding and operating automobiles, constructing narrow-gage railroads, cableways, telpherage systems, etc. Cableways and telpherage systems have given very valuable service at the front; 600 mules were turned to other service by the installation of one telpherage system. In this zone electrical engineers are at work building and operating lighting and power plants, erecting and maintaining distributing lines, handling the network of telephone and wireless centers of communication. Waterworks and water-supply engineers, sanitary engineers, engineering construction gangs erecting shelters and raising camps and cantonments and repair shops for aeroplanes, automobiles, artillery, small arms, are all necessary in the military zone.

* * *

MISUSE OF WRENCHES IN TIGHTENING COVER BOLTS

A large number of vessels used for subjecting materials to high temperatures and pressures have doors or stock openings of relatively large size that must be frequently opened and closed, such as vulcanizers, digesters, impregnating tanks, etc. As a rule, these doors or covers are furnished with a flange that matches a somewhat similar flange on the shell of the vessel proper and are fastened to the vessels by a large number of bolts. Recently, the cover of one such vessel, eight feet in diameter, failed through the breaking of its reinforced flange, which permitted the cover to blow off with explosive violence, although the pressure inside the vessel did not, probably, much exceed thirty pounds per square inch. The flange, though, was probably damaged when the vessel was being closed preparatory to cooking. After centering the cover over the vessel and making sure that the jointing or packing ring was clean and in place and that the bolt slots were opposite those on the vessel, the cover was lowered into place and the bolts swung up into the slots. Then one man started to run down the nuts of the thirty-two 1¼-inch bolts, by hand, while another started right behind him and tightened the nuts with a wrench [illegible] long. Any slight irregularity or projection of the packing caused the cover to cock up to one side when the first few nuts were tightened, then, when the man with the wrench reached the point opposite to that at which he started, an enormous strain was produced in the effort to get a tight joint.

It is as necessary to follow the proper method of fastening such a cover as it is to secure a safe design. The first requisite is to see that only such wrenches are available as will not permit an excessive strain to be put on the bolts. Socket or end wrenches of the correct length and so formed that they do not adapt themselves to lengthening with a piece of pipe are satisfactory, and at least two should be provided. Two men should run down the nuts, by hand, to a bearing, beginning at opposite sides of the cover and working in the same direction so that each will end where the other began. Then each should take a wrench and set up slightly, about half tight, on one or two bolts at points opposite each other. They should then tighten two or three bolts each at points midway between those first set up. Then all the bolts in opposite quadrants, first one pair and then the other, should be tightened. When all the bolts have been set up, the process should be repeated, the nuts being set as tightly as is felt will be required to get a tight job, and no more. If the cover joint leaks when pressure is applied, the reason should be found and the remedy applied with pressure off the vessel; in no case should the nuts be set up in an endeavor to secure tightness while the pressure exists.

Leakage after reasonable tightening of the bolts usually indicates defective packing or the presence of some foreign matter between the surfaces in contact. Excessive bolt strain may effect an apparent cure by embedding the foreign matter in the yielding packing material, but it can only do so by setting up local stresses in the flanges, which, if repeated often enough, always lead to failure by cracking. The working stress is all that the material should be called upon to carry.

Many of these vessels have reinforcing, or joint, rings of cast iron; this material should be carefully watched. It is much less trustworthy than cast steel, which replaces it in the best designs, and is much more likely to fail by cracking if abused by the operatives. Master mechanics or shop superintendents should look over the flanges of the vessels from time to time. Any cracks, no matter how small, are suspicious.—*The Locomotive.*

* * *

ALFRED HERBERT KNIGHTED

As MACHINERY went to press the following cablegram was received:

> Honors conferred: Alfred Herbert, Knight Commander, Order of British Empire; Ernest Parkinson, Parkinson & Sons, Officer of same Order; Percy John Pybus, Phoenix Dynamo Co., Commander of same Order.

PERSONALS

M. V. Terry has been appointed chief engineer of the Champion Ignition Co., Flint, Mich., manufacturer of spark plugs.

Harvey B. Wheeler has been appointed supervising engineer in the New York territory by the National X-Ray Reflector Co. of Chicago.

Oliver J. Abell, 565 Washington Boulevard, Chicago, Ill., has been elected a director of the American High Speed Chain Co., Indianapolis, Ind.

David Van Alstyne has been appointed assistant vice-president of the American Locomotive Co., 30 Church St., New York City, in charge of manufacture.

J. Gustaf V. Lang has been appointed purchasing agent for the A. Bol. Stockholms Järnmanufaktur, Stockholm, Sweden, with headquarters at 8 W. 40th St., New York City.

P. M. Kling, who has been connected with the Laconia Car Co., Laconia, N. H., for thirty-four years as consulting engineer, has resigned in order to take a well-earned rest.

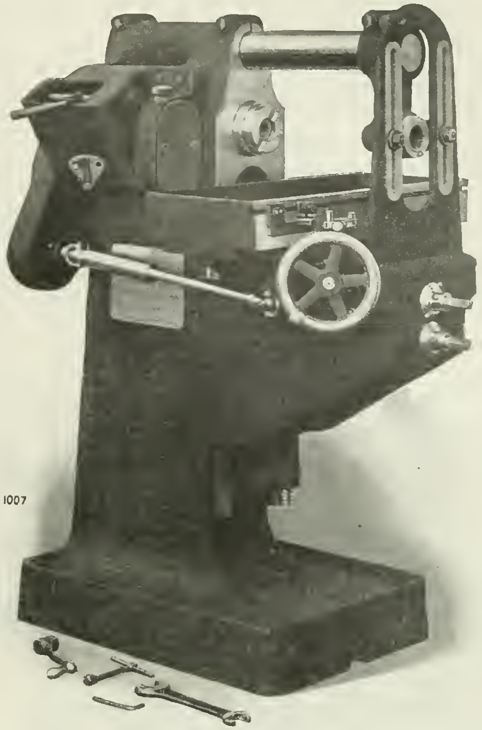
C. S. Vought, assistant general manager of sales of the American Steel Export Co., Woolworth Bldg., New York City, sailed for France August 7, to attend to business for the company. Mr. Vought will be gone about sixty days.

Robert B. Luchars, son of Alexander Luchars, and secretary of the Industrial Press, was appointed second lieutenant, Second Battery, Field Artillery section, Officers' Reserve Corps, at Officers' Reserve Training Camp, Fort Myer, Va., August 11.

J. W. Jowett, formerly general sales manager of the Ingersoll-Rand Co., 11 Broadway, New York City, was elected vice-president at a recent meeting of the board of directors. L. D. Albin, formerly assistant general sales manager, was appointed general sales manager.

The New Cincinnati 12″ Knee Type Manufacturing Miller for Repetition Work

Arms manufacturing plants and any other shops turning out great quantities of small parts will find this machine intensely profitable. Capable of standing up to the drive of twenty-four hours a day service, and giving maximum production at all times. It is compact, having only 12″ table travel. It is powerful—4 h.p. at the spindle. The drive is by constant speed belt, with a commercial range of feeds and speeds, and for the sake of simplicity, quick change mechanisms have been avoided, the change in feed or speed being made by interposing change gears.



The Cincinnati 12-Inch Knee Type Manufacturing Miller.
(Patent Rights Fully Reserved)
Single Pulley Drive—4 H.P.—Twelve speeds—Four feeds.

It Is Handy

The operator stands at the end of the table. Assume that a new piece has been chucked: He runs the table forward with his right hand at 2¾″ per turn of the hand wheel. A dog hits the trip, which automatically disengages the hand movement, and at the same time throws in the power feed. When the piece has been milled, another dog disengages the power feed, and the operator brings the table back by hand, ready to chuck a new piece. *This is quick action. The operator can slam the table forward as fast as he pleases without danger of jamming the work into the cutter.* The trip dog takes care of that, and it can be set so that the work will be close up to the cutter before the power feed engages, thus reducing the power travel of the work to a minimum.

Ask for Complete Specifications.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

H. A. Richmond has been elected managing director and treasurer of the General Abrasive Co. of Niagara Falls, N. Y., and has relinquished his connection with the American Emery Wheel Works, Providence, R. I., of which he has been president and technical expert for the past twenty years.

Edwin T. Jackman, of E. S. Jackman & Co., Chicago, Cleveland and Pittsburg, agents for the Firth-Sterling Steel Co., McKeesport, Pa., has received an appointment as first lieutenant in the ordnance section of the Officers' Reserve Corps, and is now on active duty.

Henry M. Wood has resigned from the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, to become associated with Axel Malm in the Malm & Wood Machine Co., Dayton, Ohio. The new concern will manufacture rotary punch presses and dies. Mr. Malm is president and mechanical engineer and Mr. Wood is vice-president and general manager.

J. T. Plummer, district manager for the Haynes Stellite Co., with offices in Cleveland, has been transferred to the executive offices of the company at Kokomo, Ind., and has been assigned the state of Indiana and the southwestern section of Ohio. Mr. Plummer was formerly western representative for the Driggs-Seabury Ordnance Corporation and is well known among the automobile and tractor parts manufacturers.

Walter R. Morris has been appointed assistant traffic manager of the American Steel Export Co., with headquarters in the Woolworth Building, New York City. Mr. Morris was previously assistant traffic manager of the American-Hawaiian Steamship Co., New York City, and had been associated for many years with the Southern Pacific Co., and the Pacific Mail Co., in their traffic departments in San Francisco and New York City.

M. J. McCormick, who was previously connected with the Canadian Fairbanks Morse Co., Montreal, Canada, as manager of the machine tool department, is now associated with the McCormick Machinery Co., 14 St. John St., Montreal Canada. This company manufactures machine tools and supplies, making a specialty of hobs and chasers. It will also undertake to find buyers for any surplus equipment that its customers wish to dispose of.

Alfred L. Holmes and C. M. Goldman have joined the sales organization of the Pangborn Corporation, Hagerstown, Md. Mr. Holmes will be district sales agent at Cleveland and Mr. Goldman will be district sales agent at Philadelphia. Both men are well acquainted throughout the foundry and metal-working trades. Mr. Holmes was formerly with the Pangborn Corporation in the same capacity for six years, and Mr. Goldman has been representing the Obermayer Co., in the Philadelphia territory for several years.

Stanley W. Hull, Cleveland, Ohio, is the head of a new mechanical drafting service company for inventors and manufacturers known as S. W. Hull & Co. During the past ten years, Mr. Hull has been employed in the engineering departments of the General Electric Co., Westinghouse, Church, Kerr & Co., and the Brown Hoisting Machinery Co. He has paid particular attention to limit systems for the production of interchangeable parts, and will specialize in the design of mechanical and electrical devices.

OBITUARIES

J. C. Small, former manager of the Aurora Tool Works, Aurora, Ind., manufacturer of upright drills, died July 24, aged seventy-three years. Mr. Small was for several years identified with the machine tool business and was very well known to the trade.

Arnould C. Butters, sales manager of the Industrial Press, died of pneumonia at the Polyclinic Hospital, New York City, after a brief illness, on Saturday, August 25, at the age of fifty-two. Mr. Butters, whose name is familiar to thousands of MACHINERY'S readers, was for nine years in charge of the book and subscription department of the business, and filled the position with signal ability. Quiet and undemonstrative, he was, nevertheless, remarkably efficient and possessed an extraordinary capacity for details. He liked to call himself "a detail man," but he was never lost in details—always he was master of them, and his records of work done and results obtained were models of comprehensive, intelligible business statistics, accurate, reliable records to light the way for future campaigns. His attitude toward facts—toward truth—was invariably that of the expert workman, who keeps to the line and aims for absolute accuracy.

Mr. Butters will be greatly missed by his associates, and by those whose labors he directed, to whom he was always kind and considerate. The loss of this well-trained business man will be felt by the company to which he had rendered for many years loyal, enthusiastic and highly efficient service.

COMING EVENTS

September 10-15.—Annual convention of the National Safety Council, New York City; Hotel Astor, headquarters. Marcus A. Dow, president, Grand Central Station, New York City.

September 10-15.—Exposition of safety appliances at the Grand Central Palace, New York City, under the auspices of the American Museum of Safety, 18 W. 24th St., New York City. Arthur H. Young, director.

September 25-28.—Twenty-second meeting of the American Foundrymen's Association, Boston, Mass.; Copley Plaza Hotel, headquarters. The registration booth will be in the Mechanics' Bldg., where the exhibition of foundry and machine shop equipment and supplies will be held. A. O. Backert, secretary-treasurer, 12th and Chestnut Sts., Cleveland, Ohio.

September 27.—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, [illegible]57 Genesee St., Rochester.

September 27-29.—Informal congress and reunion of American and Canadian engineers and architects of Norwegian birth or descent in Chicago at Chicago Norske Klub, 23[illegible] N. Kedzie Blvd., Logan Square, Chicago, Ill.

October 9-11.—Annual congress of Purchasing Agents at Pittsburg, Pa. James H. Robison, chairman, [illegible] Westinghouse Bldg., Pittsburg, Pa.

SOCIETIES, SCHOOLS AND COLLEGES

Society for Electrical Development, 29 W. 39th St., New York City. Booklet containing a comprehensive review of the activities of the society.

Northwestern University, Chicago, Ill. Bulletin containing the annual catalogue for 1916-1917, giving complete information relating to the university, its faculty, courses, etc.

Ohio State University, Columbus, Ohio. Bulletin [illegible] containing the following papers presented before the Conference on Human Engineering held last [illegible] at the Ohio State University: "Ideals and [illegible] for the Engineering Profession;" "The Treatment of the Employee [illegible];" "Human Engineering in Steel Mills;" "The Human Side of Labor;" "Getting on in the World;" "[illegible] Industrial Democracy;" "[illegible];" "The Humanizing of [illegible];" "The Human Factor in Industry;" "Human Engineering and Welfare Work;" "Human Engineering from the Viewpoint of a Wage Earner;" "The New Emphasis on the Human Factor in Industry;" "The Human Side of the Worker;" "The Engineering of Men;" "New Ideals in Human Engineering;" "Scientific Management and Progress."

NEW BOOKS AND PAMPHLETS

Modern Machine Shop Construction, Equipment and Management. By Oscar E. Perrigo. 384 pages, $6\frac{1}{4}$ by $9\frac{1}{4}$ inches; 219 illustrations. Published by the Norman W. Henley Publishing Co., New York City. Price, $5.

Books on machine shop construction and equipment are few, this work first published in 1905 being one of the chief examples. The second edition contains four new chapters of especial use to managers, accountants and shop men. The additional matter is on increasing the efficiency of machines and men, the relation of the overhead burden to the first cost, and manufacturing cost systems.

United States Artillery Ammunition. By Ethan Viall. 98 pages, 9 by 12 inches; 171 illustrations. Published by McGraw-Hill Book Co. Inc., New York City.

This book consists of reprints of articles on the manufacture of munitions published from time to time in the "American Machinist." Readers of that journal are familiar with the series of articles on munition manufacture which have appeared in it during the past year. The book contains chapters on 3-inch common shrapnel, 3-inch high-explosive shells, 3-inch naval shells, 3.8- to 6-inch shrapnel high-explosive shells, 6-inch naval shells, and 3- to 6-inch cartridge cases.

NEW CATALOGUES AND CIRCULARS

Himoff Machine Co., 50 Church St., New York City. Circular of the "Hercules" 12-inch screw-cutting engine lathe.

Silver Mfg. Co., Salem, Ohio. Circular of Silver's 24-inch back-geared upright drilling machine with [illegible] positive geared feeds.

Independent Pneumatic Tool Co., Chicago, Ill. Circular Z describing in detail this company's line of pneumatic tools and electric drills.

Metalwood Mfg. Co., Detroit, Mich. Folder B-54, giving specifications for the Metalwood multiple broach hydro-pneumatic broaching presses.

Challenge Machine Co., Inc., Philadelphia, Pa. Catalogue of "Challenge" emery wheel grinders, polishing machines and emery wheel dressers.

General Electric Co. (Fort Wayne Department), Fort Wayne, Ind. Circular 62557 descriptive of battery charging equipment for lead or Edison batteries.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin 1042 descriptive of E. C. & M. automatic compensators for alternating-current squirrel-cage motors.

Himoff Machine Co., 50 Church St., New York City. Circular descriptive of the "Hercules" 8- and 24-inch gear-hobbing machines, which have just been placed on the market.

Victor Tool Co. Inc., Waynesboro, Pa. Circular of the Sheuman floating reamer-holder for use on automatic screw machines, turret lathes and horizontal and vertical boring mills.

T. A. Willson & Co. Inc., 3rd and Washington Sts., Reading, Pa. Circular of Willson goggles for military wear, showing the different styles adapted for use in the army and navy.

Slocum, Avram & Slocum Laboratories, Inc., 531-537 W. 21st St., New York City. Folders descriptive of an improved type of sine bar and toolmakers' and machinists' indicating square.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y. Catalogue of drop-forged tools, printed in Russian for the convenience of customers in Russia and those who are interested in trade with that country.

A. E. Russ Forged Drill Co., Cleveland, Ohio. Price list of Russ taper and straight shank forged twist drills. The drills are forged complete from bars of round steel, and are sold under the trade name of "Drill-Far."

Gisholt Machine Co., 1209 E. Washington Ave., Madison, Wis. Bulletin entitled "Gisholt Machines and Their Work," containing illustrations of the Gisholt machines at work and giving the time for producing the parts shown.

Boston Gear Works, Norfolk Downs, Quincy, Mass. Circular showing some of the types and styles of gears carried in stock by the company. Price list of gears containing changes of prices that went into effect July 1.

Standard Pulley Co., Cincinnati, Ohio. Pamphlet descriptive of the Standard countershaft clutch, Baechle patent, which grips 100 per cent of the surface of the clutch ring. The pamphlet contains illustrations showing the action of the clutch.

Sebastian Lathe Co., Cincinnati, Ohio. Circular illustrating and describing Sebastian 13-, 14-, and 15-inch geared-head quick change-gear lathes, showing headstock gearing and giving a brief description of the construction, together with specifications.

Link-Belt Co., Chicago, Ill. Book 320, descriptive of Link-Belt "TT" roller chains for tractors and trucks, made to withstand the most severe service and the most difficult conditions under which these machines are called upon to operate.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Loose-leaf sheets for Cutler-Hammer catalogue giving list prices and dimensions of motor starters, speed regulators, controllers, self-starters, starting switches, and rheostats, together with other electrical apparatus.

The LUCAS

(OF CLEVELAND)

"PRECISION"

BORING, DRILLING AND

MILLING MACHINE

ALWAYS GOOD

and as time goes on

ALWAYS BETTER

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF **CLEVELAND, O., U.S.A.**

Detroit Belt Lacer Co., Hubbard Ave. and A St., Detroit, Mich. Circular and price list of "Bull Dog" belt lacers and closing machines. It is claimed that machine-closed wire belt lacing is stronger than hand-laced belting and quicker to apply.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin containing a reprint of a paper entitled "An Automatic Starter for Induction Motors," presented by H. F. Stratton before the Association of Iron and Steel Electrical Engineers at Chicago, May 26.

American Steel Export Co., Woolworth Bldg., New York City. Booklet entitled "Tin Plate," giving a brief history of tin plate manufacture, a description of the process of manufacture, and general information relating to tin plate of value to buyers.

Ingersoll-Rand Co., 11 Broadway, New York City. Bulletin 8213 on "Little David" pneumatic chipping, calking and scaling hammers. Bulletin 8006 on "Imperial" motor hoists and stationary motors. Bulletin 9102 on air receivers, pressure tanks and moisture traps for compressed air.

Triumph Machine Tool Co., 920 Citizens Bldg., Cleveland, Ohio. Bulletin 101 on "Triumph" heavy-duty radial drilling machines, motor driven, the motor being mounted on the radial arm, thus avoiding transmitting the driving power through long splined shafts and multiple bevel gears.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Bulletin of hoisting machinery for industrial plants. The bulletin illustrates and lists floor-operated monorail hoists; floor-operated double rail hoists, hoisting units for jib cranes, derricks, elevators and stack hoists; and motor winches and back-geared motors with high gear ratios.

Buffalo Dental Mfg. Co., Buffalo, N. Y. Catalogue B of laboratory and workshop appliances, including gas furnaces, brazing stands, blowpipes, gasoline gas generators, foot blowers, power blowers, bunsen burners, soldering blocks, melting arrangements, anvils, pickle pans, soldering fluxes, files etc.

Link-Belt Co., Chicago, Ill. Book 361 entitled "Some Facts about Roller Drives," written by A. Lee Henson of the Smith Motor Truck Corporation, Chicago. The booklet tells why the Smith Motor Truck Corporation adopted the chain drive for its "Form-a-Trucks" which are subjected to the most severe tests of service.

Brown Instrument Co., Philadelphia, Pa. Bulletin illustrating furnace and pyrometer control equipment used by Seaman-Sleeth Co., Pittsburg, Pa., for annealing semi-steel rolls. The rolls require to be kept at a temperature of 1800 degrees F., for forty-eight hours, the total time of annealing requiring six days.

Skinner Chuck Co., New Britain, Conn. Catalogue and price list 30 of Skinner chucks, containing 71 pages 4 by 7¼ inches. Dimensions and prices are given for independent chucks, faceplate jaws, universal and combination geared screw chucks, geared scroll combination chucks, faceplate castings, planer chucks, drill press vises, drill chucks, center arbors for drill chucks, etc.

Webster & Perks Tool Co., Springfield, Ohio. Loose-leaf catalogue illustrating and describing in detail the Webster & Perks complete line of grinding and polishing machinery and accessories, comprising plain and ring-oiling bearing, ball bearing, and direct-connected electrically-driven types. The company has in stock for prompt shipment, many of the different sizes and styles of these machines.

Charles A. Schieren Co., 30-38 Ferry St., New York City. Booklet entitled "Belt Buyers' Guide" containing useful data, information and directions for all users of belts. It treats of the belting problem, Schieren service, economy of good leather belts, methods of lacing belts, importance of properly aligned pulleys, how to make quick repairs, cementing belts, etc. Convenient rules are given for estimating the sizes of pulleys to secure any desired velocity ratio.

Columbian Hardware Co., Cleveland, Ohio. Poster entitled "American Fundamentals" carrying four great declarations of principles, the first being from the Declaration of Independence, 1776, the second from President Washington's farewell address 1796, the third from President Lincoln's Gettysburg address 1863 and the fourth from President Wilson's war message to Congress, 1917. Copies will be sent free for hanging in [illegible] mills and factories.

American Steel Export Co., Woolworth Bldg., New York City. English catalogue of iron and steel products for foreign distribution. Spanish, French, Portuguese, Italian and Russian editions [illegible] to be published shortly. The catalogue contains useful information, such as weights and measures, [illegible] metric tables and data on pig iron, [illegible] slabs and sheet bars, plates and shapes, tool steel, merchant bars, wire products, pipe, tubing, railway supplies, etc. The object of the [illegible] is to inform foreign buyers [illegible] American weights, measures, etc.

S K F Ball Bearing Co., Hartford, Conn. Circular containing paragraphs and statements from [illegible] giving their opinion concerning the use of S K F ball bearings on the machines of their manufacture: L. H. Colburn, Colburn Machine [illegible]; C. M. Conradson, [illegible] Mfg. Co.; W. I. [illegible], vice-president of the Gardner Machine Co.; James N. Heald, general manager of the Heald Machine Co.; A. J. Langelier, president of the Langelier Mfg. Co.; Ralph B. Lapointe, Lapointe Machine [illegible]; J. W. Miller, chief engineer, [illegible]; A. H. Moore, manager of the Bath Grinder Co.; James C. Potter, of Potter & Johnston.

Carborundum Co. Niagara Falls, N. Y. Catalogue 6, 224 pages, 6½ by 9 inches, devoted to carborundum and aloxite wheels for all classes of grinding. The catalogue treats of the characteristics and uses of carborundum and aloxite; manufacture of carborundum and aloxite wheels; characteristics and testing of grinding wheels; safeguarding and mounting of grinding wheels; rules for calculating surface and peripheral speeds; shapes of wheel edges; universal grinding; cutter and reamer grinding; plain cylindrical grinding; internal grinding; and grinding on horizontal surface grinders. The book is illustrated with color plates and other high-grade engravings.

Peter A. Frasse & Co., Inc., 417 Canal St., New York City. Catalogue of Frasse-electric and open-hearth steels, 98 pages, 4¼ by 7 inches, bound in cloth. The catalogue contains a complete description of the various grades and finishes of Frasse-electric tool and alloy construction steels. Numerous tables are included which should be of assistance to manufacturers whose products call for the various grades of steel. These tables include weights of bar steel per foot, decimal equivalents, equivalent temperatures, comparative table of gages in common use, metric conversion tables, etc. This company celebrated its one hundredth anniversary in business last year, and since its inception has always been identified with the steel industry in all its branches.

TRADE NOTES

Axelson Machine Co., has removed its office and plant to Boyle Ave. and Randolph St., Los Angeles, Cal.

Atlas Ball Co., Glenwood Ave. at 4th St., Philadelphia, Pa., has changed its name to Atlas Steel Ball Co.

National Tube Co., Pittsburg, Pa., has sold its Kewanee, Ill., plant and fittings business to the Walworth Mfg. Co.

J. C. Barrett Co., Hartford, Conn., has moved to 516 Asylum St., where better facilities have been provided for making wood and metal patterns.

American Steel Export Co., Woolworth Bldg., New York City, has appointed Woodburn's Ltd., Montreal, Canada, as its exclusive agent for Ontario and Quebec.

Cisco Machine Tool Co., Cincinnati, Ohio, is adding a building 30 by 120 feet to the present plant, and will place a 24-inch lathe on the market early in September.

Sterling Products Co. Inc., 547 Washington Blvd., Chicago, Ill., distributor of high-speed drills and hacksaw blades, has opened a St. Louis office at 938 Syndicate Trust Bldg., with R. O. McGraw in charge.

Victor Tool Co., Waynesboro, Pa., is erecting a new plant near the old location. The new structure is of brick, one story high, about 60 by 164 feet. The company will continue to manufacture its line of collapsing taps and other tools.

Pangborn Corporation, Hagerstown, Md., has purchased and taken over the sandblast department of the Curtis Pneumatic Machinery Co., St. Louis, Mo. The Pangborn Corporation will carry a complete stock and is prepared to give prompt service.

Ing. Ercole Vaghi, Corso Porta Nuova, 34, Milan, Italy, dealer in machine tools, requests American manufacturers of machine tools and small tools to send their latest catalogues and price lists. It is especially requested that the catalogues, if possible, be sent in triplicate.

Framingham Machine Works, Framingham, Mass., announce that their plant has been re-equipped with machinery and appliances for the production of gray-iron castings and the galvanizing of metal goods. Hereafter the company will be known as the Framingham Foundries.

Graham Bros. Stockholm, Sweden, manufacturers and dealers in various classes of machinery, announce that on June 1 the name of the company was changed to Graham Bros. Aktiebolag. The firm remains under its past management, its directors being P. S. Graham, K. G. Magnusson, and C. G. Rising.

Haynes Stellite Co., Kokomo, Ind., has discontinued its Cleveland office. C. G. Tarkington, district manager at Pittsburg, has been assigned the Cleveland territory and the eastern section of Ohio, and L. R. Smith, district manager at Detroit, has been assigned the northwestern section of Ohio west of Cleveland.

Anderson Die Machine Co., Bridgeport, Conn., has moved its factory from 680 Water St. to more commodious quarters on Iranistan Ave., near Admiral St. The additional floor space and new equipment to be provided will enable the company to give better service than was possible in the limited quarters just vacated.

Falls Rivet Co. Kent, Ohio, has taken over the plant and business of the Kent Machine Co. In the reorganization of the business the following officers were elected: M. G. Garrison, president; W. S. Kent, vice-president; Roy H. Smith, treasurer, and Myles E. Ewing, secretary. The business will be operated separately under the name of the Kent Machine Co.

A. Bol. Stockholms Jernmanufaktur, Stockholm, Sweden, dealers in machinery, tools and hardware, have opened an office in New York City to enable them to keep in closer touch with the manufacturers in this country. J. Gustaf A. Lang has charge of the New York office, 8 W. 40th St., and acts as purchasing agent. He will be glad to hear from manufacturers and receive catalogues and quotations.

Charles A. Schieren Co., 30-38 Ferry St., New York City, has just completed an addition to its tannery at Bristol, Tenn. Equipment is being installed for the manufacture of the Schieren brands of belts, namely, "Duxbak" (waterproof), "Bull's Head," "Royal Extra," "CasCo," etc., most of which will be shipped to southern plants. The full capacity of the plant will be 50,000 feet of belting daily.

American Telegraphone Co., Springfield, Mass., has purchased the plant of the Rockford Watch Co., at Rockford, Ill., and will use the plant and equipment for the manufacture of telegraphones. The telegraphone is a form of the phonograph that uses a magnetized wire for the record instead of a wax cylinder. It was invented by Prof. Poulson, and a large sum has been expended in perfecting the mechanism of the original machine.

Russell, Holbrook & Henderson, Inc., 30 Church St., New York City, successor to the business in machine tools, special and automatic machinery of Lewis Russell, has been incorporated with a capitalization of $25,000. The business will be continued along the same lines as heretofore, with enlarged facilities. The officers are Lewis Russell, president; C. H. Holbrook, vice-president; and Lucien G. Henderson, secretary and treasurer.

Gisholt Machine Co., 1209 E. Washington Ave., Madison, Wis., owns the controlling interest in the Northwestern Ordnance Co., of Madison, but its connection will in no way affect the product or production of the Gisholt Machine Co. The two organizations are entirely independent. The Gisholt Machine Co.'s organization is in first-class shape to produce machine tools and equipment that will be required to meet the nation's military and industrial needs.

Heald Machine Co., 20 New Bond St., Worcester, Mass., has opened a branch office in the Commonwealth Building, Philadelphia, Pa., for the purpose of giving better service to its customers in that section. S. M. Hershey, formerly connected with the Hyatt Roller Bearing Co., of Newark, and the Norton Co., of Worcester, will be in charge. The office will serve the trade in Pennsylvania as far west as Altoona and in New Jersey as far north as Trenton.

Parker Mfg. Co., Detroit, Mich., manufacturer of drill chucks and arbors, elected the following directors at a recent meeting of the stock-holders: Gorham C. Parker, David J. Rice, Howard K. Chambers, Charles D. Bennett, and Kenneth P. Albridge. The officers of the company are Gorham C. Parker, president and treasurer; David J. Rice, vice-president; and Howard K. Chambers, secretary. The company was incorporated in July with a capitalization of $75,000.

Cincinnati Electrical Tool Co., Cincinnati, Ohio, has moved into its new quarters at 1501-1505 Freeman Ave., corner of Flint St., where increased facilities have been provided for manufacturing the line of portable electrical drills and grinders. The new quarters afford 32,000 square feet of working space and give light on four sides. Removal to larger quarters was made necessary on account of the greatly increased demand for "Cincinnati" electrical drills and grinders.

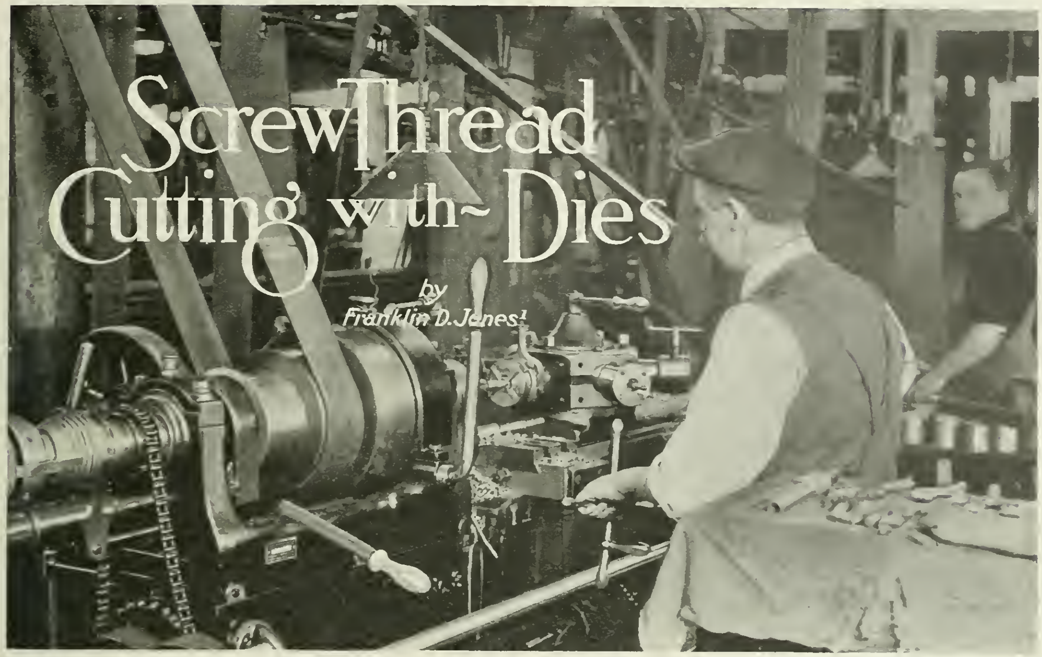
Link-Belt Co., Chicago, Ill., announces that it is now again in a position to furnish Link-Belt monorail electric hoists for quick shipment. The manufacturing of electric hoists was stopped during the past year because of unprecedented business conditions and overcrowding in the company's shops. These machines are made in the Philadelphia plant where a large additional building is rapidly nearing completion and where the present manufacturing facilities are being greatly increased.

A. S. Elektrisk Industri, Drammen, Norway, has consolidated with two other concerns in Norway, the Holm-Hansen Elektrisk A. S., Sandefjord and Fridtjoy Andersens Telepointage, Christiana, Norway. The association will continue the manufacture of articles in the electrical line, and will hereafter conduct its business under the name of the A. S. National Industri with main office at Sandefjord and branch offices at Drammen and Christiana. The association is represented in New York City by Hans Karlsrud, manager of the Drammen branch, 309 Broadway.

Gorham & Goddard Co., 15 W. Congress St., Detroit, Mich., is a partnership formed by L. C. Gorham and A. N. Goddard for the manufacture and salvaging of small tools. Mr. Gorham formerly conducted a business in the salvaging of reamers, end mills, milling cutters, etc. Mr. Goddard is an expert tool man, and was for four years superintendent of the Union Twist Drill Co., Athol Mass. The new company is equipped with modern tools and will be in a position to give prompt service. It will salvage all kinds of small tools and cutters and also manufacture special tools, dies, jigs, fixtures, gages, special cutters, reamers, end mills, etc.

Abell Howe Co., Chicago, Ill., has been incorporated to provide for the expansion of the sales and engineering organization inaugurated some months ago by Oliver J. Abell, 565 Washington Blvd., Chicago. The new company has acquired interests in some of the manufacturing concerns for whose products it will be the national distributor, and in addition it will continue to market other equipment as sales agent. Among the products to be sold exclusively through this company are "American high speed" chain and Howe "One Man" detachable tongue trucks. Oliver J. Abell is president and treasurer, Glenn G. Howe, vice-president, and [illegible] Kane, secretary. Arrangements for representation in the principal distributing centers of the country will be shortly completed.

OCTOBER MACHINERY 1917



Screw Thread Cutting with Dies

by Franklin D. Jones[1]

This is the beginning of a series of articles dealing with the design, operation, and application of various classes of standard and special tools, machines, and attachments used in producing screw threads. The general subject of thread-cutting dies is covered in this installment, which includes various types of dies, principles governing their operation and maintenance, and the causes of common defects in die-cut threads.

THE formation of accurate and interchangeable screw threads on a commercial or manufacturing basis has been a difficult proposition in many machine shops. The extent of the difficulties encountered in connection with this work may depend largely upon the meaning of that indefinite term "accurate" and also upon the length of time that is allowed for the screw-cutting operation. On many classes of threading work the degree of accuracy, combined with the speed of production demanded, makes screw cutting a troublesome operation, and even when the conditions are not unusually severe, the production of smooth, correctly formed threads requires tools that are properly made and applied. While some equipment is incapable of producing good screw threads, regardless of the time that might be expended (either because it was poorly constructed to begin with or is in bad condition), many notable improvements have been made in screw-thread forming tools and methods, and in this general review of the subject the more important types of tools or machines for producing screw threads will be described. In this particular article, which deals especially with threading dies, and in other succeeding articles, those features that have a direct bearing on the accuracy of screw threads and the speed of production will be considered, as well as the relative merits of different types of tools or machines and the general classes of work for which they are adapted.

General Methods of Forming Screw Threads

The two general methods of forming screw threads may be defined as the cutting method and the rolling or impression method. Some of the various modifications of these two general methods will be outlined. The cutting methods as applied to external threads are briefly as follows:

1. By taking a number of successive cuts with a single-point tool that is traversed along the part to be threaded at a rate per revolution of the work depending upon the lead of the thread. (Common method of cutting screw threads in the engine lathe.)
2. By taking successive cuts with a multiple-point tool or chaser of the type used to some extent in conjunction with the engine lathe and on lathes of the Fox or monitor types.
3. By using a tool of the die class, which usually has four or more multiple-point cutting edges or chasers and generally finishes the thread in one cut or passage of the tool.
4. By a single rotating milling cutter, which forms the thread groove as either the cutter or work is traversed axially at a rate depending upon the thread lead.
5. By a multiple rotating milling cutter which completes a thread in approximately one revolution of the work.

When screw threads are produced by the rolling or impression method there are two general processes:

1. By rolling the blank in contact with a revolvable disk or roll, the periphery of which has either a single thread or a multiple thread corresponding in pitch to the thread required.
2. By rolling the blank in contact with flat dies having parallel ridges which are spaced in accordance with the required pitch and which form the screw thread.

Internal screw threads, or those in holes, may or may not be produced by the same general method that is applied to external work. There are three commercial methods of importance, namely:

1. By the use of a single-point traversing tool in the engine lathe or a multiple-point chaser in some cases.
2. By means of a tap which, in machine tapping, usually finishes the thread in one cut or passage of the tool.
3. By a rotating milling cutter of either the single or multiple type.

Controlling Motion of Thread-forming Tool

The general methods of controlling the motion of a thread-forming tool relative to the work, for generating thread grooves of helical or "spiral" form, vary according to the type of tool or machine used for the screw-cutting operation. Considering, first, the action of the tool while cutting a thread groove, there are three general methods of securing the necessary motion:

1. The tool-holder or carriage (or the work in some cases) is traversed by a lead-screw driven by gearing of such a ratio that the relative motion of the tool per revolution of the work is equal to the lead of the screw thread required.

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[1] Associate Editor of MACHINERY.

2. The motion is obtained by the direct action of a lead-screw, which is not driven through gearing and has a lead equal to that required on the part to be threaded.

3. The tool when in the form of a tap or die may be self-propelling or self-leading, the tool moving each revolution a distance equal to the thread lead as the result of its screwing action, caused by the location of the cutting teeth along a helical path.

After a thread-cutting tool has completed a cut, it is usually necessary to return it to the starting point either for the purpose of taking another cut (as when using a single-point tool) or for removing the tool from the work (as when withdrawing a tap or die from the threaded part). This return movement may be obtained by the following methods:

1. By a hand or power traversing movement of the tool carriage or holder in the direction of the axis of the work, after withdrawing the cutting tool or tools for clearing the screw thread.

2. By reversing the rotation of the work- or tool-spindle for backing a non-collapsing tap out of a hole or for unscrewing a non-opening die from the threaded part.

3. By running a tap or die at a slower speed than the work while cutting the thread and then at a faster speed for unscrewing the thread-cutting tool.

When a thread is being formed by the rolling process, the tool, if of circular shape, simply moves at right angles to the axis of the work for bringing the roll into contact with the part to be threaded and for removing it after the thread has been formed. In the case of flat thread rolling dies, the blank to be threaded is rolled between a stationary die and a movable die having a reciprocating motion.

Selection of Thread-forming Method

One of the most important questions relating to the formation of screw threads is the particular method that should be employed for a certain class of work. What is the most rapid method of performing the screw-cutting operation without sacrificing the necessary accuracy? That is the question that has often puzzled shop foremen and superintendents and one that is not answered in the same way by those who have studied the problem of screw thread production. Variations of practice in different shops are often due to the fact that the equipment at hand is used not because it is considered the best, but because there is no choice. In other words, the amount of money appropriated for new tools is often the real reason why different types of tools are used for the same general classes of work. While each class or type of thread-forming tool or machine has a definite field, in some cases these fields overlap, and then judgment, experience and records of past performance must be utilized in deciding what method is to be employed.

Among the important factors that affect the thread-forming methods may be mentioned the diameter of the screw, pitch of thread, degree of accuracy necessary, number of parts to be threaded, location of thread, material of which parts are made, and relation of threading operation to other work which may precede or follow it. It will be understood that no inflexible rule can be given as a guide and that the different factors mentioned may be combined in various ways, thus changing the problem partly or entirely. Other conditions peculiar to any one job may also have a decided effect on the exact method of procedure. This matter of selecting equipment for the production of screw threads involves not only a study of the different classes of work for which various types of tools are adapted, but a careful investigation into the performance of different makes of tools of the same class or type. The difference in the quality of tools of the same class accounts for many variations of opinion. One man contends that a certain type of tap or die is incapable of accurate work, but, if the truth were known, the general type may be entirely satisfactory when properly made or applied. This is also true of thread-forming tools of other classes. In dealing with the various types of thread-forming equipment, the kind of work and the particular advantages of each type will be enumerated in as specific a manner as seems practicable. Unfortunately, however, it is not possible to deal with this question of selecting thread-forming tools in such a definite way that instructions may be followed to the letter and without the assistance of experience and judgment.

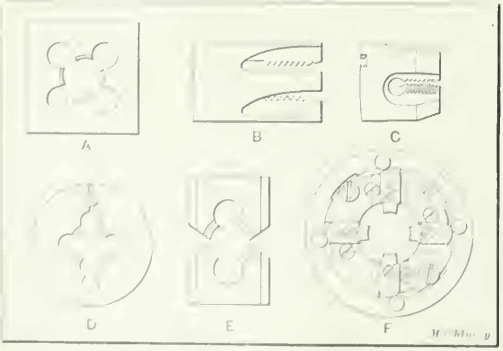

Fig. 1. Different Types of Threading Dies

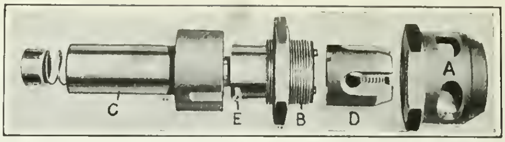

Fig. 2. Acorn Die and Die-holder

General Application of Threading Dies

Most external screw threads are cut by means of dies, because tools of this class not only cut threads very rapidly, but when properly made are capable of producing screws that meet most commercial requirements as to accuracy. It is impossible to enumerate all the classes of work for which dies are used; however, they are applied in general to the threading of a large percentage of the small and medium-sized screw threads, ranging from the smallest screws, bolts and studs up to heavy screws four or five inches in diameter, or larger in some cases. These die-cut screw threads include those of the rougher grades represented by ordinary studs, bolts, etc., and also a great deal of the more accurate work on machine parts generally.

Work of the stud and bolt class is almost invariably threaded by means of dies, but the application of dies to the better grades of screw thread cutting depends upon conditions. For instance, dies are ordinarily used on turret lathes and semi-automatic or automatic screw machines for external threading operations, because they provide an efficient method not only of forming a screw thread, but also of doing it without removing the work from the machine. On the contrary, dies are rarely used on the engine lathe, which has its own screw-cutting mechanism and is designed primarily for a wide range of work rather than for manufacturing duplicate parts in quantity like the turret lathe and automatic screw machine. In some instances, the use of dies on the turret lathe or screw machine is not practicable, as, for example, when there is a shoulder between the surface to be threaded and the turret.

While there is no well-defined line showing just where the practical application of dies ends, there are certain limiting factors which should be considered. In general, as the pitch of the thread and its diameter increases beyond certain limits, the use of dies decreases. Dies may be employed for cutting threads of coarse pitch, but, ordinarily, the lathe or a thread milling machine is used in preference. Whether or not a die could be used to advantage might depend upon the type of machine employed for the other operations, such as turning, etc., and the number of pieces to be threaded or the degree of accuracy necessary. In the manufacture of pipe, dies are used for cutting the threads even on the large sizes, because they provide a rapid means of doing the work and the pitches of the threads are fine in proportion to their diameter. The large dies used for pipe threading or other operations are, of course, quite costly and can only be employed to advantage when the quantity of work warrants the necessary investment.

Dies are efficient as a means of cutting screw threads, because they usually finish the thread complete in one cut, although two passes or cuts are desirable for certain classes of work, some dies being arranged for taking a light finishing cut. When cutting threads of coarse pitch, considerable metal is removed in a short time, especially when a single cut is taken, and although these heavy cuts may be distributed between three or four teeth at the throat of the die, the difficulty of obtaining smooth, accurate screw threads increases for the larger pitches. Dies may be used for pitches up to one-quarter or one-third inch, or even larger, but die threading operations of this kind are not common. When dies are used for cutting screws of coarse pitch and of relatively small diameter, the torsional or twisting strain on the work and the resulting impairment of the accuracy of the screw may be so great that the use of a lathe or thread milling machine is preferable, if not necessary.

When making any comparison on the basis of accuracy between screw threads cut with dies or by means of a lathe or thread milling machine, it is important to remember that there are "dies and dies." In general, a well constructed lathe or thread milling machine will cut a thread that is more accurate as to form and lead than a high-grade die, for the following reasons: In the first place, a carefully ground single-point tool or single type milling cutter is more accurate than a multiple-point die chaser or cutting edge, which must be correct both as to the form of each tooth and the pitch of the teeth; second, a die which is self-leading and not positively controlled by a lead-screw is less likely to produce a thread of accurate lead than a single-point tool or a rotating milling cutter that derives its motion directly from an accurate screw. There is a difference, however, in the self-leading qualities of different dies. Some of the important causes of inaccuracy in the lead of die-cut threads will be considered later. The difference in accuracy between the best grade of die work and the product of the lathe or thread milling machine is usually so small as to be negligible for most commercial work, which, in conjunction with the speed of dies as a means of screw cutting, accounts for the extensive application of dies in all machine building plants.

Types of Non-opening Dies

Dies may be divided into two general classes, namely, those that are removed from the screw thread by being backed off or unscrewed, and those that may be opened so that the cutting edges clear the screw thread, thus permitting the die to be removed by traversing it over the work in a lengthwise direction. The non-opening dies are capable in some cases of hand adjustment, but the object of this adjustment is to vary the size of the die, so far as machine threading operations are concerned. There are four types of non-opening dies in common use, which may be designated as (1) solid dies, or those that are rigid and incapable of any adjustment for varying the diameter; (2) flexible dies, or those that are split in one or more places and may be adjusted to some extent by compressing or expanding; (3) sectional dies, or those formed of two adjustable sections; (4) rigid adjustable dies of the chaser type, having inserted chasers that may be adjusted radially within certain limits either for maintaining a standard size or for varying the size slightly.

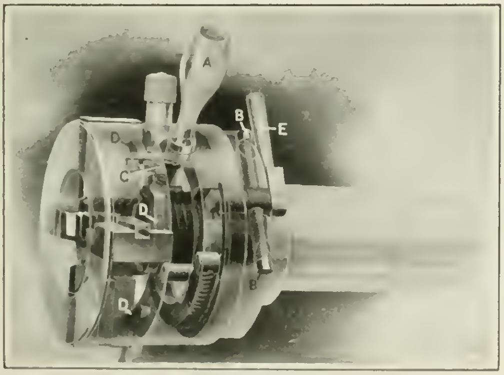

Fig. 3. Geometric Style D Self-opening Die-head

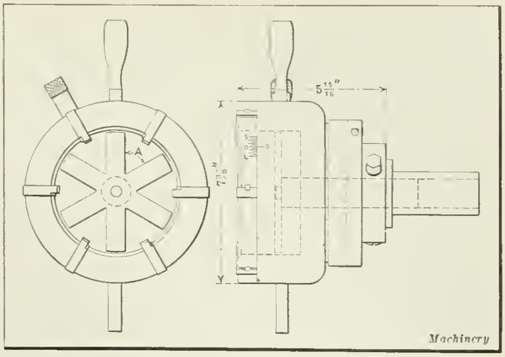

Fig. 4. Self-opening Die-head of Internal Trip Type

A common form of solid die is shown at *A*, Fig. 1. This form is used for some bolt and pipe threading operations and for the rougher classes of screw cutting. The accuracy of the die is likely to be impaired considerably by hardening, and there is no means of reducing the diameter as it gradually increases on account of wear. Most solid dies of the rigid class are square on the outside, although some are round or of hexagonal shape. The latter are similar to a nut except that they have flutes on the inside to form cutting teeth and are made of hardened steel. Dies of this kind are used principally for repair work, as they are easily turned with a wrench and are convenient for truing or recutting battered threads.

The split dies, or those having enough flexibility to permit adjustment, are made in different shapes, the three common forms being the spring screw die shown at *B*, the "acorn" die *C*, and the round split die *D*, which is sometimes known as a button die. A great many spring screw threading dies are used on automatic screw machines for cutting the smaller sizes of screws. The die has four projections or prongs on which the cutting edges are formed. These prongs are quite flexible and must be held in position when the die is in use by some form of external ring or clamp. Many of these clamping rings are split on one side, and the split ends are joined by a screw which provides adjustment for closing in the cutting edges to the required size. This type of clamp is objectionable in that it does not compress the different prongs uniformly, so that the work of cutting the thread is not properly distributed between the cutting edges. One method of overcoming this difficulty is to use a solid ring that is slightly tapering on the inside to fit a corresponding taper on the outer surfaces of the die prongs. The collet style of holder for spring screw dies is a further improvement, as it is in the form of an external sleeve completely surrounding the die, and not only holds it rigidly, but provides a convenient means of uniform adjustment for variations in size. The teeth of these dies may be cut with either a straight hob or from the back with a hob that is slightly tapering. When a straight hob is used it is a few thousandths over size, the amount depending upon the pitch of the thread; the prongs of the die are afterward forced in to the correct size by the clamp collar or chuck. This adjustment produces a slight inaccuracy in the thread, and for that reason it is preferable to use a tapering hob to obtain the necessary clearance, the die being cut to the correct size at the point and not over size, as when a straight hob is used. This back taper varies from 0.005 to 0.010 inch per inch for iron and steel, and from 0.008 to 0.015 inch per inch for dies employed for cutting threads on brass. One of the great advantages of the spring screw die as compared with the round split form shown at *D* is that the radial cutting edges can easily be reground when they become dull by using an ordinary dished wheel, the beveled edge of which is inserted in the flutes of the die. With the round split form, a special grinding wheel is required.

The lands or cutting ends of the acorn die *C* are shorter and wider than those of a spring die, which increases their strength against torsional or twisting strains. The part of each land or prong just back of the cutting teeth is made comparatively thin to give the necessary flexibility for radial adjustment. The form of holder used in connection with this die (as manufactured by the Greenfield Tap & Die Corporation, Greenfield, Mass.) is illustrated in Fig. 2. The die *D* is contained within an adjustable cap *A*, which is screwed onto section *B* of the die-holder. The outer end of each die prong is beveled to fit a corresponding conical surface on the inside of the adjusting cap *A*. The base of the die, which is ground true, bears against the end of the floating part *B* of the die-holder and has notches which engage short driving pins. The connection between part *B* and shank *C* is obtained through a cross-pin *E*, which engages the slots shown in the illustration. This arrangement is, of course, to provide a certain amount of floating movement. Radial adjustment of the lands for varying the size of the die is obtained by simply turning the adjustable cap *A* in one direction or the other after loosening the locking nut. The adjustment derived in this way, by means of the internal conical surface referred to, serves to move each of the four lands an equal amount radially, so that the work of cutting a screw thread is evenly distributed. The acorn die, like a spring die, may readily be resharpened on the radial faces, the grinding being done in the flute, the same as with a spring die.

Round split or button dies (one form of which is shown at *D*, Fig. 1) are used principally on turret lathes and hand and automatic screw machines; they are applied to the same general classes of work as spring screw threading dies. The button dies are more rigid than the spring dies, if the latter are adjusted by the usual ring or clamp, but, as previously mentioned, they are not so easily sharpened on the radial cutting faces. The initial cost of the button die, however, is less than that of a spring die and the former is not distorted as much in hardening.

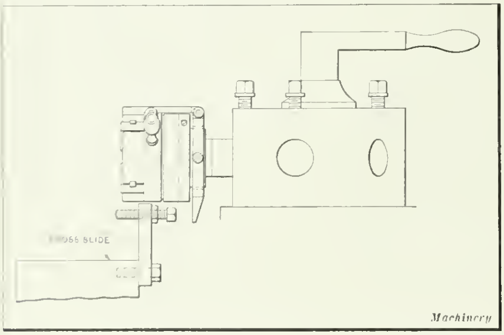

Fig. 5. Self-opening Die-head of Outside Lever Trip Type and Adjustable Stop for controlling Point at which Die trips or opens

The sectional type of die formed of two separate parts (*E*, Fig. 1) is extensively used in die-stocks for hand threading operations on bolts, pipe, etc., and also in some power-driven screw-cutting machines. The outside shape of these dies varies. The form shown has sides with a double bevel to give the two die sections a tight grip in the holder and permit reversing the position of the die for cutting close to a shoulder. Some dies of the two-piece form are round and are used in preference to the kind shown at *D*, which is split on one side only. The advantages claimed for this type are that it does not lose its shape the same as a die which springs together on one side only, and it can be more easily ground.

The rigid adjustable die of the chaser type (*F*, Fig. 1) provides a convenient means of adjusting the die either to compensate for the wear of the chasers and maintain a standard size or to vary the diameter slightly from the standard. This general type has several advantages when applied to operations for which it is especially adapted. For cutting comparatively large screw threads, the chaser type of die is preferable to a solid split or spring die, partly because it is capable of more accurate work. The one-piece die is always subject to distortion in hardening, especially when made in large sizes. The use of inserted chasers is also an advantage, because a practically new die may be obtained by inserting a new set of chasers, when, as a result of repeated grinding and wear, this becomes necessary; the body of the die may be used permanently. Dies of the adjustable chaser type may be used in preference to the automatic or self-opening class (to be described later) for cutting screw threads that are so short that the time saved by the opening dies is too small to offset the difference in cost. The adjustable chaser design, in general, is also more rigid than the self-opening die and better adapted for taking heavy cuts on threads of coarse pitch when the thread is to be finished by a single cut. The construction of these dies varies considerably. The particular design shown at *F* (the "Namco") has four chasers, which are held firmly over plates in the body by screws and dowel-pins. They are supported laterally or at the sides by hardened eccentric binding screws and are backed up at the ends by hardened pins carried by a heavy adjusting ring. A loose or tight fit may be obtained with a set of chasers by means of an adjusting screw which changes the position of the adjusting ring and pins relative to the oval-backed chasers.

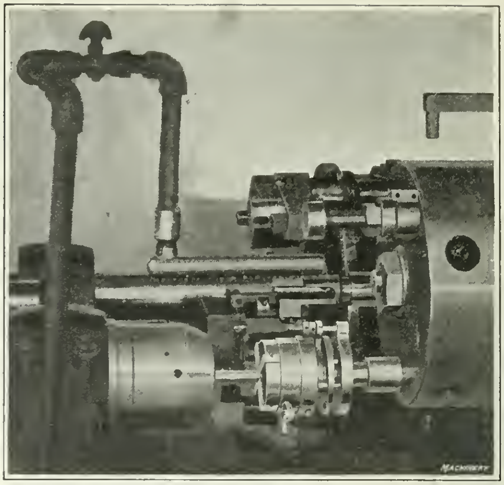

Fig. 6. Geometric Style DD Self-opening Die-head on a Cleveland Automatic

Removal of Non-opening Dies from Work

After a screw thread has been cut with a non-opening die, the latter is removed by unscrewing or backing it off the

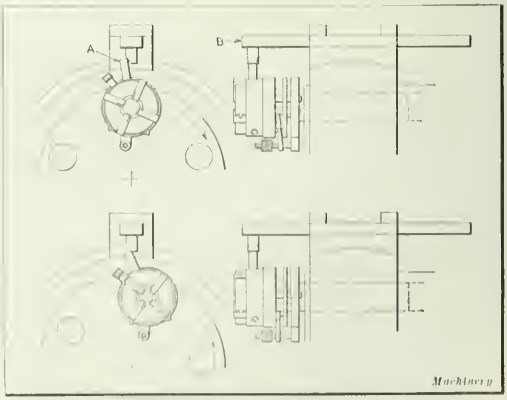

Fig. 7. Closing Attachment for Self-opening Die-heads applied to a Cleveland Automatic

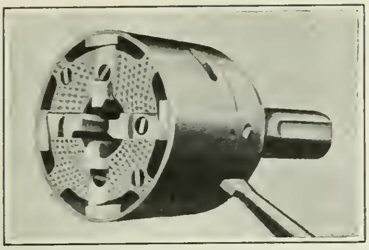

Fig. 8. "Namco" Self-opening Die-head of Non-revolving Type

threaded section, unless, as is sometimes the case, the part being threaded passes clear through the die. The latter method is sometimes followed when a vertical-spindle machine like a drill press is used for threading plugs or other parts by screwing them down through a die attached to the table; the finished work then simply falls through the die. The same method has been employed in threading taps. It is especially applicable when there is a square end on the work, or opening. to provide a convenient means of driving by simply engaging the parts with a socket or other form of driver on the spindle that readily releases after the work has passed through the die. While this method of cutting screw threads has been utilized to some extent, in most cases it is necessary to back off a non-opening die, and this may be done in three different ways: (1) the rotation of the work may be reversed after the thread is cut; (2) the die itself may be reversed, thus unscrewing it from the threaded part; (3) the die may be revolved in the same direction as the work but at a somewhat slower rate of speed while cutting the thread and then at a faster rate so that the die backs off the threaded part while it still continues to revolve in the same direction as the part being operated upon. This third method is employed on some automatic screw machines.

Application of Self-opening Dies

The automatic or self-opening type of die represents one of the most important developments in thread-cutting tools. There are two serious objections to the non-opening die: One is that time is wasted while the die is backing off the threaded part. The other and often more serious objection, especially when threading tough material, is that the threads are frequently marred, if not spoiled entirely, by the backward movement of the die. This roughing or tearing of the thread is due to the fact that when either the die or the work reverses there are chips left in front of the cutting edges especially at the throat of the die; consequently, as the die moves back these chips or others previously removed often become wedged between the lands of the die and the screw and roughen the thread or tear it as the die is being removed. Trouble of this kind may often be greatly reduced or practically eliminated by using dies having a minimum amount of relief. The roughness of the thread may also be due primarily to other causes. For instance, some grades of soft "stringy" steel are difficult to thread smoothly. In such a case, the only remedy is to use a steel higher in carbon or if a good grade of material is not necessary a steel higher in phosphorus and sulphur. The roughness of a thread may be. and often is, due to the use of die chasers which are not properly made or ground. Unscrewing the die, however, has caused much trouble, and defects from this source may be avoided by the use of self-opening dies. The latter may also increase the speed of thread-cutting operations 30 or 40 per cent, by reason of the rapid removal of the self-opening type after the thread is cut. The additional complication necessary in a self-opening die means a higher initial cost which is sometimes to be considered when the amount of work is relatively small.

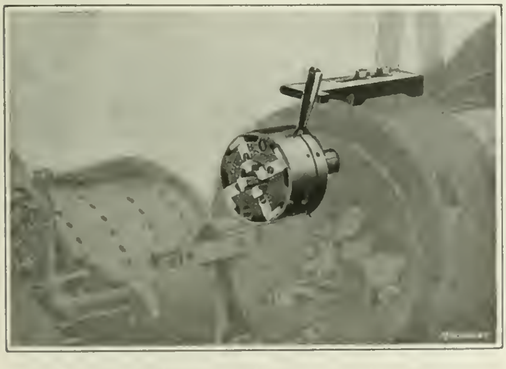

Fig. 9. "Namco" Self-opening Die-head on a Cleveland Automatic, showing Closing Device

An automatic die is, as a general proposition, less rigid than a non-opening die such as the inserted-chaser type, especially after the parts have become worn. It is for this reason that some self-opening dies will not cut a satisfactory short thread, especially if the length of the thread is about equal to the width of the die chasers. The chasers spring outward somewhat at the beginning of the cut and make the thread tapering. This error may be so small as to be negligible when a good die is used, and, in any case, screws having a length equal to several times the die-chaser width will be cut straight except for a few threads at the beginning and end of the screw where there may be an appreciable amount of taper. Another difficulty that has been experienced with some self-opening dies is in the accumulation of chips in the die-head, which interferes with the action of the movable members and increases the amount of wear; much has been accomplished, however, in the design of self-opening dies toward keeping the die-head free from chips that impair its effectiveness and also in rigidly supporting the chasers so that outward radial thrusts are taken directly by solid parts of the die.

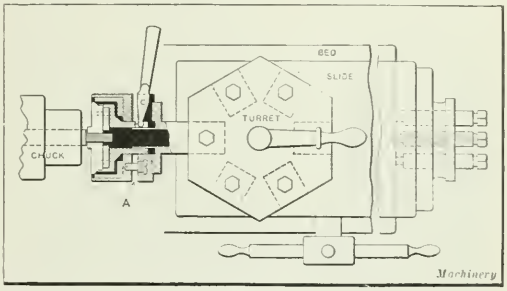

Fig. 10. Diagram illustrating Method of adjusting Turret Slide Stop for a "Namco" Self-opening Die-head

The relative merits of self-opening dies and the solid or non-opening type, may depend upon the length of thread to be cut, the type of machine, its reversing speed, and the number of parts to be threaded.

Types of Self-opening Dies

The different designs of automatic or self-opening dies differ principally in regard to the mechanism for opening the die chasers at the completion of a cut, the method of closing the chasers to the cutting position after removing the die, and the method of supporting the chasers against radial thrusts. Self-opening dies, in general, are formed of two main sections. One section, which includes the shank and inner part of the die body, is attached to the turret, spindle or other part of the machine. These two main sections have a certain relative motion for opening the die or releasing the chasers from the work and for closing the chasers to the working position. This motion for operating the die may either be parallel to the axis of the die, rotary, or helical. The radial motion of the chasers for opening or closing the die is commonly derived or controlled either from cam surfaces or the conical surface of a sleeve in contact with the chasers.

The three general methods of opening dies of this class automatically are by stopping the travel of the turret at a predetermined point; by the engagement of an outside tripping finger, latch, or lever on the die-head with a fixed stop or

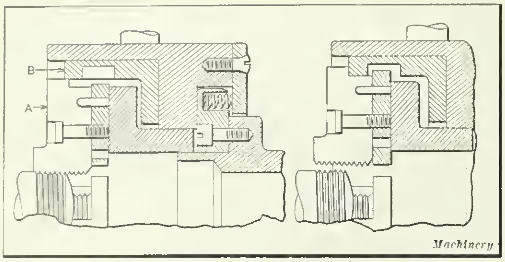

Fig. 11. Sectional Views of No. 11-22 Series "Namco" Self-opening Die-head showing Arrangement for obtaining Instantaneous Opening Action

plate; by the engagement of the end of the work with a tripping plate located inside the die. Most self-opening dies are of the non-revolving type, the die remaining stationary while the part to be threaded rotates. Dies of this class commonly have a hand-lever for opening or closing them. Some dies of the automatic class are designed to be revolved. Several commercial designs of self-opening dies will be described to illustrate the variations in construction and methods of operation.

Geometric Self-opening Dies

The standard design of Geometric self-opening and adjustable die (style D) shown in Fig. 3 is intended for use on hand-operated turret lathes and automatic screw machines. This die, made by the Geometric Tool Co., New Haven, Conn., is so arranged that it opens automatically as soon as the travel of the shank section of the die-head is retarded. When used on the turret lathe the stop-screw or rod of the turret slide may be set to stop the movement of the turret when the required length of thread has been cut. If desired the die can be opened at any intermediate point by simply holding back on the lever for operating the turret slide. The die chasers are closed to the working position after being opened, by handle *A* projecting from the slide. The die may also be closed automatically by screwing a pin into a threaded hole opposite this handle and attaching a stop to the rear edge of the turret slide in such a position that it will engage the pin as the turret revolves. Slight variations in diameter (indicated by graduations at *C*) to secure a tight or loose fitting screw may be obtained by adjusting screws *B*. The radial movements of the die chasers for opening or closing the die are derived from cams *D* which engage slots in the chasers on the rear side. The chasers are held on splines at one side of the opening in which they are a close fit to prevent tilting due to the cutting strain. This style of die is made in sizes ranging from 1/8 inch to 4½ inches. The sizes over and including ¾ inch have an attachment which permits taking roughing and finishing cuts. When the small lever *E* is turned to a position opposite that shown in the illustration, the chasers are all moved outward 0.01 inch ready for the roughing cut. Returning this lever to the position shown closes and locks the chasers for the finishing cut.

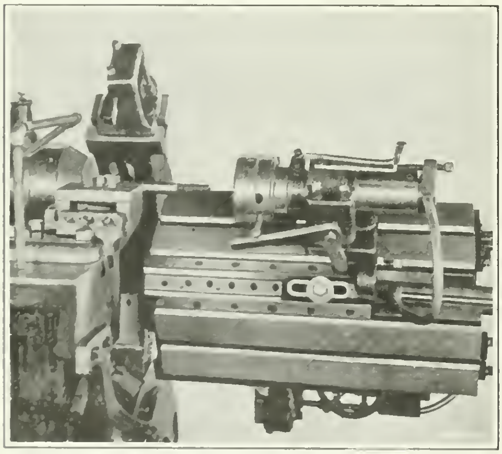

Fig. 12. Hartness Self-opening Die-head applied to a Gridley Automatic

A style C Geometric die of the inside trip type is shown in Fig. 4. This die has an internal adjustable gage or stop *A* which comes in contact with the end of the work, thus automatically opening the chasers. This type is preferable to the "pull" type (which trips after the turret slide stops) for certain classes of work and for some machines, as, for example, where turret stop-screws or rods are not provided for every turret hole. Fig. 5 shows a style C Geometric die of the outside lever trip type. A fixed stop is attached to the cross-slide and it is provided with an adjustable screw for varying the point at which engagement with the tripping lever of the die occurs. The outside lever trip type is recommended for cutting short threads of fine pitch because the chasers are relieved of all strain when tripping.

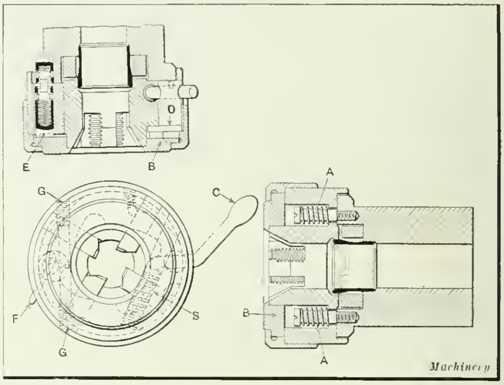

Fig. 13. Mechanism of Hartness No. 4 Automatic or Self-opening Die-head

A third style of Geometric die (style DD) is shown in Fig. 6 applied to a Cleveland automatic screw machine. This die was designed especially for use on the turret of the Cleveland machine, but it can be applied to other automatic or semi-automatic machines in which the operating requirements are practically the same. The die-head is supported by a spring mechanism between the head and shank which permits the chasers to align themselves with the work and compensate for any slight inaccuracy in turret adjustment. This floating connection also permits a certain amount of longitudinal movement independent of the motion of the turret slide so that the die is free to follow its own lead. After the turret slide stops its forward movement, the die-head has a slight independent movement which brings the lock-nuts seen in the side of

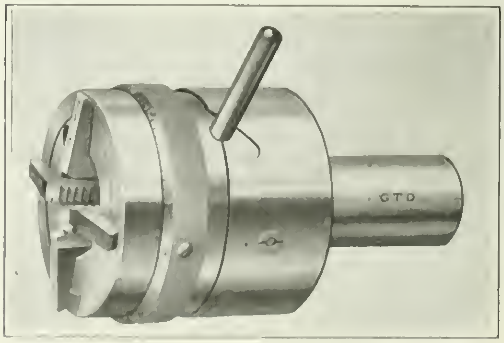

Fig. 14. Wells Self-opening Die-head of Model B Pull-trip Type

the die-head in contact with a hinged plate. The movement of this plate releases the locking bolt and allows the chasers to open or move outward. The point at which the die opens may be varied slightly by adjusting these lock-nuts. The illustration shows the die at the point where the tripping mechanism is about to operate, the lock-nut having come into contact with the tripping plate.

The arrangement for closing the die-head automatically is illustrated in Fig. 7. A closing pin *A* is attached to the die-head, and mounted above the turret there is a closing bar *B* having a beveled pin which projects downward. After a thread is cut by the die, the latter is carried around as the turret indexes until the closing bar comes into contact with the pin on the die. The upper view shows the die-head just at the point of closing and the lower view illustrates how the die is turned part of a revolution for closing as the turret indexes.

"Namco" Self-opening Dies

A "Namco" self-opening die of the non-revolving type is shown in Fig. 8, and applied to a Cleveland automatic screw machine in Fig. 9. This is another die of the type that opens when the turret slide reaches the end of its travel. When the forward movement of the slide is discontinued, further rotation of the screw thread draws the die-head forward, thus releasing the chasers from their bearing on the cam ring arms and allowing them to spring open. The die is closed by the lever seen projecting from the side which serves to draw the body back into the hood, thus bringing the chasers into contact with the cam ring arms. Whatever variations in diameter may be required are obtained by a sensitive adjusting screw in the side of the die-head. The hand-lever may be operated automatically by the rotation of the turret, as when the die is used on an automatic screw machine. The closing device shown in Fig. 9, consists of a projecting plate or arm having an inclined edge over which the closing lever slides as the die is indexed past this point. The form and location of this closing attachment varies more or less for different machines.

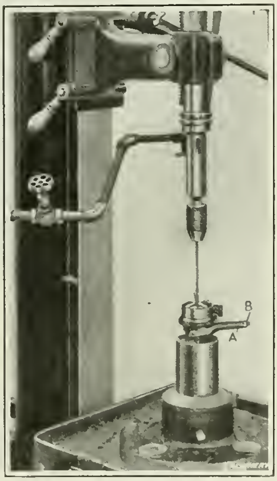

Fig. 17. Thread Cutting on a Drilling Machine with Stationary Self-opening Die

When the die is used on the turret lathe the general method of adjusting the turret slide stop for controlling the operation of the die is as illustrated by the plan view, Fig. 10. After the die is attached to the turret, the first thread is cut to the required length and the machine stopped with the die chasers still engaged with the thread, the chasers being closed. The turret slide stop is next adjusted until the slide moves backward sufficiently to take up the lost motion or longitudinal float at *A* in the die-head, and the die chasers spring open. Another trial screw thread is then cut, and if the length of the thread must be exact a slight further adjustment may be necessary. The method of arresting the feeding movement of the turret varies on different machines.

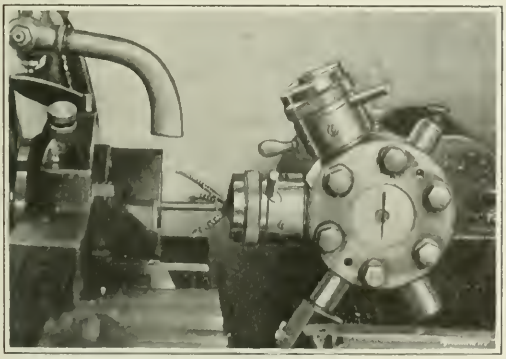

Fig. 15. Two Wells Self-opening Die-heads for taking Roughing and Finishing Cuts on a Brown & Sharpe Automatic Screw Machine

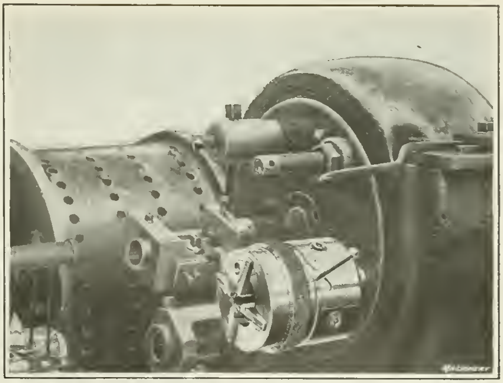

Fig. 16. Wells Self-opening Die-head applied to a Cleveland Automatic

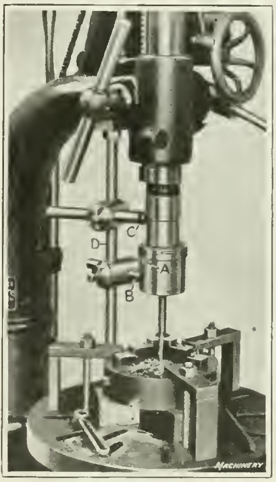

Fig. 18. Drilling Machine equipped with Revolving Type of Self-opening Die

The "Namco" die-heads do not have a cover or plate in front, but are left open; one reason for this construction is to permit a free flow of oil through the die-head to flush or wash out the chips so that the die will be self-cleaning. Some "Namco" die-heads (the No. 11-22 series) are designed especially for cutting very short threads or those of ordinary lengths right up to a shoulder if necessary. The die-head is designed to open the chasers instantaneously at a given point. The top or outer ends of the chasers are not beveled as in the dies previously referred to, but have square shoulders instead, as shown by the sectional view, Fig. 11. The bearing arms *B* of the cam ring rest on the top of these shoulders until the chasers *A* are pulled forward at the end of the cut by the action of the screw thread; the arms of the cam ring then drop down into the lower shoulders, as shown by the view to the right, thus allowing the chasers to fly outward instantly, in order to prevent interference with a shoulder on the work.

The revolving type of "Namco" self-opening dies is designed for use on the Acme automatic multiple-spindle screw machine, on bolt and stud threaders, and other machines in which the work is held stationary while the die is revolved, or, in cases where both the work and die rotate. The opening and closing of the chasers is effected by the longitudinal motion of the hood relative to the body of the die, the same as with the designs previously referred to. The floating style of revolving die-head is designed for threading parts that are not finished from the bar at one setting but are chucked

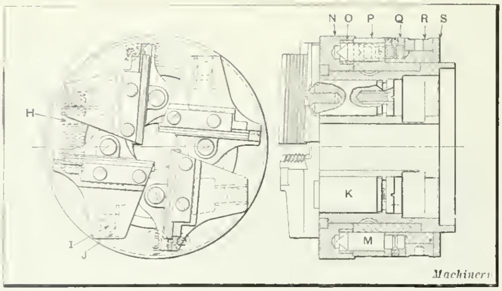

Fig. 19. Landis Rotary Die-head

either by hand or from a magazine for the threading operation. This floating mechanism compensates for any variation in alignment between the work and die-spindle. The "Namco" dies are made by the National Acme Co., Cleveland, Ohio.

Hartness Automatic Die

A Hartness automatic or self-opening die is shown applied to a Gridley automatic in Fig. 12, and in section in Fig. 13. The construction of these dies varies somewhat for different sizes, although they operate on the same general principle. The description applies to the No. 4 size shown in Fig. 13. The die body is held to the shank by screws *A* and the springs around them. An equalizing collar provides the driving connection between the body and the shank and allows the body with its chasers to float and thus center itself relative to the action of the work. The chasers are held in position in radial slots in the body and their movements are controlled by cam ring *B*. By throwing over the locking lever *C* against the pressure of the main springs the cam crank *D* and the cam ring are turned, thus closing the chasers. The cam ring is held in the closed position by the latch pin *E*, which has two engaging surfaces for locking the cam ring. One of these surfaces is regularly used for taking the finishing cut. If the material is hard or the pitch coarse enough to require two cuts, the roughing handle *F* is thrown over, so that another surface on the latch pin is utilized and holds the chasers in position for the roughing cut. After roughing out the screw thread, the chasers are set for the finishing cut by simply throwing handle *F* back to its original position. The latch pin is contained in an eccentric sleeve, which may be turned to vary the position of the cam ring for adjusting the radial location of the chasers and the finished size of the work. The size-adjusting screws *G* are used for making this change. The two cuts (roughing and finishing) are seldom required for threads smaller than one inch in diameter and 12 pitch, but are intended to be used for coarse pitches and on materials that are especially hard and tough. The largest of the Hartness dies (the No. 9) has three separate adjustments so that two roughing cuts and a finishing cut may be taken if necessary, without disturbing the adjustment for the final or finishing size. Fig. 12 illustrates one method of closing the die automatically. A pin projecting from the side of the die engages the inclined plate shown. This self-closing feature varies, of course, on different makes of machines, so far as its exact arrangement is concerned. The automatic opening of the die occurs whenever the feeding movement of the tool-slide discontinues. The die-head travels forward a short distance before opening, after the tool-slide has stopped. These dies are manufactured by the Jones & Lamson Machine Co., Springfield, Vt.

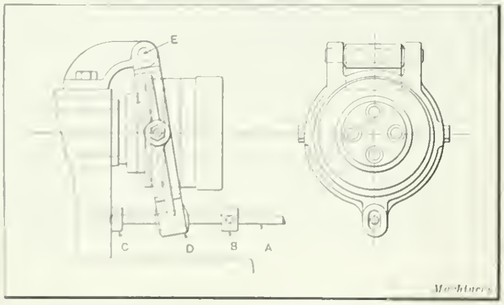

Fig. 20. Mechanism for opening and closing Landis Rotary Die-head

Wells Self-opening Dies

The Wells self-opening die, manufactured by the Greenfield Tap & Die Corporation, Greenfield, Mass., is made in three models. Model B, intended for general use on turret lathes, automatic screw machines, etc., is shown in Fig. 14. This model is a pull-trip design, the chasers opening automatically after the advancing movement of the turret slide is discontinued. The chasers are held in slots in the body of the die, and are supported near the rear end by hinge pins, which serve as fulcrums for the opening and closing action. A spring-actuated plunger bears against the short rear ends of the chasers, forcing the front ends of the chasers outward against an external sleeve or shell. This shell has a beveled surface on the inside which bears against a corresponding bevel on the back of the chasers and furnishes a firm backing or support directly back of the cutting teeth. This outer shell slides in a lengthwise direction on the inner body of the die, permitting the chasers to open as it slides back and closing them as it is pushed forward. In action, as soon as the turret slide stops, the die is automatically tripped by a specially shaped shoulder on the trip screw engaging with the latch. The opening action is as described in the preceding. The die is closed by the handle or pin, which projects from the side, coming in contact with a stop, where it is latched in position ready for the next cut. Slight diameter adjustments for making the thread either larger or smaller than the standard diameter are made by turning a knurled and graduated ring.

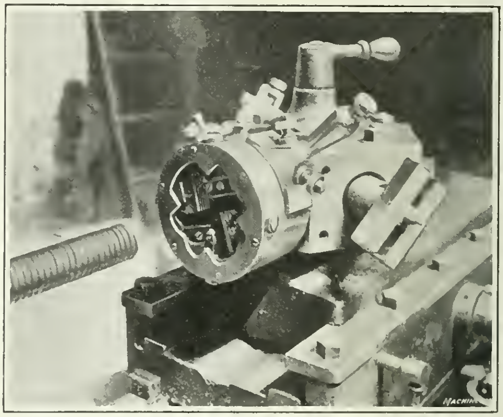

Fig. 21. Landis Automatic Self-opening Die applied to Turret Lathe

Fig. 15 illustrates two Model B dies, applied to a Brown & Sharpe automatic screw machine. This is particularly fine work where a specially finished thread is desired; one of the dies is used to take the roughing cut and the other the finishing cut. These dies are closed automatically by the rotation of the turret, the closing handles on the dies coming into contact with a stationary spring finger or other form of fixed stop. The operation of the same type of die on a Cleve

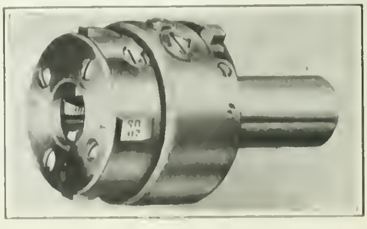

Fig. 22. H & G. Revolving Self-opening Die-head

land automatic is shown in Fig. 16. The die just described has in some measure replaced the Model V, which is shown on a drilling machine in Fig. 17. This is not a typical application, however, as this design is used more generally on hand-operated screw machines or turret lathes. This is the simplest form of any of the three models. It is opened automatically by the engagement of a latch projecting from the face of the die with the work-holding chuck or some form of stop that may be attached to the machine. The hand-lever on the die is intended for operating it when setting up the machine. A twist of the cross-bar at the top of the lever releases the latch, permitting the die to open.

Drilling machines are often used for thread cutting when this is the only operation and it is not convenient to use another type of machine. The revolving or "rim trip" type of Wells self-opening die, Model T, is intended for application on such machines as drill presses, bolt cutters, multiple-spindle screw machines, etc. This die, which is shown applied to a vertical-spindle drilling machine in Fig. 18, is tripped or opened by a ball shaped latch *A*, which projects through an opening in the side of the die shell or body. This model is closed by a yoke pushing the outer shell forward, or it can be closed by a stop bearing upon one side only. As arranged in Fig. 18, stop *B* trips the die when latch *A* has descended far enough to strike it. When the spindle is raised, stop *C*, which carries a roller at its end, engages the upper end of the sliding shell and holds it stationary while the die body is pulled up far enough for the trip latch to drop into place. These stops may be adjusted on the vertical rod *D* for varying the tripping and closing points in accordance with the length of screw thread. This die is adjusted by turning a small screw in the die face, which changes the position of the stop for the tripping latch. The chasers are the same as those in the other models, and their position in the body and opening and closing motion are exactly the same. Models B and V are equipped with or without a floating shank, permitting the die to advance upon the work according to the lead of the chasers and independently of the travel of the turret slide.

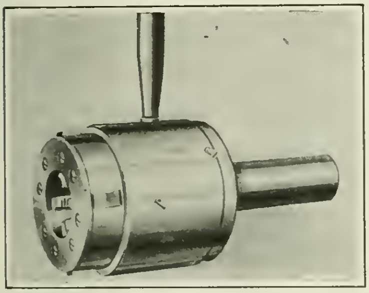

Fig. 23. H. & G. Hand-closing Die-head

Landis Self-opening or Rotary Die-head

The die-head illustrated in Fig. 19 differs from any of those previously referred to partly in that the chasers are set in a tangential position relative to the work instead of in a radial position. This particular design is designated by the manufacturer (Landis Machine Co., Inc., Waynesboro, Pa.) as the "rotary die-head," and has been used extensively on threading machines of the bolt cutter type. The general method of operating the die is indicated by the diagram Fig. 20. Rod *A* is attached to the slide or carriage that holds the work. This rod carries two adjustable collars *B* and *C*, which control the action of the die. The yoke ring *D*, which is pivoted at *E*, transmits motion to the die for opening and closing it. The die is opened when collar *B* engages the yoke ring at the completion of the thread-cutting operation, and it is closed when the carriage is returned to the starting point, thus bringing collar *C* into engagement with the yoke ring. The diametral adjustment of this die is obtained by means of an adjusting worm *H* (see Fig. 19), which is located in adjusting ring *P*. This worm engages the body of the die-head and moves closing ring *N*, adjusting ring *P*, operating ring *Q*, and retaining ring *S* as a unit. Graduations on the rear of the die-head indicate the position or adjustment for different diameters. Any adjustment is retained by means of a lock-nut. Two closing pins *M*, located diametrically opposite each other, are fastened at their rear ends to operating ring *Q*. The cylindrical portions of these pins pass through adjusting ring *P* and enter two hardened bushings *O*, which prevents relative motion of the closing ring with the rest of the die-head, except through the adjusting worm *H*. Closing ring *N* is subjected to pressure exerted by four springs. When yoke ring *R* is moved backward by engagement with the collar previously referred to, it transmits motion to operating ring *Q* and pins *M*. As this movement continues, the conical ends of the closing pins *M* engage beveled surfaces on bushings *O*, and closing ring *N*, because of the spring pressure, turns relative to the die-head body and opens the die. On the front face of closing ring *N* there are four pins *I*. These pins carry the blocks *J*, which impart the rotary motion of the closing ring to the chaser holders. Most of the cutting strain is taken by the large trunnions *K*, to which the chaser holders are securely fastened. As the closing ring rotates, the holders turn with their trunnions and open simultaneously. The conical points of the closing pins *M* are prevented from leaving the hardened bushings *O* by stop-screws in operating ring *Q*. The chasers are backed up at the rear and advanced in the holders by abutting screws, the correct cutting position being determined by means of a small hook gage. These chasers are sharpened by simply grinding the ends. By using right- and left-hand holders the same chasers may be employed for cutting right- and left-hand screw threads. The Landis "automatic" self-opening die, Fig. 21, is intended more especially for application to screw machines, turret lathes, etc., and is arranged to open when the forward motion of the turret is stopped. The continued pull of the work disengages the latch, and coiled springs within the head pull the four tangential chasers out of engagement with the work.

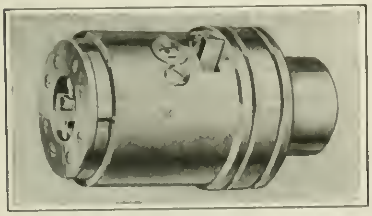

Fig. 24. H. & G. "Ford Special" Die-head

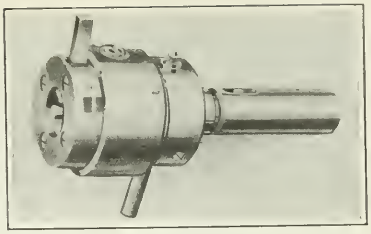

Fig. 25. H. & G. Automatic Self-opening Die-head

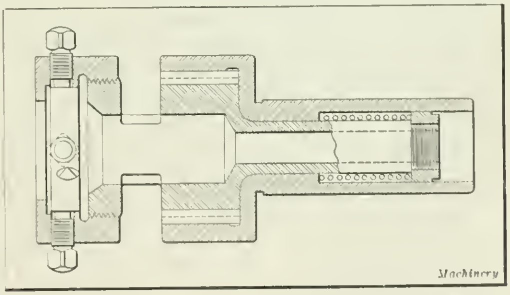

Fig. 26. Brown & Sharpe Die-holder of Non-releasing Type

H. & G. Self-opening Dies

The self-opening dies made by the Eastern Machine Screw Corporation, Truman and Barclay Sts., New Haven, Conn., are shown in Figs. 22 to 25, inclusive. The automatic self-opening die-head shown in Fig. 22 is used on National-Acme and Gridley automatic screw machines and other machines in which the die-head revolves. All the parts of this head are interchangeable, there being as few as possible to obtain the desired result. The simplicity of the design gives durability and makes it improbable that the die-head will get out of order. A quick-release mechanism makes it possible to cut a thread right up to a given point and also up to a shoulder on the work; and the cams are all enclosed, so that chips cannot get in and clog the mechanism or cause the size of the threaded work to be changed. Support for the chasers is provided in such a way that it is impossible for them to be tilted and cut a tapered thread on the work. This die can easily be adjusted to suit the size of work by loosening a screw and moving a dial which is graduated to 0.001 inch. The chasers are removed by releasing a catch, and the head does not have to be taken apart. This die-head is of exceptionally small diameter and length for the size of work that can be threaded, thus making it especially adapted for use on automatic screw machines.

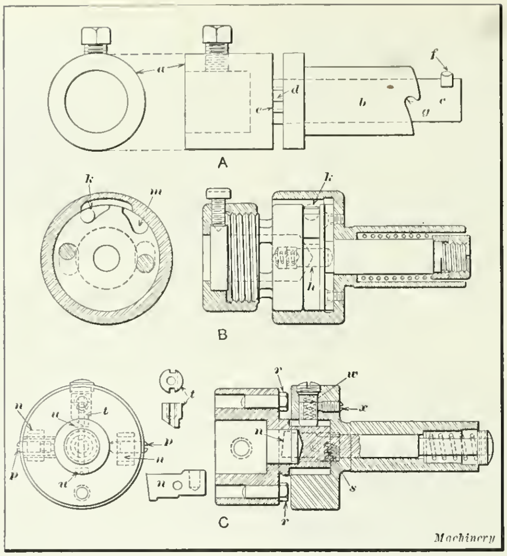

Fig. 27. Three Designs of Releasing Die-holders for holding Non-opening Dies

The automatic self-opening die-head shown in Fig. 25 is especially adapted for use on Brown & Sharpe automatic screw machines and other single-spindle screw machines. The lock is positive, so that a shock or jar of the turret cannot unlock the head. Closing is effected by a rotary cam, and takes place easily while the machine turret is revolving. The trip mechanism is positive and instantaneous in operation, thus allowing a thread to be cut close up to a shoulder or other specified point on the work. The chasers are held firmly, which insures the production of straight threads; and the head is furnished with a floating shank and compensating spring to assist in starting the thread. The chasers are made of high-speed steel and specially hardened.

The "Ford special" die-head shown in Fig. 24 works in a revolving position, and is especially adapted for use on threading machines. It is used on the automatic threading machine built by the E. J. Manville Machine Co., of Waterbury, Conn., and other machines of a similar type. This die-head is furnished with liberal adjustment and has large wearing surfaces to give durability. The hand-closing die-head shown in Fig. 23 is adapted for use on all turret machines. This die-head has a floating shank. The chasers are held in such a manner that the threads are sure to be straight.

Floating Movement for Die-holders

Die-holders for both non-opening and automatic dies may be arranged to hold the die rigidly or to permit either a longitudinal movement or a combined longitudinal and universal "floating" movement. Many of the die-holders used in connection with machine or power-driven threading operations allow the die a limited amount of motion in the direction of its axis, so that it will be free to follow its own lead and will not be retarded by a backward pull of the tool-slide to which it may be attached. For instance, when cutting a thread with a die in a hand-operated turret lathe, the turret slide is moved up until the die has started on the work. If the die-holder has longitudinal motion, the turret can lag behind somewhat without interfering with the forward motion of the die, which simply has to overcome the friction of the driving pins or keys of the die-holder as it screws itself onto the work. Of course, if the turret were not shifted along periodically when cutting a long screw, the lost motion in the holder would soon all be taken up and then the die would have to drag the turret slide. This extra load might seriously impair the finish and accuracy of the screw thread. When the machine is of the automatic type the cam operating the turret slide is generally designed to start the die on the work and then the slide is allowed to travel a little slower than the die that governs its own motion independently. If the cam were laid out to control the motion of the die positively, any variation between the motion of the die and the pitch of the chaser teeth would affect the thread being cut.

Some die-holders are arranged to give the die a free floating movement in a direction perpendicular to the axis, so that if the part to be threaded is not exactly in line with the die the latter can center itself relative to the axis of the work and cut a concentric thread on it. While every holder having the axial motion also has some lateral play, this is very slight in some holders and is a special feature in others. A lateral or universal float is especially desirable for dies used on parts that are chucked either by hand or from a magazine attachment for the threading operation. This floating motion is found on holders for both non-opening and self-opening dies.

The amount of longitudinal movement or float that a die-holder should have may depend upon the type of machine on

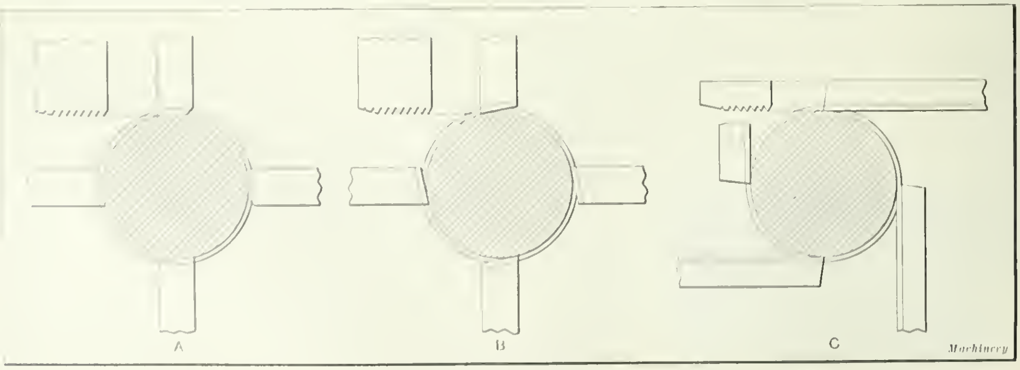

Fig. 28. (A) Hobbed Die Chasers. (B) Straight Milled Die Chasers. (C) Milled Chasers of Tangential Type

which it is used. If the die is used on a hand-operated screw machine or turret lathe, or a single-spindle automatic screw machine, the floating movement may not be over ¼ or ½ inch, the amount varying somewhat according to the size of the die-head. If the die is applied to a multiple-spindle automatic screw machine, considerably more floating movement may be necessary; in fact, the die, in some cases, may be attached to a telescoping sleeve arranged to give it a lengthwise movement of several inches, so that the die is enabled to move considerably in advance of other tools in the turret that may not have to move in so far from the end of the work.

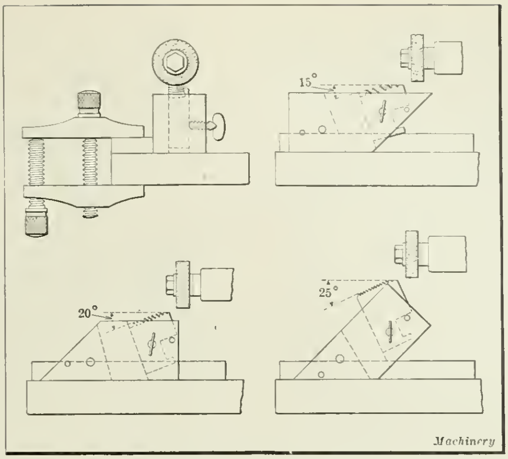

Fig. 29. Throat Angles for Chasers and Fixture for grinding

Releasing and Non-releasing Die-holders

The die-holders used for solid or non-opening dies may be of the rigid type, the floating non-releasing type, or the releasing type. For turret lathe and automatic screw machine work, the non-releasing type, which is free to move in a lengthwise direction a limited amount, is used extensively, although the releasing design is preferable under certain conditions. With this type the die is released or is not held against rotation after the thread has been cut to the required length. When the forward motion of the turret slide discontinues, the rotation of the screw thread draws one section of the die-holder farther forward until the driving connection between the two sections disengages; the die then continues to revolve with the work as long as the latter continues to run forward. When the spindle is reversed the die starts to rotate backward with it, but this reverse movement is stopped automatically by the die-holder, and the stationary die is then backed off the screw as the spindle continues its reverse rotation.

The releasing type of die-holder (which is intended only for non-opening dies) is used when it is necessary to govern closely the length of the thread, as, for example, when cutting a thread close to a shoulder. If the reversal of the machine is controlled by the operator, as in a hand screw machine, a releasing die-holder should be used, because, if the machine is not reversed at the instant a die of the non-opening type reaches the limit of its forward travel, the thread may be stripped or the die broken when attempting to cut close to a shoulder. When the releasing type of holder is applied to the threading spindle of a multiple-spindle automatic screw machine, if the the threading operation is completed before the other operations, the releasing device permits the die to revolve loosely until all the operations are completed.

The non-releasing type of die-holder is used for most of the thread cutting done on Brown & Sharpe automatic screw machines with non-opening dies. One design is shown in Fig. 26. The arrangement is such that the part to which the die is attached can move in a lengthwise direction relative to the shank. The releasing type is sometimes used to avoid having a narrow or pointed lobe on the cam controlling the thread-cutting operation. In some cases a cam that is laid out for the non-releasing type of holder has a thin, sharp threading lobe, but by substituting the releasing type a certain amount of dwell is obtained, so that the top of the cam lobe can be made wider.

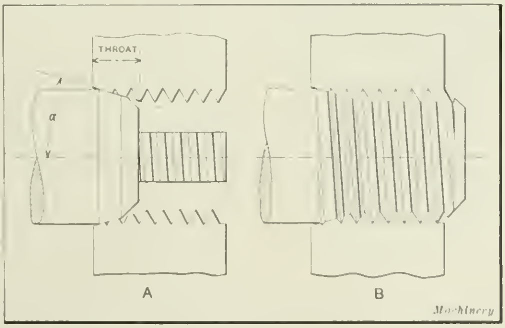

Fig. 30. Diagrams Illustrating how Throat of Die serves to start Thread-cutting Operation gradually by distributing Work between Several Chaser Teeth

Different Designs of Releasing Die-holders

A simple form of releasing holder is shown at *A*, in Fig. 27. The holder *a* has a shank *c* which passes through the sleeve *b*. This sleeve is held in the turret. When the die is cutting, the holder *a* is prevented from rotating with the work by the engagement of lugs *d* and *e*. When these lugs separate at the end of the cut, the die revolves with the work until the rotation is reversed; then pin *f*, as it revolves with shank *c*, engages notch *g* as the turret slide is returned, and stops further rotation of the die, which is backed off the threaded section.

The holder illustrated at *B* operates on the same general principle as the one just described, although the construction is quite different. The driving connection between the two main sections of the holder is through the pins *h*. When the turret slide stops and the die-holder is drawn forward, these pins *h* are disengaged, thus releasing the die. As soon as the work-spindle reverses, a ball *k* slides out of the deep part of the pocket in which it normally rests, thus locking the two main sections together while the die is being removed. The ball is inserted in pocket *m* when the die-holder is used for cutting left-hand threads.

The releasing die-holder shown at *C* is known by the manufacturer (the Cleveland Automatic Machine Co.) as the "silent" type, because the driving members are so arranged that they will not strike against each other after being disengaged. The main part of the die-holder, which is held in the turret, carries two bevel-ended driving lugs *n*, which are mounted upon pins *p*, so that they are free to swivel. These driving lugs engage pins *r* in the die-holder proper; when the latter is drawn forward at the end of the cut or after the turret slide stops moving, lugs *n*, acted upon by springs *s*, swivel until the beveled ends are practically in a plane at right angles to the axis of the holder. This swiveling movement provides clearance between lugs *n* and pins *r* so that the parts cannot strike against each other while the die is revolving with the work. When the spindle reverses, the beveled plunger *t* drops into slot *u* and holds the die stationary. This plunger is backed up by spring *w*. To change this die-holder for cutting left-hand threads, the driving lugs *n* are turned over, thus reversing the position of the straight driving side. The plunger *t*, which is held in position by the end of screw *x*, is also reversed.

Chasers for Threading Dies—Forms of Teeth

The chasers used in screw-cutting dies vary in regard to the form of the teeth, the angles of the cutting faces or edges and the position relative to the axis of the die. The cutting qualities of a die and the accuracy of the screw threads produced by it may be affected greatly by the form of the teeth or the location of the cutting faces or edges of the chasers relative to the axis of the work.

There are three methods of forming the teeth of die chasers. One is with a hob having helical-shaped cutting teeth. A second method is by using a milling cutter which has teeth perpendicular to the axis and is set to the helix angle of the screw thread when milling the teeth of a chaser. The cutter is fed across the chaser blank and forms a series of straight teeth corresponding in cross-section to the shape of the thread to be cut. The third method is by the use of a milling cutter like the one just referred to, with teeth which are at right angles to the axis (not helical), but which, after being set to the proper helix angle, is sunk into the ends of the chaser blank and forms teeth that are circular in a lengthwise direction instead of being straight.

The hobbed chasers represented by diagram *A*, Fig. 28, are formed by a tool which is similar to a tap, except that there are usually a greater number of flutes and cutting edges. The teeth are helical, corresponding to the threads of a screw, instead of being annular or at right angles to the axis. The chaser teeth formed by a hob are like sections on the thread of a nut, except that they are given a slight amount of relief or clearance back of the cutting edges. The clearance may be obtained by using a hob of the same size as the die and setting the chasers (which are held in a special fixture) a little off center while hobbing, or a hob that is somewhat smaller than the nominal size of die may be used to obtain clearance, especially when recutting the die chasers while they are held in the die-head. The "heel" or rear corner of each chaser is removed after hobbing by beveling it in as far as the center line to provide clearance. *B* shows milled chasers the teeth of which are straight, in a lengthwise direction, instead of curved. These teeth are formed by a cutter, having teeth which are perpendicular to the axis, instead of being helical, and when milling the teeth the cutter is fed straight across the end of the chaser.

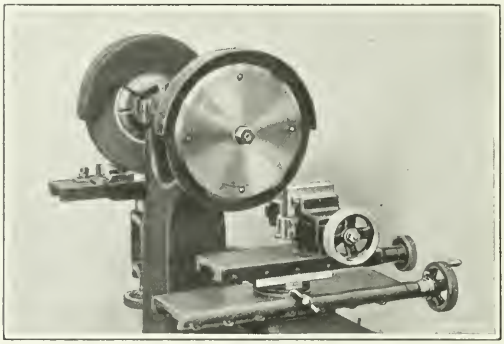

Fig. 33. Geometric Chaser Grinder set up for grinding Throat of Hobbed or Tap-formed Chaser

The chasers in the Hartness automatic dies are milled, but the teeth are circular, in a lengthwise direction, instead of being straight. According to the manufacturer, these chaser teeth are so formed that the front teeth form a cutting tool while the rear teeth form a lead-screw or act like the section of a nut on the threads formed by the leading side of the die. The milling cutter has teeth which are perpendicular to the axis and it is 2½ inches in diameter for all chasers, regardless of the pitch of the teeth or the diameter of the die in which they are to be used. The bearing of the chaser teeth on the finished thread is obtained by setting the cutter in such a position relative to the cutting edge of the chaser, when milling the teeth, that the full depth of the cut extends to the cutting edge only at the throat of the chaser. The reason given for avoiding contact with the work only at the cutting edges of the chaser teeth is that, when the chaser is made in this way, pressure in the direction of the axis of the screw causes the cutting edges to dig into the threads already cut, thus thinning them and changing the pitch of the thread. In order to prevent any such action, the rear chaser teeth on the Hartness dies are made to serve practically the same purpose as a nut, in order to steady the die and cause it to move forward at a uniform rate and in accordance with the lead of the thread being cut. It is also claimed that this feature has an important effect in producing clean, finely finished threads, as the chasers have a slight burnishing effect and impart a close grained surface to the thread.

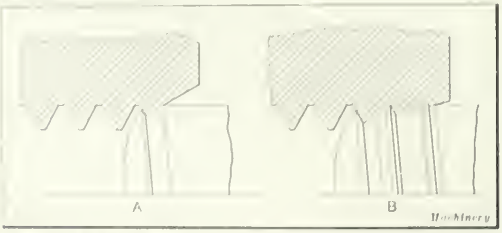

Fig. 31. (A) Throat that extends considerably beyond Roots of Chaser Teeth so that it is not Effective. (B) Throat that is Effective

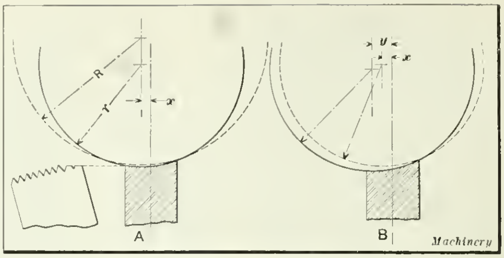

Fig. 32. Relative Relief obtained by varying Diameter of Grinding Wheel and Distance Wheel is offset from Center Line of Chaser

Still another form of milled chaser is illustrated at *C*. These chasers are the form used on the Landis die-head previously described) are set tangentially to the work. The milled teeth extend throughout the length of the chasers and they are in the form of straight parallel ridges corresponding in cross-section to the shape of the screw threads they are intended to cut. These chasers are sharpened by grinding on the ends, and as they become shorter as the result of repeated grinding, they are simply adjusted to the correct cutting position. The throat of the chaser and the front teeth shape the thread, while the rear teeth extend across the center line and take a bearing on the work just back of the cutting end of the tool. This is to make the four chasers act as a lead nut for controlling the forward movement of the die in accordance with the lead of the thread being cut.

Angle of Chaser Throat or Chamfer

The leading side or corner of each chaser in a die-head is usually beveled as shown in Figs. 28 and 30. This beveled edge is known as the "throat" of the chaser and serves to begin the cut gradually when the die is first starting a thread and also when it advances. At *A*, Fig. 30, is shown a chaser at the point of starting a cut, and *B* represents the position of the chaser after it has advanced far enough to begin forming a "full" or complete thread. The throat of the chaser not only inclines relative to the axis of the die (or screw being cut), but it is given clearance back of the cutting edge in a circumferential direction. In some cases the throat angle *a* must be abrupt in order to cut a full thread close to a shoulder. Aside from a requirement of this kind, the throat should preferably be ground so that the work of cutting a thread to the full depth is distributed over at least two or three teeth on the leading side of the die. It is common practice to grind the throat at such an angle that the beveled part extends from the root or base of the leading or most advanced tooth in the set of chasers back to the third tooth, which may be slightly beveled. The throats of some dies extend back over four, five or more teeth, although the shorter chamfer is more common. Each chaser should, of course, be ground to the same angle and so that each throat will be the same distance from the axis of the die when in the die-head.

The throat angles of chasers for the Hartness dies depend upon the pitch of the thread. The angles for different pitches

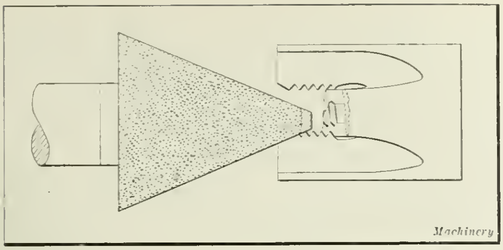

Fig. 34. Method of grinding Throat of Spring Die

are shown in Fig. 29, which also shows the type of fixture used for holding the chasers while grinding them. This fixture may be applied to different types of grinding machines by clamping a guiding strip to the grinder table, as indicated by the illustration. A throat angle of 15 degrees relative to the axis of the die is recommended for chasers intended for cutting threads varying from 4 to 5½ per inch. The angle of 20 degrees is intended for pitches varying from 6 to 8 per inch; and 25 degrees for pitches of 9 or more per inch. The object of decreasing the throat angle for the coarser pitches is to increase the length of the throat somewhat and distribute the work of cutting over more of the chaser teeth.

Die-chaser Throat that is Ineffective

A method of chamfering dies or die chasers that sometimes causes trouble is illustrated at *A*, Fig. 31. The die chaser may appear to have considerable chamfer, but when the relation between the throat of the die and the work is considered, it will be seen that there is little effective chamfer or throat. This is due to the fact that the beveled edge extends beyond or outside of the root or bottoms of the chaser teeth, where it cannot be effective when a screw thread is being cut; consequently the entire work of cutting the thread groove is imposed upon the leading tooth of each chaser. The chamfer, or throat, to be effective should begin near the root of the leading tooth (as indicated at *B*), so that it assists in the work of cutting the thread groove. If the die is held in a floating holder and the work is likely to be considerably out of line, the edges can be beveled beyond the root of the teeth somewhat, but this extra chamfer should not be considered as a part of the throat.

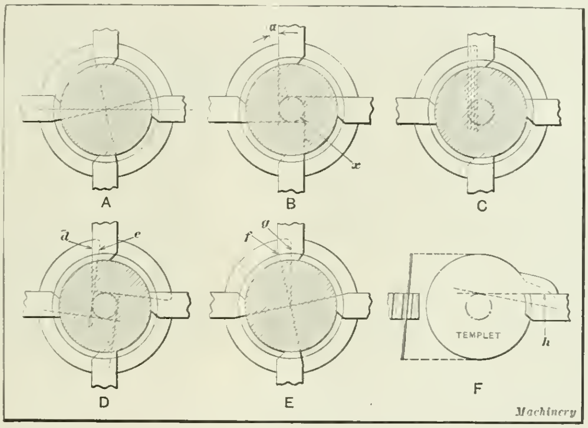

Fig. 35. Rake Angles or Relation between Front Face of Chaser and Axis of Work

Effect of Clearance or Relief of Chaser Throat on Action of Die

The relief or clearance at the throat of a chaser should be just enough to insure free cutting, and is subject to variation according to the diameter of the die or the screw that is cut by it and often by the conditions under which the die is used. It is essential to have the correct amount of relief back of the throat, because insufficient relief may prevent cutting action altogether or retard the action of the die, and prevents it from advancing at the proper rate. If a die has excessive relief, the chaser teeth are weakened and the die tends to move forward too rapidly when controlling its own lead, especially when cutting soft material like brass. The result is that threads are left rough and may be almost entirely cut away in extreme cases. If the rear or turret side of the thread is rough, this indicates that the die is leading or advancing too fast; and if the opposite or front side is rough, this shows that the die is not advancing fast enough. The leading of the die or the rate of its advance may be varied by changing the amount of relief or clearance in the throat of the die chaser. The greater the relief, the faster the die will lead, and *vice versa*. Relief, however, is not the only thing that may affect the leading qualities of a die. This point will be considered more fully later.

Grinding Throat of Die Chaser

The throat of a die chaser should be ground both with reference to its inclination relative to the axis of the die and also the amount of relief or clearance for the cutting edge. If the chasers to be ground have hobbed teeth or milled teeth which are circular in a lengthwise direction, it is common practice to use a wheel which is from 1/16 to ¼ inch larger in diameter than the nominal size of the die or the size of the screw the die is intended to cut. Ordinarily, a wheel about ⅛ inch larger than the die size is employed. The center of the wheel is offset relative to the center line of the chaser when grinding, in order to obtain clearance for the cutting edge of the throat. The exact method of grinding depends upon the type of machine used. In some cases, the chaser is held in a fixture which can be tilted to the throat angle and is graduated to indicate both the angular position and the amount that the chaser is offset relative to the wheel. The fixture shown in Fig. 29 is in the form of a block arranged to hold a chaser at the three angles recommended, by changing the position of the chaser and block.

The amount of clearance back of the cutting edge should be as small as possible without preventing a free cutting action. While it is common to use a wheel that is about ⅛ inch larger than the nominal size of the die, the use of a larger or smaller diameter wheel has less effect on the amount of clearance than the distance that the wheel is offset. For instance, if the wheel has a radius r (see diagram *A* Fig. 32) and this wheel is offset an amount x, a certain clearance will be obtained. Now if the size of this wheel were increased to some radius R, this would not affect the clearance to any great extent, assuming that the amount of offset x remained the same. On the other hand, if a wheel having a radius r is offset first a distance x and then some greater distance y, as shown by diagram *B*, this will increase the amount of clearance decidedly.

As a general rule, most of the grinding should be done on the throats of chasers, the faces being ground as little as possible. Repeated grinding on the throat extends the latter back farther from the leading side of the chaser (assuming that the same throat angle is maintained as it should be); if, as the result of repeated grinding, the die finally will not cut a full thread close enough to the shoulder, this can sometimes

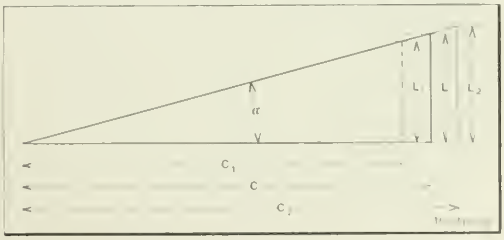

Fig. 36. Diagram showing how Lead of Thread may be varied by adjusting Die Chasers too much above or below Diameter for which Die is intended

be remedied by grinding away the front edges of the chasers, so that they will clear the shoulder.

The method of grinding the throat of a hobbed chaser with a "Geometric" chaser grinder is illustrated in Fig. 33. A large grinding wheel is used in this case and the chaser is swiveled about the wheel to give the clearance surface or throat a curved form. If the chaser for a one-inch die is to be ground, the scale on the pivot of the vise is set to the radius of the die or one-half inch minus the depth of one tooth or thread. The die is located by a stop on the vise and the jaws of the latter are adjusted to the right or left of the center (depending upon whether the chaser is for right- or left-hand threads) just enough to give the proper clearance. After releasing the swiveling base of the vise-slide by unscrewing the small handle shown, the chaser is ground by swinging it to and fro about the wheel, at the same time slowly feeding it in toward the wheel by turning the handwheel of the slide feed-screw of the vise. After grinding one chaser a stop ring is set to control the inward feeding movement so that the remaining chasers of the set are ground alike, or to correspond with the first one. When using the same machine to grind the throat of milled chasers having straight teeth, the die is traversed back and forth across the face of the grinding wheel; as the chaser is being traversed it is also fed forward by the handwheel of the feed-screw.

Fig. 34 illustrates a method of grinding the throat of a spring die. A cone-shaped wheel of suitable diameter is used, the axis of the wheel being offset slightly with reference to the axis of the die to give the throat or chamfered part a slight relief. Spring dies are not ordinarily ground in the throat, but are sharpened by grinding the radial cutting faces with an ordinary dish-shaped or saucer wheel, as explained later. If dies have been forced to cut when dull, they may be injured to such an extent that some grinding in the throat as well as along the cutting faces is necessary in order to obtain a sharp cutting edge. If the throat is ground away considerably, it may be necessary to grind back the ends of the lands or prongs, especially if there is a shoulder on the work which would strike these prongs before the thread has been cut the required length.

It is of especial importance to have as little clearance as possible on the chasers used for brass work because the throats of the chasers steady the die when starting to cut a thread. When it is desired to cut a thread close up to a shoulder in brass, the chaser teeth are sometimes relieved on the sides instead of chamfering the teeth. This relieving may be done by means of a brass lap, the working edge of which is formed to an angle of about 50 degrees for a 60-degree tooth, so that the lapping may be confined to one side of a tooth. This beveled or working edge of the lap is charged with a suitable abrasive and the side clearance is given to two or three of the leading teeth. When chasers are set tangent to the work as shown at *C*, in Fig. 28, the throat like the teeth has a natural clearance due to its tangential position.

Rake Angles or Relation between Chaser Cutting Face and Axis of Work

The relation between the front cutting faces of die chasers and the axis of the screw thread that they are used to cut varies for different materials. As a general rule, the front face of each chaser in a set lies in a plane intersecting the axis of the die or screw thread (as shown at *A*, Fig. 35) when the die is to be used for cutting threads on cast brass. For yellow brass, machine steel or tool steel, the chasers are usually given rake by locating the cutting faces in planes that are in advance of the center on the cutting side, as shown at *B*. There is considerable difference of opinion among manufacturers and users of dies as to the amount of rake that will give the best results. As a general rule the tenacious or tougher materials which have the quality of flexibility without brittleness, like wrought iron, steel, copper, and pure aluminum require positive rake. If there is not enough rake, more power is required for revolving the die or work and the chasers tend to tear the metal. Materials having a granular structure like cast brass and cast iron should ordinarily be cut with chasers having little or no rake. An excessive amount of rake would cause the chasers to ride and dig in alternately. Some grades of cast iron may be threaded satisfactorily with dies intended for steel. Most aluminum castings, because of the zinc in their composition, cut very much like brass and should preferably be threaded with chasers with little or no rake.

Many dies used for cutting threads in machine steel have the front faces located a distance ahead of the center equal to about one-fifth the radius of the die. In other words, the plane of the front face is tangent to a circle x, see *B*, Fig. 35, having a radius equal to one-fifth the radius of the die or a screw cut by the die. The angle a corresponding to the rake of the die chaser, is about 12 degrees when the front face is one-fifth the radius off center. This rake corresponds approximately to the angle of rake or slope that would be given to a lathe turning tool for use on machine steel, although the rake is, of course, subject to more or less variation. For threading copper and tobin bronze, dies having a rake of about 14 degrees have given satisfactory results. Die chasers are sometimes given negative rake when the die is to be used on very soft "greasy" brass, the face of the die being slightly back of the center instead of in advance.

Some of the die chasers for the Wells self-opening die are ground to a slight angle along the front face above the throat instead of leaving this face parallel to the axis of the die or the screw which the die is to cut. It is claimed that a die equipped with such chasers tends to throw the chips ahead and avoid clogging. This method of grinding the die chasers is the same in principle as that employed on the "gun taps" made by the Greenfield Tap & Die Corporation.

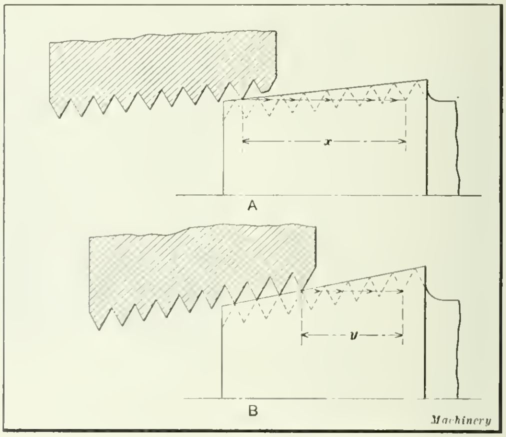

Fig. 37. Views illustrating how Longitudinal Movement of Solid Die for Taper Threading is reduced as Taper increases

Maintaining Rake Angle of Chaser when Grinding

The front faces of chasers should always be ground so that they are in the same position relative to the axis of the die assuming that the die has been cutting properly and a change is not desired. Chasers located with the front faces in advance of the centers (as illustrated at *C*) are sometimes ground back so that the faces are always parallel to the side of the chaser (as indicated by the dotted lines) which reduces the angle of rake and impairs the cutting action of the die. In order to maintain this angle, it is necessary to incline the faces of the chasers as they are ground back so that they will remain tangent to a circle at the center representing the amount of offset as indicated by diagram *D*. When a chaser has been ground back considerably it appears to have more rake, which may account for the difference of opinion in regard to rake angles. A chaser which is radial may also appear to have "positive" rake after repeated grinding, even though the cutting face is still in a radial position. For instance, when the chaser face is at f (see diagram *E*) the cutting action will be practically the same as when the chaser is ground back to some point *g*, since the cutting faces are radial in each case. If the position of the cutting face, however, relative to the axis of the work were not considered, one might naturally suppose that a chaser ground as at *f* would have negative rake, whereas with the cutting face at *g* there would be positive rake.

A simple form of templet and the method of using it to test the front cutting face of a chaser is illustrated at *F*. This templet is made of thin sheet steel and it has the same radius as the die or the outside radius of the screw the die is to cut. The gaging edge *h* is given the same location relative to the axis of the templet that the cutting faces of the chasers are to have relative to the axis of the die. The gage is used by simply placing it between two chaser teeth and turning it around until the testing edge *h* is in contact with the chaser face that should coincide with it. If a die is to work satisfactorily, each cutting face must be in the same position relative to the center or axis of the die. Dies are frequently used which have one cutting edge in a radial position and the others somewhat in advance of the center or back of it. A die ground in this way will not do good work especially when cutting threads in steel. In order to maintain a uniform rake angle all chasers should be ground so that the faces of chasers that are diametrically opposite are parallel, assuming that the die has an even number of chasers. The rake of a chaser of the tangential type (see diagram *C*, Fig. 28) may, of course, be varied according to the requirements by simply grinding the end of the chaser to the angle desired.

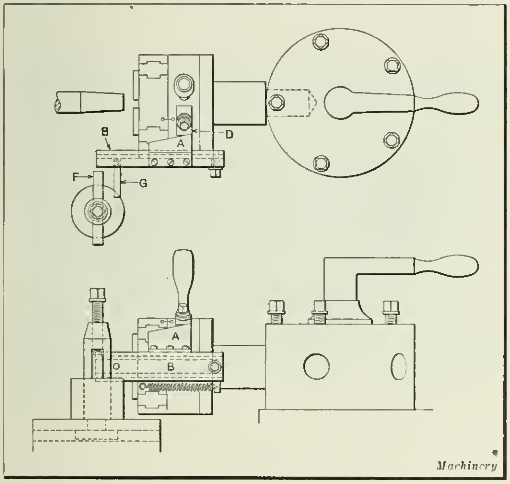

Fig. 38. Geometric Self-opening Taper-threading Die-head of Outside Trip Type

Causes of Lead Errors in Die-cut Screw Threads

The accuracy of a die-cut thread depends primarily upon the cutting edges of the die or form of the chaser teeth and the rate at which the die advances for each revolution. Most dies are self-propelling or self-leading and move along as the screw is cut, except when the die is held stationary and the work is revolved, in which case the action is reversed but is similar so far as the practical result is concerned. As is well known, this motion of the die relative to the screw or *vice versa*, is due to the fact that the cutting teeth lie in a helical path; consequently, as one tooth cuts a thread groove the next successive tooth follows in the same groove and even though it may cut the groove deeper, it serves in part, to steady the die like the section of a nut and force it to advance at a rate equal approximately at least to the lead of the helical path in which the die teeth lie. If a die has too long a throat or one extending back over quite a number of teeth it may act somewhat like a reamer when starting and merely cut away the end of the screw blank instead of forming a thread. This reaming or turning action is due to the fact that each tooth along the throat cuts such a shallow groove that the following teeth do not have sufficient bearing surface in the groove to guide the die and force it to advance along a helical path; the result is that the die either does not advance along the screw thread or moves so slowly that the teeth at the throat merely cut off the end of the screw blank.

It is evident that under certain conditions a self-leading die may not advance at the proper rate and cut a thread of correct or uniform lead. There are several reasons why lead errors occur in die-cut screw threads. To begin with, the die or die-chaser teeth may have been cut with a hob or milling cutter of incorrect lead. The pitch of the die teeth may also have been changed as a result of shrinkage in hardening. Even though the die teeth are accurate as to pitch, the lead of the thead may not be correct, which indicates that the die does not advance a distance per revolution of the work or die, as the case may be, corresponding to the lead of its own teeth. The result is that the full sized thread that would otherwise be formed is cut away partially, thus producing a thread that is incorrect as to shape and lead.

The advance movement of a die may be affected by the amount of relief or rake at the throat of the die. If the die is ground so that it has plenty of clearance at the throat, the edges tend to feed in faster, especially when the front face has considerable rake in addition to the relief; consequently, the die tends to move forward farther for each revolution of the work than the lead of its teeth or the screw being cut. On the contrary, if there is insufficient relief the forward movement is retarded. The action may also be affected by dull cutting edges at the throat or by the length of the throat or chamfer.

The advance of a self-leading die of the adjustable class is sometimes affected by adjusting it too much in one direction or the other from the standard size for which the chasers were hobbed. There are certain limits above or below the standard or nominal size within which it is practicable to adjust threading dies without affecting the lead to any appreciable extent. If the diameter for which the die is adjusted is too large, the lead of the thread will be increased; whereas, if the die is adjusted too much under size the lead will be reduced. The changes in lead are due to the angle of the helical threads being the same for the different diameters. This point is illustrated by the diagram Fig. 36, in which *L* represents the lead of the threading die; *C*, a circumference corresponding to the standard diameter for which the die is intended; C_1 a smaller circumference; and C_2 a larger circumference. Angle a represents the standard helix angle or the angle of a path which coincides with the die teeth. If a thread is cut to this angle a on a circumference C_1 that is considerably less than circumference *C* corresponding to the standard size of the die, the lead will be reduced from *L* to L_1 and if the same thread is cut on a larger circumference C_2, the lead will be increased as indicated by dimension L_2. This is just what happens when the die is adjusted for a larger or smaller diameter than the standard. (It is assumed that the adjustment is not so great as to cause the "heels" of the chasers to drag excessively and prevent cutting action because of the lack of clearance.) The teeth of the die naturally tend to cut a thread having the same helix angle as that represented by the helical path in which the chaser teeth lie. If the diameter of the screw blank is larger than the standard, the die advances farther than it should per revolution; the result is that the lead is increased and, consequently, in the case of a U. S. standard thread, the width of the flat is reduced at the top of the thread and increased at the bottom, for successive chaser teeth cut away the left-hand side of the thread groove as the die moves to the left. The thread form undergoes a similar change if the die is applied to a diameter smaller than the standard, but in such a case the rate of advance per revolution is less than it should be and the successive chaser teeth cut away the thread on the right-hand side of the thread groove as the die moves to the left. The fact that the lead is long in the first case mentioned causes each successive chaser tooth back of the die throat to cut along the left-hand side of the thread groove as mentioned. When the lead is less than it should be, the chaser teeth remove metal from the opposite side of the thread

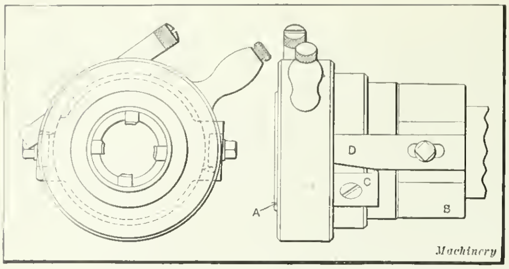

Fig. 39. Hartness Die-head for cutting Tapered Screw Threads

section. If the chasers in either case were long enough or had enough teeth following the throat, the successive action of these teeth on the side of the thread would remove the thread entirely.

Lead variations in die-cut screw threads are sometimes due to a drag on the die or excessive resistance to its motion, such as may result if the die is attached to a heavy turret slide which does not follow up the die properly. The common method of avoiding drag such as would occur if the die were forced to pull a heavy turret slide along with it is by using a die-holder of the type previously referred to, which has a certain amount of lost motion or float so that the turret slide may lag behind and the die will continue to advance independently of it, provided the lost motion in the holder is not completely taken up. When the die must pull a slide along with it the gibs of the slide should be loosened somewhat to reduce the friction as much as possible. An excessive backward pull on the die naturally causes the teeth to generate a helical path, the lead of which is somewhat less than the lead of the die, because the cutting edges on the rear sides of the teeth are forced against the side of the thread groove and gradually reduce the rate of advance by cutting on that side.

When a die or other type of thread-cutting tool produces a screw thread which seems to be inaccurate, the discovery is often made that the defect is in the thread gage rather than in the tool itself. The manufacturers of thread-cutting equipment frequently find that accurate screws and well constructed tools are condemned because of inaccurate thread gages.

Positive Control of Die-feeding Movement

While most dies are "self-leading," it is sometimes advisable to control positively the longitudinal motion of the die relative to the work. This control may be utilized merely to start the die, or the arrangement may be such that the longitudinal motion of the die is controlled positively throughout the entire screw-cutting operation. This positive action may be derived from a lead-screw or from a cam, depending upon the type of machine. When a lead-screw is applied to a threading machine of the bolt-cutter type, it is geared to the die-spindle so that the work-slide is advanced a distance equal to the lead of the thread for each revolution of the work, the same as when cutting a thread in a lathe with a single-point tool. When cutting threads such as the U. S. standard, V-threads, or the Whitworth thread, a good die will follow the lead accurately enough for all ordinary commercial requirements. When cutting square threads, however, or special forms such as the rachet thread, a lead-screw should be used to control the longitudinal motion of the work relative to the die, especially if the pitch is coarse. For screw-cutting operations of this kind, if the die follows its own lead the accumulated error is often considerable; that is, the lead error between two threads might be small, but the total error in the length of the screw, or a section of it, might be considerable. By using a lead-screw, the die is prevented from increasing or decreasing the lead, but to secure satisfactory results it is, of course, essential that the pitch of the die teeth correspond to the leading movement obtained from the lead-screw. It is important to eliminate lost motion in the drive to the lead-screw as far as possible, and the screw should be large and strong enough to resist the torsional strains without excessive distortion. If more than one cut is required, as when cutting a screw of coarse pitch, an indicator or thread-chasing dial of the type used on engine lathes for catching the thread is convenient on a die threading machine having a lead-screw.

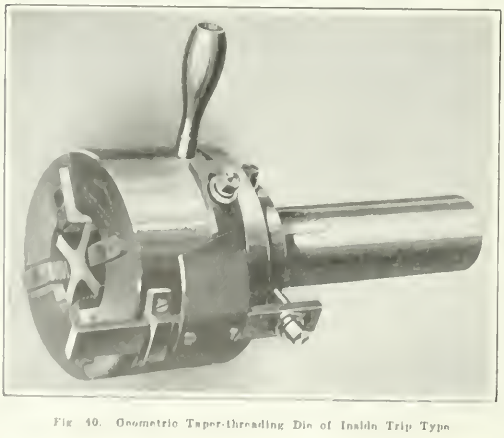

Fig. 40. Geometric Taper-threading Die of Inside Trip Type

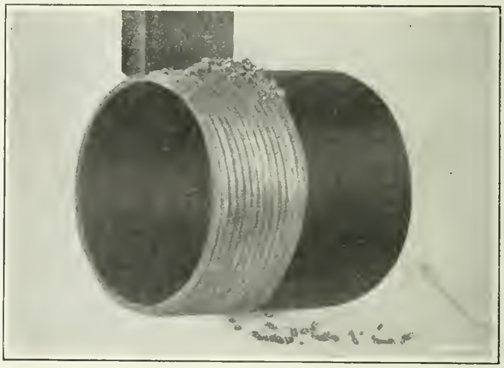

Fig. 41. Rough, Poorly formed Pipe Thread cut with Die having Insufficient Rake

The general method of cutting threads on the automatic screw machine is to use a cam that starts a die onto the work and then allows the turret slide to lag behind somewhat so that the die can lead itself on. As previously explained, lost motion in the die-holder allows the die to follow its own lead or move independently of the turret slide.

Maximum Pitch of Thread Cut with Dies

The maximum pitch of thread that can be cut satisfactorily with a threading die may, of course, be subject to considerable variation. It may depend upon several factors, such as the design of the die in regard to rigidity, the accuracy required in the screw thread, the degree of finish or smoothness, the relation between the pitch of the thread and the diameter of the screw, and the condition of the chasers, especially as to sharpness. As a general rule, when the pitch is coarser than four or five threads per inch, the difficulty of cutting threads with dies increases rapidly although some dies are used successfully on screw threads having two or three threads per inch or less in extreme cases. Some die manufacturers would regard these pitches as too coarse for dies, whereas others have proved in actual practice that dies may be constructed which are capable of handling such heavy thread-cutting operations, if other conditions are favorable to the use of dies. Of course, dies of special design could be constructed for practically any pitch if the size of the die, its cost and the power for driving it were regarded as secondary, and the screw blank were strong enough to resist the cutting strains.

When considering the use of a die on a thread of coarse pitch, it is important to bear in mind the relation between the pitch of the thread and its diameter. If the screw diameter is relatively small in proportion to the pitch, there may be considerable distortion of the screw due to the torsional strains set up when cutting the thread with a die. For this reason, dies for coarse pitches work better when cutting threads on screws which are large enough in diameter to resist the torsional or twisting strains. As a general rule if the number of threads per inch is only one or two less than the standard number for a given diameter, the screw blank will be strong enough to permit cutting the thread with a die without excessive distortion. When a coarse thread is cut by the milling process, the cutting is done, of course, much more gradually and there is not the same difficulty due to a twisting action that is encountered when using a die of coarse pitch on comparatively small diameters.

Cutting Taper Threads with Dies

Taper threads may be cut by using dies with chasers which taper to correspond to the taper on the work and are arranged to move outward radially as the die traverses toward the large end of the taper; by using dies of the solid or non-opening class which have the same taper as that required on the work, assuming that the length of the threaded part does not exceed the length of the cutting edges on the die or the width of the chasers; by using dies intended for parallel threads and arranged to open radially for producing a taper thread. The first type of die referred to, which has tapering chasers that move outward in accordance with the taper, is preferable for the most accurate work. The solid or non-opening die which simply tapers to correspond to the taper screw thread to be cut, is not only limited to comparatively short screw threads but does not produce a very satisfactory thread because ridges are left wherever each cutting edge stops cutting. The use of a solid tapering die also subjects the work to considerable torsional strain (which might be objectionable) because there are more cutting edges at work at the same time and the power required to turn the die increases as the length and taper increases. The greater the length the more cutting edges will be at work simultaneously, and the more abrupt the taper the less the number of revolutions of the die for completing the thread. The effect of the taper on the number of revolutions for completing the thread is illustrated at *A* and *B*, Fig. 37. In one case the die moves inward a distance *x* before the teeth cut to full depth, but when the taper is more abrupt, as shown at *B*, the die only needs to move longitudinally a distance *y*, in order to cut the full depth of thread.

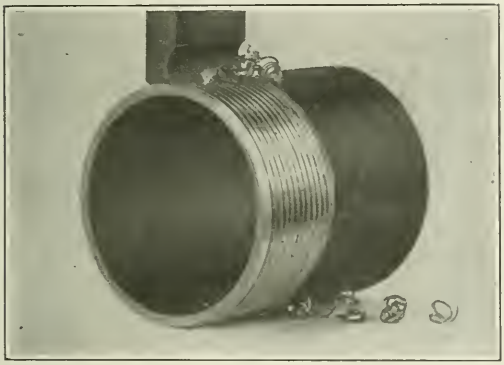

Fig. 42. Result obtained when Die is given Proper Amount of Rake

The third method mentioned, by which a die for straight thread cutting is used for tapering work, may be applied to cutting threads having a slight taper, but is not recommended for the usual classes of taper work, which include such parts as wash-out plugs for steam boilers, the ends of faucets or cocks of various kinds, buffing lathe spindles, etc. A tapering die of the non-opening class does not require a throat or chamfered teeth on the leading side unless the taper is slight, because several cutting edges begin work at the same time, as indicated at *B*, so that there is no need for a throat, since the object of the chamfered edges in a straight die is to start the cut gradually between several teeth, instead of having one leading tooth cut the thread groove to the full depth.

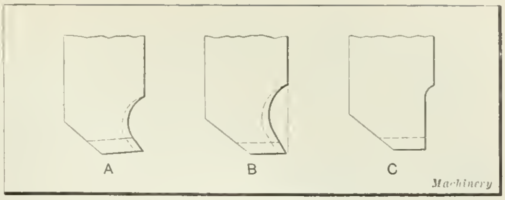

Fig. 43. Different Methods of grinding Chasers of Pipe-threading Dies

Self-opening Taper Threading Dies

A self-opening die-head for taper threading differs from one used for parallel or straight threading in that the chasers move outward at a rate depending upon the angle of taper, until the thread is cut, and then move outward suddenly to clear the work, instead of remaining in one position until the completion of the thread-cutting operation. The radial movement of taper threading die chasers is ordinarily controlled by means of a tapering former plate, which allows the cam or scroll ring of the die-head to turn slowly as the die advances, the rate of this turning movement depending upon the angle of the former plate relative to the axis of the die. The former plate serves about the same purpose as the adjustable slide or bar of a taper attachment for the engine lathe. Taper threading dies of the self-opening class may be either of the inside or outside trip type.

A "Geometric" die of the outside trip type is shown applied to a turret lathe in Fig. 38. A tapering plate *A* is attached to a taper bar *B*, which is free to slide over a guide of T-shaped section. This guide is attached to the front part of the die-head, but not to the cam ring, which is free to turn and carries a lug *D* that is in contact with the former plate. A stop *F* is clamped in the toolpost (or is bolted to the side of the cross-slide) in position to engage pin *G* projecting from taper bar *B* of the die-head. This stop is so located that it holds bar *B* stationary as the chasers begin cutting the thread. As the die advances, lug *D* slides along the tapering surface of plate *A*, which causes the cam ring to turn slowly and the chasers to move out gradually for producing a thread, the taper of which depends upon the inclination of the former plate. When lug *D* reaches the end of plate *A* it drops off and the chasers fly outward radially, thus releasing the die, which is then withdrawn. Die-heads of this kind are made specially for a given class of work, and in many cases must be arranged with reference to the screw machine or turret lathe on which they are to be used.

The Hartness die-head for cutting tapering threads is illustrated in Fig. 39. The front section *A* of the die-head, and the cam ring for controlling the action of the chasers, slides on the rear or shank end, which is held in the turret. The forward movement of the shank of the die is arrested by one of the regular turret slide stops after the chasers have begun to

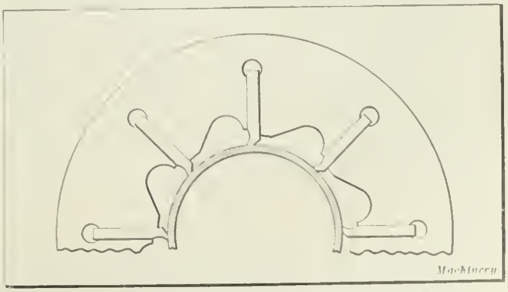

Fig. 44. Approved Form of Chip Space for Pipe-threading Die

TABLE 1. SURFACE SPEEDS FOR CUTTING SCREW THREADS IN STEEL WITH DIES

Material to be Threaded	Steel for Chasers	Surface Speeds in Feet per Minute for Different Pitches			
		3½ to 5½ Threads per Inch	6 to 7½ Threads per Inch	8 to 11 Threads per Inch	12 to 32 Threads per Inch
Hard Steel	Carbon	8	10	12	15
	High Speed	10	12	15	20
Mild Steel	Carbon	12	15	20	25
	High Speed	15	20	25	30

Machinery

cut the thread. The front section of the die then continues to advance until lug *C* reaches the end of the tapering former plate *D;* as soon as lug *C* and plate *D* are disengaged, the cam ring quickly turns part of a revolution and the chasers are opened. Another lug and former plate are located on the opposite side of the die-head, as there is a floating connection between the two sections of the die-head.

A "Geometric" taper threading die-head of the internal trip type is illustrated in Fig. 40. When this die-head is moved up to the working position, the end of the work comes into contact with the cross-shaped gage or stop located inside the die-head. This gage is connected with the taper bar that carries the former plate, and as the chasers begin cutting the thread, the gage and taper bar are held stationary. The length of thread that is cut depends upon the position of the gage or stop, which is set previously. When the chasers have advanced the required distance, the cam lug slides off the tapering plate, thus allowing the cam controlling the chasers to make a partial turn and open them quickly.

When dies of the former-plate type are in operation, the chasers follow the taper of the work automatically and no more power is required for cutting a taper thread than for cutting a straight thread of corresponding diameter and pitch. These dies make it possible to do the work rapidly and produce accurate smoothly finished screw threads. The working edge of the former plate on dies of this class should so control the turning movement of the cam ring that the resultant of the longitudinal and radial movements of the chasers conforms to a straight line, so that the tapering screw will not be convex or concave. The edge of the former plate would be a true helix if the chaser cam had a uniform rise, but since it is more convenient to make these cams plain circular arcs located eccentrically to the axis of the die, the edge of the former plate may not be made truly helical, especially if the taper of the thread to be cut is rather abrupt; for cutting threads having slight taper, it would not be necessary to modify the former plate, as the error would be quite small; in fact, a plain inclined edge not of helical form would produce work accurate enough for ordinary requirements.

TABLE 2. REVOLUTIONS PER MINUTE FOR GIVEN SURFACE SPEED AND DIAMETER

Diameter of Screw Thread	Surface Speed in Feet per Minute						
	8	10	12	15	20	25	30
	Revolutions per Minute for Different Surface Speeds						
⅛	244	305	366	458	611	764	917
¼	122	153	183	229	306	382	458
⅜	81	102	122	153	204	255	306
½	61	76	92	115	153	191	229
⅝	49	61	74	92	122	153	184
¾	41	51	61	76	102	127	153
⅞	35	44	53	66	88	109	131
1	31	38	46	57	76	95	115
1¼	24	31	37	46	61	76	92
1½	20	25	31	38	51	64	76
1¾	17	22	26	33	44	55	65
2	15	19	23	29	38	48	57
2¼	14	17	20	25	34	42	51
2½	12	15	18	23	31	38	46
2¾	11	14	17	21	28	35	42
3	10	13	15	19	25	32	38

Machinery

When the work is stationary and the die-head revolves it may be arranged as follows: The bar to which the former plate is attached carries a roller at its outer end, which runs around a ring the surface of which is in a plane at right angles to the axis of the machine spindle. This ring may be attached wherever convenient, and it serves merely to hold the former plate stationary while the die-head advances.

Cutting Smooth Threads on Pipe

Many dies used for cutting threads on pipe do not give satisfactory results, ragged or torn threads often being produced. After the introduction of steel for pipes, defective threads were even more numerous than before, although it has been demonstrated that steel pipe can be threaded as rapidly and efficiently as wrought iron when the correct form of die is used. Experiments of the National Tube Co., Pittsburg, Pa., for determining the cause of defective pipe threads showed that the angle of rake is of particular importance. Other important factors are as follows: lack of adequate chip space; improper grinding of the throat; excessive or insufficient clearance; and incorrect number of chasers. Steel pipe is naturally soft and tough, and for that reason it was more difficult to thread with some of the dies used for wrought iron which had radial cutting faces or chasers without positive rake. Fig. 41 shows the kind of pipe thread that is cut when the die is without rake and simply pushes the metal off, instead of operating with a clean cutting action. Fig. 42 illustrates the results obtained when the chaser is properly made and ground. This die has positive rake, which is preferable for wrought iron as well as steel. The form of chaser illustrated at *A*, Fig. 43, is recommended for cutting ordinary steel pipe. The form of cutting edge illustrated at *B* is recommended for use on open-hearth steel pipe, which requires a rather long and gradual "lip" or curvature back of the cutting edge, owing to the toughness of the material. The form of chaser illustrated at *C* is considered unsuitable for threading either steel pipe or wrought iron. The angles of rake recommended vary from 15 to 25 degrees, depending upon the conditions. For threading open-hearth steel pipe, the rake angle should be 25 degrees.

TABLE 3. THREAD CUTTING SPEEDS FOR DIES BASED ON REMOVING AN EQUAL AMOUNT OF METAL PER MINUTE

Diameter of Screw Thread	Number of Threads per Inch	Revolutions per Minute	Surface Speed, Outside Diameter	Cubic Inches Removed per Minute
1/4	20	1062.0	69.5	0.5896
5/16	18	691.5	56.5	0.6004
3/8	16	453.0	44.5	0.6025
7/16	14	297.5	34.0	0.6009
1/2	13	224.5	29.0	0.6084
9/16	12	169.5	25.0	0.6085
5/8	11	128.7	21.0	0.6147
11/16	11	117.0	21.0	0.6201
3/4	10	88.5	17.0	0.6177
13/16	10	81.7	17.0	0.6225
7/8	9	61.7	14.0	0.6170
15/16	9	57.6	14.0	0.6276
1	8	40.6	10.6	0.5948

Machinery

It is important to have the proper amount of space in front of each chaser to allow for the accumulation of chips. If there is not enough space, the chips frequently pack tightly in front of each chaser and mar or tear the thread. An approved form of chip space for a pipe die is illustrated in Fig. 44. The curvature of this space is such as to provide an easy path for the chips to follow; at the same time, the back of the chaser is rigidly supported. The chip space is of especial importance on dies intended for cutting open-hearth steel pipe, because the chips from this material are usually long and tough.

The throat or chamfer of pipe dies should extend over about three threads or teeth. As the heaviest cutting is done in the throat of the die, this section should have a little more clearance than the rest of the chaser teeth, which applies to threading dies in general. If a tooth in a die is broken away, it is preferable to remove the remaining part entirely by grinding with a thin wheel, because the broken part tends to tear or roughen the thread. To obtain the best results with pipe dies, the number of chasers should be varied according to the size of the die, four chasers being used for diameters up to 1¼ inch; six chasers for diameters from 1½ to 4 inches; eight chasers for diameters from 4½ to 8 inches; twelve chasers for diameters from 9 to 12 inches; fourteen chasers for diameters from 13 to 16 inches; and sixteen chasers for diameters from 17 to 20 inches.

Cutting Square Threads with Dies

The cutting of square threads with dies is usually regarded by die manufacturers as a difficult proposition, and unless the die is made very carefully unsatisfactory results are obtained. While square threads have largely been replaced either by the Acme or another form, some manufacturers prefer the square thread, and occasionally they are cut by means of dies. The chasers for square threading dies that are to be self-leading should have teeth that are slightly relieved on the sides by lapping. Unless there is a little side relief, the chaser teeth bind and are frequently broken. If the die is to be self-leading, however, the side relief or clearance must be very slight, as otherwise the die will not be properly supported and will cut a very inaccurate thread as to lead. A die of this kind should preferably be controlled by a lead-screw and the chaser teeth should be given enough side clearance to prevent binding. As the Acme thread is superior to the square thread and may readily be cut with dies or taps, the use of dies for square threads is not common.

Steel for Threading Die Chasers

There is some difference of opinion regarding the relative merits of carbon steel and high-speed steel for the chasers of threading dies. The results obtained with different steels may, of course, depend considerably on the exact composition of the steels in question and the heat-treatment to which they are subjected. In general, carbon steel chasers are preferable for cutting smooth, accurate screw threads, owing to the fact that they retain a fine cutting edge better than chasers made of high-speed steel. A fine sharp cutting edge on a high-speed steel chaser is not affected by hardening and tends to crumble slightly when the chaser is first used. The result is that screw threads cut with high-speed steel chasers are not so smooth, although the cutting speed can be considerably higher. As a general rule, carbon steel is recommended when finish is of especial importance, whereas high-speed steel is preferable when maximum production is the principal object and a nicely finished thread is of secondary importance. Incidentally, many manufacturers or users of dies order the more costly high-speed steel when carbon steel or "semi-high-speed steel" would be preferable. The semi-high-speed steel, which has been used for many die chasers, contains much less tungsten than the steel ordinarily used for turning tools.

The National Acme Co. recommends the use of carbon steel chasers for cold-rolled screw stock, Bessemer and open-hearth steel, 3 per cent to 5 per cent nickel steel, malleable iron, brass, bronze and similar alloys. High-speed steel chasers, or those made of semi-high-speed steel, are recommended for cutting threads in chrome-vanadium steel, tough alloy steels, cast iron, drop-forgings and all heat-treated steels.

Amount of Carbon in Steel for Screw Stock

The kind of stock that is used often greatly affects the quality of thread that may be cut with a die, tap or other type of thread-cutting tool; in fact, the tool is often considered at fault when the stock is the real cause of the trouble. The so-called "screw stock" may have from 0.08 to 0.20 per cent carbon, with possibly 0.06 to 0.12 per cent sulphur; 0.30 to 0.80 per cent manganese; and phosphorus up to about 0.12 per cent. Ordinarily, a steel containing from 0.18 to 0.25 per cent carbon is very satisfactory for thread cutting, the carbon content preferably being about 0.20 per cent, or a little more. If there is too little carbon in the steel, the metal is stringy or tends to tear, and it is more difficult to cut a smooth thread.

Cutting Speeds for Threading Dies

There are few, if any, subjects connected with machine shop practice which are more difficult to deal with in a definite, specific manner than the general subject of cutting speeds, because there are so many different factors that may have a decided effect on the speed for any one operation. If cutting speed data based on past records or experience are not available, it is preferable to begin with a general idea as to what speeds are practicable than to be entirely in the dark. For this reason, general information on cutting speeds for threading dies will be given, and while the speeds listed may be subject to considerable variation, they will doubtless prove of some value as a starting point until tests can be made that will give more nearly correct cutting speeds.

When experimenting in order to determine what speed is the most economical, the speed should be increased gradually from a safe or conservative speed, until it is as high as possible without wearing or dulling the die chasers excessively. When a die is dulled it is not so easily resharpened as many other metal-cutting tools, and for that reason it is better to sacrifice the cutting speed somewhat in order to keep the die in good cutting condition for a longer period. As one prominent die and machine tool manufacturer expressed it, "Better half speed than a trifle too fast."

Just what the cutting speed in feet per minute should be depends not only upon the kinds of material being cut, but also upon the pitch of the thread and the kind of cooling compound or oil used on the die. The National Acme Co. gives the following general data on cutting speeds, based upon a vast amount of experience in screw cutting. Under normal conditions, a die equipped with carbon steel chasers should be operated at about 30 feet per minute (surface speed at the pitch diameter) when cutting threads in cold-rolled screw stock, Bessemer open-hearth stock, 3 to 5 per cent nickel steel, malleable iron, brass, bronze and similar alloys. A cutting speed of 20 feet per minute is advocated when using high-speed steel chasers or those of semi-high-speed steel for cutting threads in chrome-vanadium, tough alloy steels, cast iron, drop-forgings and all heat-treated steels. The speeds given, both for carbon and high-speed steel chasers, may be increased about 20 per cent when cutting threads of fine pitch.

The surface speeds given in Table 1 are recommended by the Jones & Lamson Machine Co. for cutting threads of different pitch in both hard and mild steel and when using either carbon or high-speed steel chasers. The figures in the body of the table represent surface speeds in feet per minute and not revolutions per minute. The speeds are increased considerably for the finer pitches, the speed recommended for from 3½ to 5½ threads per inch being increased approximately 100 per cent when cutting threads varying from 12 to 32 per inch. The revolutions per minute corresponding to these various surface speeds are given in Table 2.

Cutting speeds have been determined on the theory that the amount of metal removed by the die per minute should be the same for cutting screws of all pitches. For instance, if a die is found to operate satisfactorily when cutting a thread in a certain material, whatever fractional part of a cubic inch of metal is removed per minute is determined, and then cutting speeds for the same material and for coarser or finer pitches are based on removing an equal amount of metal per minute. While this method seems to be logical, it involves a wide range of speeds if extended to include very coarse and very fine pitches. Table 3, which applies to U. S. standard threads, was calculated on the basis of removing approximately 0.6 cubic inch of metal for threads of all pitches. As the table shows, the surface speeds vary from 10.6 to 69.5 for U. S. standard threads ranging from 1 to ¼ inch in diameter, and the speeds in revolutions per minute for the same range of diameters vary from 40.6 to 1062. This table is based on actual practice in cutting threads on screw stock with self-opening dies at the plant of the Greenfield Tap & Die Corporation.

* * *

This summer 13,000 tons of coal, or 350 carloads, were floated down the Ohio River to Cincinnati by means of an artificial flood. Dams on the various tributary rivers were opened until an artificial crest of from three to six feet was formed, which was sufficient to float the fleet of barges.

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

CUTTING SCREW THREADS

Drilling holes and cutting screw threads are the most common machining operations. They are performed in the most primitive communities by blacksmiths whose knowledge of general machining methods is very limited indeed. Notwithstanding the commonness of threading operations, there is probably no other machining operation on which there is such a diversity of opinion; nor is there any for which so many kinds of tools, dies and machines are used.

The treatise on thread-forming processes begun in this number analyzes the operations of cutting screw threads with dies, milling cutters, taps and single-point tools; it describes the tools, and takes up phases of the general problem of thread making. The analysis of a fundamental process of machining will, we believe, be of great practical value to all classes of readers. Too little has been published in the past on fundamentals, and too much, perhaps, on collective work which should have been analyzed and separated into its basic operations. Given a knowledge of basic principles, the intelligent mechanic can adapt them to the production of any machine, tool or part, the same as a bricklayer, given bricks and mortar, can build walls of any structure that the architect designs.

One important service rendered by the publication of this treatise is the placing before the reader concisely of the various means and methods for making screw threads and the classes of work for which they are best suited. Every machinist is familiar, no doubt, with the various methods of making screw threads, but few have a clear conception of the classes of work for which each is best adapted. For example, during the past few years thread milling has come to the front as a method of producing accurate threads, true to pitch and thread shape. It is important for the production engineer to know when and where thread milling should be used in preference to the older and better known methods.

• • •

INTERCHANGEABILITY IN MANUFACTURE

The production of modified Lee-Enfield rifles required for the army is being delayed because of certain difficulties encountered by the army officers in charge, due to lack of interchangeability of work produced by the three concerns now manufacturing these rifles in the United States. Interchangeability is a highly desirable feature of any manufactured product, but it is not absolutely vital to the success of a rifle that its parts shall be strictly interchangeable with the same parts of all other rifles of the same model used by our army. Strict interchangeability is most highly desirable for the bolt and component parts. The fitting of new barrels to rifles in the field is practically never done, nor is the reassembly of other important component parts attempted.

Interchangeability is a feature of modern manufactured products that has been highly advertised as something of great value to the users. One manufacturer of rifles has for many years published a statement in his catalogue in regard to interchangeability that is absolutely misleading. The statement is to the effect that the rifles manufactured by the company are made interchangeable at great expense in order that the users shall be able at any time to replace broken parts without fitting or trouble. As a matter of fact, interchangeable manufacture was developed because parts can be made cheaper under a strictly interchangeable system than where each part is made by methods that do not insure accuracy of dimensions and shape. The cost of fitting and assembling then becomes excessive. A rifle made with strictly interchangeable parts can be assembled rapidly, and the assembly cost is low. When that is said, practically everything is said in favor of the interchangeable system from the manufacturer's viewpoint. The advantage of the user being able to replace broken or worn parts without fitting is incidental, and would be generally neglected were it not for the saving in manufacture.

In the case of the three great concerns making Lee-Enfield rifles, each has developed the interchangeable system for itself; but the tolerances are not in agreement, so there is not strict interchangeability of the parts made by the three concerns. It hardly seems desirable from any practical standpoint to hold up production of the rifles so badly needed in order that an ideal interchangeable system of manufacture may be perfected.

* * *

THE NEW MECHANICAL ENCYCLOPEDIA

Throughout this country there are thousands of men who are experts in their respective lines of endeavor. They have become experts by accumulating knowledge gained through personal experience, by contact with other well-informed men, and through their studies; their minds are storehouses of mechanical knowledge. If this knowledge could be transferred to the pages of books, the result would be an encyclopedia of mechanical information that would prove of incalculable value to the mechanical world at large. Such a record of experience would be invaluable to those who otherwise would have to gain this experience for themselves.

The mechanical and engineering fields have produced many excellent handbooks that present in condensed form valuable data based on what might be called the composite experience of hundreds of men, and no mechanic's library is considered complete without one or more of these; but no comprehensive work has been available relating to the machine-building trades that completely records the knowledge acquired by experience in this field in such a way that others may benefit by it. There are hundreds of books on various mechanical subjects; there are dozens of handbooks; but there has been no encyclopedia devoted to the thousands of questions and problems met with in machine design, construction and operation.

After a long time of preparatory work, Machinery has filled this gap in mechanical literature. The best mechanical ability engaged in actual practice in scores of the best known shops and designing offices in the country has been called upon to assist in this work, and comprehensive articles completely treating the various phases of the methods used in the machine building trade in design and construction, patternmaking, foundry work, machine shop practice, power plant requirements, electrical installations, etc., have been collected. In undertaking the publication of this great work, Machinery believes it has performed a distinct service to the mechanical trades, and hence deems it proper to announce the completion of the work in this manner.

ORGANIZATION

The Secretaries of the Army and Navy are civilians, in keeping with a government policy that has been found consistent and wise. But, unfortunately, the policy of employing civilians in charge of the production of army and navy munitions and material has not been followed. Is an army officer generally fitted by training to be the practical head of an armory? Experience has shown that he is not. He may know everything about an army rifle and its use, but that is quite different from knowing how to organize a manufacturing plant and conduct manufacturing operations efficiently and economically. His training has seldom included practical manufacturing experience.

We hope that one outcome of the present struggle will be the displacement of army and navy officers generally in charge of the production of our war material, in favor of civilians who are not politicians, but who by reason of their practical experience have shown themselves competent to organize and conduct great manufacturing operations as efficiently as some of the men who have volunteered for such work at the sacrifice of their personal interests.

Frank A. Scott, chairman of the War Industries Board, in replying to an attack by a well-known politican on a rifle contract awarded by the War Department, said, "The most valuable asset of the companies (to whom the contract was awarded) is their organization; and without that the machinery would be of no use." The American concerns now engaged in manufacturing rifles, other than those that were equipped for such work when the war began, required from twelve to twenty-four months to organize their plants before they turned out a single rifle; and the process of organization would be far more difficult now, because the mechanical executives and the equipment, especially the former, are practically unobtainable.

* * *

WORKMEN'S COMPENSATION AND OCCUPATIONAL AND TRAUMATIC DISEASES

BY CHESLA C. SHERLOCK [1]

Under the workmen's compensation acts, diseases may be roughly divided into two general classes: compensable and non-compensable. The most common of the non-compensable diseases are the so-called occupational diseases, which are those arising from causes incident to the workmen's employment, as copper or lead poisoning. As a rule, these diseases are of slow origin and are reasonably sure to occur in certain employments, if followed a sufficient length of time. The authorities are well settled and agreed on the point that they are not "injuries by accident" within the meaning of the compensation acts, and, consequently, are not compensable. The so-called traumatic diseases, however, are compensable. These are defined by one authority as diseases caused by physical injury. While occupational diseases may be due to external conditions, they depend in part on conditions inherent in the individual. Traumatic diseases, on the other hand, are caused ordinarily by external conditions entirely, resulting in physical injury, which, in turn, produces the disease.

The whole theory of recovery under the workmen's compensation acts is based on personal injury by accident arising out of and in the course of the employment. Diseases depending in whole or in part on conditions inherent in the individual are not compensable, unless they are the result of a compensable injury. Traumatic diseases, depending largely or wholly on external conditions and having no reference to the previous condition of the individual or to the employment, are in the nature of injury by accident, and if they can be established as arising, at a time certain and fixed, out of the employment, they are compensable. Among the diseases that the courts have construed as traumatic are: Anthrax, bends or caisson diseases, cancer following blow, heat stroke sustained by steamship stoker, nephritis following working in cold water, nervous shock causing neurasthenia, neurasthenia following fall, overexertion causing cerebral hemorrhage, peritonitis following fall, phlebitis following strain, pneumonia caused by miner's inhaling carbon monoxide generated by explosion, pneumonia following chill resulting from miner's being detained at bottom of shaft by breaking machinery, pneumonia following fall, retinitis in plate printer occasioned by experimental use of bright light, rheumatism following wetting of workman baling out water accumulating in bottom of mine shaft following breaking of pump, and sunstroke.

Hernia may be traumatic, but all hernias are not of traumatic origin. Dr. Oliver J. Fay states that the national insurance bureau of France demands that the following conditions be present in order that a hernia may be adjudged traumatic: (1) There shall have been a direct contusion of the inguinal region, or the work being done shall have required more than usual exertion. (2) The injured man must have been forced to stop work immediately following the accident. (3) He must have been forced to seek medical attention at once, or at most by the evening of the following day. In Germany, the injured man is required to show that the injury received is of a character capable of producing a hernia, and that the hernia appeared suddenly as the immediate result of the accident. Doctor Fay is of the opinion that the forcing of an incipient hernia through the subcutaneous inguinal ring so that a complete hernia results is so serious a happening that a continuance of work is inconceivable, and expressions of pain and a desire to consult a physician are to be considered necessary results. While these conditions apply specifically to hernia, they are equally applicable, in a general way, to all diseases of a traumatic origin. While there is some natural difference in the various jurisdictions, the general consensus of opinion is as stated.

Many of the diseases mentioned in the foregoing list are not ordinarily compensable for the reason that they depend more or less upon conditions inherent in the individual; but under a certain condition they may become compensable. Take, for instance, pneumonia. Ordinarily, it is not a compensable disease, because it is not ordinarily of traumatic origin. In its more common appearances, it depends primarily on conditions inherent in the individual rather than on external or traumatic conditions. Pneumonia, however, in certain instances, changes its character and enters the traumatic class of diseases. There can be no fixed and certain rule in compensation practice. Each case must depend largely on its own circumstances, and for that reason hard and fast rules are not established or entertained in compensation practice. The measuring stick more properly applied in a compensation case where disease is involved is whether or not it is of traumatic origin, or resulting from physical injury. It is safe to say that if such is the case and the physical injury arose through an accident in the course of the employment, compensation is properly payable.

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[1] Address: Box 253, Des Moines, Iowa.

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NEW MARKETS AFTER THE WAR

The wholly abnormal conditions under which business everywhere is now conducted lend particular interest to the finding of new outlets for present products and new products for existing plants. To take an extreme case, no one, for example, realizes better than the duPonts that the vast new plants which they have constructed for the manufacture of explosives to meet the requirements of the war will ultimately, and let us pray it may be soon, find their occupation gone. The sagacious officers of this corporation are therefore already turning their attention to the utilization of their plant and special products in the constructive arts of peace. They have begun the manufacture of artificial leather, lacquers, celluloid, picric acid for use in dyeing, heavy chemicals and many individual dyes and intermediates.—*Arthur B. Little, before Canadian Manufacturers' Association.*

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INDEX TO MACHINERY

The yearly index to the twenty-third volume of MACHINERY (September, 1916, to August, 1917) is now ready for distribution, and copies will be sent upon request.

SCREW MACHINE TOOL EQUIPMENT[1]—1

TOOL EQUIPMENT AND ATTACHMENTS FOR THE GRIDLEY MULTIPLE-SPINDLE AUTOMATIC SCREW MACHINE

BY DOUGLAS T. HAMILTON [2]

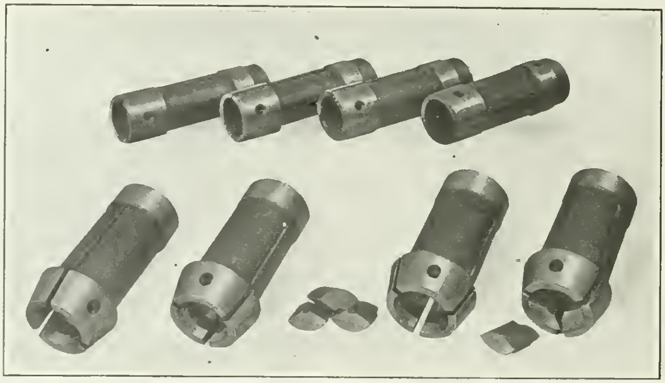

Fig. 1. Group of Spring Collets and Feed Chucks for Use in Gridley Multiple-spindle Automatic Screw Machine

THE standard tool equipment used on the Gridley multiple-spindle automatic screw machine differs from that used on other automatics in that the tools are designed for use on a flat type of turret; therefore, the standard tools are not provided with shanks, except those that can be most conveniently held in this manner. Turning tools are clamped directly to the turret face, and such tools as drill-holders are held in rigid holders, which, in turn, are clamped directly to the turret. The standard tools comprise spring chucks, feed chucks or pushers, vertical forming tools, blade-type cutting-off tools, drill-, tap- and die-holders, turners, supports, etc. The attachments include high-speed drilling attachments, taper-turning attachments and attachments for automatic dies. Other attachments, of course, are designed special for performing operations that cannot be produced as economically by the use of the standard types of tools.

Spring Chucks and Feed Chucks

The spring chucks and feed chucks used on the Gridley multiple-spindle automatic screw machines are of two types: for the ¾-inch machine, these chucks are made solid, whereas for the 1¼-, 1¾- and 2¼-inch sizes, they are provided with bushings, which are made to suit the work that is to be held. A group of spring and feed chucks is shown in Fig. 1, together with some of the bushings that are adapted to them. The illustration accompanying Table 1 also shows the two types of spring chucks used. A spring chuck that is provided with bushings is called a "master," as it can be used for handling a large number of different diameters by substituting bushings of the correct size and shape. The principal dimensions of the spring chucks

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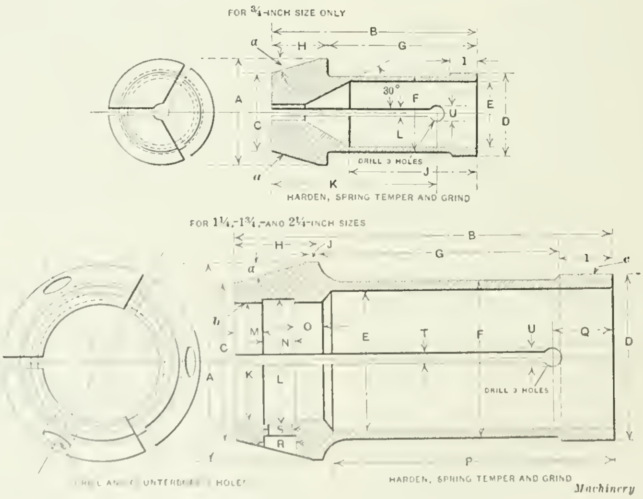
[1] For other articles on Gridley automatic screw machine practice, see "Gridley Turret Lathe Equipment," in the August and September numbers of MACHINERY.

[2] Address: Fellows Gear Shaper Co., Springfield, Vt.

TABLE 1. PRINCIPAL DIMENSIONS OF SPRING CHUCKS USED IN GRIDLEY MULTIPLE-SPINDLE AUTOMATICS


FOR ¾-INCH SIZE ONLY
B
H
G
I
a
A
30°
F
E
C
U
D
L
DRILL 3 HOLES
J
K
HARDEN, SPRING TEMPER AND GRIND
FOR 1¼-, 1¾- AND 2¼-INCH SIZES
B
H
J
G
I
c
a
b
M
O
N
E
T
F
U
Q
D
C
A
K
L
DRILL 3 HOLES
S
R
P
DRILL AND COUNTERBORE HOLES
HARDEN, SPRING TEMPER AND GRIND
Machinery

Size of Machine	Dimensions, Inches																				Degrees a
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	
¾	1 1/4	3 1/4	1 1/4	1 11/32	1 1/16	1 1/4	2 3/8	7/8	7/16	2 1/16	2 5/8	1/16	—	—	—	—	—	—	—	—	1/8	15
1¼	2.1538	3 31/32	1.700	1.915	1 1/16	1 7/8	2 5/8	1	11/16	3/32	1 1/4	1 11/32	5/16	3/8	5/16	2 13/64	25/32	3/8	17/64	1/16	5/32	14 1/2
1¾	3.0915	6	2.455	2 1/2	2 1/4	2 1/4	3 11/16	1 5/16	3/4	1/8	1 7/8	2 1/16	7/16	1/2	7/16	4 1/4	1	1/8	3/8	1/8	1/4	15
2¼	3 1/4	5 1/4	2.7966	3	2 1/16	2 1/16	2 1/2	1 1/2	7/8	1/16	2 3/8	2 3/8	9/16	1/4	9/16	3 1/4	1 1/16	1/4	3/8	1/8	1	14 1/2

are given in Table 1. These chucks are made from a special grade of steel, which will take a spring temper; after machining, they are hardened and spring-tempered, and then ground at *a*, *b* and *c*. At *A* in Fig. 2 is shown a sectional view of a spring chuck, which illustrates how the bushings are held in place. It will be noticed that the bushings are held in place by means of fillister-head screws fitting in counterbored holes in the three sections of the spring chuck.

The feed chuck used in the ¾-inch size of machine, as shown in the illustration accompanying Table 2, is also made solid, whereas for the 1¼- 1¾- and 2¼-inch sizes it is made so that bushings can be added to accommodate various sizes and shapes of bars. These bushings are shown assembled in the feed chuck *B*, Fig. 2; they are held in place by cone-head screws, and fit in a recess, so that the drawing action of the chuck on the bar will not loosen them or disturb their correct longitudinal position. Table 2 gives the principal dimensions of both the solid and master type of feed chucks for all sizes of Gridley multiple-spindle automatic screw machines. The feed chuck is also made from a special grade of steel that will spring-temper well, and before hardening and spring-tempering, is closed in to give it the desired grip on the work.

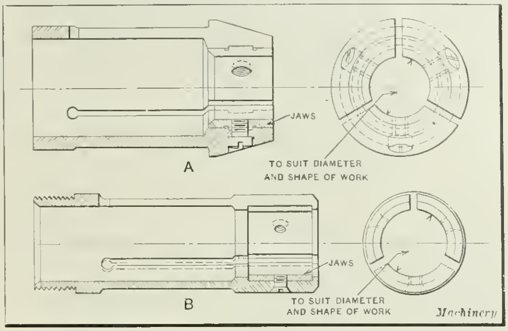

JAWS
TO SUIT DIAMETER AND SHAPE OF WORK
A
JAWS
TO SUIT DIAMETER AND SHAPE OF WORK
B
Machinery

Fig. 2. Diagram showing Method of holding Bushings in Spring Collet and Feed Chucks

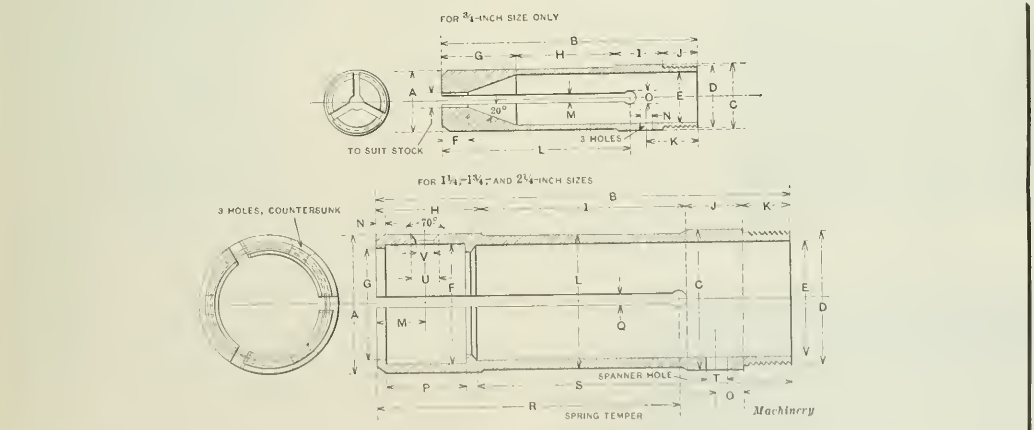
Forming and Cutting-off Tools and Holders

The type of forming tool generally used on the Gridley multiple-spindle automatic screw machine is the vertical forming tool; this is held in the holder by a dovetail projection. The type of forming tool-holder used is shown in Fig. 3, fastened to the forming slide. Reference to this illustration, and also to *C*, Fig. 4, will show that the holder is split, and is clamped to the forming tool by means of two fillister-head screws. This tool, it will be noticed, is held by friction, and an adjusting screw in the bottom of the tool, so that a perfect fit must be obtained between the tail of the tool and the slot in the holder. The forming tool is sharpened by being ground on the top face; the grinding should be so done that the corrections made on the tool for the angular position are not disturbed. This point is important, if it is desired to retain the diameter laid out on the tool when it is made. In the forming of some materials, such as cold-rolled steel, it is occasionally necessary to provide a top rake. This changes the difference between the diameters produced on the work, and allowance must be made for the amount of top rake given, when laying out the tool. Forming tools of the type shown in Fig. 3 are generally ground on the cutting face after hardening, so that warpage or other defects are removed. The methods used in grinding this type of tool were described in detail in the article "Making Vertical Forming Tools," in the December, 1914, number of MACHINERY.

When only a simple form is required, a tool-holder like that shown at *A*, Fig. 5, is used. This holder is clamped to the forming slide in the usual manner, and carries a single-blade forming tool, which is held in place by two screws and rests on an adjustable wedge. One screw backs up the wedge and the other the forming tool. This type of forming tool is made for either right- or left-hand work, as illustrated at *B* and *C*, respectively.

Fig. 6 shows a special cut-off tool-holder, which is used principally for cutting off washers or similar shaped work. This holder is arranged to carry five cutting-off blades, enabling

TABLE 2. PRINCIPAL DIMENSIONS OF FEED CHUCKS USED IN GRIDLEY MULTIPLE-SPINDLE AUTOMATICS



Size of Machine	Dimensions, Inches																					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
¾	31/32	4 1/16	1 1/32	0.920-32 P. L. H.	25/32	—	1 3/16	1 9/16	¾	9/16	13/16	3	⅛	3/16	3/16	—	—	—	—	—	—	—
1¼	1 17/32	4 7/16	1.555	1 7/16-20 P. L. H.	1 3/16	1 3/16	1 1/16	1 5/16	2⅛	⅜	⅝	1 13/32	19/32	3/32	¼	1	⅛	3 5/16	3 1/16	¼	27/64	3/16
1¾	2 3/16	6½	2 3/16	2 1/16-24 P. L. H.	1 13/16	1⅞	1 11/16	1⅝	3¼	⅞	¾	2 1/16	¾	⅛	7/16	1¼	⅛	4¾	4 13/16	5/16	7/16	5/16
2¼	2.560	7	2.620	2¼-24 P. L. H.	2⅛	2¼	2⅛	2¼	3	¾	1	2⅜	⅞	⅛	⅜	1½	⅛	4 15/16	—	5/16	33/64	5/16

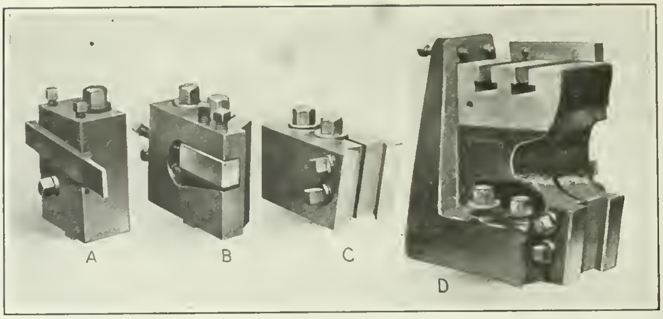


Fig. 4. Forming and Cut-off Tool-holders

five washers to be cut off at one time. The die-spindle is arranged with a stripper rod, as shown, to prevent the washers from wedging in between the cutting-off blade, and when the tool-slide retreats the washers are removed from this rod by a stripping plate held on the side of the holder carrying the cutting-off blades.

When the amount of forming to be done is considerable and consumes a large proportion of the cutting time, the cut is sometimes divided between two forming tools. This is accomplished by the use of the double tool-holder shown at *D*, Fig. 4, at *E*, Fig. 5, and in Fig. 7. The last illustration shows the method of carrying the oil or cutting compound to the forming tools. With this double tool-holder, the tool in the first position (the lower tool) is used for roughing, and when the bar is indexed to the second position it is finish-formed by the top tool. In this way the forming cut can be divided between two tools; the production is thereby increased, and the greatest degree of accuracy is obtained.

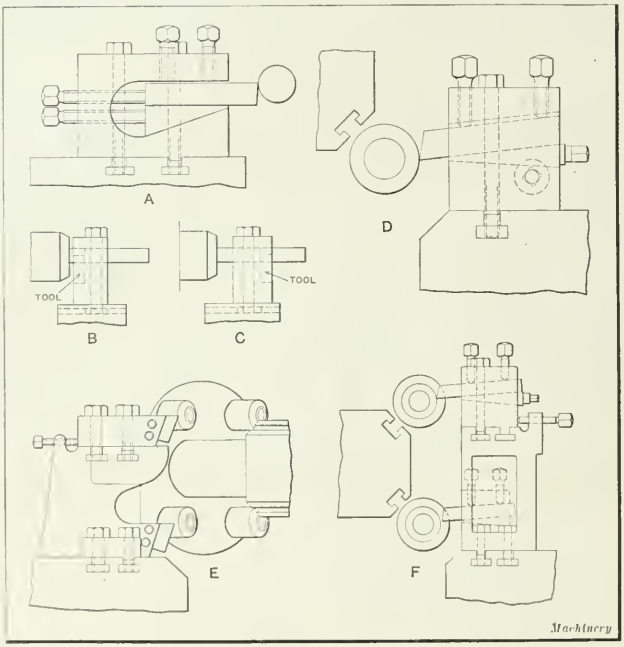


Fig. 5. Diagram showing Forming and Cut-off Tool-holders

The five standard sizes of dovetails used on the vertical type of forming tool are shown in Fig. 8. The size of dovetail used on the tool is governed by the width or depth of the form. The wider the form, of course, the wider must be the dovetail to furnish the required support for the tool. The double type of forming tool-holder, as shown in Fig. 7, is cast solid with the main holder, and in order to accommodate different widths of dovetail, shanks are made for the 3/4-inch, 1 1/4-inch, 1 3/4-inch and 2 1/4-inch machines in the sizes shown at *A*, *B*, *C*, *D* and *E* in Fig. 8. The dovetails are made with the regular 60-degree angles, and range in width from 7/16 to 1 5/8 inch, measured at the narrow part. All are tapped for a vertical adjusting screw (except the smallest size shown at *C*), which provides convenient means of adjustment in relation to the center of the work and gives extra support when heavy forming is being done. This latter is an important consideration for the first forming operation, in which generally the greater amount of stock is removed. The typical set-up at *E*, Fig. 5, shows the relation of the two tools clearly.

When the shape and diameter of the part to be formed is such that a circular forming tool can be used to better advantage than the dovetail type, the special double-deck forming tool-holder shown in Fig. 9 is used. This holder is fastened to the forming slide in the usual manner, and carries two shank holders, which are arranged to carry circular tools. The circular type of forming tool is only recommended for light forming.

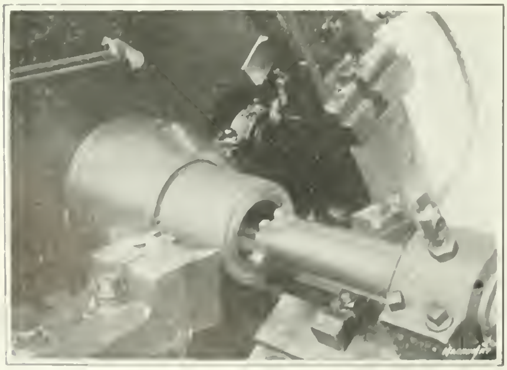


Fig. 3. View showing Dovetail Forming Tool at Work

The cutting-off tools used on the Gridley multiple-spindle automatic are of the blade type, and are held in a holder of the type shown at *A*, Fig. 4, and at *D*, Fig. 5. This holder is clamped to the cutting-off slide by two screws, the tool resting on an adjustable wedge, as shown. As the cutting-off tool is seldom used for anything but plain cutting off, the ordinary type of forged tool or blade can be used. When it is necessary, however, to chamfer the end of the work, this can best be done with the forming tool, keeping the cutting-off tool plain. When there are only a few operations to be performed on the part being produced, consisting chiefly of forming and cutting off, it is possible to use the arrangement shown at *E* and *F*, Fig. 5, having forming and cutting-off tools working in all four positions. For instance, the first and second positions can be used for forming, and the third and fourth positions for cutting off.

Turners and Back-rests

The design of the Gridley turret is such that it is possible to use a type of turning tool that is more rigid than the well-known box tool, and that consequently cannot be described by that term. Fig. 10 shows a group of standard turners and supports. The holder is made to straddle the corner of the turret, and is clamped to the latter by two T-bolts. The turning tool and the roll supports are held in blocks that are capable of being adjusted. Fig. 11 shows most of these holders in diagrammatic form. It will be seen that the turning tool is of the tangent type. With the exception of the lower one, the turners shown in Fig. 10 are of the plain type, and are used for general straight turning. When more than one shoulder is to be turned down at one time, the multiple type of turner shown is used. This tool will be described later.

When heavy forming is being done from the forming or cutting-off slides, or when a rigid support for the work is necessary, back-rests are used. Two of these are shown at *A* and *B* in Fig. 11, and are for right- or left-hand work, for use in the second position. The back-rests can be used in connection with the double-deck forming tool-holder when it is necessary to support the work against the thrust of the cut, the work previously having been reduced by the roughing-forming tool. At *C* is shown another type of roller back-rest, both for right- or left-hand work, for use in the first or third positions.

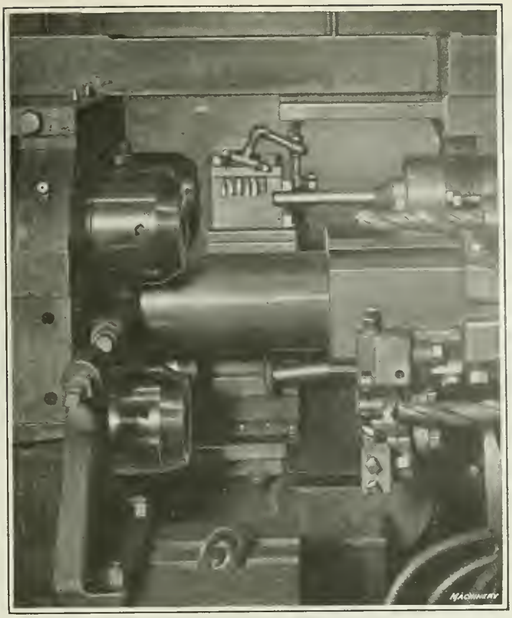


Fig. 6. Multiple Cutting-off Tool-holder used for cutting Five Washers simultaneously

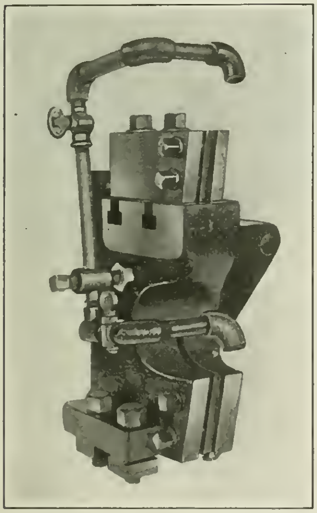


Fig. 7. Double-deck Forming Tool-holder

The capacities of the standard roller and plain back-rests are given in Fig. 12. *A* and *B* illustrate a roller and a plain rest for use on the ¾-inch machine. It will be noticed at *A* that the smallest diameter than can be supported with the rollers 1/32 inch apart is 0.303 inch; whereas, with the rollers touching, the smallest diameter that can be supported is 0.258 inch. With the plain type of back-rest shown at *B*, the smallest diameter that can be supported with the rests 1/32 inch apart is 0.169 inch; whereas, with the supports touching, the smallest diameter that can be supported is 0.125 inch. As shown at *C*, on the 1¼-inch machine, the smallest diameter that can be supported with the rolls 1/32 inch apart is 0.484 inch, and with the rolls touching, 0.440 inch. With the plain type of rest shown at *D*, the smallest diameter that can be supported with the rolls 1/32 inch apart is 0.294 inch; closed, 0.250 inch. On the 2¼-inch size of machine, shown at *E*, the smallest diameter that can be supported with the rolls 1/32 inch apart is 0.561 inch, and with the rolls touching, 0.516 inch. When requirements demand it, special roller rests are made.

Stud Turner

A common type of stud turner for use on the Gridley automatic, adapted for use in the second or third position, is shown in Fig. 10 and diagrammatically at *E* in Fig. 11. This stud turner is provided with holders for retaining three turning tools, each one being individually adjusted by means of a collar-head screw. The work is supported by a combination back-rest, made double-ended and holding four rolls. These back-rests are adjustable along the holder and can be placed to support the work at the point or points desired. With a stud turner of this type, it is possible to produce more than one diameter at one traverse of the turret, and thus produce in one cut multiple shoulder studs, shafts, etc. Fig. 13 shows a recessing tool-holder at the left-hand side, which is operated by the pusher shown at the right, held on the forming slide. Fig. 14 shows a swinging stop, which is held in a bracket on the main frame of the machine, and is operated by a cam disk on the main cam drum in the 1¾-inch machine. On the other sizes the stop is operated by a cam carried on one of the miter gears that actuate the cut-off slide.

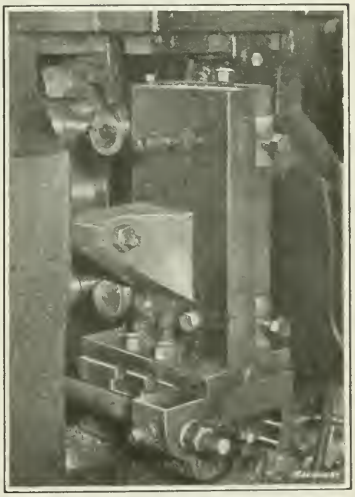


Fig. 9. Type of Double-deck Holder used for Circular Forming Tools

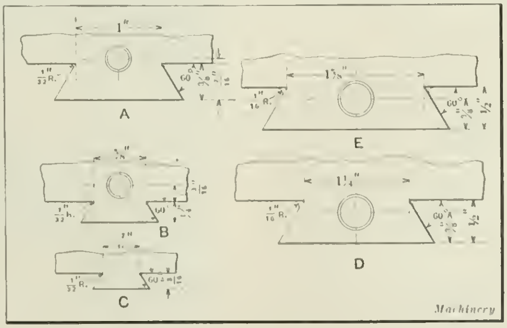


Fig. 8. Diagram showing Proportions of Dovetails for Straight Forming Tools for Use on the Various Sizes of Machines

Tool-slide Tool-holders

The standard tool-holder used on the tool-slide carries such tools as drills, reamers, boring tools, knurl-holders, etc. This form of holder is

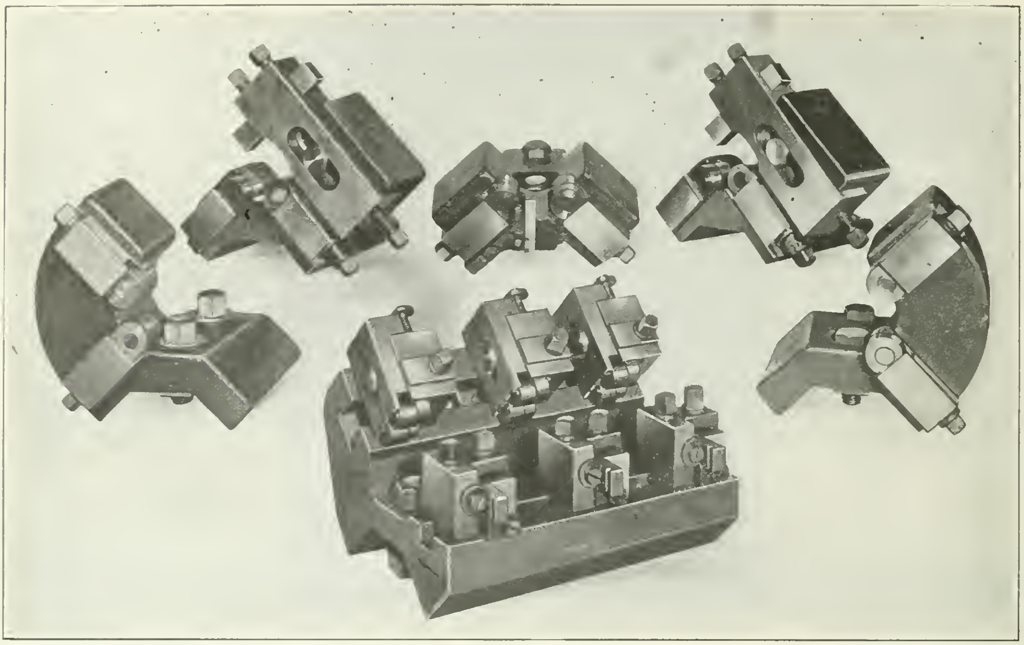


Fig. 10. Group of Supports, Turners, and Stud Turners

shown in Fig. 15, and in diagrammatic form in connection with Table 3, which gives the principal dimensions of the tool-holder, namely, the length of the base, length of the bushing, the distance from the front of the bushing to the edge of the base, and the diameter of the hole. The last dimension corresponds to the shank of the tool that is to fit into it when no bushing is used. This standard holder can be used in all four positions on the 1¾-inch multiple-spindle machine. All other sizes of machines have special tool-holders for the fourth position; but the fourth position tool-holder is not furnished unless specially ordered. The tool-holders are clamped to the tool-slide by means of T-bolts, which permit them to be adjusted to the desired position. The tool is clamped in the holder by means of two collar-head screws, the upper part of the holder being split to allow for expansion and contraction.

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Although 75 per cent of the 1916 output of crude rubber was produced within the British Empire, the United States manufacturers took about 62½ per cent of the total output, while British manufacturers took only 12 per cent

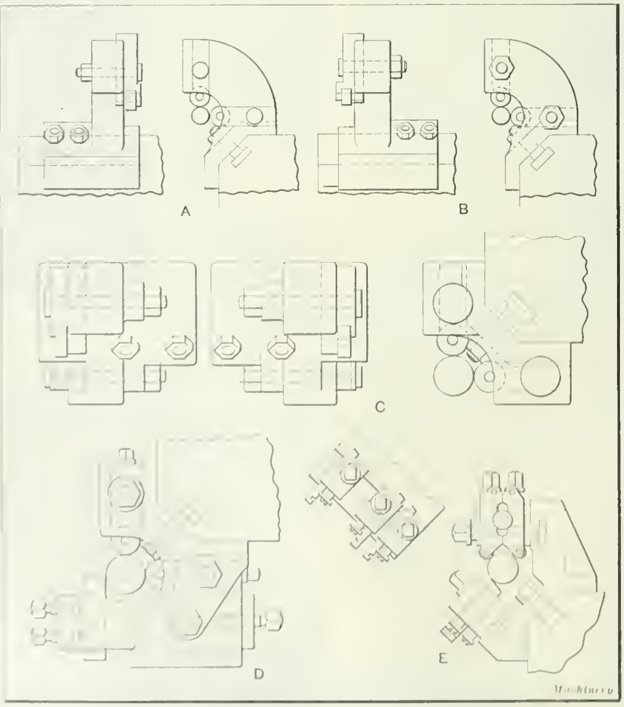

Fig. 11. Diagram showing Different Types of Turners and Supports

LABORATORY FOR TESTING AEROPLANE MOTORS[1]

In an aeroplane fight, victory is with the aviator whose machine can attain the greatest speed and reach the highest elevation. At present an aeroplane can reach a height of only about 23,000 feet, on account of the thin air and intense cold, and in order to overcome these difficulties the United States government is building the first "altitude" laboratory to experiment with aeroplane motors under these very conditions. The laboratory will soon be completed on the grounds of the Bureau of Standards, Washington, D. C. The chamber in which the motors will be tested is about twelve feet long, six feet wide and seven feet high. It is enclosed by reinforced concrete walls built to withstand a pressure of one ton per square foot on the outside, to prevent them from being crushed by the weight of air at the earth's surface, when the air inside has been rarefied to the thinness of an altitude of about 20,000 feet. This room

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[1] Abstract of an article published in the New York Times Magazine, September 9, 1917.

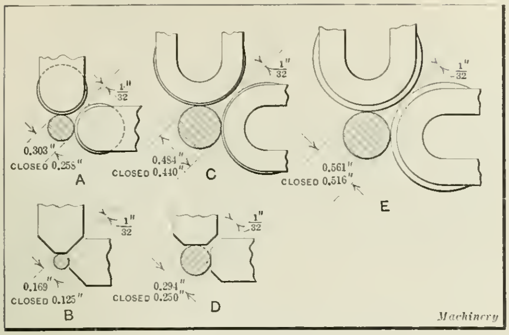


Fig. 12. Diagram giving Capacities of Solid and Roller Rests

will contain refrigerator coils to absorb the heat from the exposed parts of the engine, and fans for circulating the cooled air over the engine and past the cooling coils. The pressure in this chamber can be maintained at any desired point down to one-half atmosphere by means of an exhaust blower that is capable of drawing away 1600 cubic feet of air per minute, which takes the exhaust from the engine, as well as any air leaking into the chamber, and discharges it outside. The power from the engine is absorbed and measured by means of an electro-dynamometer, mounted outside the vacuum room. The behavior of the engine at all speeds can be measured at will, making possible a systematic study of the performance. Provision is made for supplying air to the carbureter not only at any desired pressure, but also at any desired temperature by means of a twenty-four-ton refrigerating plant. Among the points to be investigated with the equipment are the effects of different grades of fuel. This laboratory offers a complete equipment for investigating the performance of aeroplane engines up to about 300 horsepower and of many types of much higher power at all practicable altitudes and temperatures.

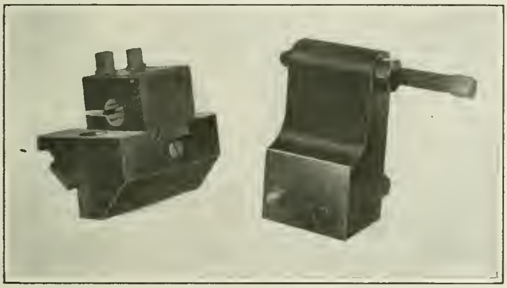


Fig. 13. Recessing Tool-holder and Pusher used for operating it

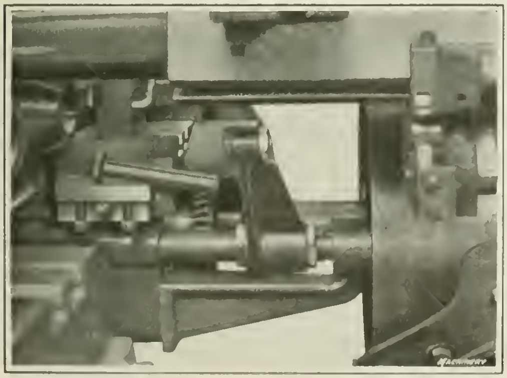


Fig. 14. Swinging Type of Stop used on 1¾-inch Machine

MODERN LOCOMOTIVE PRACTICE[1]

Comparatively few locomotives are now built without a fire-tube superheater, as the economy resulting from the use of this device is marked. To reduce the fuel consumption further, the use of brick arches supported on water tubes is common, as modern improvements in the design of the arches have made their use practical. On road locomotives the outside valve gear of the Walschaerts type is used almost entirely, and is also used on some switching locomotives. Accessibility, better distribution of steam and freedom from breakdowns make outside gearing desirable. The majority of engines now built are so heavy that the usual reversing mechanism is not suitable, and power reverse gearing has been introduced with satisfactory results. Pneumatic fire doors relieve the fireman of much work and greatly reduce the time that the door is kept open. It is now the practice to have outside steam pipes to the steam chest, instead of having them placed in the smoke-box, thus eliminating to a large extent trouble from leaky joints, and giving easier access to the smoke-box appliances. The advent of long freight trains called for air compressors of greater capacity, and two single-stage pumps, or one compound pump, are used. On some large locomotives mechanical stokers have been installed and are doing very good work.

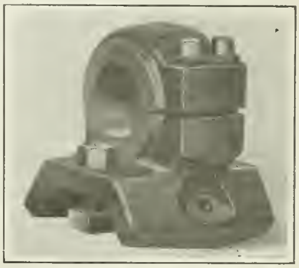
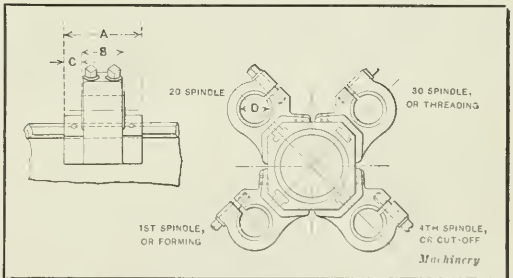


Fig. 15. Standard Tool-holder used on Tool-slide

The tendency today is toward locomotive tenders of large capacity. To save labor and because of legislation, tenders are now constructed with coal hoppers designed so that the coal will automatically be placed within easy reach of the fireman.

TABLE 3. PRINCIPAL DIMENSIONS OF TURRET TOOL-HOLDERS



Dimensions, Inches	Machine Sizes			
	¾-inch	1¼-inch	1¾-inch	2¼-inch
A	3 7/8	3 3/4	5	5 1/2
B	2	2	2 1/2	2 1/2
C	15/16	7/8	1 1/4	1 1/2
D	1 1/2	2	2	2 1/2

Special attention has been given for a number of years to truck design, with a view to eliminating dangerous roll at high speeds. In many derailments the forward tender truck is the first to leave the track. Comparatively slight depressions in the track may set up a rolling of the tender, which, accompanied by a reverse roll of the locomotive, will cause the forward tender wheels to jump. The connections between the locomotive and tender also have a bearing on this, and one connection has been designed which is a vast improvement over anything used before.

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[1] Abstract of a paper read before the Minnesota Section of the A. S. M. E., March 10, 1917, by T. A. Foque, Minneapolis, Minn.

THE FUTURE OF THE MACHINE TOOL BUSINESS IN RUSSIA

CONDITIONS THAT WILL CONFRONT THE MANUFACTURER AND DEALER AFTER THE WAR

BY A. M. PESKINE[1]

THE purpose of this article is to give in concise form some ideas that may be of interest to American manufacturers in regard to the sales policy of machine tool builders in Russia in the future. The writer's principal reason for going into this matter is that during frequent conversations with American machine tool manufacturers on the subject the question most frequently asked has been: "Can you recommend to me someone who would make a good agent for my concern in Russia?" This question has been asked so often that it appears to be the opinion of the majority of manufacturers that all they need in order to sell their product in Russia is the right kind of agent, and that, provided they can get such an agent, everything will run smoothly. This is by no means the case, and the entire question is a somewhat difficult one, depending not only upon the agent himself, but also upon other matters that will be mentioned later.

There have been many radical changes in the selling of machine tools in Russia, and, therefore, a change should be made not only as far as the agent is concerned, but also in the entire system and methods of selling. There are several points that must be considered in this connection: First, the changes in the American machine tool market; second, the fact that the buyer of the present time and the buyer in Russia after the war should be two distinct types of men; third, the new method that should be applied when selling machine tools in Russia, due to the two radical changes mentioned above.

In taking up this matter in detail, the writer would first call attention to the fact that before the war American manufacturers did not show much energy in the matter of selling their machine tools generally in Europe and principally in Russia. There is no exaggeration in saying that American manufacturers do not understand even at the present time the proper methods used in selling machine tools in Russia, and, in fact, they have no experience whatsoever as to actual conditions. This may sound strong, yet it is the truth.

Before the war, agencies for all the largest machine tool concerns were given to a small number of large machinery dealers, who were handling all the sales. The American manufacturer, as a rule, did not take pains to ascertain whether the dealer in Europe was doing his utmost to secure all the business possible. He was generally well pleased if the European dealer would send in a few orders from time to time. Whether these orders represented the maximum that might have been obtained under the circumstances has never been determined. How little the average machine tool manufacturer understood the details of his sales campaign in Russia can best be shown by the fact that some of the machinery dealers in Europe were handling machine tools of one and the same kind, yet made by three or four different manufacturers who are strong competitors in this country. Such conditions should never be permitted, and the American machine tool manufacturer should look seriously into the details of the methods employed in the selling of his machine tools in Russia.

German Competition

The matter of competition with German manufacturers is of sufficient importance to be considered under the other factors that affect the sales campaign. Before the war it was necessary to take into consideration these German machine tool manufacturers, although their tools were always poor copies of machine tools made in this country. The writer recalls from his own experience how difficult it was for him a few years ago to sell a few Lodge & Shipley lathes to a machine shop in the southern part of Russia, just because one German manufacturer from Hamburg was selling a poor copy of the same lathe at a much lower price than the American tool.

Naturally, as soon as the war is over, German competition will be much stronger, and due preparation must be made to meet it, for the reason that during the entire war German industries have developed rapidly, due to the exigencies of the situation. Manufacturers in Germany have not been importing any machine tools from abroad, and as they have been obliged to produce large quantities of war material, it has been necessary for them to develop superior types of machine tools in order to handle their production. It is probable that the developments in machine tools have kept pace with some of their achievements in industrial chemistry.

Changes in American Machine Tool Market

Since the beginning of the war many new concerns manufacturing machine tools have been formed in the United States, and no doubt a considerable number of these will pass out of existence at the close of the war. Many of these machine tool builders, however, have developed to such an extent that they will continue to produce, as they have invested large amounts of money in buildings and equipment, and on account of the huge war orders they have secured, have paid comparatively little for what is usually the largest expense of every new enterprise, *viz.*, the experimental stage. It cannot reasonably be expected that these new firms will give up the results of their work, and, therefore, this competition is a factor in America and will be also a factor in the Russian market. The old and well established machine tool concerns are often inclined to believe that they have no competition whatever. It is well to keep in mind the old business rule, "Better overestimate a competitor than underestimate him."

The Russian Buyer after the War

In taking up these points in detail, let us consider why the Russian buyer after the war will be different from the former buyer. During the war a large number of Russian engineers came to this country. All the government controlled concerns sent their inspectors and engineers, and many private concerns followed their example. If, therefore, we take it for granted that 50 per cent of these men have been taking advantage of their opportunities properly, this experience must eventually bear fruit. All these technical men have become more or less acquainted with American methods of manufacture and management. Many of them have visited American machine shops, and through their duties as inspectors have had plenty of opportunity to become thoroughly familiar with the most minute details of manufacture. It follows that if these men are spread through Russia in the future, and if they are factors in the buying of machine tools, they will be in a position to know what is required. The time has passed when the man was called a good salesman because he could sell a shaper where the work called for the installation of a lathe. The buyer in Russia at the present time understands that there is more than one concern in America manufacturing and selling certain types of machine tools. A short time ago, however, the word "milling machine" or "turret lathe" recalled to the Russian buyer's mind only the name of the best known concern making the one tool or the other. Now since a large number of Russian engineers have been visiting the different factories and have seen the different makes of machine tools, they have become familiar with the different concerns manufacturing various types of machines.

The writer is still receiving proposals from machinery dealers with circulars attached on which the manufacturer's name has been blotted out; but in most cases he has made inquiry of the manufacturer direct. The Russian buyer has now become familiar with the prevailing prices of machine tools, and this fact is of extreme importance for future business, because Russian machine tool dealers have been taking advantage of this lack of knowledge on the buyer's part to a considerable extent. Naturally, the prices during the war are much higher than normal, yet due allowance can be made so as to take the changes of price into consideration. Aside from this,

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Russian buyers have been in this country long enough to become acquainted with manufacturers and many other people in the trade who are able to post them on current prices.

Russian industries have never been so much in need of suitable methods for interchangeable manufacture as during this war. The enormous demand for war material has revolutionized the methods in the majority of Russian machine shops, and without doubt has been as deciding a factor for these industries as automobile manufacture has been for American machine shop practice. All the above matters must be considered in taking up methods of selling to be applied to American machine tools in Russia.

Methods of Selling in Russia

As previously stated, all American machine tools before the war were handled by a few machinery dealers in Russia. To these dealers due credit must be given for the great persistency applied in their selling campaign. They were spending a great amount of money for printing beautiful catalogues, which were frequently produced at a cost of $10 to $15 each, yet all these catalogues were given out free upon request. The salesmen themselves were recruited from people of good standing, and a great deal of attention was paid to their manners. The offices and show rooms were furnished in the most luxurious way, and much attention was paid to appearances generally, no expense being spared to make a good showing. The writer knows absolutely that the sales costs to some machinery dealers ran as high as 18 per cent. All of this would have been very effective, providing more attention had been paid to the professional training of the salesmen.

Unfortunately, this phase of the situation was completely ignored. Personal connections and friendships among business men were appreciated more than engineering knowledge. It is true that once in a great while a salesman was enabled to obtain a talking point about the tools he was selling from American experts who were sent to Russia. Still, while talking points are important assets for a salesman who has the necessary knowledge of machine tools, without that knowledge talking points are good only during the first call. After a few visits the salesman has run out of facts and is obliged to recall obsolete and old-fashioned terms like "best in the world," or "best on the market," or "most reasonable," etc. It will be seen, therefore, that if a thorough knowledge of tools was important before the war, it is imperative now. Less attention will have to be paid to appearances and more to essential mechanical points.

The fundamental question of selling may now be taken up. Is it really possible to find a man who knows every kind of machine tool thoroughly? The answer to this question is, of course, that such a man is almost impossible to find. In the United States no attempt is made to find a man with such an amount of knowledge, but the matter is arranged by having specialists for certain kinds of machine tools. These specialists sell one type of tool and one only. It is the belief of the writer that the time has come when Russia will need salesmen highly specialized in one particular line. His advice to large American concerns is to start independent sales offices in Russia. This method, without doubt, has a bright future. In the first place, thanks to the comparatively small variety of tools that any one concern can produce, it is a simple matter to be conversant with the entire line. Therefore, the proper kind of salesmen can be selected without difficulty, and their training is comparatively simple. In the second place, the price for one kind of machine tool will be the same for everybody, and there will be no complaints from the customers as to differences in price. In the third place, the sales offices will be in direct touch with the buyer, which is much better for both. The buyer will be able to come personally to the sales office and ask certain questions about details with which he is unfamiliar. For example, in an office for selling automatic machinery, the buyer will find samples of work produced on automatics and will be able to judge for himself the kind of machine best suited to his requirements.

It is surprising that large machinery concerns making lathes, milling machines, small tools, and the like, should concern themselves at all as to whom to appoint as their representative in Russia. The best solution of this problem is to start a sales office of their own. It is unnecessary to consider the question of details for an organization of this kind. I would suggest, however, that there should be a few Americans working together with an experienced man familiar with local conditions. The only drawback to this arrangement would be the comparatively large expenditure, so that only concerns having a large volume of business could probably afford it. For concerns of smaller size, the most practical solution of the problem would be one sales office for a number of manufacturing concerns. The essential point in this plan is that a number of concerns making different types of tools, each type being of approximately equal importance to the average shop, should combine and start a sales office. All the advantages of the first method mentioned are found with the second, and some additional benefits. The expenses are greatly reduced for each partner of the sales office, and the enlarged organization is of assistance in securing additional information relative to new business. Suppose that one salesman is selling a planer. It is easy for him to ascertain whether any other machine tools are required, and he can immediately notify the office in regard to it, so that another salesman will be put in touch with this manufacturer. The second method of selling is a great advantage to a concern making special machinery, for the reason that the amount of business is too small for it to afford an office or a direct representative, yet by combining an office with some other manufacturer the advantages of a separate organization are gained.

In deciding which of these two methods would be more advantageous in Russia, the American manufacturer must make up his mind in regard to the matter of credits and collections. This question was not taken up seriously by American manufacturers before the war because their product was handled entirely by the dealer. After the war, however, it will be of the greatest importance. The writer believes, however, that this matter will not be as serious as it has been in the past, as many American banks have opened branch offices in Russia. It can also be stated from the writer's own experience that, although machinery dealers have extended long term credit to the buyers in Russia, the percentage of actual loss has been small. In the event, however, that an American manufacturer positively refuses to handle the account of a Russian customer, nothing remains to be done except to use the old method of selling, which means giving the agency to any kind of machine tool dealer in Russia. This brings us back to the first question once more.

Selection of the Dealer

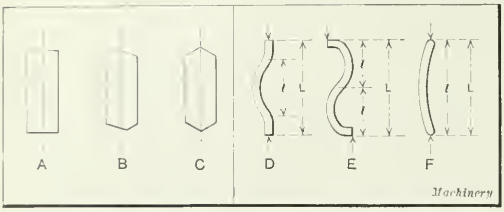
In the first place, the machinery house should be one specializing in selling machine tools only without any side lines whatsoever, and should employ salesmen who, by training and experience, are fitted to sell high-grade machines only. It is a well-known fact that unless a salesman is accustomed to sell only high-grade tools, if he is unable to close a sale, he will invariably follow the line of least resistance and try to substitute an inferior tool. There should be an iron-clad rule that a salesman must sell his own machine or nothing.

Now in regard to the financial end of the business. Machine tool manufacturers in this country are likely to overestimate the value of large financial assets of concerns selling machine tools abroad. It should be emphasized that dealers in machine tools need a certain minimum of working capital in order to carry on their business, but this minimum is all that is necessary. It is useless to cater to concerns that work with very large capital, because such a condition places a dealer at the mercy of other firms backed up by large banking interests. Bankers are poor partners for machine tool dealers, as their desire is for large transactions and quick returns, and they overlook the importance of establishing a trade, failing to realize that a trade once established is a great asset. The banker is eager to throw his money into entirely different channels when he finds that he is obliged to wait a long time for settlement, while a specialized machine tool dealer who has nothing else in which to invest his money will have more patience, as he knows good times follow slow times in the machinery business. Furthermore, a machine tool dealer will continue to work in one direction regardless of the favorable or unfavorable conditions of the money market.

COLD-HEADING OF WIRE[1]

COMPARATIVE LENGTHS OF WIRE UPSET UNDER DIFFERENT CONDITIONS

BY ROY H. SMITH[2]



Figs. 1 and 2. Different Types of Cut-offs and how Each tends to bend in cold-heading

COLD-HEADING of wire is essentially a modern development. It is true that cold-heading, in one form or another, has been done for a great many years, but real progress dates from the advent of a good quality of open-hearth steel which can be bought for a moderate price. The process of cold-heading is steadily gaining in importance, and every year sees the production of some new parts by this method. When wrought iron was the only wire obtainable, satisfactory rivets and screw blanks were made by the cold-heading process; and at the present time there are still some buyers who insist upon having rivets of genuine Swedish iron. The pioneers who first realized the possibilities of working steel wire in cold-heading machines spent many thousands of dollars in converting good material into scrap. For a number of years the writer has been connected with the cold-heading industry, and it was with great interest that he read MACHINERY'S Reference Book "Cold-heading." In one of the introductory paragraphs of this pamphlet, under the heading "Principles of Cold-heading," the following statement is made: "These three simple experiments outline the principles in cold-heading." This statement is, of course, very broad and apparently was not intended to be taken literally; yet the real principles involved in upsetting a piece of wire are so often confused or ignored that a more accurate analysis of existing conditions would apparently be worth while.

In beginning a study of the theory and practice of cold-heading, it is essential to keep clearly in mind the fact that theoretically a piece of wire, no matter whether it is long or short, should upset uniformly when subjected to compression. Practice has shown, however, that when the length of the wire is great in proportion to its diameter, there is a tendency for the wire to bend laterally, instead of being upset to the desired form. The trouble encountered from the buckling of blanks in automatic cold-heading machines is probably greater than that experienced from the tendency of any other form of strut to buckle. The reason for this is apparent from the following considerations:

1. A large number of cold-heading machines are run without any adequate straightening device; in other words, wire comes to the header in the form of a coil and is fed into the header with a slight initial bend. When a straightening device is used, it may safely be said that this initial bend is not entirely removed from the wire before the attempt at upsetting is made.

2. Ordinary rivet wire is drawn from rods that are frequently considerably out of round, the result being an appreciable difference in the hardness of the metal at different points on the surface of the wire. In itself, this would be sufficient to result in one side of the wire failing before the other side reached the elastic limit.

3. Unevenness of the cut-off or inaccuracy in setting up the dies produces an eccentric loading, and as shown by Goodman in his "Mechanics Applied to Engineering," this increases the stress in the material. In fact, where the loading deviates from the center of gravity of the section by an amount equal to one-eighth of the diameter, the magnitude of the stress is doubled.

Severing the blank or cut-off from the wire is the first step in starting to make any part by the cold-heading process, and a consideration of the properties of this cut-off is the logical starting point in making a study of the conditions that exist in performing cold-heading operations. Referring to Fig. 1, *B* and *C* represent the two most common forms of cut-off used in automatic cold-headers; the form shown at *A* is a theoretical condition and could not be obtained in practice. When the load is perfectly central and the heading dies and machine are absolutely true, these three forms of cut-off, when struck by the upsetting machine, will tend to assume shapes similar to those shown in Fig. 2 at *D*, *E* and *F*, respectively. For all practical

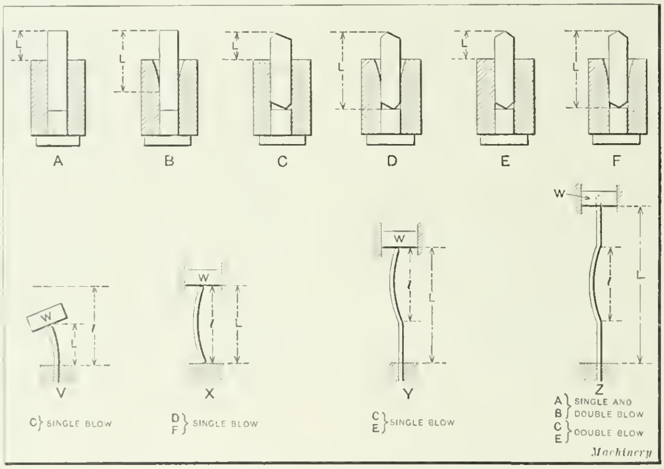


Fig. 3. Types of Cut-offs shown in Fig. 1 in Tight and Poorly Fitting Dies, and Comparative Lengths of Wire upset under Different Conditions

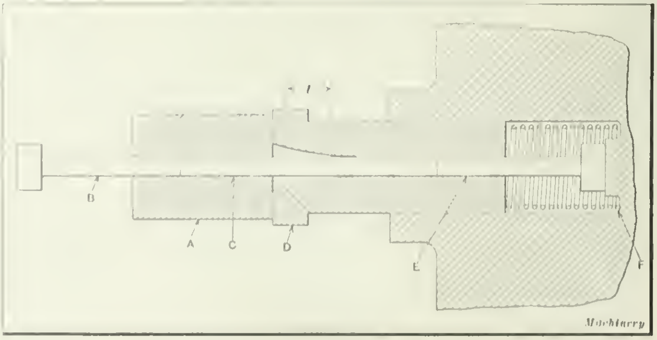


Fig. 4 Device sometimes used to obtain Larger Sized Heads by supporting Cut-off at Both Ends

purposes, cut-off B can safely be assumed to approximate C, because the eccentricity of loading is not great, and roughness of the dies and softness of the wire will minimize the effect of eccentricity at the ends. It is well, however, to emphasize the evil that may result from this form of cut-off, as it may easily become serious if the dies fit poorly or become very dull.

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[1] For other articles on this subject see "Cold-heading" in the May and July, 1913, and the February 1914 numbers of MACHINERY. MACHINERY'S Reference Book No. [illegible] contains the gist of these articles.

[2] Address: Kent, Ohio.

At the top of Fig. 3 are shown the three types of cut-off illustrated in Fig. 1, each type being shown in a tight-fitting die and a worn die, respectively; at the bottom of the illustration are shown the comparative lengths of wire that can be upset for these different conditions. This illustration is developed from the theory of strains and stresses in struts presented in Goodman's "Mechanics Applied to Engineering." In these illustrations l designates what is known as the effective length of a strut, and in the present case is presented merely for illustrative purposes. At V is shown the condition for a single-blow machine and badly fitting dies, so that there would be no support for the projecting end of the wire when struck. The actual length of strut, *i. e.*, the length of wire which it is desired to upset, is shown at L, and in the case illustrated at V, $L = \frac{l}{2}$. For the condition shown at X, where both ends of the cut-off are guided in line but are free to pivot about the ends, $L = l$; in other words, the whole length of wire tends to bend, and with this type of loading it is only possible to handle rather a short length of wire, so that the amount of bending shall be as small as possible. At Y is shown the condition that exists when both the die and hammer fit well but when there is a tendency for the cut-off to pivot, due to the form of its ends. Here $L = 1.43 \times l$; in other words, it is well known that a strut thoroughly supported at one end will not bend through its entire length, but that a certain portion will be subjected to practically straight compression. When both ends of the blank are well fixed as shown at Z, the actual length that can be upset will be $L = 2 \times l$. To express this in another way, if an operator can produce on an ill-fitting, inaccurate header, satisfactory results that require as a maximum two diameters of wire for the head, he can with equal skill and less effort produce work requiring 2.86 diameters for the head if the operation is done on a well-fitting, accurate heading machine. Similarly, if he uses a well-fitting header and the nature of the work permits the wire to extend into and be supported by the hammer, four diameters of the wire can be headed without difficulty.

Fig. 3 shows the effect on the three forms of cut-off shown in Fig. 1, when the upsetting dies fit closely and when they have become a bad fit from excessive use or from some other cause. In this connection it should be explained that the actual length L that can be upset in an ill-fitting or bell-mouthed die will be the amount that projects beyond the point where the die fits the wire and not the amount of material that projects beyond the actual face of the die. Where this ill-fitting or bell-mouthing is not great, the initial upsetting of the wire will soon fill the additional space in the die, and little trouble will be experienced; but where there is a considerable bell-mouthing of the die, the maintenance of uniform heads on the work will be found very troublesome. It has been mentioned that the condition shown at A, Fig. 3, could not exist in practice, but if the cut-off could be made perfectly square so that it would fit into the cold-heading die without lost motion, a length of upset equal to that shown at Z could be obtained. In practice, the condition shown at B would be almost as good as that shown at A, in so far as the actual length of upset is concerned, but this length L now becomes the distance from the outer end of the blank to the point where this blank is actually supported by the die.

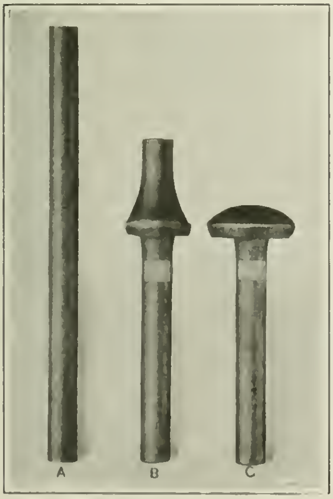

Fig. 5. Example of a Difficult Double-blow Job of Upsetting

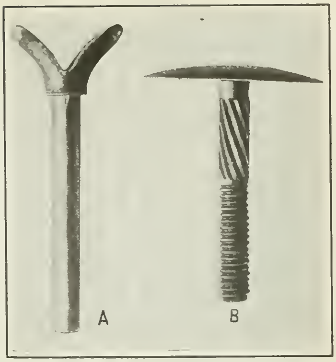

Fig. 6. Result of Four-blow Heading Operation: A shows Work after receiving Third Blow and B illustrates Piece as finisbed by Fourth Blow

At C is shown the most common form of cut-off. The comparative length L that can be upset at a single blow will vary from that shown at V to that shown at Y, depending upon the condition of the heading machine. At D is shown the same condition that is illustrated at C, except that the die is badly worn; and practically no head can be put on this blank and held uniformly central by a single blow. If the form of cut-off shown at C in Fig. 1 were substituted for that shown at B in any of the dies illustrated in Fig. 3, (see condition shown at E and F) somewhat better work would be obtained on account of the more central loading. In any case, absolutely uniform, centrally located heads can only be made by a single blow when the machines are in good repair and when the heads are made small enough to be formed from a short wire.

It is well known that the theory of struts—and more especially of short struts—is neither accurate nor complete. Therefore it is impossible to calculate exactly the length of wire that can be headed under various conditions to which reference has been made. However, the comparative amounts can be calculated, *i. e.*, the conditions shown in Fig. 3 are accurate under all conditions; but the actual amount L will vary even on the same header and with wire of the same chemical analysis, depending upon the physical treatment that the wire has received. By preparing the wire with especial care, and keeping all other conditions identical, it is possible to vary L within one or two diameters.

One frequently hears mention made of the so-called "2½ diameters" rule of thumb. This rule was evolved some years ago and will be found fairly accurate for work done on single-blow machines where the dies fit well and where the hammer is lined up with a fair degree of accuracy, but where the hammer affords no support for the work. The line along which operators work in attempting to produce articles that require more wire in the head than 2½ times the diameter, is shown at Z in Fig. 3, *i. e.*, where the hammer is accurately lined up and well supported, where the die fits the wire and where provision is made for the projecting end of the wire to be supported by the hammer. In extreme cases it is also necessary to have the wire straightened and especially drawn to overcome troubles incident to the unevenness of temper referred to in one of the preceding paragraphs. In Fig. 4 is shown the device sometimes used to further support the wire at both ends. In this illustration, A represents the die, B the knock-out pin, C the blank to be headed, and D the supporting hammer, which is advanced by spring pressure ahead of the main upsetting pin until it strikes the face of the die. It will be seen that a considerable amount of material may be upset in the cone by the action of upsetting pin E, while the unsupported or effective length of wire l is comparatively short. Spring F allows hammer D to telescope into the holder while heading pin E upsets the end of wire C.

The 2½ diameters rule of thumb for the amount that it is possible to upset at a single blow is only satisfactory for the general guidance of those who are inexperienced in work done on cold-heading machines. Greater lengths of wire are constantly being handled when proper care is taken in maintaining both machine and tools in satisfactory condition and by designing special tools to meet the requirements of unusual cases. The writer sees no reason why five diameters of wire should be the limit for the size of head that can be produced on a double-blow machine; as a matter of fact this amount is greatly exceeded under suitable conditions of operation. Fig. 5 shows an excellent example of difficult double-blow upsetting. At *A* is shown the blank before upsetting, at *B* the results obtained by the first blow and at *C* the finished piece after receiving the second blow. Owing to the fact that this piece requires a "swelled neck," a white band was painted around the work to indicate the real effective upset, which upon examination will be found to be nearly eight times the diameter of the wire. Although we find interesting and difficult work produced by double-blow heading operations, there is none that is more interesting or difficult than that which is done with the recently developed three- and four-blow headers. Fig. 6 shows one of the simpler of these operations where *A* represents the result of the third blow, and *B* the final result obtained by applying the fourth blow. There are numerous devices for accomplishing this purpose, all of which work on the principle of keeping the wire straight, centrally loaded and supported at both ends.

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OUR MOST IMPORTANT INDUSTRY

BY J. P. BROPHY [1]

Did it ever occur to you that producing machine tools is a very ticklish though necessary business? This is true for many reasons. In the first place, the design must be well considered. If a blunder is made, the man who purchases a machine quickly discovers the fault and the manufacturer cannot escape severe criticism and loss of future business. Machine tools are purchased chiefly by companies that employ men whose judgment in such matters cannot be questioned. Genuine mechanics will not accept flimsy excuses, and therefore must be satisfied. If the tools should be sold to persons who know nothing about machinery, there is some chance to escape loss of business if the machinery is inferior in design or workmanship; but any person who expects to remain in the machine tool business must not attempt to market something that is not first-class. If he does, he will awaken to the fact that most men who are buying machine tools scrutinize them very closely before accepting them, and these men are as well qualified as the manufacturer to discover inferior design and workmanship. In the machine tool business, exceptional results are expected. Everything must be up to specifications and outputs must be maintained, as most purchasers crowd machine tools to the extreme. Unless the builder is very cautious, he will have a good deal of trouble.

Another reason why producing machine tools is a ticklish business is that machine tools are used in every town and city worth mentioning in this country, and if an inferior machine is sold in Boston, for instance, the man who might use such a tool in San Francisco learns that fact from various sources in a very short time. So extreme care must be taken in the building of these tools from the drawing-board to the shipping room. It may look easy to build planers and lathes to the man lacking experience; but anyone who tries will find that he has a tremendous job ahead. Duplications must be considered, and anyone who has not started at the bottom in some manufacturing plant on machine tool work and stayed with the business until it was a success can have no conception of what this undertaking is. Should the purchaser break some important piece, he will telegraph an order for that part and will expect prompt service. If he has to work a few hours placing this piece in position, he will send the manufacturer a bill for his labor.

Such exactness is not demanded of other kinds of machines. Those who build engines, pumps, printing presses, motors and many other kinds of machines that are well made and designed are given an opportunity to correct any fault that may develop, but should the milling machine or lathe, screw machine, planer, gear-cutter, grinder, boring mill, etc., look out of proportion, that is, appear too heavy or too light, or if it has not a good appearance, seems too complicated, etc., there will be condemnation from some source. In addition, if a machine will not stand the test as a producer, using high-speed cutting tools, this fact will soon be known, for competent men will test it in all sections of this country.

This is the age of real efficiency, a real hurry-up age; time is the all-important factor and a minute is divided into many parts. In making estimates on production to meet competition, it is necessary to take advantage of all possible time-saving devices, and in this field the machine tool leads the way. The American tool builder has been the pioneer in developing devices that lower the cost, and he is expected to continue the good work. He must keep on improving. In every line of work in which metal is employed, the machine tool is likely to be necessary in producing the first model, and when the business is exploited the machine tool is a most essential element in its success. The fine results obtained, in many instances, through the guaranteed outputs of machine tools is the only hope of the inventor and his associates in keeping down the cost of production, who thus add another line of business and keep workmen busy.

Machine tools, without question, are of more importance than any other line of machines; they are the real foundation of many industries and much is expected of them. In any country, the manufacture of the ordinary things, including the locomotive and the powerful engines of an ocean liner, would not be possible without machine tools; so if a tool manufacturer is careless in designing his machines, allowing himself to think that this or that is good enough, when he knows better, he will soon agree that the first statement of this article is true.

The adaptability of machine tools of all kinds to work where duplication is necessary, completing a piece in one operation or adding special features in many operations, often makes the cost of the article so low as to seem almost unbelievable. As a result, the capitalist is encouraged to invest freely, for he knows that all those engaged in the machine tool business can be consulted as to the probable cost of producing almost any shape from the bar, and in many instances from castings, and that these men can always guarantee results. This is conclusive proof that the business is ticklish, although necessary, and that exaggerations in making estimates, coupled with faulty design, must be avoided. Any manufacturer who requires special machines in his business cannot possibly consider such work until he is equipped with the various kinds of machine tools that form the foundation of nearly all things mechanical. The lathe, planer, milling machine, gear-cutter, etc., are all important tools, while the grinder, boring mill, screw machine, keyseater, etc., are, without question, essential in the production of accurate work at low cost.

The writer hopes that this article will prove that this country owes a vote of thanks to the men who have done so much toward building up the great manufacturing interests of this nation, until we are superior to all others, and who have helped to a wonderful extent in encouraging the mechanical brains of our country, knowing the machine tool manufacturer will find the way to produce the article they have in mind. Everlastingly at it is characteristic of all leading men engaged in the machine tool business; they are always improving their product to enable the user to lower his cost and consequently enlarge his own business. As a result, all civilized nations have studied our tool designs closely and have copied nearly every machine of merit produced in America. So the credit of actually uplifting our own and all other countries mechanically should be given to the men who never cease to improve the tools that rapidly produce millions of different shaped metal pieces with accuracy and at the minimum cost. This conclusively proves the business in question to be a very necessary one.

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DIAMONDS FOR DRESSING GRINDING WHEELS

FACTORS GOVERNING THE VALUE OF BORT DIAMONDS AND METHODS OF SETTING AND USING THEM

BY G. T. LINTING [1]

DIAMONDS commonly used for dressing grinding wheels are called bort diamonds. They come from the same source as our gems and comprise a large percentage of the diamond-mine product. Primarily, diamonds are mined for the gem-quality stones only and bort is the refuse; it consists of all stones not good enough for gems on account of being cracked, off-color, impregnated with foreign matter, etc., but which can be used as tools. Other refuse consists of stones of such poor quality that they can be used only for crushing into diamond dust; this dust is used for cutting gem diamonds.

The hardest and best quality diamonds formerly came from India, but as that country has ceased to produce any appreciable quantity, we receive no bort from that source. Brazil is also a producer of very hard and fine quality stones, which are principally found in river gravel or a matrix of such where they have lain for ages, which accounts for their polished appearance. Brazilian bort diamonds are the most desirable on account of their hardness and comparative freedom from cracks and other flaws commonly found in the African stone. They can be easily distinguished by their polished appearance and their almost invariable apple-green yellow color. They are also much higher in price than the African product. The amount of the Brazilian product, however, has been decreasing of late years.

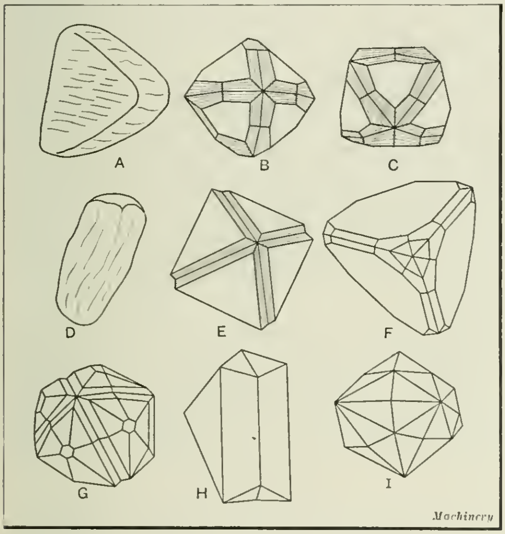

Fig. 1. Common Shapes of Wheel-dressing Diamonds

Over 90 per cent of the diamonds produced today come from the South African mines. The product of these mines is controlled by a selling syndicate in London, which fixes the price and limits production to just what the market will absorb. This accounts, in part, for the rapid rise in prices of all stones. This situation peculiarly affects the market for bort for the following reason: The world demand for diamonds has fallen to a very low ebb on account of the war—the United States being the only good customer. As a result, there is a restricted output of the mines, which are operated for the gem diamond alone, and the quantity of bort produced corresponds with the reduced supply of gem stones. The small supply of bort, coupled with the increased demand on account of the greatly increased industrial activity of the last two years, also accounts for the rapid rise in price, and it is predicted by the diamond-trade journals that the price will go much higher in the near future. Until two years ago, the price of wheel-dressing diamonds ranged from about $8 per carat, for poor-quality goods, to $15 per carat for the best grade. The price has now advanced from 200 to 400 per cent, and the quality and quantity has steadily decreased, until it behooves the manufacturer to look well to his supply and select his stock with great care. The enormous demand and the small available supply of these stones has resulted in much trash being put on the market, which is frequently mixed with better grade goods. It is almost impossible for the average purchaser, even with a magnifying glass, to grade the stones intelligently. Therefore, it would seem economical for the large purchasers to employ an expert to examine each and every stone and reject such as are unsuitable.

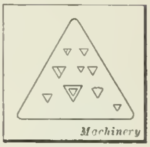

Fig. 2. Triangular Depressions in Sides of Diamonds

Selecting the Diamonds

The shape of a wheel-dressing diamond is an important factor in determining its value; the ideal shape is a perfect octahedron, or an eight-sided crystal. Such a stone has six hard points, which can be seen with the naked eye. As each point may in turn be presented to the wheel, this stone will render the greatest amount of service, other qualities being equal. It can also be held in the holder more easily than any other form. The next best shapes are the various modifications of the octahedron, which are shown at *B*, *C*, *E*, *G* and *I*, Fig. 1. These will vary from the stone with five good points and one blunt point to an irregular sphere. The less marked the points, the more difficult it is for the setter to determine the proper setting and the greater is the liability of setting a side instead of a point to the wheel. Such a setting will result in rapid wear on account of cutting with the lines of cleavage, or grain, instead of against them.

The form shown at *G* is known as a hexakisoctahedron, or an octahedron with a six-sided formation upon each of the eight sides. This form can be readily distinguished by the appearance of the six scalene triangles upon each side. As this stone is almost round in shape, it will render less service per carat than the regular octahedron, but it is a very good shape. A shape occasionally found, shown at *F*, is a triangular, cone-shaped stone with four hard points. It is compact in shape and is of good form, except that it has only four hard points, while the octahedron has six. It is therefore worth less, per carat, than the more perfectly shaped stone.

Other common shapes are modifications of the octahedron that have one or more additional hard points in close proximity to a natural point; such a stone is shown at *H*. These are called macles, or twins. Such shapes are less valuable than the preceding on account of the difficulty in determining the cleavage lines or the proper point to present to the wheel, and the consequent grinding away of the adjacent points. It is impossible to set a stone of this kind without presenting some of the cleavage lines sidewise to the wheel. All of the foregoing shapes are called close goods on account of their compactness.

Next come the flat triangular shaped stones *A*. As these have

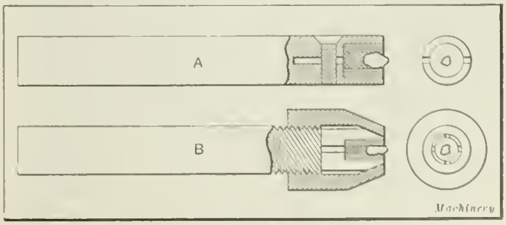

Fig. 3. Methods of holding Wheel-dressing Diamonds

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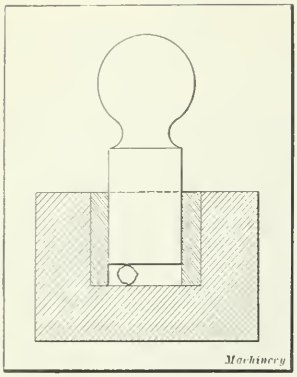

Fig. 4. Mortar for pulverizing Diamonds

but three hard points, they will not render the service of a stone with more points. These are not bad stones, however, if the points are stubby and the cleavage lines can be determined. The least desirable is a long, slender stone *D* that has been broken from a larger crystal. Such a stone must be set with reference to its mechanical shape, and its cleavage lines and hard points ignored. It will wear away much faster, is more likely to break, and can be reset fewer times than the octahedrons. Such stones are worth about one-half as much as the more compact shapes.

As shown at *B*, *C* and *E*, striations occasionally appear upon the corners and edges of the diamonds. These stria are excellent guides in determining the cleavage lines, and the more marked they are, the easier it is for the setter to recognize the natural hard points, and thus determine the proper setting. Other valuable aids in determining which are the natural hard points are the small triangular depressions that frequently appear on the sides of the diamond, as shown in Fig. 2. The natural hard points are always perpendicular to the base of these triangles, which are readily recognized. These depressions occur in almost half the stones on the market. They appear upon the sides of the stones even after the sides have been flaked off, proving the cleavage lines and indicating that the crystal is built up of a series of layers.

Color of Stones

Another important consideration in the selecting of a stone is its color. The hardest and therefore the best stones are of a clear white crystal or grayish color; in fact, the less color the more valuable is the stone. The colors run from white through varying shades of blue, green, yellow, and brown to black. The various shades of brown indicate the presence of iron oxide and depreciate the value of the stone. In fact, color of any kind indicates the presence of impurities, and therefore softness. The apple-green color, blending into a canary yellow, of the Brazilian bort is an exception, however. One should not be misled by a superficial examination of an apparently brown stone, however, for under the magnifying glass the body of the stone may show a quite clear crystalline structure and the color may be merely superficial—on the surface only. Such a color does not detract from the value of the diamond, but the deep brown stone, with or without visible cracks, is of the poorest quality. Diamonds from the Wesselton South African mines occasionally have this greenish-yellow color and may be mistaken, by the uninformed, for true Brazilians.

Cracks and Flaws

Cracks or flaws come in all bort diamonds; if it were not for cracks and other flaws they would be classed as gems. It is necessary to examine a stone very carefully in order to discover all the cracks, as they are frequently difficult to see. Cracks are more or less serious, according to their location and the direction of cleavage. If one should appear directly under and at right angles to a hard point, it is probable that such a point will break off almost immediately, and that part of the stone will be lost, also, the diamond will require resetting. Should a crack appear parallel to the axis of a hard point, the stone should be used so that the crack will be in a perpendicular plane, in which position it will probably do little harm.

Frequently one or more of the hard points of the stone will have the appearance of frozen snow or show a honeycomb appearance. Such a point is very poor and will wear away rapidly. Interior black spots and bubbles are a serious defect and affect the value according to their size, number and location.

Setting and Using Diamonds

It is very important that the setting be properly done; otherwise much of the care employed in the selection of good stones will be wasted. Frequently a stone that is poorly set will fall out and be lost. If the proper point is not set outward, the full value of the diamond is not realized on account of rapid wear. The setter should be instructed to examine each stone carefully before setting to determine the natural hard points and set the stone accordingly. It can readily be seen that any stone will wear more rapidly if it is so set that the wear will be parallel with the lines of cleavage, or grain, instead of at right angles to these lines.

There are various methods of setting bort diamonds. An excellent way is to cast the diamond in solid steel; another good way is to wrap it with strip sheet copper, about 1/16 inch thick by 3/4 inch wide, until the cylinder is about 1/2 inch in diameter; then pour hard solder around the stone and place the cylinder in a holder, as at *A*, Fig. 3. At *B* is shown a similar holder, but the copper cylinder is held in place by a collet instead of being clamped by a screw. These holders have an advantage over those that are cast solid because the copper cylinder can be easily removed from the holder, the diamond reset, wrapped, resoldered and then replaced in the holder.

Too much care cannot be used by the operator in dressing the wheel, for while the diamond is the hardest substance known, it is very brittle. For this reason, should the operator jam the diamond into the wheel, he may break the stone. The brittleness of the diamond is shown by the method used to produce diamond dust. A diamond is placed in a mortar, Fig. 4, that has been liberally oiled and the pestle is struck sharp blows with a hammer until diamond dust of the required fineness is produced. If the operator of the grinding machine is taught the brittleness of these stones, he will be more careful of them.

The diamond holder, which should accompany the grinding machine, should be so constructed that the diamond will be presented to the wheel at right angles, or slightly below a right angle, to the periphery of the wheel. Finally, each diamond should be numbered and weighed and a record kept of the number of times it is reset and of the service rendered; thus the purchaser can keep an intelligent record of its performance.

Summary

Have all diamonds selected by one who is competent to judge the relative value of the stones. See that they are properly set and reset and that the operator is fully instructed as to the nature of the diamond and a proper method of presenting it to the wheel. Keep an accurate record of the service rendered by each stone. If these instructions are properly carried out, they should result in a marked saving to users of diamonds for dressing grinding wheels.

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Every enlisted man and officer of the navy, in accordance with a regulation issued by Secretary Daniels, is to wear an indestructible metal tag by which he may be identified in the event of death or injury. The tag is to be made of monel, an alloy which is not affected by heat and which will not corrode in salt water. It will bear on one side the wearer's name, date of birth and enlistment, and in the case of an officer, his rank and date of appointment. On the other side will be etched the print of the right index finger. Under this system, finger-print experts estimate that there is not one chance in 65,000,000 of a mistake in identification. The finger print is taken in ink on the metal, the name and dates are written on the tag, and the latter is sprinkled with powdered asphaltum and held over an alcohol lamp until the asphaltum melts into the ink. The tag is then placed in a nitric acid bath, which etches the finger print and inscription on the metal.

* * *

This country is now turning nearly 1,000,000 bales of cotton into explosives each year.

ELECTRIC JAPANNING[1]

The term japanning refers principally to the covering of wood or metal with a coat of black varnish and hardening by baking in an oven. The process can be regarded as a step between painting and porcelain enameling. Records show that as early as 392 B.C. the Japanese applied to wood the juice of a tree, known as Rhus-vernicefera, belonging to the same family as the sumach. As the liquid oxidized, it turned black and formed a glossy, smooth lacquer. The product was costly and the process took considerable time, but the finished articles withstood the elements for years.

When the work was taken up in Europe in about the fifteenth century, a substitute for the Japanese lacquer was found; this consisted essentially of the same constituents as our present-day japan, usually an asphaltum base combined with oils, dryers and various oxides. The solvents keep the material liquid until it has spread or flowed evenly over the surface to be coated, whereupon it evaporates, leaving a smooth, viscous covering. The material thus left is changed from a viscous to an elastic solid by oxidation, the action being quickened by raising the temperature.

Great strides have been made in shortening the time of japanning operations in the last few years. Work that formerly required from five to nine hours is now done in from thirty minutes to one hour, and even better speeds are expected, especially with the electric oven. The heating units of this oven consist, in general, of a framework of steel or cast iron, supporting insulators made from mineral compounds which afford high insulation resistance even at the fusing point of the metal resistor. This resistor is usually a nickel-chrome alloy, manufactured as a flat ribbon, which is wound continuously around two insulators, thus forming one heating unit. It is non-corrosive in air at 800 degrees C., but in japanning ovens the air seldom reaches a temperature above 600 degrees F. Practice has shown that it is best, where a number of these heaters are connected, as in ovens, to use steel bus bars and to have all connections mounted on insulators having the same characteristics as the heat insulators. The complete heater usually runs in units of from 2½ to 10 kilowatts, which may be placed anywhere on the walls or floor of an oven until practically a uniform temperature is obtained throughout. This leads to high quality finish and speed together with duplication of work, both as to quality and time. Microphotographs taken of japanned pieces, where the same grade of metal was covered by the same japan in the same room, one man performing all operations, show that the higher the proportion of heat by radiation and the less by convection, the higher is the quality of the work. The second coat baked electrically is superior to a third coat of the other type.

The control of temperatures in japanning is most essential, especially where it is desired to insure uniform production of duplicate parts. Electric control is of two kinds, hand and automatic. Hand control consists of numerous switches so connected with the heating elements that the desired number of heaters to produce or hold a given temperature can readily be turned on or off. This is a cut-and-try method, but in several instances is giving satisfactory service. Automatic control consists of a capillary-tube thermometer that actuates a contactor through a relay, throwing off part or all of the heaters when the oven reaches the desired temperature, and again throwing in these heaters when the temperature falls. The bulb, or sensitive member, of the thermometer is usually about 15 feet in length and is immersed inside the oven. The extension of this tube outside the oven is armored and made of sufficient length to locate the instrument properly. A liquid that vaporizes at a temperature slightly above ordinary atmospheric temperature is used as the actuating fluid. The instrument has two indicator hands, which are set at the maximum and minimum points of temperature desired.

Heat Losses and Ventilation

The principal heat losses of a japan oven are losses due to radiation from the oven, losses due to ventilation, and losses due to absorption of heat by the work together with all parts within the oven. The less the radiation and ventilation losses from the oven, the greater is the amount of heat available for actual work. As a result, the oven walls, roof, and floor should be constructed of a high-grade heat-insulating material and should have little mass, in order to keep its heat absorption as low as possible. A 4-inch to 6-inch wall lined with diatomic earth or similar products seems to meet these requirements. Furthermore, as little through metal as possible should run from the inside to the outside of the oven. The thermal conductivity value of wrought iron and mild steel, such as is used for channel irons and bolts, is about 1400 times that of a good insulating material; a ¼-inch bolt will radiate nearly the same amount of heat to the outside air as a 7-inch square of good insulating material.

From both a baking and a safety standpoint, just enough air must be brought into the oven to reduce the vapors given off by the japan to below a point where it becomes an explosive mixture; but not enough air should be brought in to cool the oven and retard the baking. This means that for every gallon of japan baked within an oven at one time, 1200 cubic feet of free air should be taken into the oven during the vaporizing period. It has also been found good practice to have the ventilators distributed in different parts of the oven. As the volatiles liberated from the japan are heavier than air, it is well to place some of these ventilator openings where the heavy gases will be removed first. With radiation, ventilation, and absorption values expressed in British thermal units, the installation of the proper number of electric heaters to equalize these losses becomes a simple matter. For, when heat is generated electrically, its conversion is accompanied by 100 per cent efficiency; in other words, one kilowatt-hour will always generate 3412 British thermal units.

Types of Japanning Ovens

Japanning ovens can be divided into three types: the box or kiln type, the semi-continuous conveyor type, and the continuous conveyor type. Little need be said about the box type, as everyone is more or less familiar with its construction. As used electrically the heaters are arranged on the side to give the proper distribution of heat. The semi-continuous conveyor oven has become popular with manufacturers who do not have sufficient output of one kind to warrant carrying on the operation continuously. It may be a rotary oven or a box type oven with a conveyor that is moved as the operator desires. The rotary oven is built in the form of a cylinder with a heat-insulating partition through the center; with this arrangement, the operator can load half the oven while the other half is baking. This oven is convenient when many pieces of different sizes and shapes are to be japanned. In the conveyor box type oven, doors are placed at both ends and a conveyor runs through the upper part, from which the work is hung. This conveyor is made long enough to extend the same distance beyond each end of the oven as its length within. One charge is baking within this oven while another charge is being loaded on the receiving end. When the first japan coat is baked, the conveyor takes the baked pieces out of the discharging end and the newly dipped pieces into the baking chamber. Ovens of this type are usually built double or triple, depending on whether two- or three-coat work is desired.

The continuous conveyor oven is much more efficient than the others. It consists usually of a long enclosure through which the work is passed on a slowly moving conveying apparatus. If desired, all handling may be eliminated by installing apparatus for loading and unloading the conveyor automatically. In most cases, the electric heaters are so arranged within the different sections of the enclosure that the incoming work is brought up to its final baking temperature by steps. Usually no heaters are installed in the first section of the enclosure, as the hot baked work is brought out of the oven in such a way as to give up a good share of its stored up heat to the cold incoming work. For the same amount of energy consumed, as much as three times the amount of work has been gotten out of the conveyor oven as out of the box type.

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[1] Abstract of a paper read before the Cleveland Engineering Society, April, 1917, by C. D. Carlson, Engineer, Cleveland Electric Illuminating Co., Cleveland, Ohio.

Fire Risk with Electric Ovens

Electrically heated ovens, from the first, have been looked upon as the solution of the problem of preventing the fires and explosions that were so common in japanning. Yet even in electric ovens two kinds of fires are possible, although at the same time easily preventable if proper care is taken to clean the ovens thoroughly and regularly. When pieces freshly dipped with japan are placed within an oven, there is likely to be what is called a secondary drip when the heat is first applied. This waste japan bakes on the floor of the oven and each successive oven charge adds to the accumulation until a thick, porous crust of baked japan has formed, which, when heated from 500 to 600 degrees F. in the presence of oxygen, will ignite spontaneously. If confined to the oven floor, this burning is harmless, but if it reaches freshly japanned work, a disastrous fire may result.

Again, when the volatiles given off by the japan strike a surface with a temperature lower than their own, they condense; naturally the flues of the oven will gather most of this condensed volatile. These deposits may ignite spontaneously, backfiring into the oven, or the flues may become so clogged with them that proper ventilation is cut off, leaving an explosive mixture within the oven. Then ignition of any sort might cause serious results. From an electrical standpoint great care has been taken to prevent ignition, even where the precautionary measures have been disregarded, as the heating units are designed to have a temperature not much over 100 degrees F. in excess of the oven baking temperatures. Except in unusual cases, this temperature is below the flashing point of japans.

Results of Electric Japanning

Electric japanning is a new industry, having practically grown up within the past three years. Among its largest users are automobile builders, one of whom is baking its cars almost entirely by electric heat. The success of electric heat in japan and varnish oven work has led to considerable investigation along the line of what might be called low-temperature heating; that is, temperatures up to 600 degrees F. The results of these investigations have disclosed numerous other applications, most prominent among which are electric core-baking ovens, electric bread-baking ovens, ovens for baking cereals, drying woolen articles, and equipments for sherardizing. The applications of industrial electric heating are being developed along sound engineering lines, and thus have brought out quality, accurateness, speed, and efficiency, all of which tend to a firm commercial development.

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CASTING OF GERMAN SILVER[1]

German silver is a composition of nickel, copper and zinc in varying proportions. Its value in the arts depends on its color, luster, hardness, tenacity, toughness, malleability, ductility, machining qualities, and resistance to alkalies and acids. Generally speaking, it is manufactured in three ways. The German method is to melt all the copper and two-thirds of the nickel and zinc in a graphite crucible and then add the rest of the nickel and zinc. In the English method, all the copper, nickel and zinc are melted at one time, then zinc and copper are added; should a test show that the metal is porous, a fireclay pipe containing pitch is pushed into the metal to deoxidize it. One American method is to melt a copper-nickel alloy and then gradually add the preheated zinc. In another method, monel metal is used as a base, the necessary copper and zinc being added later.

One of the great difficulties found in the preparation of German silver is to so unite its constituents as to avoid porosity and produce a homogeneous alloy. Besides having a high melting temperature, nickel has an affinity for carbon and nitrogen at a high temperature and occludes both hydrogen and nitrogen within its pores. A good protection against these ills is to prevent the access of these gases to the metal by a protective covering and a deoxidizing flux. Charcoal should not be used alone as a covering; broken glass and a small amount of soda ash or calcined borax are much better. A good deoxidizing flux is the proper use of zinc in the making of the alloy; also, the careful stirring through the hot mass of a small amount of dry chloride of zinc just after skimming the pot preparatory to pouring.

Very good quality castings have been secured by adding 4 ounces of cupro-nickel-vanadium to the molten bath, just about five minutes before the heat is ready to pour. The cupro-nickel-vanadium, either in granulated form or broken into small pieces, is wrapped in a piece of paper so as to keep the mass together. After it becomes a bright cherry red, it is pushed down and held near the bottom with an inverted cupped disk having a handle about 4 feet long. When the mass is completely absorbed by the charge, the metal is gently stirred with a pumping motion and then allowed to remain quiet for about five minutes, so as to give the vanadium a chance to perform its scouring and purifying action. When the metal reaches a clear, limpid state, as evidenced by its greater mobility, the heat is ready to pour.

Any alloy containing nickel chills with surprising rapidity and thickens by rapid oxidation; moreover, its shrinkage, when reaching the freezing point, is great. To overcome its tendency to chill, the melting point must be materially reduced by the use of some alloy that will promote its fluidity. The introduction of a little aluminum-zinc alloy is advisable when the castings do not have to sustain a hydraulic test; otherwise a calcium-zinc alloy may be used. To overcome the tendency to rapid oxidation on the surface of the bath, chloride of zinc in a perfectly dry state is almost a specific. To overcome excessive shrinkage, the runner must have sufficient thickness.

While chloride of zinc will preserve the metal from surface oxidation, it will not protect the body of the molten charge from absorbing such gases as oxygen, nitrogen and sulphur. The only reagent that will reach these products is one that will be decomposed by them when in a nascent state so as to act as a carrier for them and bring them to the surface to be absorbed in the slag, or some element that has a greater affinity for them than the basic metal in the pot, such as zirconium, boron and titanium. Vanadium acts as a carrier of oxygen and has a strong affinity for nitrogen and sulphur, so that it is the most rapid and thorough reagent. But a pure product of cupro-vanadium must be used; one having any aluminum at all should not be used for castings requiring a severe hydraulic test.

Having secured a perfect composition and skillful treatment at the melter's hands, the foundryman is still far from ultimate success. The body of his mold must be an open sand and his facing must be of some fine molding sand, which must be skin dried and then the molds must be smoked by a torch. When a heavy casting is to be made, even these precautions will not insure success. The sprue head and main feed gate must be brushed down with graphite and smoothed down with a slicking tool; the mold must be vented at all places where it is possible for the gas to become trapped or pocketed; the core must be well made and vented, if necessary; and the metal must be properly skimmed before pouring, and then poured with a uniformly steady stream, at such a rate as to keep the descending column full, so as to avoid spelter marks and cold-shuts. The art of making sound German silver castings is one that is accompanied by infinite precautions, painstaking details and absolute thoroughness.

* * *

The scarcity of coal in the neutral countries in Europe during the past two years has made it necessary for these countries to investigate all the possibilities of finding coal within their own borders. Last summer drillings were made in Iceland, by means of which it was determined that in one place there are at least 180,000,000 tons of coal available. This coal is of high quality, and as a result of the investigations, a Danish company has been formed for mining the coal. In Sweden a company has been formed for mining coal in Spitzbergen, and drillings are also to be made in the southern part of Sweden, where it is expected that coal will be found at a considerable depth.

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[1] Abstract of a paper read before the American Institute of Metals by C. P. Karr.

MARINE ENGINE CONSTRUCTION

METHODS USED IN BOSTON NAVY YARD FOR MAKING ENGINES OF NEW SUPPLY SHIP "HORATIO BRIDGE"

BY N. I. MOSHER [1]

THE supply ship *Horatio Bridge* was the first large steel ship ever constructed at the Boston Navy Yard. The propelling machinery, which consisted of two sets of vertical inverted-cylinder, direct-acting, three-cylinder, triple-expansion engines, with the necessary auxiliaries, was made in the shops of the machinery division. This work was carried on between the repair periods of naval fleets, thus tending to hold together a permanent organization of skilled mechanics, and to this end proved very satisfactory.

Fig. 1 shows one section of the bedplate secured to the planer platen. In this position the bottom and both ends are being planed at once, four tools being in operation. After the bottom and ends of each section are planed, the sections are drilled and bolted together. Fig. 2 shows the three sections of the bedplate bolted together and mounted on an open-side planer while the column seats and bearing housings are being planed. Performing these two operations at one setting insures perfect alignment. Fig. 3 shows the operation of boring bolt holes for securing the bearings and caps to the housings, the radial drill being mounted on the bedplate. A portable crane mounted on the opposite end of the bedplate handles the bearing boxes while they are being fitted to the housings. By this method much time was saved, owing to the large overhead crane not being available at all times. The weight of the bedplate with its bearings is approximately 25 tons. Fig. 4 shows the twelve main bearing caps being planed at one setting, while Fig. 7 shows a bearing and cap fitted into a fixture for boring and squaring up the ends. Fig. 8 shows 120 main bearing shims of various thicknesses pressed together and

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[1] Address: Bldg. 42, U. S. Navy Yard, Boston, Mass.

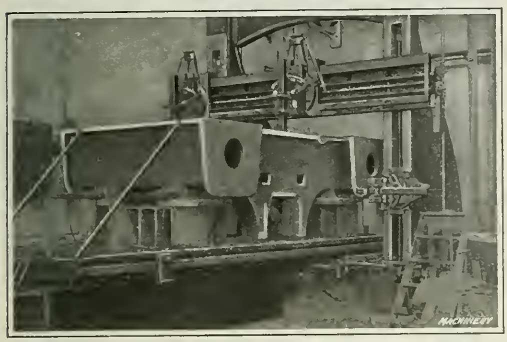

Fig. 1. One Section of Bedplate set up on Planer to enable Bottom and Both Ends to be planed simultaneously

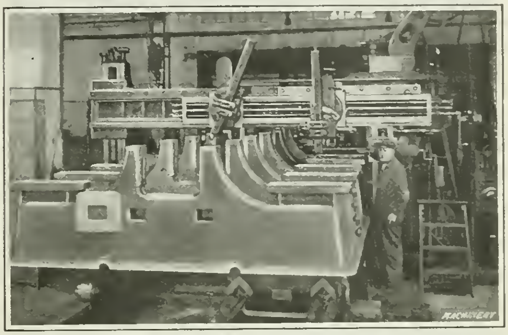

Fig. 2. Three Sections of Bedplate bolted together and set up on Planer for finishing Column Seats and Bearing Housings

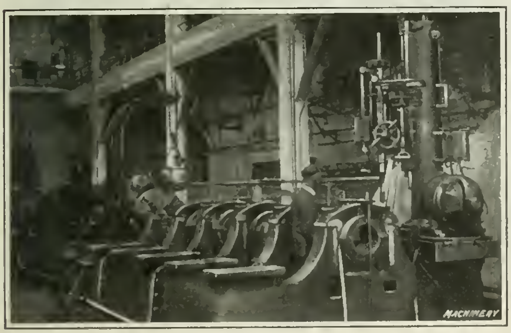

Fig. 3. Boring Bolt Holes for securing Bearings and Bearing Caps to Housings. Radial Drill is mounted on Bedplate

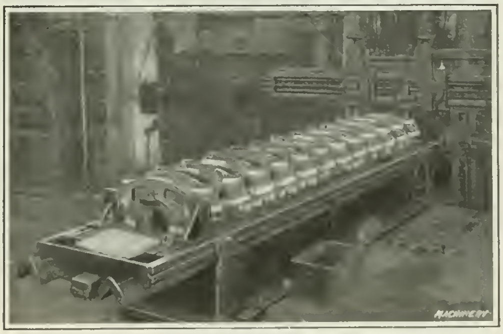

Fig. 4. Twelve Main Bearing Caps set up to be planed at a Single Operation, thus saving a Considerable Amount of Time

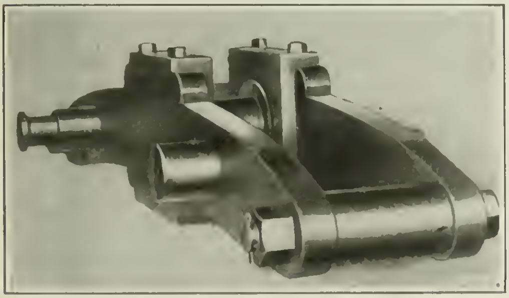

Fig. 5. Completed Link with Gibs fitted, Gibs having been planed to Same Radius as Link Bars

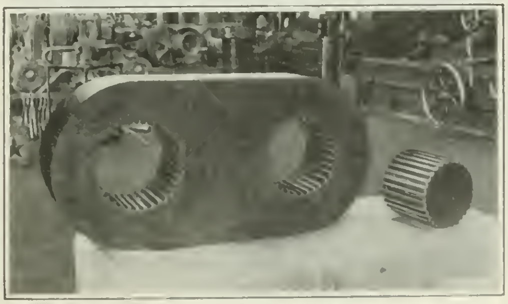

Fig. 6. How Stock is removed from Cranks, Holes being drilled in Crankpin and Shaft Ends, respectively

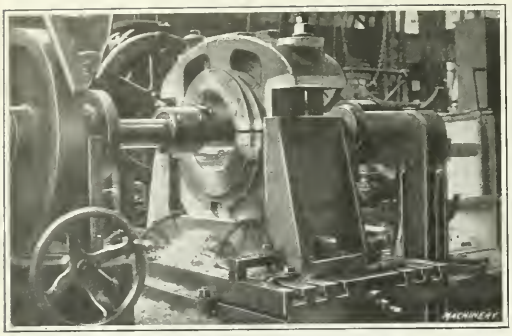

Fig. 7. Bearing and Cap mounted in Fixtures for boring Bearing and squaring up Ends at a Single Setting

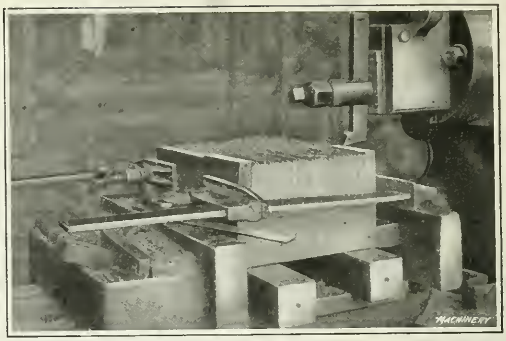

Fig. 8. How 120 Main Bearing Shims of Various Thicknesses are pressed together as Solid Block and planed to Desired Shape

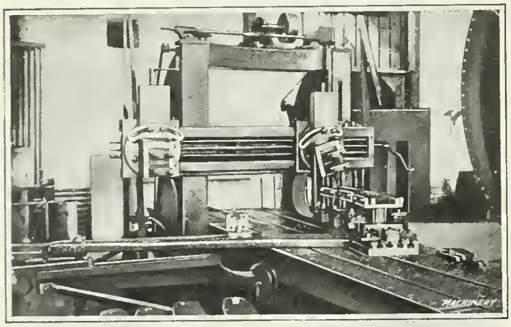

Fig. 9. How Engine Link Blocks are planed in Pairs on Radius Planer Attachment, which insures Accuracy of Work

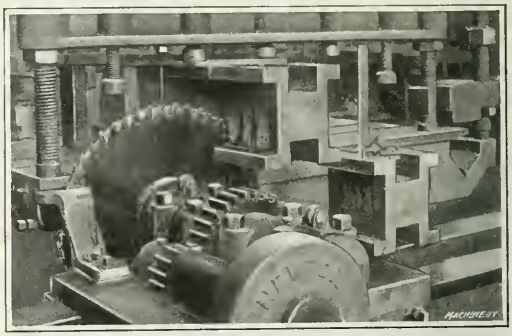

Fig. 10. Link Blocks being cut from Billet on Newton Cold Saw. Billet has been planed to Desired Cross-section

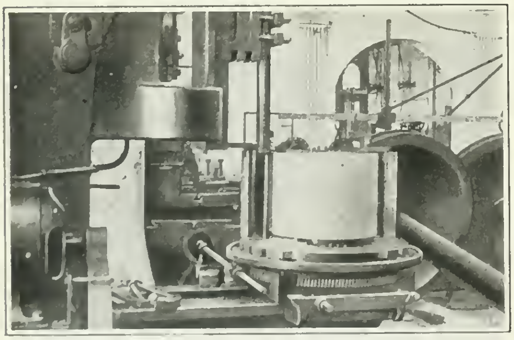

Fig. 11. Crank Webs set up in Pairs on Slotter Platen for rounding Ends and cutting Keyways

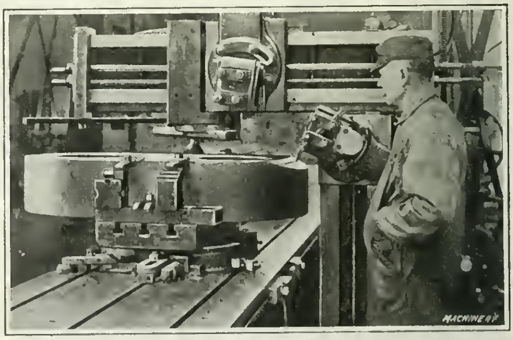

Fig. 12. Crankshaft Web mounted on Radius Planing Attachment for cutting Clearance at Top of Web

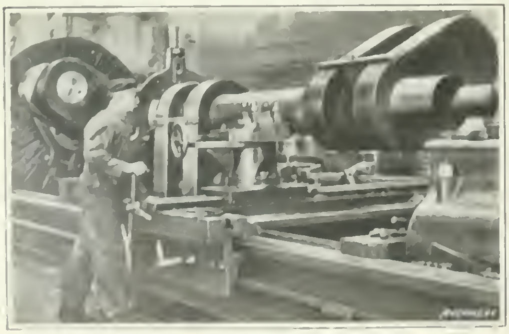

Fig. 13. Crankshaft assembled and set up on Lathe ready for finish-turning Journals and Eccentric Seats

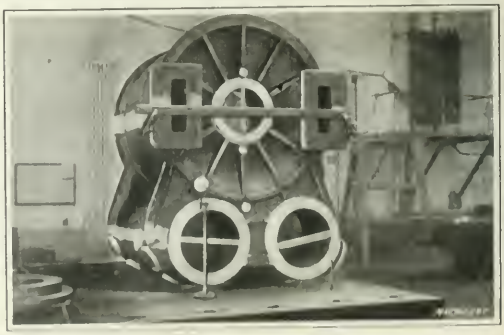

Fig. 14. Low-pressure Cylinder on Lay-out Platen ready for Inspection and Establishment of Centers and Finish Lines

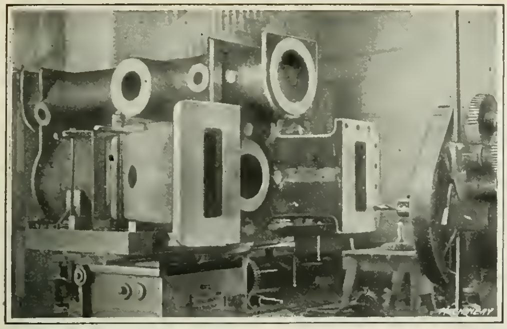

Fig. 15. High-pressure Cylinder mounted on Horizontal Mill for Boring, Milling and Drilling Operations

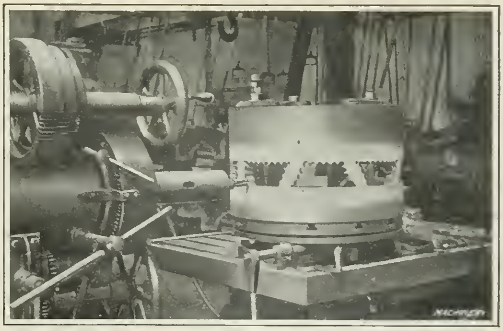

Fig. 16. Cutting out Ports of Valve Cages from Solid Metal, which gives Clean Castings and Sharp Port Edges

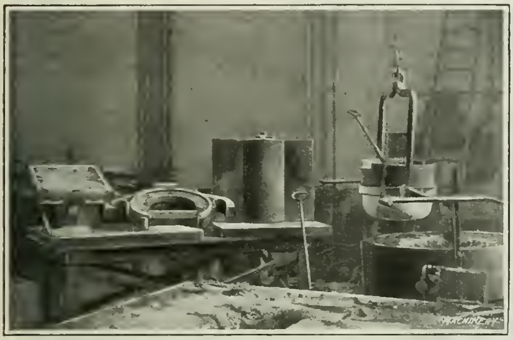

Fig. 17. Babbitting Department equipped with Oil-burning Forge, Iron Bench and One-half Ton Jib Crane

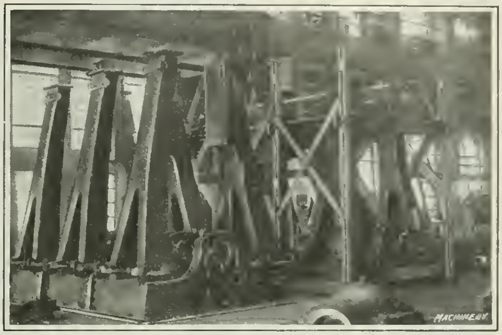

Fig. 18. Starting Erection of Engine in Shop. Three Sections of Bedplate are bolted together and Columns erected

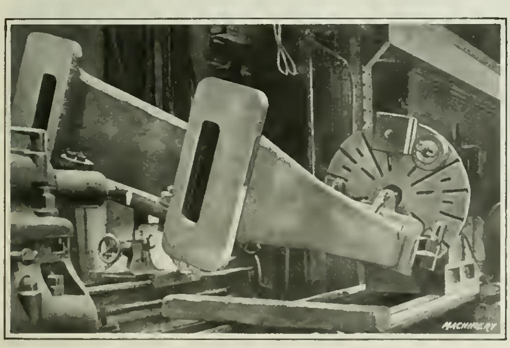

Fig. 19. Method of squaring Column Ends. It is a Common Practice to square these Castings up on a Planer

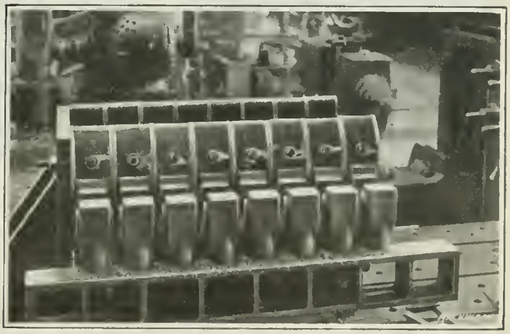

Fig. 20. Arrangement for planing Eight Horseshoe Bearings, thus reducing Time for Operation

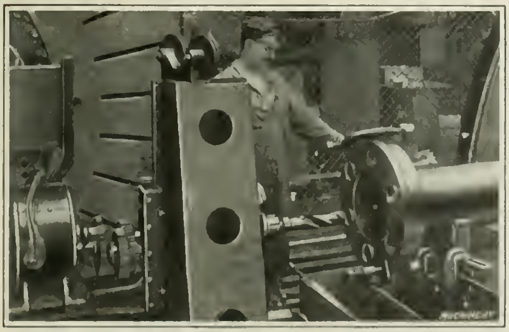

Fig. 21. Portable Machine mounted on Lathe for drilling and reaming Bolt Holes in Coupling Flanges

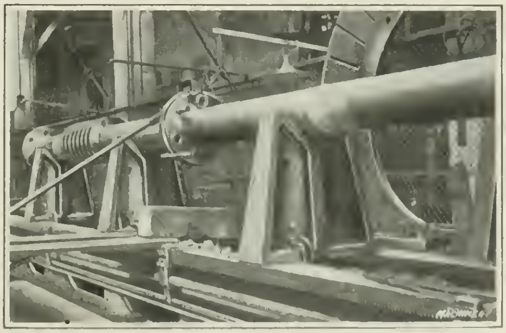

Fig. 22. Thrust and Tunnel Shafts lined up in V-blocks for finish-reaming Coupling Bolt Holes by Hand

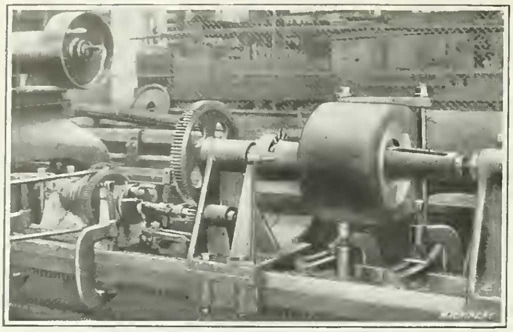

Fig. 23. Tapered Boring-bar mounted in Special Fixture that can be moved along Ways to Different Lugs on Work

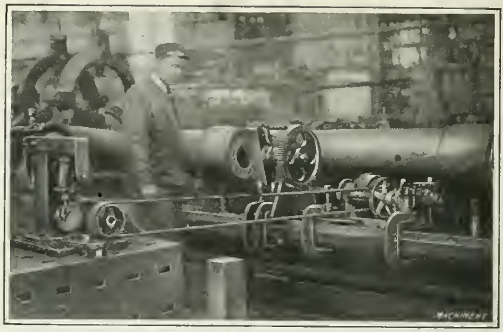

Fig. 24. Same Machine as shown in Fig. 23 with Facing Head installed for squaring up Faces of Lugs to provide Perfect Seating for Nuts

being planed as one solid block to the required shape. The holes for the dowels are drilled before the shims are separated. This method of making shims effects a great saving of time over individual machining.

Engine Links, Shafts and Cylinders

The engine links are of the Stephenson double-bar type, bolted together onto thimbles with through fitted bolts. The general dimensions of the link bars are 1⅝ by 5¼ by 38 inches; the bars are finished all over and planed to a radius of 8 feet, 5 inches. The eccentric-rod pins are forced into the bars and riveted over on the inside of the bar. The bars are planed in pairs on the radius planer attachment shown in Fig. 9. This method of planing links has been in use for many years and is very satisfactory. The link blocks are made from a one-piece billet planed to section, as illustrated in Fig. 10, which also shows the billets on the Newton cold saw being sawed up into six pieces. By this method time and labor are saved over rough-forging the six blocks and then machining them. Fig. 5 shows the completed block with the gibs secured, planed to the same radius as the link bars.

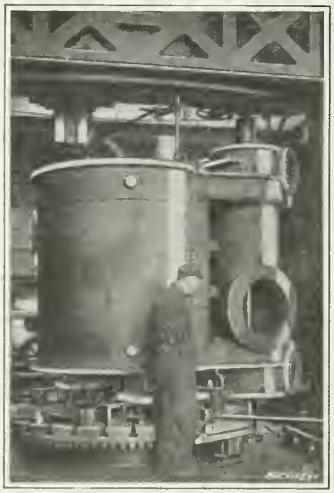

Fig. 25. Low-pressure Cylinder on Boring Mill. Cylinder Bore is finished and Valve Chest is being bored

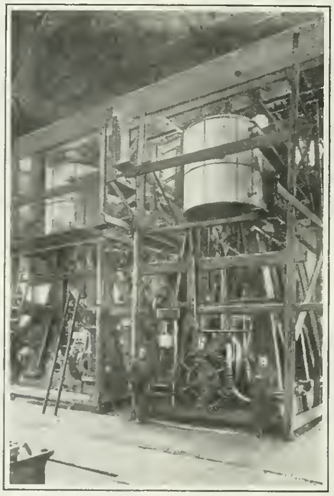

Fig. 26. Starboard Engine completed with Turning Gear installed as it will be under Actual Conditions of Operation

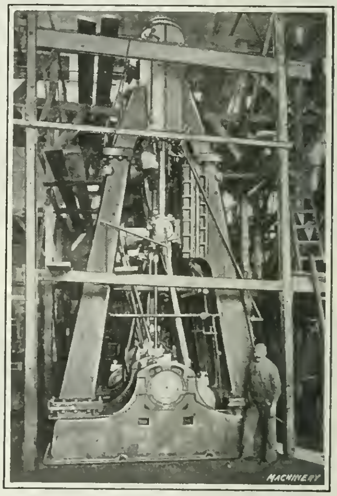

Fig. 27. High-pressure Cylinder End of Starboard Engine ready to be dismantled for Transfer to Ship

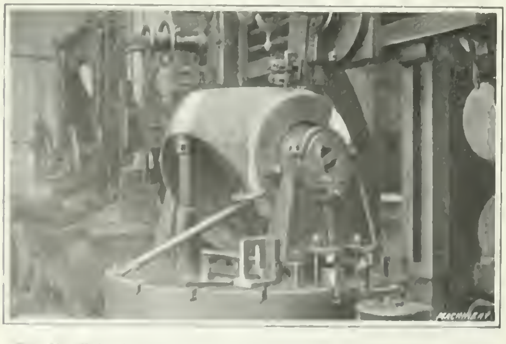

Fig. 28. Hub of Propeller with Shaft Hole bored and fitted with Cast-iron Arbor held in V blocks to machine Taper Fits for Blade Seats

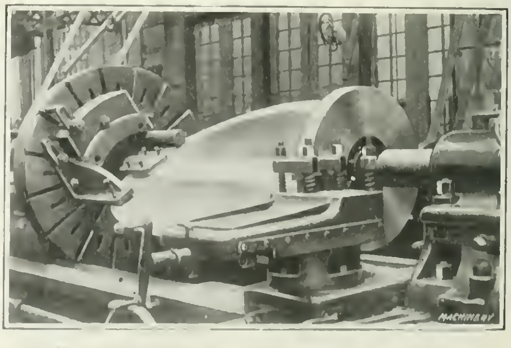

Fig. 29. Propeller Blade centered and set up in Lathe for facing and turning Tapers to fit Hub

The crankshaft is composed of fourteen pieces, which are assembled by shrink fits. It is 18 feet, 7¾ inches long, and weighs 20,600 pounds. The diameter of the journals is 12¼ inches, and of the crankpins, 12 inches. The three-throw cranks are set at 120 degrees, their sequence being high-pressure, intermediate-pressure and low-pressure. Fig. 6 shows the method of removing stock from crank-webs. Thirty-one holes, 1 1/16 inch in diameter, are drilled for the crankpin end, and thirty-three holes for the shaft hole. The thin webs left between the holes are easily parted by the use of a special broach, which is guided by the drilled hole, and carries a ⅛-inch cutter. By this method a 200-pound billet is pushed out, as shown in the illustration. Fig. 11 shows the webs, in pairs, secured to the slotter platen for the operation of rounding the ends and cutting the keyways. These webs are carried through to the finishing operations in pairs and are not released until completed. This insures perfect alignment when they are shrunk onto the pins. Fig. 12 shows the web mounted on a radius planing attachment, having a clearance cut at the top of the web. This is to facilitate feeling of the crankpin brass while in motion. In Fig. 13 is shown the crank assembled and set up on a lathe ready for the finish-turning of the journals and the eccentric seats.

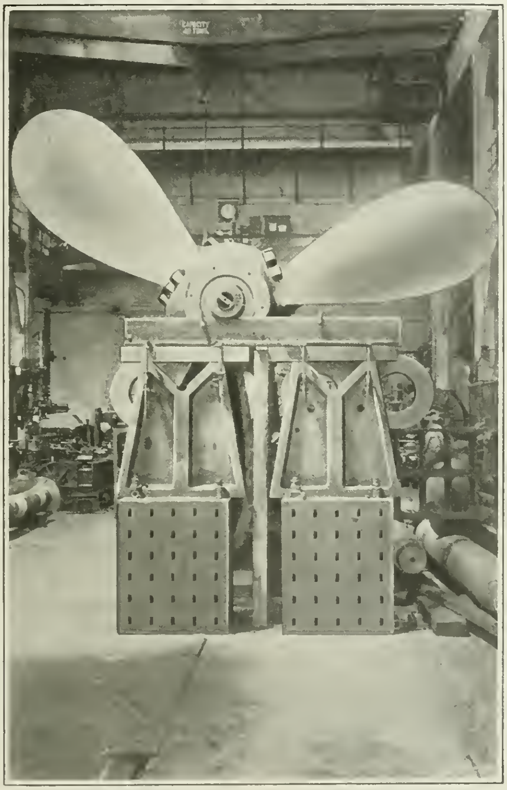

Fig. 30. Completed Propeller being tested for Balance preparatory to sending it on Board Ship for Erection

In the manufacture of this crankshaft, the crankpins and webs are machined to finish dimensions before they are shrunk together, while the shaft, including the journals and eccentric seats, are finished true on centers after the parts have been shrunk and bolted together. This is to overcome any irregularities that may have developed during the process of heating and shrinking. The shafts run true to within 0.016 inch after being shrunk together. The heat for expanding the webs is furnished by two Hawk burners. The amount allowed for all the fit is 0.01 inch diameter.

Each engine has three cylinders. The high-pressure cylinder and the intermediate cylinder have one valve each, but the low-pressure cylinder has two; all the valves are of the piston type. The high-pressure cylinder is 20¼ inches in diameter; the intermediate cylinder is 37½ inches, and the low-pressure cylinder is 60¼ inches. Fig. 14 shows the low-pressure cylinder on the lay-out platen for inspection and establishing the centers and finished lines. Fig. 25 shows the same cylinder on the boring mill. In this case the cylinder bore has been finished and the valve chest is being bored with a 6-inch boring-bar, the cylinder remaining stationary and the boring-bar being driven by the boring and drilling attachment that is installed on the cross-rail of the machine. Great accuracy can be procured by boring the valve cages in this way, as the bar can be set parallel with the center line of the cylinder before starting the work. With this method the cylinder is bored, faced and drilled at one setting. Fig. 15 shows the high-pressure cylinder mounted on a large Bement & Smith horizontal mill. This machine permits boring, milling and drilling at one setting. The table on which the cylinder is secured can be revolved on its vertical axis to any desired angle, making any operation possible. Fig. 16 shows the method of cutting out the ports of the valve cages from solid metal; by this method clean castings and sharp port lines are produced.

Fig. 17 shows a babbitting space equipped with an oil-burning forge and iron bench and a one-half ton jib crane. On the bench are shown the horseshoes for the thrust, also the cross-head shoes and a form for the babbitting of the main bearings and caps.

In Fig. 18 is shown the beginning of the shop operations of erecting the engines; the three sections of the bedplates are shown bolted together and the columns are erected. On the starboard engine, the high-pressure cylinder is shown placed on the columns. The leveling of the bedplates is of the greatest importance in erecting engines of this type. In this case, a surveyor's transit was used to a good advantage, as the ordinary shop levels are not reliable enough for this work. Great accuracy in leveling foundations in the shop erecting is necessary, for most of the lining up of the various parts is obtained by the plumb-line. In placing these foundations on the erecting floor, they were set to the same lines and angles they would have when installed in the ship; this point was necessitated by the communicating shaft used for turning the engines. The lay-out of shaft centers on the ship was so perfectly done that these communicating shafts fitted without any change being made from the shop set-up. Fig. 26 shows the starboard engine complete with the turning gear installed. Fig. 27 shows the high-pressure cylinder end of the starboard engine ready for dismantling. These engines were finished in every detail, including oil-pipe, water cooling lines, indicator gear, counter and gages. Upon completion in the shop the engines were dismantled in three complete sections, the high-, intermediate- and low-pressures, loaded on flat cars, hauled to the fitting out pier, and reassembled in the ship.

Fig. 19 shows the method of squaring up the ends of the columns that support the cylinders; these castings are in most cases squared on the planer, but the writer prefers the method shown, because it saves time and insures greater accuracy. The lugs for the center and cross-bar are cast on, and the 4-inch bar shown is secured with fitted bolts. The center holes are laid out and reamed on the lay-out platen before the columns are placed in the lathe. For the convenience of measuring the finished length of the column, a tram gage is used and all columns are finished to equal length. The length of the finished columns is 12 feet, and each column weighs from 4000 to 6000 pounds. Fig. 20 shows the arrangement for planing eight horseshoe bearings in one setting.

The shafting, the total length of which is 136 feet, 8 inches, is composed of the crank, thrust, tunnel, stern-tube and propeller shafts. The stern-tube shaft is entirely cased with a water-tight bronze sleeve. All outboard bearings on the shafting are of hard bronze and run in lignum-vitæ bearings, with the wood placed endwise. Fig. 21 shows a portable milling machine mounted on the ways of a 60-inch lathe and used for drilling and reaming the bolt holes in the coupling flanges. An interchangeable drilling jig is secured to the flange and is centered by the outside diameter of the coupling. Fig. 22 shows the complete thrust and tunnel shafts carefully lined up in V-blocks for the purpose of finish-reaming the coupling bolt holes by hand. All coupling bolts are tapered and without heads, and are accurately fitted to the reamed holes.

Rudder Machining Operations

The machine operations on the rudder show an original and ingenious method of boring and facing the rudder pintel fits. The rudder weighs 18,000 pounds; its length is 23 feet, and its extreme width, 8 feet. Four pins are fitted into taper-bored holes, ordinarily called pintels. After stretching a piano wire through the cored holes and establishing the correct centers for the rudder to pivot on, the casting is placed on the ways of a large lathe and set central and parallel with the ways on one side of the lathe. Fig. 23 shows the tapered boring-bar mounted in a special fixture that can be moved along the ways of the lathe to the various lugs that are to be machined. It will be noticed that the bar is made tapering, the same as the pintel, and the tool is carried in a square groove and is fed with a screw and star feed. The power is furnished by a small air engine, and is transmitted through a 14-inch lathe headstock to the bar driving gear. Fig. 24 shows the same machine, with a facing head installed, squaring up the faces of lugs suitable for the perfect seating of the nuts. This method worked out satisfactorily with a small labor cost.

Machining Operations on Propeller

The two propellers were of the built-up type, with steel hubs and three bronze blades. Fig. 28 shows the hub with the shaft taper hole bored and fitted with a cast-iron arbor, which is mounted on a pair of V-blocks on the platen of a 60-inch boring mill for machining the taper fits for the blade seats. When one seat is finished, the hub is revolved 120 degrees and the next one is machined, until the three seats have been completed. Fig. 29 shows one of the blades centered and placed in a 48-inch lathe for facing and turning tapers to fit the hubs. Gages have been previously machined for calipering the diameter and gaging the angles. Fig. 30 shows the completed propeller being tested for balance.

* * *

INDUSTRIAL DEVELOPMENT IN FRANCE

L. R. Duffield, of the Machinery Exhibition Department of the Philadelphia Bourse, sees evidence that France is preparing to become self-sufficient in machinery and machine tool manufacture, and even a competitor of the principal machine tool building countries, at the close of the war. In his opinion, France will have gained more industrially by the war than any other nation, not excepting America. She is buying millions of dollars worth of steel machinery and machine tools in the United States. The Bourse received inquiries for more than one million dollars worth within thirty days in the late summer, over half of which came from France, the remainder being from South American, Swedish and Norwegian firms. France plans to become industrially independent and to place "Made in France" products in international competition. She is bending every effort to become also a great dye, chemical and pharmaceutical manufacturing and exporting nation. A large part of her war industrial organization can be transformed for this purpose after peace is declared. She has gained a sense of confidence in her ability to manufacture, and her industrial organization is highly developed. Before the war the French were largely bankers, and silk, perfume and wine producers. Her leading men did not dream that she could become independent of Germany, England and America for her machinery and machine tool needs. Now they know different, and are preparing to act.

* * *

Because of the high prices of coal, the Honduras National Railway is forced to burn wood. In the past, when unable to obtain coal, the railway used coroza or cahoon nuts, but the intense heat these generated injured the boilers.

USE OF PULVERIZED FUEL ON LOCOMOTIVES[1]

When solid fuel is burned on grates in a modern locomotive, from 45 to 70 per cent of the heat is absorbed by the boiler. Most of that which is wasted is due to incomplete combustion, sparks, cinders, smokebox gases and combustible in the ash. Owing to the necessarily limited grate area, the high draft essential to induce sufficient air through the grates for combustion causes these enormous losses. Generally speaking, it is necessary to break up any fuel to such uniform size that the oxygen in the air can unite perfectly for combustion. For the best results, coal should be sized to about three-inch cubes, but as this is impracticable, because of methods of mining and the cost, a mixture of fine and large coal is usually supplied, which tends to burn irregularly and results in a reduction of boiler capacity and efficiency. A one-inch cube exposes but six square inches of area for absorbing oxygen and liberating heat, but when pulverized to the proper fineness it will expose from twenty to twenty-five square feet; hence the first essential for complete combustion is the breaking up of the fuel into dry, minute and uniform particles. Then by diffusing these so that each may be surrounded with the right quantity of air, it will be possible to burn practically all the available combustible. Any solid fuel that, in a dry pulverized form, has two-thirds of its contents combustible, is suitable for pulverizing, and to produce the best results should be mechanically dried and milled so that it will be of about the same dryness and fineness as portland cement.

In the process of burning pulverized fuel, the fuel in the enclosed tank provided for the Muhlfeld system gravitates to the conveyor screws, which carry it to the fuel and pressure-air feeders, where it commingles with the air. It is then blown through the connecting hose to the fuel-and-air delivery nozzles and blown into the burners. Additional air is supplied and the mixture is drawn into the firebox by the front-end draft. More air is supplied in the furnace where complete combustion of the fuel in suspension takes place. The liquid ash runs down the under side of the roof, sides and ends of the furnace, and is precipitated into a self-cleaning slag-pan, where it solidifies into a mass that can be readily dumped. The blower is driven by a constant-speed turbine which requires no regulation or control. The fuel conveyors, feeders and comminglers are driven by a variable-speed steam turbine which is controlled by the fireman.

The waste of fuel from the stack, where coal having a large percentage of dust and slag is used; the lowering of the firebox temperature and draft, due to opening the fire door; and the resultant variation in steaming and general results under high rates of burning fuel on grates, are entirely eliminated. With pulverized fuel a locomotive having the boiler filled with cold water may be brought under maximum steam pressure within an hour, and the fuel feed then stopped until it is needed for service. When standing or drifting, the fuel feed can also be discontinued, as the steam pressure can always be quickly raised. From the actual operation of steam locomotives, the use of pulverized fuel has demonstrated in particular the practicability of eliminating smoke, cinders, sparks and fire hazards; increasing draw-bar horsepower per hour per unit weight; reducing non-productive time at terminals; improving the thermal effectiveness of the locomotive as a whole; utilizing otherwise unsuitable or waste fuels; eliminating arduous labor; providing greater continuity of service; and producing more effective and economical operation and maintenance.

* * *

The coefficient of friction of solid rubber tires on cement and vitrified brick roads is about 0.6, while that of pneumatic tires under similar conditions is 0.5. The coefficient of adhesion is greater than that of friction and incidentally this partly explains why a motor car stops more rapidly when the wheels are kept moving than when they are locked; hence the increased danger when a car skids if the rear wheels are locked by the brakes.

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[1] Abstract of a paper read before the Minnesota Section of the A. S. M. E., March 10, 1917, by John E. Muhlfeld, New York City.

JIGS AND FIXTURES FOR MILLING AND ASSEMBLING

FEATURES OF DESIGN OF SOME SPECIAL FORMS

BY S. HELWEG[1]

IN manufacturing interchangeable parts, it is necessary to have a complete set of tools and gages. The two chief factors in designing these tools are the construction and the cost. Much thought should be given to the construction, as the quality and cheapness of the parts to be manufactured largely depend on the tools. Care should be taken to lay out the jig or fixture in such a way that the parts to be machined will be properly located, and so that the operator who uses the tools cannot get the work in wrong and thus spoil the parts. The fixture should be easily loaded and unloaded, and it should be as open as possible, to make cleaning easy and to prevent

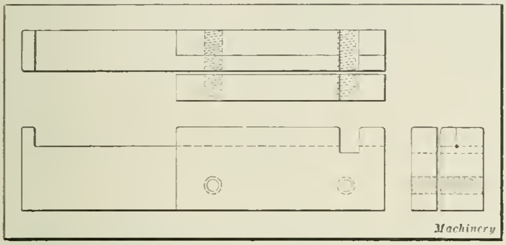

Fig. 1. Detachable Vise Jaws for Use in cutting off Bar Stock

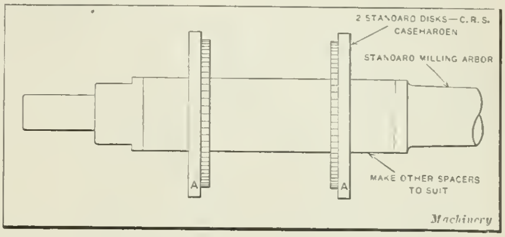
2 STANDARD DISKS—C. R. S. CASEHARDEN
STANDARD MILLING ARBOR
MAKE OTHER SPACERS TO SUIT
A
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Fig. 2. Arrangement of Cutters used with Fixture shown in Fig. 4

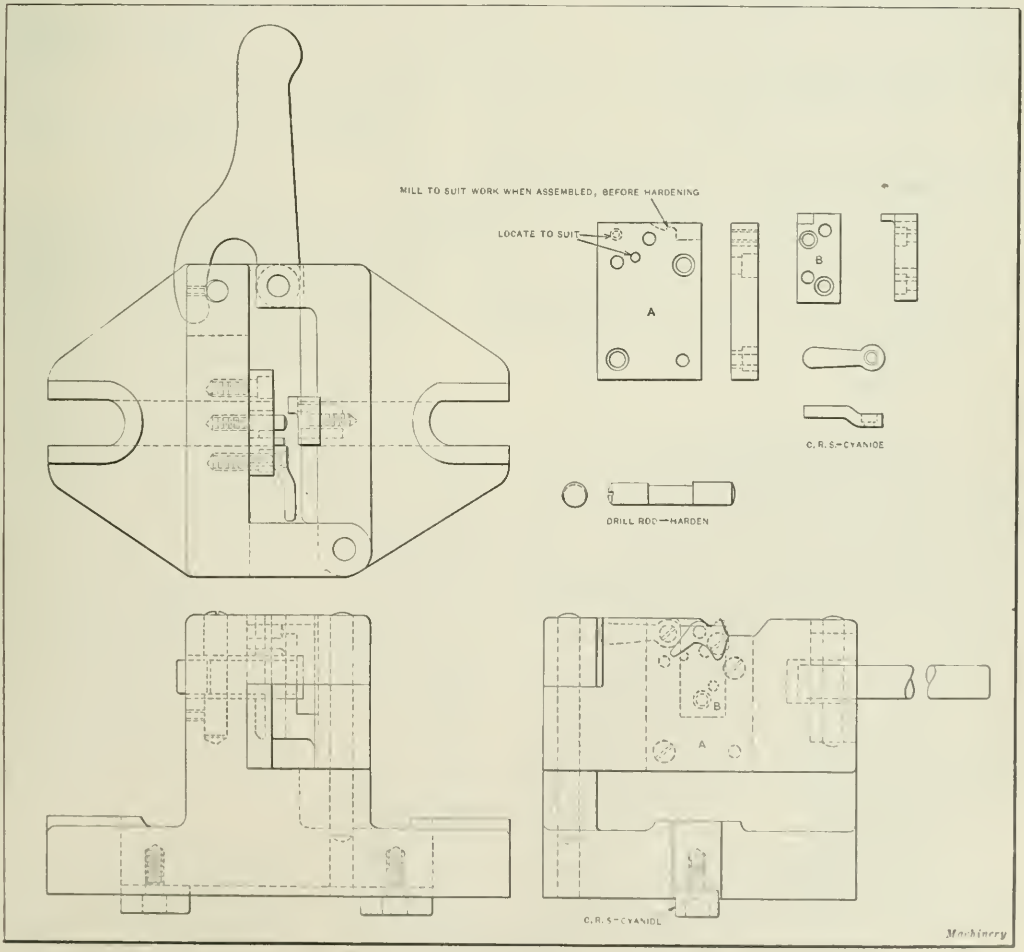

Fig. 3. Fixture for holding Work while milling Point

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[1] Address: 260 Gold St., Brooklyn, N. Y.

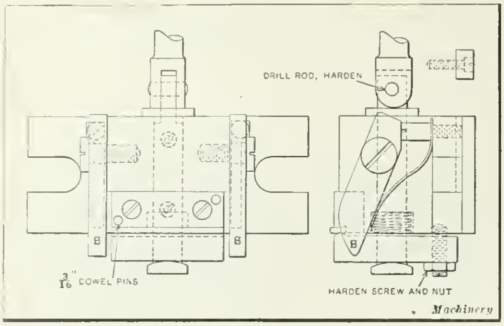


Fig. 4. Straddle-milling Fixture

pockets for chips. Hardened steel seats should be ground parallel with the base after assembling to obtain the best results. To bring the cost as low as possible, the tool parts should be standardized wherever practicable. Jig bodies and fixture bases should be made of cast iron and kept in stock in various sizes to meet the requirements of the shop. Clamping cams, dowel-pins, bolts and screws should be made up in large quantity, and steel seat blocks, straps and other steel parts should be made of standard stock sizes, if possible, to prevent unnecessary machining.

The cheapest kind of milling fixture that can be built is a pair of detachable vise jaws, as shown in Fig. 1. These jaws are made of cold-rolled steel and casehardened. They can be removed from the vise quickly and replaced by other jaws. It is advisable, however, to use vise jaws only where great accuracy is not required, such as when cutting to length or milling clearance cuts. The jaws here shown are used for cutting off pieces from a bar of stock, which is pushed up against the stop and then cut off to the desired length.

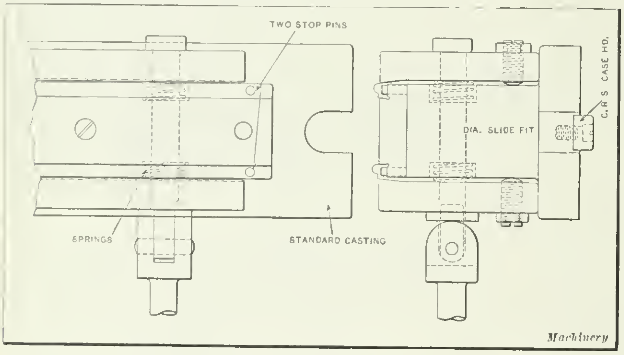


Fig. 5. Fixture for machining Two Parts in One Operation

In Fig. 3 is shown a standard milling fixture where the part to be machined is located on a stud and held against a stop-pin by a small cam; then the fixture leaf is closed and the work is held in place ready for milling. The base, leaf and cam are made of cast iron. These fixtures should be machined and fitted in large quantities, with the exception of steel seat block *A* and clamping block *B*, which are made to suit the job in hand.

When accuracy in length is essential, a fixture like the one shown in Fig. 4 can be used to advantage. The part to be machined is cut to the approximate length in vise jaws or with a power hacksaw and then straddle-milled in the fixture. Here it is located between the two pawls *B* and clamped in place by the strap and cam. On the arbor shown in Fig. 2 are mounted two steel disks *A* about ¼ inch larger in diameter than the two side milling cutters. When the fixture is fed underneath the arbor, these disks depress the pawls and give clear passage for the cutters. On the same arbor can be mounted other cutters to suit the work. This arbor should never be taken down, as it is important that the distance between the straddle-mills be kept constant; the cutters should be ground on the arbor.

The milling fixture shown in Fig. 5 is made for machining two parts in one operation. On the cast-iron base is mounted a double seat block and the seats are ground after assembling. The parts to be milled are clamped in place by cam binders at each end and two straps. By using set-screws in the straps, accuracy in making the cams is not necessary, and wear on the cam faces can be taken up by these adjusting screws. The fixture shown in Fig. 6 is very effective, as the strap can be pulled back out of the way, leaving the whole seat block uncovered, so that a brush can be easily inserted for cleaning, when necessary.

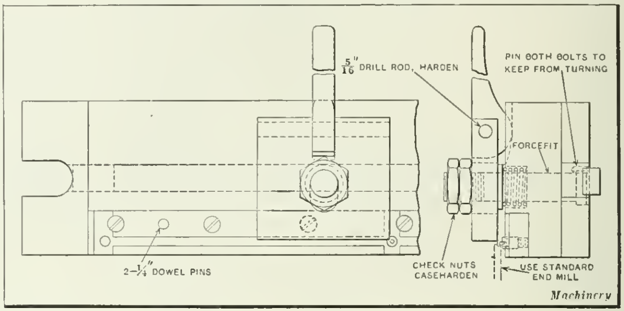


Fig. 6. Fixture that can be easily cleaned

Assembling Fixtures

When assembling different parts, hand-riveting should be avoided wherever possible, foot-presses or small power presses being used with suitable fixtures. In Figs. 7 and 9 are shown simple but effective riveting punches and dies to be used in presses. First, the hub is assembled with the lever. The hub is seated in a hardened steel bushing and staked over with a plain 60-degree point punch. After assembling, the shoulder rivet is secured in place with a star riveting punch. As the head of the rivet is flattened on two sides, it is necessary to locate the two parts in the right relation to each other. This is done by mounting the lever on a pin and locating the rivet on a stud, where a milled groove brings the rivet in the right relation to the center of the lever.

A riveting fixture with a self-contained punch is illustrated in Fig. 10. The part to be assembled is located on a pin and the head of the stud rests in a recess in the steel anvil. This

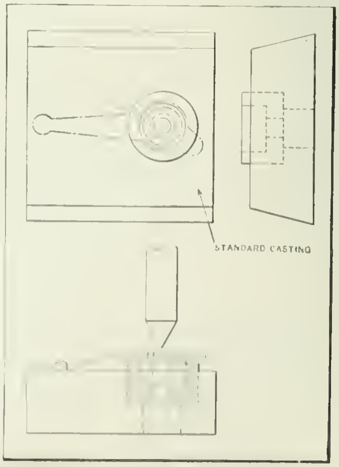


Fig. 7. Simple Riveting Punch and Die

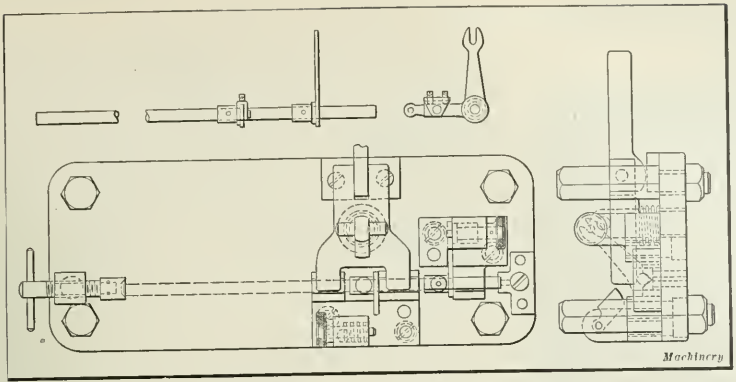


Fig. 8. Open Assembling Jig for drilling and reaming Holes for Taper Pins

fixture can be used both in a press and for hand-riveting, as the punch is always in line with the stud to be riveted.

When pinning one or more levers and arms on a shaft, it is necessary to design assembling drill jigs for locating the different parts in the right relation to each other and at the right distance from the end of the shaft. Two jigs for this purpose are shown in Figs. 8 and 11. One is an open-style jig, where the drilling is done through bushings in the base; the jig is then turned over and the holes taper-reamed from the open side, after which the parts are pinned. The other is a leaf jig, where the shaft is clamped by the leaf and the bushings are located in the leaf. When taper-reaming and pinning, the leaf is opened. The illustrations show clearly how the parts are located in the right relation to each other.

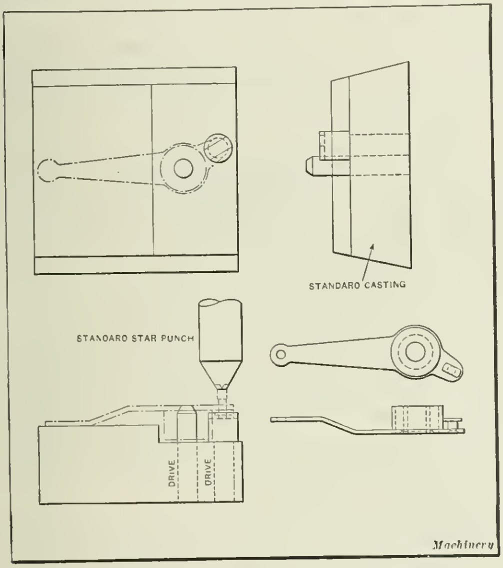


Fig. 9. Another Type of Simple Riveting Punch and Die

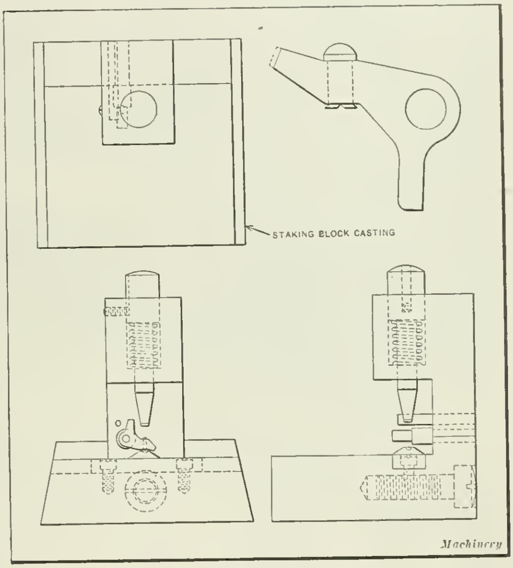


Fig. 10. Self-contained Riveting Fixture

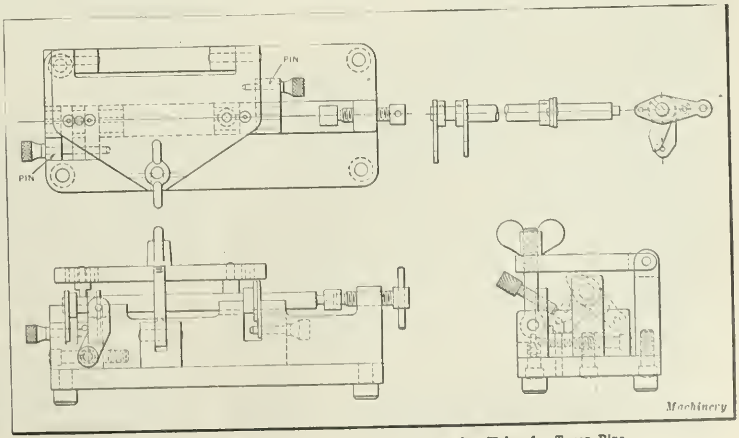


Fig. 11. Leaf Assembling Jig for drilling and reaming Holes for Taper Pins

* * *

Three million feet of mahogany and black walnut will be required for the propellers of the aeroplanes America is expected to build in its first year at war.

ELECTRICAL EXPORTS

American electrical apparatus is gaining rapidly in popularity the world over. The value of electrical machinery, appliances and instruments exported from the United States in the fiscal year 1917 aggregated more than $50,000,000, against $20,000,000 in 1914, $10,000,000 in 1911, and $6,000,000 in 1900. Of the telephones exported (nearly $2,000,000 worth), more than $100,000 worth went to Asia, about an equal value to South America, nearly as much to Oceania, $300,000 worth to our North American neighbors, and practically $1,000,000 worth to Europe. The total value of telephones exported in 1917 was twice as great as in 1912. The largest market for electric fans was India, while the Straits Settlements, China, Japan, and even Siam imported a large number. The total exports of electrical apparatus of all kinds in 1917 was nearly ten times as much as in 1910 and thirty times as much as in 1900.

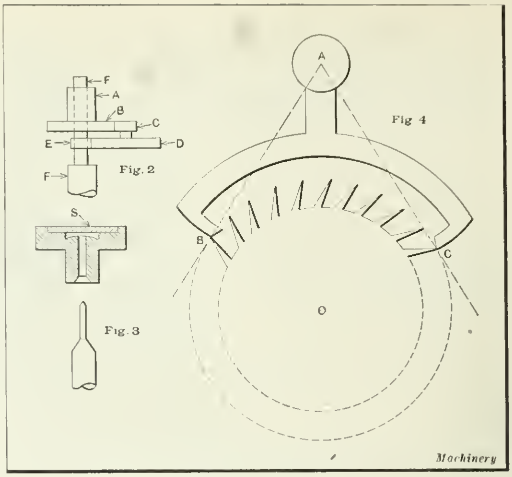
DESIGNING AND CONSTRUCTING A CLOCK

BY GUY H. GARDNER[1]

The accompanying illustrations show how a machinist, with scant knowledge of horology, designed and constructed a timepiece whose running compares favorably with that of "regulators" costing $100 or more. The construction is ordinary lathe work, but the designing called for some knowledge of escapements and compensating pendulums, which were supplied by a friendly watchmaker. As the machinist had no gear-cutting facilities, he was obliged to use stock gears, the pitch of which is coarser than that used in most high-grade clock trains, and the performance of the clock has led him to suspect that undue importance is sometimes attached to fineness of pitch. The high cost of brass led to the use of sheet steel for the plates, bushings of phosphor-bronze being inserted for the pivots to run in. The bushing holes were reamed with what the watchmaker calls a "broach"—a five-sided reamer—and finished with a similar round tool used with oil.

In Fig. 1, *S* denotes sprocket wheels. The large wheel *A* has 240 teeth; the center wheel *B*, 120 teeth; the center pinion *C*, 20 teeth; the third wheel *D*, 72 teeth; the third pinion *E*, 12 teeth; and the escape pinion *F*, 12 teeth. All these are 48-pitch brass gears. The sprocket marked S_4 has its arbor squared on the front end for a key. The arbor carries a ratchet wheel, and a pawl prevents backward rotation; it winds right handed. The motion work, or "back-gears," shown in Fig. 2, consists of the cannon *A* for the hour hand; the hour wheel *B*, which has 60 teeth of 32 pitch; the minute pinion *C*, which has 20 teeth of 32 pitch; the minute wheel *D*, which has 96 teeth of 48 pitch; the cannon pinion *E*, which has 24 teeth of 48 pitch; and the center staff *F*.

For both ends of the center staff and the escape-wheel staff, which carry the minute and the second hand, respectively, the bushings have a simple straight hole, with a countersink to hold oil, and are without caps. For all other pivots, the bushings are made as in Fig. 3 and are capped with thin disks of hardened steel; this form of bushing causes the oil to be held by capillary attraction about the end of the pivot. These pivots are coned on the end, and are allowed about 0.020 or 0.025 inch end shake. This arrangement makes it possible for the clock to run at least two years before requiring cleaning and fresh oil. The disk *S* is tool steel, hardened and surfaced bright. It is held by fillister-head screws, not shown, the heads of which overlap the disk.



Figs. 2 to 4. Important Details in Clock Construction

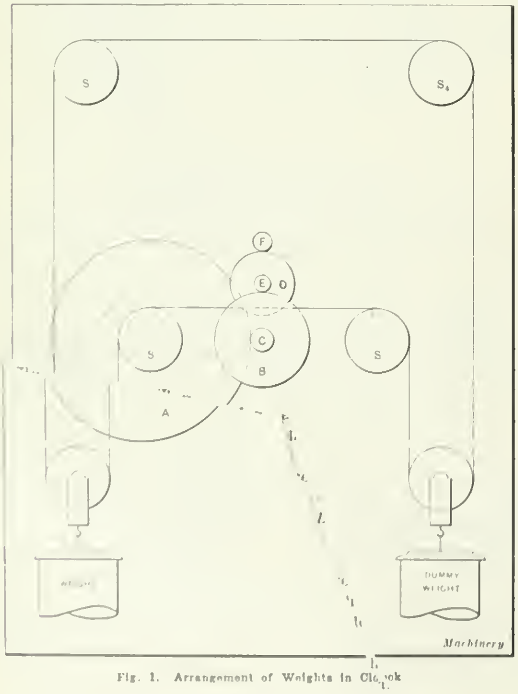


Fig. 1. Arrangement of Weights in Clock

The escapement presents no difficulties after its underlying principles are comprehended. As Fig. 4 shows, the center distance between the escape staff and the pallet arbor is readily determined, either by calculation or by lay-out, as it depends solely on the outside diameter of the escape wheel and the number of its teeth embraced by the pallets. As is usual in clocks beating seconds, this wheel has thirty teeth, of which the pallet embraces ten. As lines *AB* and *AC* are tangent to the circumference of the wheel, it is easy to determine the center distance *AO* and the radii for laying out the locking "planes." The "lift lines"—the beveled edges of the pallet—are at an angle of 30 degrees to the tangents *AB* and *AC*. The so-called locking planes of the pallet are not planes, but, as in all "Graham" escapements, are curved surfaces that have the same axis as the pallet arbor. The pallet is of tool steel, hardened, and the locking surfaces are lapped in the lathe, the pallet being mounted for this purpose on a stud carried by the tool-block.

In all high-grade clocks there has to be some device to keep the movement running during the winding, as otherwise several seconds will be lost each week. For this purpose a spring-driven "maintaining power" is usually employed, but in the present design this is unnecessary, as the drive is by an endless sprocket chain, and the act of winding the clock does not interfere with its operation. The clock was designed to be wound by a key and to run eight days. However, the builder has attached an electric device whereby a small motor winds the clock at the end of every hour for another hour's running, but this is not an essential part of the design. It was added, the owner says, "just to make the clock complete." If the motor or the battery should fail to perform its function, the clock will continue to run until the end of the week.

The pendulum rod is well-seasoned, straight-grained, white pine, and is thoroughly shellacked. It is of elliptic cross-section, except for about 14 inches at the bottom, where it fits a square brass tube running through the center of the bob. The adjusting screw below the bob is cut thirty-six threads per inch, and the nut has thirty graduations to facilitate regulation; one graduation corresponds nearly to one second in twenty-four hours.

The bob is of 1¾-inch brass tubing, about 12¾ inches long, and is filled nearly to the top with shot; the exact quantity must be determined by experiment, as will be explained later. The weight and also the dummy weight on the opposite loop of the chain are of the same tubing. This dummy is added solely for appearance's sake, and both weights, like the pendulum bob, are plated with nickel. The driving weight contains about two pounds of lead. As all the staffs are of drill rod, the pivots ground after hardening, and the whole train carefully constructed, a much smaller weight will drive the clock, but it was thought best to allow an ample margin.

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[1] Address: New London, N. H.

The case is made of birch, finished to resemble mahogany; it is of unusual strength and solidity. The back is of hard wood, 1½ inch thick, with two strips of ½- by 1½-inch steel set into gains to prevent warping. These strips carry the studs to which the movement is held by a "three-point" fastening, while the piece that carries the suspension spring of the pendulum is bolted to the upper one. The axis of the pallet arbor, produced, would pass through the under surface of the "chocks" holding the pendulum suspension. The dial is 12 inches in diameter.

The compensating property of the pendulum depends on the fact that lead has a higher coefficient of expansion than wood, and its adjustment was effected in the following manner: When the clock was otherwise completed, the pendulum bob was filled with shot to a depth of 11½ inches and the clock run for several days in a room open to the winter air. Its rate having been found and recorded, the room was warmed and a run of an equal number of days showed that the compensation was inadequate, as the clock ran more slowly in the warm room. More shot was accordingly added to the bob and the trials in cold and heated rooms repeated. This tedious process was continued until satisfactory compensation was attained, after which the regulation by the nut at the bottom of the bob finished the job.

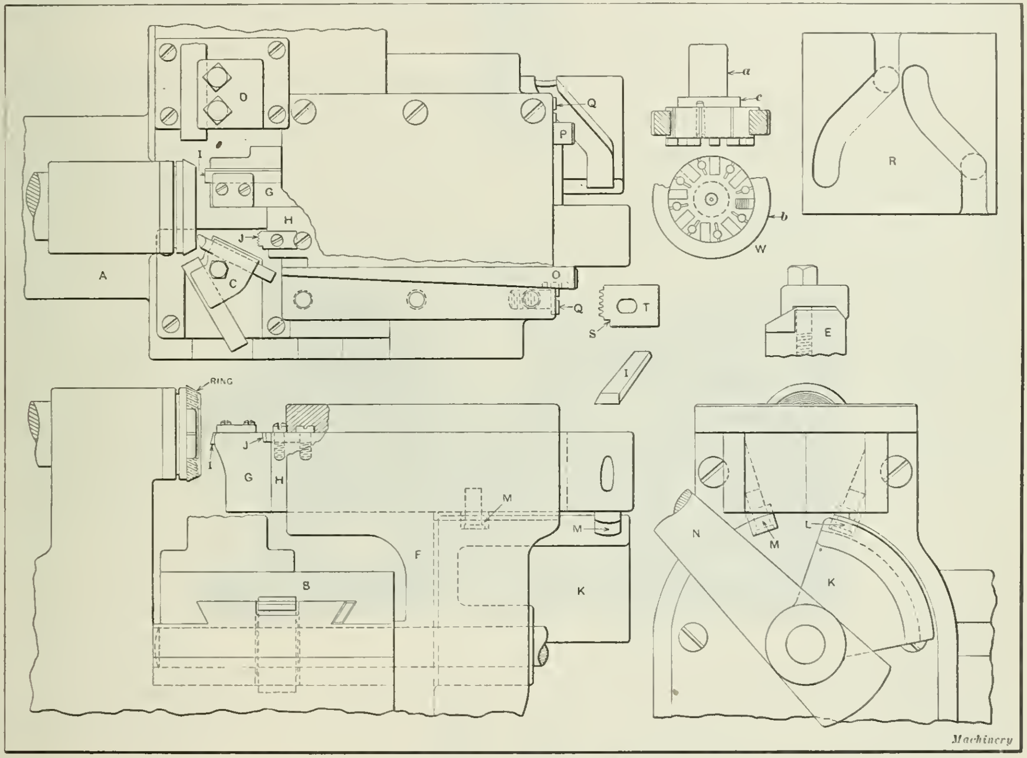
* * *

An alloy for soldering cast iron, melted steel, aluminum, etc., recently patented, consists of twenty-five parts each of lead and tin and fifty parts of zinc. After the articles to be soldered are cleaned, they are covered with stearic acid, or similar flux, and the alloy is applied with an extra hot soldering copper.

RING TURNING, FACING AND SERRATING MACHINE

BY DONALD A. BAKER[1]

The accompanying illustration shows the details of a simple special machine for completely finishing the bottom ring of the Type 80 time fuse after it has been reamed and one side has been faced. The capacity of the machine is from 3500 to 4000 finished rings per ten hours, as it can be run continuously. The spindle does not have to be stopped when putting on or taking off the rings. The frame of the machine *A* is mounted on cast-iron legs. The cross-slide *B* is similar to that used on turret lathes, but of a much more rigid construction. In a tool-block *C* in the front of the cross-slide are mounted the rough-turning and rough-facing tools; these are regular high-speed tool bits. At the back of the cross-slide is mounted the finish-shaving tool *D*. An end view of this tool and its holder is shown at *E*. Attention is called to the clamp, which holds the tool down and also draws it back against the holder. Instead of being tangent to the work, the tool is held at an angle of 5 degrees and is intended to stop just a little behind the vertical center line of the work.



Ring Turning, Facing and Serrating Machine

A substantial bracket *F* is bolted to the lower half of the cross-slide and to the frame of the machine. The top part of this bracket is planed out to receive the two tool-slides *G* and *H*. One of these slides *G* carries a roughing tool *I* that removes most of the stock and prepares the face of the ring for the serrating tool *J*, carried by the other tool-slide *H*. These two slides are operated by a segment of a drum cam *K* which bears against two hardened tool-steel cam rollers *L* and *M*, which are held on studs secured to the tool-slides. The cam is actuated by a hand-lever *N*. This lever, the cam and a gear that engages with a rack on the top half of the cross-slide are keyed to the same shaft, so that all the tools that work on the ring are operated by this lever.

The front angle roughing and facing tools are brought up to the work at the same time that slide *G*, carrying its tool *I*, moves forward, so that all three tools are presented to the work at the same time. When the hand-lever *N* is pressed down, these tools are moved back and the angle shaving tool *D* and the serrating tool *J* are moved forward to do their work. The hand-lever *N* is then brought back to a neutral position, when all the tools are out of the way sufficiently to allow of the ready removal of the ring. A lay-out of the cam used to actuate the tool-slides is shown at *R*. The two tool-slides *G* and *H* are held sidewise by the taper gibs *O* and *P*. These gibs are adjustable and are held in place by hardened screws *Q*, the heads of which enter slots in the sides of the gibs.

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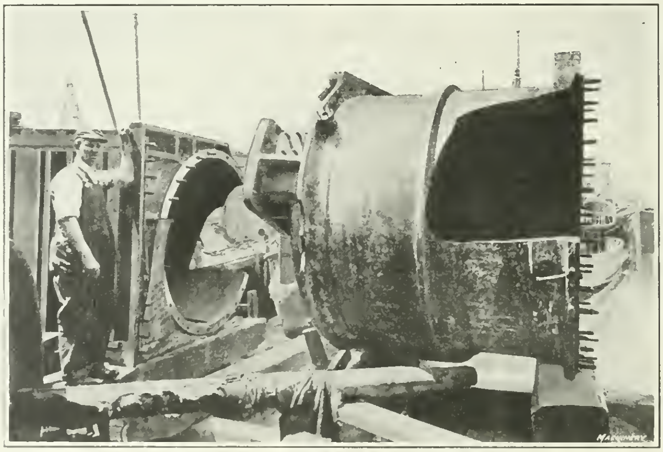
[1] Address, Layman Pressed Rod Co., 1790 Broadway, New York City.

An enlarged view of the serrating tool is shown at *T*. This is made from high-speed flat stock and is held in place by two screws, as shown. An elongated hole allows a slight adjustment to be made by placing thin shims of steel behind the tool. The step *S* in the tool takes care of the depth of the serrations from the top of the ring, as it faces off the top at the same time that the serrating is being done, and assures that all rings will gage correctly at this point, providing the tools are made right.

The novel method of making these serrating tools is illustrated at *W*. A mandrel *a* is first turned up, good centers being left in the ends. Next slots are cut in the circumference, into which the serrating-tool blanks, which have been milled to size on two sides and one edge, can be placed. These slots are of a uniform depth and hold the tool in the same relative position that it will have in the tool-slide. Then holes are drilled and reamed to take taper pins, as shown, and narrow saw slots are cut down through the center of each taper-pin hole, so that when the tool blanks are tapped into place, pins driven into the holes will wedge the metal on each side over against the tool blanks and hold them securely while the outside and the step are being turned. As extra support, a close-fitting ring *b* is forced on over the arbor to hold the tool blanks while they are being formed on the face and backed off. This last operation is done by holding the arbor in a special chuck and backing off the tools by using the lathe backing-off attachment. A collar *c* is screwed onto the arbor *a*, against which the back end of all the cutter blanks rest, thus holding them in a uniform position.



Broken Cylinder Castings from a German Liner

While this machine was designed for the bottom ring, it may be used for the top ring with equally good results, but in that case only one tool-slide is required for finishing the top of the ring, as there is no serrating to be done. While the machine as a whole somewhat resembles a turret lathe, every detail is of much more rigid construction, especially the spindle, the cross-slide, and the tool-slides, there being as little overhang in all parts as possible, and no indexing of a turret with its accompanying inaccuracies to contend with.

* * *

DETAILS OFTEN IGNORED

BY GEORGE F. KUHNE[1]

In performing certain work, we sometimes disregard the minor points, which, if they were recognized, would aid in attaining the desired end; and this is not only true of the successful executive, but of the bench hand, machinist and worker in general. For instance, in putting a set-screw into a pulley, bolster, or whatever the case may be, there is seldom thought given to how the set-screw is to be removed later. Or, perhaps, a nut on some part of a machine that is exposed to the weather must be removed. If the nut is stubborn, the hammer and chisel will very likely be resorted to; and if the nut should not respond (the corners having been chipped off), perhaps the Stillson wrench is applied. Had some heavy oil been put on the screw when the nut was screwed in, all this fussing and waste of time and energy might have been avoided. A few drops of oil in cases of this kind will help, but it is so small a matter that many mechanics never think of it.

Sometimes difficulty is experienced in piercing stock and a number of punches are broken; but if the steel for the punch is forged or hammered slightly, allowed to cool, turned to size and hardened in the usual manner, better results are frequently obtained. Also, if in the making of a punch for redrawing shells, tubes, etc., the piece of steel is heated, one end placed on an anvil and the other end hammered, it will be less likely to bend in hardening; but this must be done before the hole is drilled for the escapement of air; otherwise the punch may be bent after hardening as much as it usually is when this plan is not used.

* * *

AN EXAMPLE OF "GERMAN EFFICIENCY"

In one of our Atlantic shipyards these two cylinders lie, just as they were taken out of one of the interned German liners, and they show how "German efficiency" was applied in destroying these castings before the boats were seized by the American government. The cylinders are about five feet in diameter and the sections were broken out by driving heavy wedges in the cap bolt holes and at the same time applying a turnbuckle bar across the diameter of the cylinder to help break out the sections between the wedges. One of these wedges may be seen where it was left in a bolt-hole at the extreme right of the illustration. To repair this damage is several months' work, because new patterns must be made, the cylinders cast, and then machined and installed in the boats. But an accurate record will be kept of all this work, and it will be charged against the ship and held for "the day of reckoning."

* * *

The manufacture of special wire nails coated with a rosin compound for use in box nailing machines is a small but important branch of the nail making industry. Box nails are tumbled to remove burrs from the heads and are carefully inspected, all crooked or defective nails being rejected. They are then coated in revolving drums with the rosin compound, and are packed in kegs containing between 70 and 80 pounds. Each keg is marked with the number of nails it contains instead of the weight, being sold by count instead of pound. The rosin compound considerably increases the holding grip of the wood on the nail and permits the use of smaller nails for a given purpose. This is important in boxes made of thin lumber, as the small nails are not so likely to split the thin material. Careful inspection is necessary to eliminate defective nails that stop the nailing machines and reduce production.

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[1] Address: 44 Washington Place, E. Rutherford, N. J.

WORK-HOLDING ARBORS AND FIXTURES

DEVICES FOR HOLDING AND CLAMPING WORK ON THE FELLOWS GEAR SHAPER

BY DOUGLAS T. HAMILTON [1]

THE methods of holding work on the gear shaper differ from those used on practically all other machine tools, especially other gear-cutting machines. The reasons for this difference are the peculiar design of the work-arbor and the construction of the machine as a whole, which is such that, with a properly designed work-holding fixture, the gear being cut can be rigidly supported. There are, of course, certain fundamental points that are of vital interest to those using the gear shaper, a few of the more important of which are here described.

A characteristic of the gear shaper that is not at first appreciated is the fact that it has a considerably greater range than appears at first sight. The capacity for diameter is 35 inches and for stroke 5 inches; but many modifications are possible, such as increasing the distance between the face of the work-spindle and the extreme lower or upper point of the travel of the cutter, and enlarging the hole through the work-spindle. The column is raised by inserting blocks beneath it, and when long-shank gears are to be held, a work-spindle having a larger hole through it is used. These particular points are mentioned, as a clear understanding of the modifications that can be made is necessary to fully appreciate some of the fixtures and work-holding outfits that will be described.

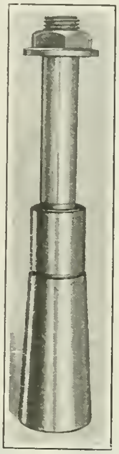

Fig. 1. Reverse-taper Work-arbor used on Fellows Gear Shapers

Design of Standard Work-arbor and Work-spindle

The work-arbor used on the gear shaper, shown in Fig. 1, is of the reverse-taper type. It differs from all other work-arbors in this respect that the tighter the work is clamped to it the more rigidly is the arbor held in the work-spindle. This can be seen from Fig. 2. By tightening the nut on the top of the work-arbor, the latter is drawn up into the corresponding taper in the work-spindle, and the work is, in consequence, bound tightly to the top face of the work-spindle. With this arrangement, it is evident that, with a work-arbor that runs true, properly machined gears can be held rigidly without springing the arbor; but if the faces of the gears are not true with the hole, the arbor will be sprung out of alignment with its true vertical plane. Instead of being a disadvantage, this point is one of the good features of the gear-shaper work-arbor, because gears that are not machined true might give trouble in assembling. The gear shaper reveals defects in the previous machining operations.

In order to test whether the gears are accurately machined or not, the first step is to clean the arbor and spindle thoroughly, and then insert the arbor in the work-spindle from the lower end. The arbor is then tested for truth, as shown in Fig. 3. If it is found to run out slightly in the first trial, it should be given a quarter turn in the spindle, as a speck of dirt may be holding it out of line. When the arbor runs true, the gear blanks are put on it, as shown in Fig. 4, and rotated by hand; this tests the concentricity of the hole with the outside circumference. A dial indicator, as shown, is used to make this test. The reading for eccentricity on the indicator is noted, and then the nut is tightened down on the work, clamping it rigidly in place.

Another test is now made, as shown in Fig. 5. If the work runs out more than it did in the previous test, it is clear that the faces of the gears are not true with the holes, and that the work-arbor has been sprung out of its true vertical plane. If the difference between the two readings exceeds the manufacturing tolerance on the gears for eccentricity, the gears should be refaced before being cut. This test is especially necessary when setting up a new batch of gears, as it eliminates troubles that might crop up in subsequent operations.

The Swinging Apron

Another characteristic feature of the gear shaper is the swinging work-apron, which permits the easy insertion and removal of the work. Work up to the full capacity of the machine for diameter and face width can be easily mounted on the arbor by simply opening the apron and swinging it back clear of the machine. Advantage is sometimes taken of this swinging feature of the apron in connection with the machining of pinions or gears integral with a shaft. The apron can be swung clear of the machine and the pinion dropped down into it. The maximum diameter of shaft that can be handled is 5 inches, but the only limitation for length of shaft is the distance between the top face of the work-spindle and the floor, and by cutting a hole in the floor to clear the shaft this limitation is eliminated. The other features of the apron are not directly connected with the methods of holding and clamping work, and so will not be described here.

Work-support on Saddle

The gear-shaper cutter can be made to operate on either the "pull" or the "push" stroke. When the pull stroke can be used, this method is preferable, because of the reverse-taper work-arbor. The pulling up of the work, which is the result of using the pull stroke, is overcome by the resistance of the reverse-taper work-arbor. As an additional support, a work-support carried on the saddle, as illustrated in Fig. 6, rests on the surface of the top plate or on the work, if the latter has a smooth, plain surface, and transfers all vibration or thrusts to the frame of the machine, where it is taken up by the massiveness of the construction. Another feature of the work-support is that it can be

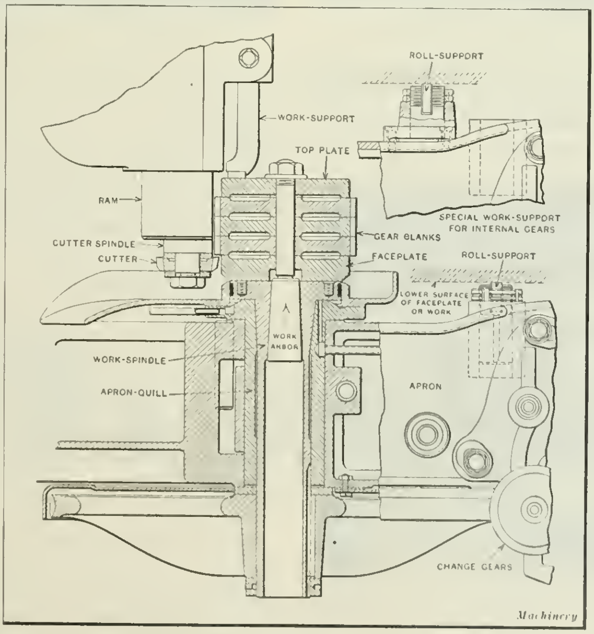

Fig. 2. Section through Work-spindle and Apron showing Construction

placed directly over the thrust of the cutter, and thus prevents not only chattering but also any springing tendency of the work-arbor. Whenever possible, the work-holding fixtures should be mounted so that the work-support can be used, as this adds greatly to the rigidity with which the work is held.

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Work-support in Apron

Another work-support is held in the apron, as shown in Fig. 2; this is used for supporting large faceplates or internal gears. It is of especial advantage for supporting internal gears which, as a general rule, must be cut by the push stroke, in which case the thrusts are down instead of up. This support, as illustrated, carries a roll that contacts with the work, reducing friction between the two members and at the same time supporting the work directly under the point receiving the thrust of the cutter. When cutting internal gears that are not large enough in diameter to reach to the support in the apron, a special support, shown in the detail view in Fig. 2, is used. This support consists of a bracket fastened by screws to the apron and carries a roll that supports the work.

Ganging of Gear Blanks

Owing to the reciprocating action of the gear shaper, there is no necessity for ganging or grouping a large number of gear blanks on the work-arbor at one time. The excess travel of the cutter is only from 1/16 to 3/32 inch; consequently little time is gained in clamping a large number of blanks on the arbor at one time. As a matter of fact, greater refinement and accuracy can be obtained by holding only a few blanks at one time. The greatest production is obtained when the blank permits the stroke of the cutter to be from 2½ to 3 inches.

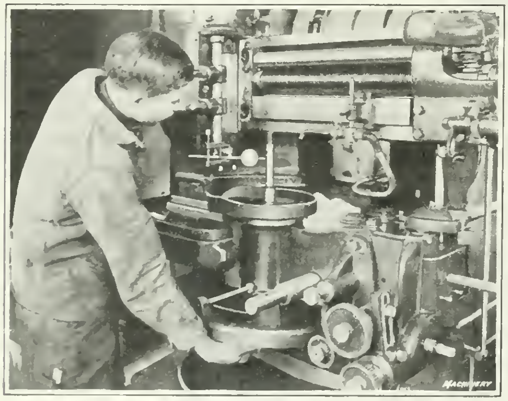


Fig. 3. Testing Truth of Work-arbor with a Dial Indicator

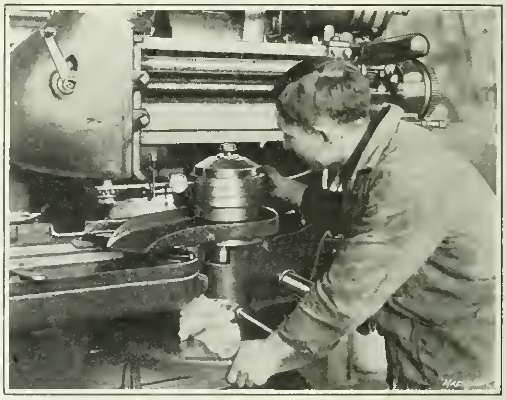


Fig. 4. Testing Concentricity of Circumference of Gear Blanks with Hole

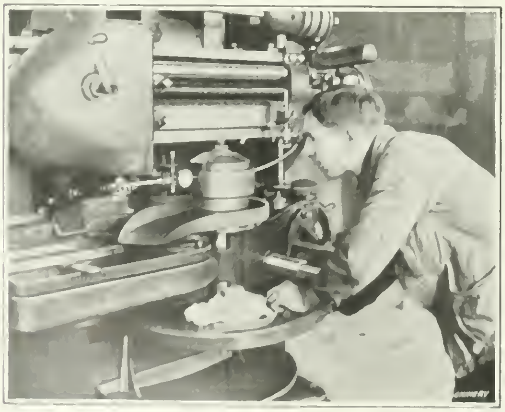


Fig. 5. Testing Truth of Gear Blanks after clamping on Work-arbor—This Test indicates if Faces are Square with Holes

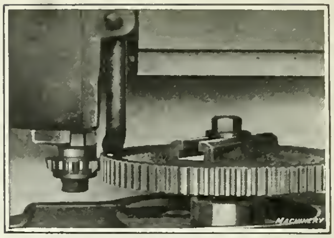


Fig. 6. Work-support mounted on Saddle—applied when Shape of Work will permit and when Cutter is operated on Pull Stroke

Two methods of holding gear blanks are shown in Fig. 7. The gear blanks shown at *A* are of the arm type and have a face ¾ inch wide. Four of these blanks are held on the arbor at one time, making a total travel of 3 inches. The work rests on a faceplate that supports it at the rim, and is clamped down by means of a top plate, against which the work-support carried on the saddle rests. This forms a compact and rigid method of holding this type of gear. The gear blanks shown at *B* have a larger hole; hence the faceplate is made with an extended shank or projection. This fits the holes in the gear blanks, and locates them centrally from the work-arbor. The top plate is also used for clamping the work down, as in the previous case, the work-support resting against it.

One exception to the rule regarding ganging is shown in Fig. 8, where the parts being held are disks for a friction disk-plate clutch. Owing to the requirements of these disks, exceptional accuracy is not necessary; as a consequence, a large number can be held at one time. The best practice, however, is to limit the travel of the cutter to 3 inches, for then the gear shaper can be operated at its greatest efficiency. At *A*, in Fig. 8, is shown the type of work fixture used for holding disks when cutting teeth on the external diameter; and at *B* the type of fixture used for cutting smaller disks with the teeth on the internal diameter. It will be noticed that the work-arbor is used simply for locating the fixture centrally and for clamping it rigidly to the top face of the work-spindle. The disks are held in the internal fixture by means of a clamping ring that has elongated slots for the screws to facilitate removal. Holes are drilled, at an angle, from the fixture pocket out to the circumference to facilitate the removal of oil and chips. Owing to the small diameter of these internal disks, the hub type of gear-shaper cutter is used; this is threaded and held directly onto the cutter-spindle, no nut being used.

Method of Holding Typical Automobile Gears

The sliding type of automobile transmission gears are either provided with a splined hole or with a square hole. When they have a splined hole, the gear blanks can usually be held directly on the work-arbor, but when they have a square hole, it is better to use bushings with a square external surface to fit the square hole in the gear and a round hole to fit the arbor. Fig. 9 shows two fixtures used for this purpose. At *A*, the hubs on the gear blanks extend past one end only; hence it is necessary to use a faceplate and a top plate cupped out to clear these projections. Bushings that are squared on the outside to fit the gear blanks and are round in the hole to fit the arbor are so made that one of the bushings extends through one gear and into the next, positively centering both gear blanks accurately with each other and with the arbor. The faceplate and top plate are made large enough so that they support the work as close as possible to the root diameter of the teeth in the gear blank.

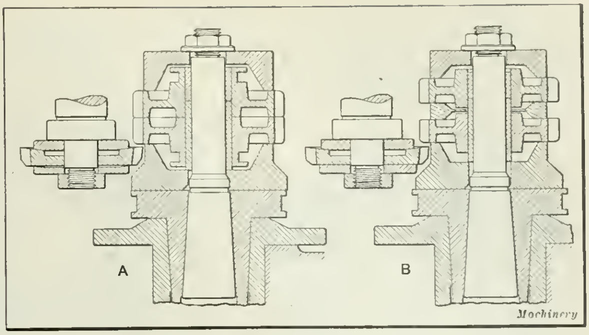


Fig. 9. Methods of holding Automobile Transmission Gears

At *B* is shown a fixture that differs slightly from that at *A*. The design of these gears is such that the hubs extend past both faces of the rims; so to get a rigid support it is necessary to provide a spacing plate of sufficient thickness to make up for the distance that the hubs extend past the faces of the rims. With this arrangement, it is obvious that the gear blanks are supported much more rigidly than they could otherwise be, and consequently can be cut more rapidly.

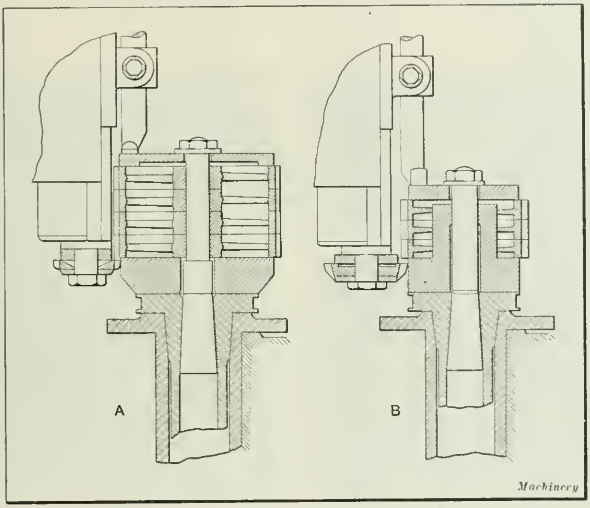


Fig. 7. (A) Method of holding Armed Gear Blanks. (B) Method of holding Automobile Timer Gears

Fixtures for Holding Shank Gears

As mentioned, shank gears can be held on the gear shaper by having the shank extend through the hole in the work-spindle and using a floating fixture or other means of clamping and supporting the work. Figs. 10, 11 and 12 show three interesting fixtures of this type. That shown in Fig. 10 was designed for holding the pinion shaft for a lathe. This shaft is of such diameter that the standard work-spindle cannot be used; hence it is necessary to use the largest work-spindle, which has a capacity of 5 inches in diameter. The fixture comprises two bushings *A* and *B*, which are inserted into the work-spindle and held in place by screws, as shown. The lower bushing *B* is supported by a lower plate *C*, which is fastened to the lower end of the work-spindle. Inserted in the bushings *A* and *B* are two additional bushings *D* and *E*, the former being split into two parts to facilitate removal of the work. The work, which has a shoulder on it, is clamped against bushing *E*, by means of a through bolt *F* and nuts *G* and *H*; nut *G* is pinned to the through bolt, but nut *H* is removable. With this work fixture, it is possible to support the work directly from those points on which it rotates when assembled in the machine in which it is to be used; consequently, the teeth in the blank can be cut concentric with the journals upon which the shaft rotates in the bearings.

A somewhat similar fixture is shown in Fig. 11. In this case the pinion blank is much shorter; consequently, a shorter bushing can be used. This fixture is fastened directly to the top face of the work-spindle and the bushing is made to fit the two bearing surfaces on the gear blank. The gear blank has a small shoulder which rests on a projection in the bushing. The blank is clamped directly into the bushing by means of a lower plate and a through clamping bolt, as illustrated. The through bolt is keyed to the lower plate to prevent its turning. The cutter is mounted so as to operate on the push instead of the pull stroke, because of the narrow recess in which the cutter must work. As far as the design of the fixture is concerned, however, the cutter could be made to work on either the pull or the push stroke. In Fig. 12 is shown a fixture of this type that was designed for cutting internal gears; the cutter in this case also operates on the push stroke.

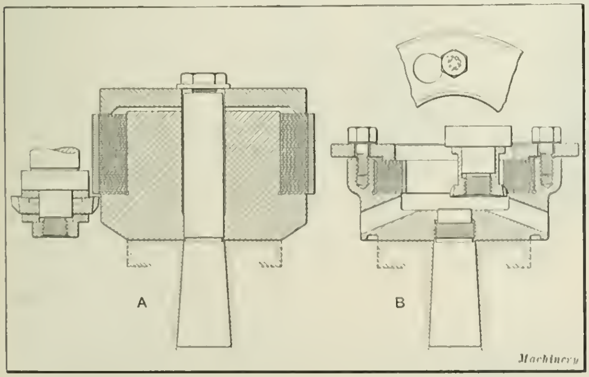
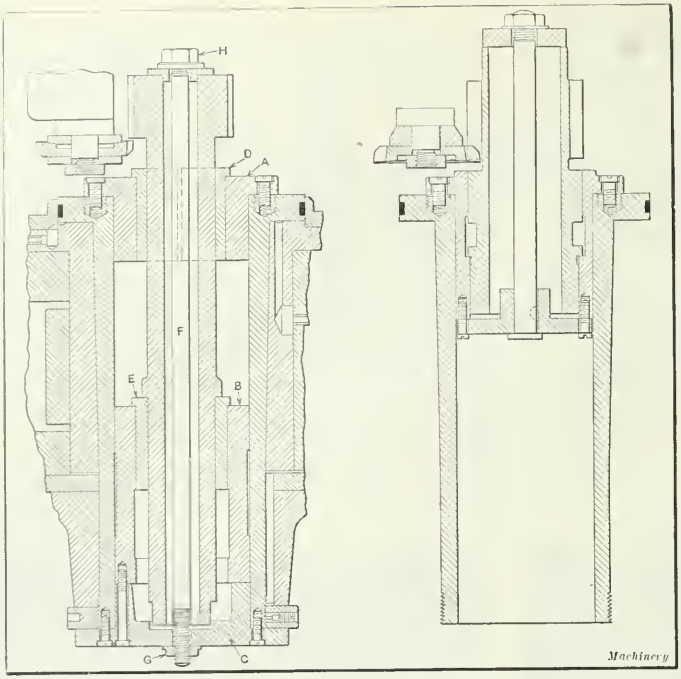


Fig. 8. Methods of holding Disks for Automobile Disk Plate Friction Clutches

Holding Shank Gears in Floating Fixtures

In the previous examples, the gear blanks were held in fixtures that located the work directly from the hole in the work-spindle. In Figs. 13 and 14 two fixtures are illustrated in which the floating principle is adopted. In the fixture shown in Fig. 13, the lower end of the work is guided by a taper bushing *A* fitted into the lower end of the work-spindle and the work is clamped and located by a floating fixture *B*, which is fastened by screws to the top face of the work-spindle. It carries a bushing that fits the shank of the gear, and the latter is clamped in the fixture by a headless screw and segment brass shoe. In setting up, this type of fixture is trued up before it is rigidly clamped to the work-spindle. The method used is to put the gear blank in the fixture and have it extend sufficiently above the bushing



Figs. 10 and 11. Fixtures for holding Large-shank Gears on No. 64 Gear Shaper

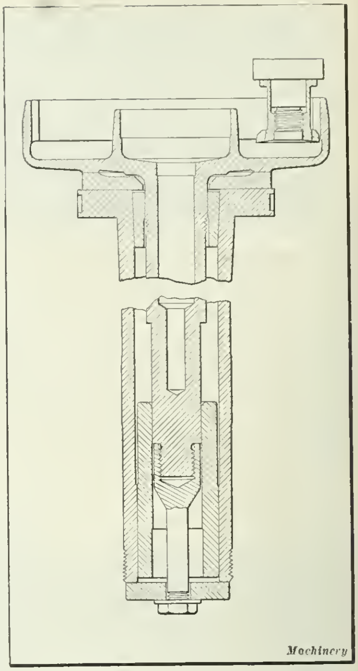
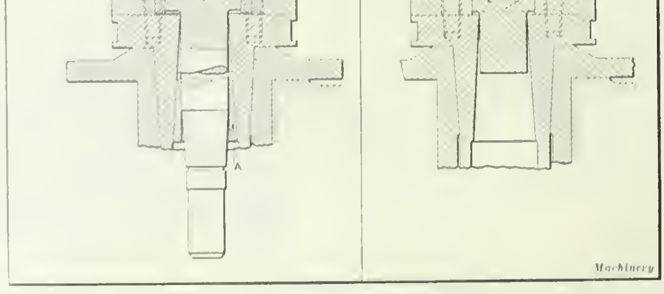


Fig. 12. Fixture for holding Internal Shank Gear

for the needle of an indicator to be brought to bear on it. The fixture is then shifted into a position where the bearing on the gear blank runs dead true, when it is clamped rigidly to the work-spindle and the gear blank is pushed down into place and clamped. By following this procedure, the pitch circle of the teeth will be concentric with the bearing from which the pinion shaft is located when in use. In this particular case, the pinion is provided with helical teeth and the helical gear-shaper cutter is used, operating on the push stroke.

In the fixture shown in Fig. 14, the gear blank has a much shorter shank; hence it does not require an additional support or guide in the work-spindle. The floating fixture, as before, is fastened directly to the top face of the work-spindle and carries a bushing for centering the work. This fixture is trued up in the manner just described.



Figs. 13 and 14. Floating Type of Fixtures used for holding Gears with Extended Shank

Special Work-arbor Support

In cases when a long work-arbor is necessary, or the work has an extended shank that, owing to the design of the gear and the point where the teeth are to be cut, cannot be so located as to pass through the work-spindle, it is necessary to provide a work-arbor support. A case in point is the oil-pump drive shaft for an aeroplane motor, shown in Fig. 15. In this case, a helical gear is to be cut in the rear of a bevel gear, and extending out from this is a long shank. This particular gear represents a difficult holding proposition, so the special fixture illustrated was designed. The work-arbor is provided with a very short projection, which is made to fit a special faceplate that it centers and that is clamped to the top of the work-spindle. This faceplate also centers the lower end of the drive shaft. The work is clamped to the faceplate by means of a through bolt and plate, as illustrated, the through bolt being keyed to the faceplate to prevent its rotation, and provided with a head to prevent its being pulled out of the faceplate. At the upper end, the drive shaft is supported in a bushing, which is retained in a special bracket *A*. This bracket, in turn, is held on a large stud *B*, which passes down through the special support, and is located at the rear end by means of another stud *C* centered by a bushing. The lower end of the large stud is provided with annular gear teeth in which pinion *D* meshes. This pinion, as shown in Fig. 16, extends out from the special bracket and is squared on the end to fit a crank-handle. By placing a crank-handle on the squared end of the pinion-stud, the large supporting stud *B* can be raised or lowered so as to move the top bracket *A* from the work. A screw *E* is also provided for clamping the elevating stud to increase the rigidity of the fixture. The bracket itself is so

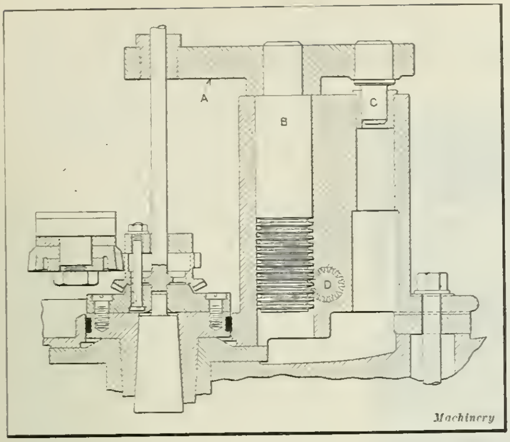


Fig. 15. Special Work-arbor Support for Extra-long Arbors and Shank Gears

made that it forms the cover *F* for the apron; it is clamped also to the apron by a through bolt passing through the hole ordinarily occupied by the support in the apron (see Fig. 2).

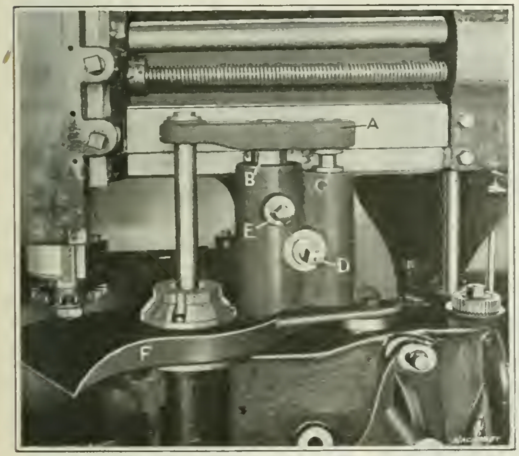


Fig. 16. Method of mounting Special Work-arbor Support

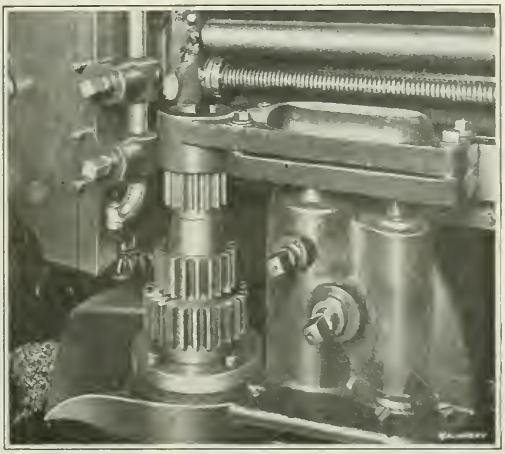


Fig. 17. Special Fixture for supporting Cluster Gear

A fixture constructed along similar lines is illustrated in Fig. 17. In this case, the fixture is used for holding a cluster countershaft gear. The hole in the lower end of the countershaft gear fits over a special work-arbor, which is clamped directly to a plate fastened to the top face of the work-spindle, the bolts passing through the holes in the flange of the gear. At the upper end it is supported in a bushing in the special type of work-support. In cutting this particular gear, the two lower gears are cut with the cutter operating on the push stroke, and the upper gear with the cutter operating on the pull stroke.

Still another fixture of this type is shown in Fig. 19; this is used for holding a herringbone reduction pinion that has an extended shank on both ends. One shank passes down through the hole in the work-spindle, whereas the other shank extends up through the special support. The lower end is supported by a fixture, which carries a locating finger that holds the blank in the proper relation to the cutter, so that the teeth will match. The shoulder of the gear rests on the top face of the work-spindle and is held down by a clamping collar and screw from the lower end, the lower shank being provided with a tapped hole.

Fixture for Holding a Large Internal Gear Ring

Fig. 20 illustrates a fixture used for holding a large internal gear ring. This fixture is made with a hub in the center in the form of a wheel, and is held centrally by means of the work-arbor. It is provided with a machined shoulder, which locates the ring centrally and against which the work is clamped by means of toe clamps, as illustrated. This is a very simple fixture and is easily and quickly operated. Of course, it is necessary on work of this kind to open the apron in order to remove the work from the fixture.

Still another method of holding an internal gear is shown in Fig. 21. In this case, no fixture except the regular work-arbor is necessary. The gear blank being held is a combined internal and external helical gear, and is supported at the rim by means of the support held in the apron. Owing to the small diameter of the internal gear, the regular roll support cannot be employed; hence a disk made eccentric with the shank so as to reach over far enough to support the work is

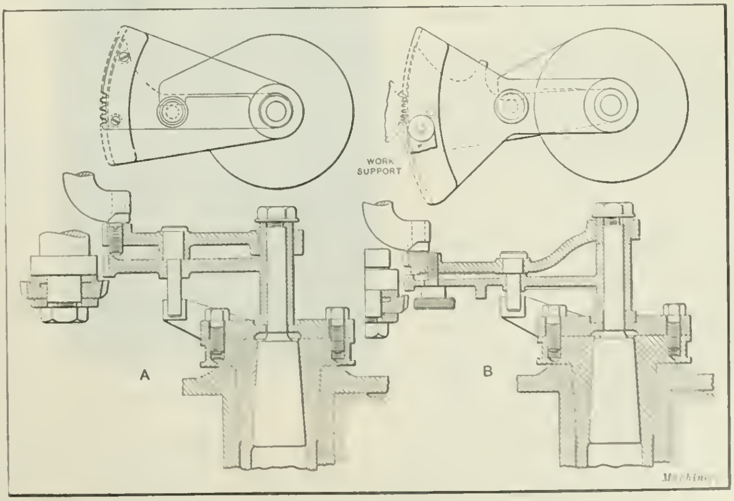


Fig. 18. Two Types of Fixtures for supporting Quadrants for Automatic Saw Trimmers

used. The cutter is operated on the push stroke and the thrust is taken directly on the support in the apron. Owing to the fact that when cutting an internal gear an intermediate gear is introduced into the change-gear mechanism, the greatest production can be obtained by cutting the internal and external gears in separate settings.

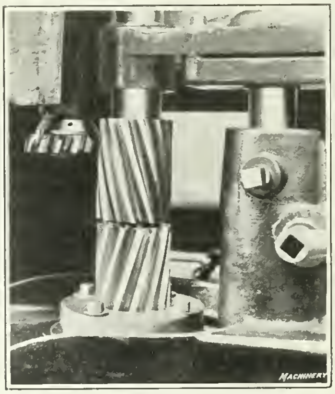


Fig. 19. Special Fixture for supporting Herringbone Reduction Pinion

Simple Fixture for Holding a Cam

A simple type of floating fixture used for holding a motion-picture cam is illustrated in Fig. 22. The fixture is so made that it is fastened directly by screws to the top face of the work-spindle, and is split for clamping the special arbor on which the work is held by means of a nut. The irregular outline on this cam must bear a certain relation to one of the three holes in the cam, so a pin is driven into the fixture to fit one of these holes, and thus locate the work in the correct position. The cutter also must start to operate at a certain point on the work; the simplest way to do this is to set the cutter to a master cam. Change-gears are selected so that the work makes two revolutions to one revolution of the cutter. The cutter is made twice as large as the blank being cut and one-half revolution of the cutter completes one cam.

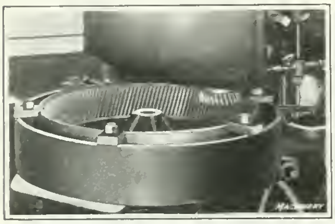


Fig. 20. Fixture for holding Large Internal Gear Ring

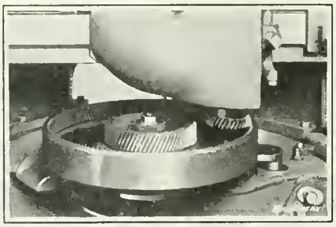


Fig. 21. Method of holding Internal and External Helical Gear Blank

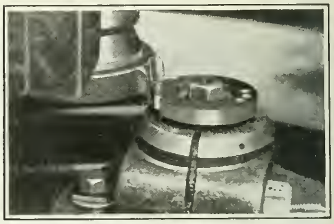


Fig. 22. Simple Type of Floating Fixture for holding Cam

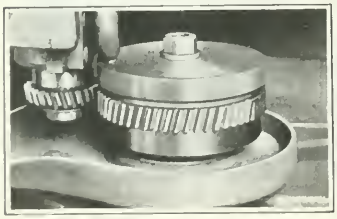


Fig. 23. First Setting on Herringbone Gear Blank

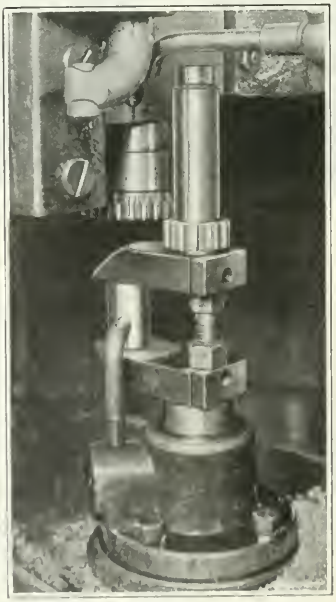


Fig. 24. Method of supporting Single-throw Crankshaft

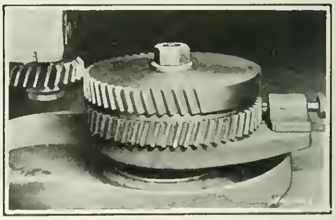


Fig. 25. Second Setting on Herringbone Gear Blank

Method of Holding Herringbone Gear Blanks

Figs. 23 and 25 show how herringbone gear blanks are cut on the gear shaper. The first operation, which is illustrated in Fig. 23, is a simple one; it consists simply in locating the gear blank on a faceplate and clamping it down by means of the nut on the arbor. The work support held on the saddle is then brought to bear on the top face of the gear blank to provide additional support. The helical cutter is operated on the pull stroke working into the recess.

For the second operation, it is necessary to use a locating fixture. As shown in Fig. 25, this consists of a special faceplate having a boss fastened to it in which a locating pin is held. This pin is beveled to fit in the tooth space in the gear previously cut, and thus accurately centers it with the cutter. The method of locating the herringbone gear in which the teeth are not staggered is done in two ways. When a master gear is available, the cutter can be set to this, but when not, the cutter must be rotated by hand and lined up with the lower points of the teeth in the gear previously cut.

Holding Odd-shaped Work on Gear Shaper

The work shown in Fig. 18 is a quadrant for an automatic saw trimmer. It has a boss with a hole through it and the teeth are cut at the rim of the segment. The fixture used comprises the regular work-arbor, which is made to fit the hole in the boss and is long enough to carry a special supporting fan-shaped bracket. This bracket is placed on top of the quadrant being operated on, and is held by the regular arbor-nut. On the outer end, near the rim, it carries two headless screws, which are brought to bear against the top face of the rim of the quadrant. It also carries a stud, which is used for locating the quadrant in the correct relation to the cutter. In order to preserve this relation, a special faceplate is used; this has an extended boss against which this locating stop is brought to bear. The cutter is operated on the pull stroke, and the thrust is taken directly by the work-support held on the saddle, which rests on the top of the quadrant support.

A somewhat similar fixture is illustrated at *B*, Fig. 18. In this case, however, the headless screws are dispensed with and a clamping screw binds the top supporting plate to the work.

The fixture shown in Fig. 24 was not made especially for the work in hand but was rigged up to handle a comparatively small number of parts. The work is a single-throw crankshaft on which an external gear is to be cut close up to the cheek of the crank. The fixture is of the floating type with a hole through it to fit the shank of the crankshaft. A stop locates the gear teeth in the correct relation with the crankpin. The cheeks of the crankshaft are prevented from collapsing by a nut and screw.

PRODUCTION OF METAL FURNITURE

PLANNING, ESTIMATING, DESIGNING, CHECKING AND MANUFACTURING

BY K. GEORGE SELANDER [1]

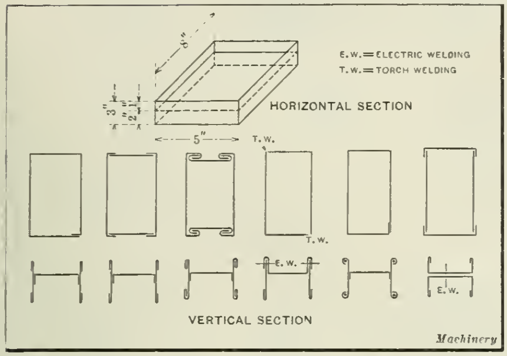


Fig. 1. Display Tray for Department Store, which illustrates Principles in Metal Furniture Design

LITTLE has been written of the actual process of making metal furniture. Though some parts of the work, such as welding, estimating, bending allowances, designing forming tools, etc., have been described by various writers, the real process of development of a piece of furniture has not been described. According to its use, metal furniture may be divided into ten classes: bank equipment, library equipment; office equipment, which may be subdivided into the American and the European systems; ship furniture; equipment for the government, such as post-office boxes, shelving and bag racks, court-house equipment, etc.; telegraph and fire-alarm equipment; interior of railroad cars and automobile bodies; factory equipment; household equipment, such as chairs, kitchen cabinets, etc.; and miscellaneous equipment, which includes articles often made of wood or other material that can be made at a profit from sheet steel. According to its process of manufacture, metal furniture may be divided into two classes, built-to-order and stock work. At first, only built-to-order furniture was made, but the tendency has been to produce stock work to a greater and greater extent during the past eight years, so that some firms are now specializing in this work and a few are making a specialty of certain classes of furniture, such as office filing devices, desks, safes, etc. Considering the breadth of the field, it is surprising that so few engineers and draftsmen have shown interest in metal-furniture manufacture.

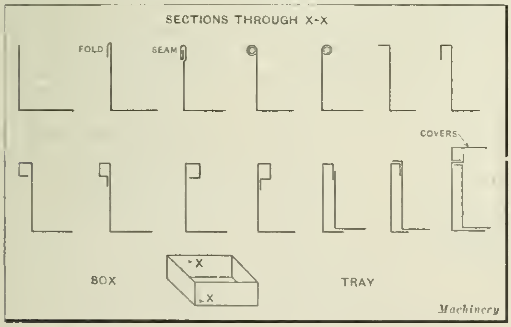


Fig. 2. Vertical Sections through Boxes of Similar Construction, showing Variations in Design

The manufacturing process consists of six steps: planning, estimating, engineering, manufacturing, shipping and erecting. Planning or analyzing the work requires a thorough knowledge of construction combined with inventive ability. The man doing this work must know the various shapes and bends and their names. In all cases, he must know the finished product that is to be made, its purpose, way in which it will be used, construction, gage of the metal, quantity to be manufactured and tools required. The method followed is best shown by an example, for the same general principles govern all cases. Suppose that it is required to make a box or tray, as shown in Fig. 1, 8 inches long, 5 inches wide and 3 inches high, which is to be used in a large department store for the storage and display of small articles. It is to have a division 1 inch from the top and 2 inches from the bottom, so that it may be inverted and the deeper side used. Six methods of making this box are shown here, but many more could be devised. Fig. 2 shows vertical sections through boxes of similar construction; Fig. 3 is a horizontal section through the uprights, showing bends and forms used for this purpose; and Fig. 4 is a vertical section through the shelves or tops, showing bends and forms that may be used. The construction method will depend first on the tool equipment of the factory and then on the amount of material and labor required. After the construction method is determined upon, it is necessary to decide the cutting size of the piece, or size of blank that will be required, also what notching, bending, seaming, drilling, filing and welding must be done.

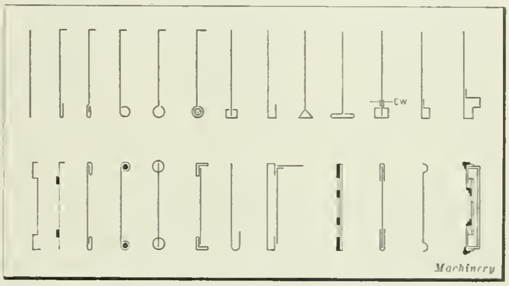


Fig. 3. Horizontal Cross-sectional Views through Uprights

When the planning is completed it is necessary to estimate the labor and material required. To the actual cost of these must be added a certain percentage for overhead expenses. It makes considerable difference in the cost of an article whether it is made in lots of ten, fifty, one hundred, or one thousand.

Engineering Department

The duties of the engineering department are many and varied on account of the many types of cases and requirements. Standardization of construction has lately been adopted by many concerns; but this is a slow process on account of the alteration or betterment of construction that is continuously being made in order to reduce the cost of production.

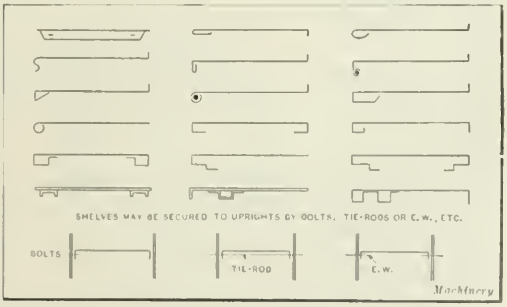

SHELVES MAY BE SECURED TO UPRIGHTS BY BOLTS, TIE-RODS OR E.W., ETC.
BOLTS
TIE-ROD
E.W.
Machinery

Fig. 4. Vertical Cross-sectional Views through Shelves or Tops

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[1] Address, O. M. Edwards Co., Syracuse, N. Y.

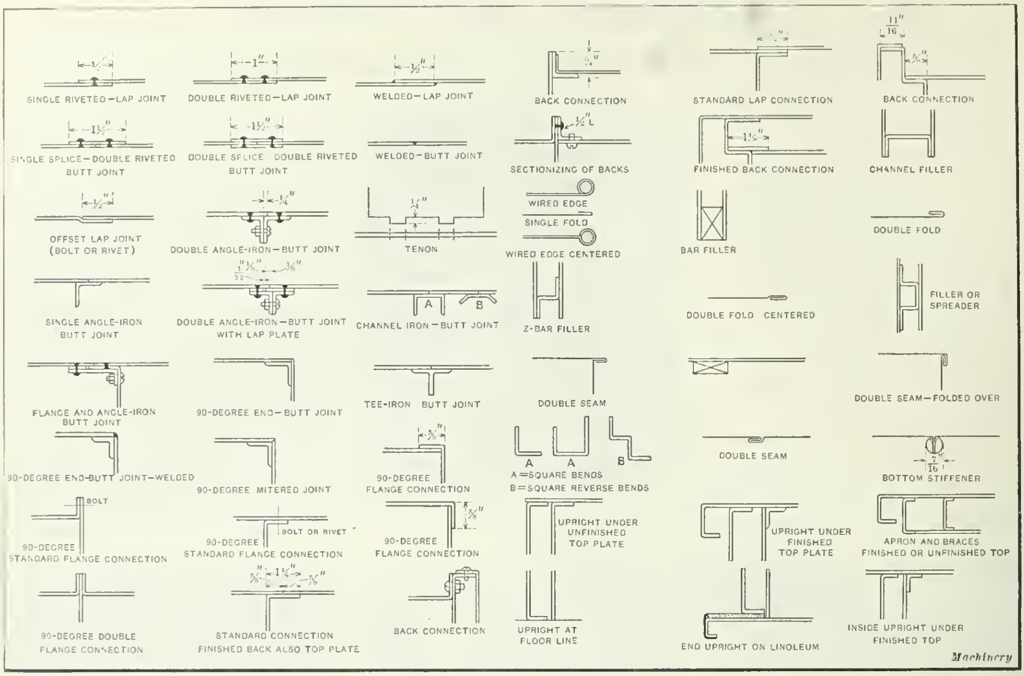

SINGLE RIVETED—LAP JOINT
DOUBLE RIVETED—LAP JOINT
WELDED—LAP JOINT
BACK CONNECTION
STANDARD LAP CONNECTION
BACK CONNECTION
SINGLE SPLICE—DOUBLE RIVETED BUTT JOINT
DOUBLE SPLICE DOUBLE RIVETED BUTT JOINT
WELDED—BUTT JOINT
SECTIONIZING OF BACKS
FINISHED BACK CONNECTION
CHANNEL FILLER
OFFSET LAP JOINT (BOLT OR RIVET)
DOUBLE ANGLE-IRON—BUTT JOINT
TENON
WIRED EDGE
SINGLE FOLD
WIRED EDGE CENTERED
BAR FILLER
DOUBLE FOLD
SINGLE ANGLE-IRON BUTT JOINT
DOUBLE ANGLE-IRON—BUTT JOINT WITH LAP PLATE
CHANNEL IRON—BUTT JOINT
Z-BAR FILLER
DOUBLE FOLD CENTERED
FILLER OR SPREADER
FLANGE AND ANGLE-IRON BUTT JOINT
90-DEGREE END—BUTT JOINT
TEE-IRON BUTT JOINT
DOUBLE SEAM
DOUBLE SEAM—FOLDED OVER
90-DEGREE END-BUTT JOINT—WELDED
90-DEGREE MITERED JOINT
90-DEGREE FLANGE CONNECTION
A =SQUARE BENDS
B =SQUARE REVERSE BENDS
DOUBLE SEAM
BOTTOM STIFFENER
BOLT
90-DEGREE STANDARD FLANGE CONNECTION
BOLT OR RIVET
90-DEGREE STANDARD FLANGE CONNECTION
90-DEGREE FLANGE CONNECTION
UPRIGHT UNDER UNFINISHED TOP PLATE
UPRIGHT UNDER FINISHED TOP PLATE
APRON AND BRACES FINISHED OR UNFINISHED TOP
90-DEGREE DOUBLE FLANGE CONNECTION
STANDARD CONNECTION FINISHED BACK ALSO TOP PLATE
BACK CONNECTION
UPRIGHT AT FLOOR LINE
END UPRIGHT ON LINOLEUM
INSIDE UPRIGHT UNDER FINISHED TOP
Machinery

Fig. 5. Commonly used Forms of Construction in Sheet Metal Furniture Manufacture

A first-class drafting or engineering department should be divided into the following sections: submission drawing, contract drawing, and stock drawing. The submission drawing consists generally of a front and an end elevation, with the necessary over-all dimensions and schedule of devices, that is, the number of drawers, files, shelves, roller shelves, etc., that the article may contain No construction is shown nor are sections made until the contract is received, for this would increase the cost of this work and at the same time show the construction methods to competitors. This section of the engineering department should be equipped with cuts of moldings, samples of castings, marbles and catalogues of metal fixtures made by other manufacturers. After they have been used, the drawings should be indexed and filed for future reference. All mail inquiries, providing a drawing is required, should be submitted to this department. It is quite necessary for this department to have all the information in such shape and form that drawings can be made up quickly and accurately

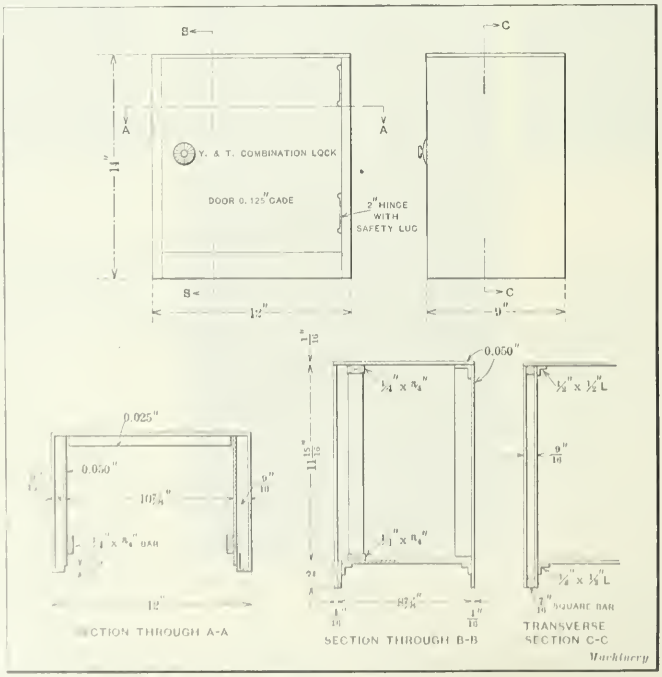


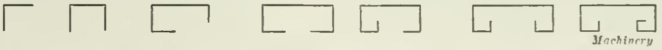
Fig. 6. Sheet Metal Safe, 14 by 12 by 9 Inches, equipped with Yale & Towne Combination Lock

The contract drawing is a submission drawing on which proper horizontal and vertical sections have been worked out, full size, if necessary; this drawing should specify the stock parts used and give the numbers of hardware parts, etc. The making of these drawings is the most interesting of all the work in the engineering department. A metal-furniture draftsman should compile a book of constructions and methods. Fig. 5 shows constructions generally used and Fig. 7 illustrates the various pipe connections and how they may be employed. The electric-welding process has revolutionized the metal-furniture industry by reducing the amount of labor necessary. Thousands of rivets were used a few years ago, whereas now spot welding is generally employed wherever possible. The field is open to the inventor, and many things never made of metal are constantly being produced. A study of the catalogues of steel-furniture manufacturers will give a fair knowledge of what is now being made. The stock drawing is a more finished drawing and gives all information, showing all bent uprights in flat, lay-out of holes, notches, cut-outs, etc. In other words, it should comprise a complete factory drawing.

Detailing or Listing

After the factory drawing has been made, with all its sections and dimensions, it is transferred to the detailer or the man who makes out the listing of material. It is strange, but there are few men who are able to make a complete finished drawing and also list the material correctly. The only reason for this is that it involves good memory, a system, and a knowledge of construction; the lack of handbooks giving the necessary information makes the work more difficult. The best men in this branch today are men who have worked up from the ranks; these men are actually the constructors and developers of the present construction in filing devices. Listing is very interesting, as it involves an all-around knowledge of the trade.

TABLE 1. ALLOWANCE FOR SQUARE BENDS IN INCHES (FRACTIONS AND DECIMAL EQUIVALENTS)



Wt.Sq.Ft. Ounces	Wt.Sq.Ft. Pounds	Gage	Frac.	Decimal	1 Bend	2 Bends	3 Bends	4 Bends	5 Bends	6 Bends	7 Bends
32	2.000	18	1/20	0.0500	5/64 0.0840	5/32 0.1680	1/4 0.2520	11/32 0.3360	13/32 0.4200	1/2 0.5040	19/32 0.5880
40	2.500	16	1/16	0.0625	7/64 0.1042	13/64 0.2084	5/16 0.3126	27/64 0.4168	33/64 0.5210	5/8 0.6250	23/32 0.7294
50	3.125	14	5/64	0.0781	1/8 0.1300	17/64 0.2600	25/64 0.3900	33/64 0.5200	21/32 0.6500	25/32 0.7800	29/32 0.9100
60	3.750	13	3/32	0.0937	5/32 0.1562	5/16 0.3125	15/32 0.4688	5/8 0.6250	25/32 0.7813	15/16 0.9375	1 3/32 1.0937
70	4.375	12	7/64	0.1094	11/64 0.1823	23/64 0.3646	35/64 0.5469	47/64 0.7292	29/32 0.9115	1 3/32 1.0938	1 17/64 1.2670
80	5.000	11	1/8	0.1250	13/64 0.2083	27/64 0.4167	5/8 0.6250	53/64 0.8333	1 1/32 1.0417	1 1/4 1.2500	1 29/64 1.4560
90	5.625	10	9/64	0.1406	15/64 0.2344	15/32 0.4688	45/64 0.7031	15/16 0.9375	1 11/64 1.1720	1 13/32 1.4063	1 5/8 1.6400

In using the table it would be advisable to change fractions such as 17/64 to 1/4, 25/64 to 3/8, and so on. For single bends in 18-, 16- and 14-gage stock, the rule is take off 1/8 inch; for 13-gage, 1 or 2 bends, 3/16 inch; and for 1 or 2 bends in 12-, 11- and 10-gage, 1/4 inch. For more than 1 or 2 bends where work does not have to be held to absolutely correct measurement, the above rule may be used, but where correct measurements are required, use the table.

Until the adoption of definite allowances for bends, which were published in MACHINERY in 1911 and 1915, each foreman was the ruling power in his department, and all the young engineer or draftsman could say was, "O, yes; I see," although he never did. As it would greatly increase the expense if the manufacturer had to have a complete mechanical drawing made of each case, it has been left to the listers of materials, who generally are practical men, to check up the construction as to practicability, etc. Convenient tables should be provided to facilitate the work and relieve the men of strain. Among the tables and charts that will be found useful by listers are the allowances for square bends, which are given in Table 1; list of stock parts used by the manufacturer, such as hinges and hardware in general; chart showing the general construction, bends and flanges, as given in Fig. 5; chart of irregular bends produced by specially made dies; cutting or blank allowances; tables of screws and rivets; table of standard gages and weights of steel; table of allowances for pins, studs, wheels, etc.; and table of drills to be used. Many draftsmen specify material made of stock that is not available. When using the allowances for square bends given in Table 1, fractions like 17/64 and 25/64 should be reduced to 1/4 and 3/8, etc. A simple rule where absolute accuracy is not required is to take off 1/8 inch for single bends of 18-, 16- or 14-gage material, 3/16 inch for one or two bends of 13-gage stock, and 1/4 inch for one or two bends of 12-, 11- or 10-gage material. In all other cases, the table should be used.

Fig. 6 shows a factory drawing. It is necessary for the lister, or the man who makes out the bill of material, to know how the lock is fastened on; whether the lock is fastened to the door direct or if a lock block or bar must be supplied; if the hinges are made with a straight or bent leaf; if the top plate is fastened on with rivets, screws, or by welding; the cutting size of the outside shell or jacket, which is 0.050 U. S. standard gage; and if the case is to be assembled before finishing. As insignificant as these questions may seem to be, they must be answered, for the man at the bench, or the actual builder, must know these facts. A correct way of listing the material is to follow a certain rule and not jump from one item to another, which leads to many omissions. A good rule is to list all vertical plates first, such as ends, inside ends and inside upright fillers; second, all horizontal plates, such as tops, shelves, drawer strikes, bars, etc.; third, stock parts used; fourth, all wrought material, such as angle bars, etc.; fifth, hardware. Manufacturers usually provide printed sets of listing sheets, each sheet in the set containing only the information that is required by the department to which it is sent.

The checking chart shown in Fig. 8, which has been developed by the writer, will be found handy by metal-furniture draftsmen. One of the greatest troubles of the metal-furniture manufacturers today is to obtain correct measurement and field data from inexperienced salesmen. Memoranda charts of the kind shown in Fig. 9 will be useful for remedying this trouble. The table of fractions given in Table 2 will also facilitate more accurate additions, as common fractions are used almost entirely on factory drawings. In order to cut costs to a minimum, it is important that all available shortcuts and tables be used. Long rules and circular letters disturb the regular routine, and in many instances actually prevent speed. It takes special training and experience to be a first-class lister and do it right, as a few "misses" in dimensions and errors in figuring of bends will cost the manufacturer a good deal of money. The work is pleasant if a person becomes acquainted with all the "in's and out's" in the trade. Too many rules and tables are confusing to some men; therefore a proper analysis of what is needed will materially assist the lister in getting out the work required quickly, neatly and accurately.

TABLE 2. ADDITION OF 32NDS AND 16THS

32nds		10	20	30	40	50	60	70	80	90	100	16ths		10	20	30	40	50	60	70	80	90	100
..	..	5/16	5/8	15/16	1 1/4	1 9/16	1 7/8	2 3/16	2 1/2	2 13/16	3 1/8	..	..	5/8	1 1/4	1 7/8	2 1/2	3 1/8	3 3/4	4 3/8	5	5 5/8	6 1/4
1	1/32	11/32	21/32	31/32	1 9/32	1 19/32	1 29/32	2 7/32	2 17/32	2 27/32	3 5/32	1	1/16	11/16	1 5/16	1 15/16	2 9/16	3 3/16	3 13/16	4 7/16	5 1/16	5 11/16	6 5/16
2	1/16	3/8	11/16	1	1 5/16	1 5/8	1 15/16	2 1/4	2 9/16	2 7/8	3 3/16	2	1/8	3/4	1 3/8	2	2 5/8	3 1/4	3 7/8	4 1/2	5 1/8	5 3/4	6 3/8
3	3/32	13/32	23/32	1 1/32	1 11/32	1 21/32	1 31/32	2 9/32	2 19/32	2 29/32	3 7/32	3	3/16	13/16	1 7/16	2 1/16	2 11/16	3 5/16	3 15/16	4 9/16	5 3/16	5 13/16	6 7/16
4	1/8	7/16	3/4	1 1/16	1 3/8	1 11/16	2	2 5/16	2 5/8	2 15/16	3 1/4	4	1/4	7/8	1 1/2	2 1/8	2 3/4	3 3/8	4	4 5/8	5 1/4	5 7/8	6 1/2
5	5/32	15/32	25/32	1 3/32	1 13/32	1 23/32	2 1/32	2 11/32	2 21/32	2 31/32	3 9/32	5	5/16	15/16	1 9/16	2 3/16	2 13/16	3 7/16	4 1/16	4 11/16	5 5/16	5 15/16	6 9/16
6	3/16	1/2	13/16	1 1/8	1 7/16	1 3/4	2 1/16	2 3/8	2 11/16	3	3 5/16	6	3/8	1	1 5/8	2 1/4	2 7/8	3 1/2	4 1/8	4 3/4	5 3/8	6	6 5/8
7	7/32	17/32	27/32	1 5/32	1 15/32	1 25/32	2 3/32	2 13/32	2 23/32	3 1/32	3 11/32	7	7/16	1 1/16	1 11/16	2 5/16	2 15/16	3 9/16	4 3/16	4 13/16	5 7/16	6 1/16	6 11/16
8	1/4	9/16	7/8	1 3/16	1 1/2	1 13/16	2 1/8	2 7/16	2 3/4	3 1/16	3 3/8	8	1/2	1 1/8	1 3/4	2 3/8	3	3 5/8	4 1/4	4 7/8	5 1/2	6 1/8	6 3/4
9	9/32	19/32	29/32	1 7/32	1 17/32	1 27/32	2 5/32	2 15/32	2 25/32	3 3/32	3 13/32	9	9/16	1 3/16	1 13/16	2 7/16	3 1/16	3 11/16	4 5/16	4 15/16	5 9/16	6 3/16	6 13/16

Machinery

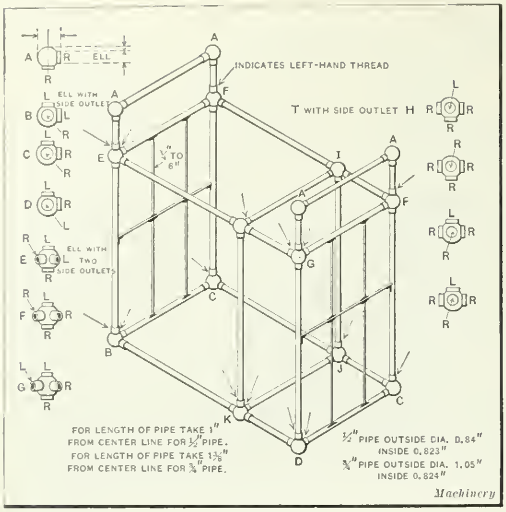

A
R
ELL
R
L
ELL WITH SIDE OUTLET
B
L
R
C
R
D
E
ELL WITH TWO SIDE OUTLETS
F
G
INDICATES LEFT-HAND THREAD
T WITH SIDE OUTLET H
¼" TO 6"
I
J
K
FOR LENGTH OF PIPE TAKE 1" FROM CENTER LINE FOR ½" PIPE.
FOR LENGTH OF PIPE TAKE 1⅛" FROM CENTER LINE FOR ¾" PIPE.
½" PIPE OUTSIDE DIA. 0.84" INSIDE 0.823"
¾" PIPE OUTSIDE DIA. 1.05" INSIDE 0.824"
Machinery

Fig. 7. Various Forms of Pipe Connections and how they are used

Manufacturing Process

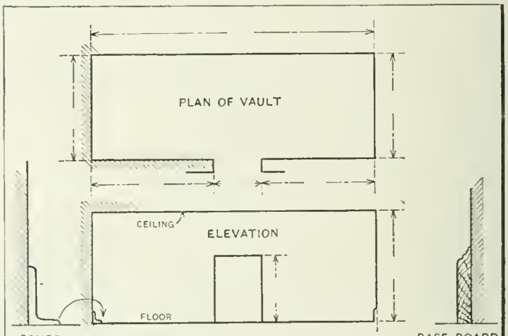
So many manufacturing methods are employed that it is impossible to state which is preferable, but the methods given here are those used by the largest manufacturers. The metal used may vary in thickness, but that from 1/4 inch to No. 30 gage is the most satisfactory. The sheets vary also in length and width; the usual limit, however, is 44 inches wide and 120 inches long, but wider and longer stock may be manufactured when desired. After the sheets are cut to size, they pass from the cutting department to the rolling, or straightening, department, where they are passed through the hammer block or rolling machine. If this process is omitted, the finished plates will have a most unsatisfactory appearance. The plates are then passed to the lay-out department, where they are squared and measured, and the positions of bends, notches, holes, etc., indicated upon them. The bends are marked with chalk directly on the plate or on a special paper blank that accompanies the work when it is sent to the next department. In the press room the plates are divided into classes, so that it will not be necessary to change the dies or machines too often. After all the necessary machining has been done, the plates are sent to the bench department, where they are fitted together according to the factory drawing. Here the work is assembled in the raw state and then taken apart so that the pieces may go to the finishing department.

CHECK FROM LEFT TO RIGHT IN ORDER AS GIVEN		
JOB NO OR CONTRACT	HOW TO SHIP	SET UP OR K.D.
COLOR OR FINISH	EXTERIOR INTERIOR	
FINISH HARDWARE		BRASS OR BRONZE
NUMBERS	NAME PLATES	TRANSFER
FRONT ELEVATION	TOP	LINOLEUM
CORNICE	PROPERLY SECTIONIZED	
LABEL HOLDER	PULLS, HANDLES, RODS	
BASE		
SCHEDULE OF DEVICES	DRAWERS, ETC.	WIDTH
HORIZONTAL SECTION		CHECK OVER ALL
END FILLERS		DETACHABLE
INTERMEDIATE SECTION	SECTION NUMBERS	REINFORCEMENT
BACKS		SECTION BACKS
VERTICAL SECTION		
TOP FILLER	ANY FASTENING TO WALL	BY MEANS OF
INTERMEDIATE SECTION		CHECK OVER ALL
BASE		
SCHEDULE OF DEVICES	REINFORCEMENT	HEIGHT AND DEPTH
MATERIAL	BOUGHT OUTSIDE	
CAST N[illegible]	BRASS, BRONZE GRAY IRON	MALLEABLE
LOCKS KEYS	DIFFERENT ALIKE	MASTERKEYED
FLAT KEY	PARACENTRIC KEY	
SPECIAL [illegible]		
STOCK [illegible]	SHIPPED IN ADVANCE	

Machinery

Fig. 8. Checking Chart developed to facilitate Work and eliminate Errors

When the work arrives in this department, the steel is first washed with benzine in order to remove all grease and oil, for the enamel will peel off if the steel is not properly cleaned before being given the desired enamel finish. To the writer's knowledge, no special cleaning apparatus has yet been designed, but it will probably be worked out eventually. After the plates are cleaned and dried, they receive the first coat of enamel, either by dipping them into troughs or by spraying. They are then placed in the baking oven, where they are heated to from 150 to 300 degrees F., the various colors requiring different temperatures. Several coats of enamel may be given, but the plates must be baked after each coat. Solid colors of various kinds are generally used, two coats being the maximum. When baked, the plates are water- or oil-rubbed, either by hand or by machine, and are then filled, sprayed and again baked. All imitations of wood are generally made by hand, although transfers are used. Steel plates have been finished in circassian walnut that have looked so natural that an expert would have difficulty in telling that they were imitations. Oak and Indiana walnut are difficult to imitate. After the work is entirely finished by the japanning department, it is delivered to the general assembling department for reassembling, if necessary; locks, hardware, etc., are then put in place, after which the work is checked up with the blueprint and prepared for shipment.



GIVE ALL MEASUREMENTS AS INDICATED.

ARE WALLS BRICK, TILE, CONCRETE, MARBLE?

ANY OBSTRUCTIONS SUCH AS ELECTRIC SWITCHES, STAND PIPES, BEAMS, TIE-RODS, RADIATOR, STEAM PIPE, AIR DUCTS?

ARE WALLS PLUMB? FLOOR LEVEL?

GIVE DOOR OPENING—CLEAR WIDTH AND HEIGHT

HOW IS ACCESS TO VAULT OR ROOM—STAIRWAY OR ELEVATOR?

GIVE ELEVATOR DOOR OPENING AND INSIDE SPACE OF CAR

STOP AND THINK. CAN WORK BE TAKEN INTO SPACE AND ERECTED CONVENIENTLY?

Machinery

Fig. 9. Memoranda for Guidance of Draftsmen and Salesmen when taking Data in Field

* * *

Learning a trade is a good education for any young man. Learning to do things with the hands trains the brain, and even though a man may not intend to follow a trade as a means of livelihood all his life, the fact that he possesses knowledge of a trade will give him confidence and practical knowledge invaluable in any position in life.

LETTERS ON PRACTICAL SUBJECTS

WE PAY ONLY FOR ARTICLES PUBLISHED EXCLUSIVELY IN MACHINERY

PRESENT DEMAND AND STANDARDIZED PRODUCTION

A small manufacturer of lathes, shortly after the beginning of the war, decided that the demand for his product was such that he could sell all he could make of one size and style. He had been connected with the automobile industry and had learned its lesson of specialization. So he built 1200 lathes, all three-step cone, double back-geared, of not only the same swing, but also the same length. The length of bed was such as to load his planers most economically, and the other details were figured out in the same way. At the same time, he secured another shop and started building 800 lathes, slightly larger, identical throughout. Regardless of the nature of the request, he quoted on these two sizes of lathes and refused to change anything from the length to the smallest item of equipment. It took nerve, but it worked. His production jumped without an effort over 25 per cent, and the quality of the product was uniformly better.

There is, in this manufacturer's success, a lesson that is of especial importance just now when it is only a question of meeting the demand. It may not be that every plant can afford to cut down its line to one product. It may be necessary for a plant to hold its prestige in different lines, pending the return of normal conditions, and its equipment may not be adapted for so limited a product; but it will pay every manufacturer to study the lines he is producing and find which he can manufacture most profitably. He should see if there is enough business in those lines to keep his plant busy under normal conditions and concentrate on them now, when the demand will keep him busy. Then he can plan his marketing and improvements in his product, and study its manufacture and standardization, so that when business is again normal he will be able to secure enough of the line in which he specialized to keep his factory humming. Such a concentration will result in a simplifying of the machines and interior arrangement of his factory, with a corresponding reduction in the work of planning, routing and cost keeping. The greater efficiency that is bound to follow will do much to enable the manufacturer to maintain his production against the decreasing man supply.

Cincinnati, Ohio — D. M. Perrill

OIL-GROOVE RECESSING TOOL

A short time ago an interesting problem arose that caused us considerable trouble. A certain oil-groove in a large casting that had previously been cored was to be finished as shown in Fig. 2. Owing to the small size of the bore, 1¼ inch, it was difficult to design a tool that would have sufficient strength and rigidity; and as this particular grooving operation was to be repeated at least 200 times every eight hours, a strong, durable tool was absolutely necessary. After some discussion, the design shown in Fig. 1 was decided upon. The tool-holder *A* is turned up with a semispherical tongued end, which rocks in a slot cut in the end of shank *B*. This tongue acts as a driver. A retaining collar, locked in place by means of a lock-nut and peened over at *C*, holds tool-holder *A* in place. The hardened steel bushing *D* is turned up on one end to fit into the bore of the work and a depression machined in the other end allows part *A* to rock in it. With the bushing in place and the center line of the shank in line with the center line of the bore, the tool is fed to the left as it revolves until surface *Y* coincides with surface *Z*. The tool bit will then have risen to the position shown by the dotted lines. Parts *A* and *D* are made of hardened tool steel, while collar *C* and shank *B* are of machine steel and casehardened The cutter was made adjustable for the various depths of the different grooves, as well as to allow for grinding. Of course, distance *X* must be less than the bore of the work to permit the entrance of the tool. This tool has been in use for over three months, and, considering its rough usage and large output, it accomplishes its purpose remarkably well.

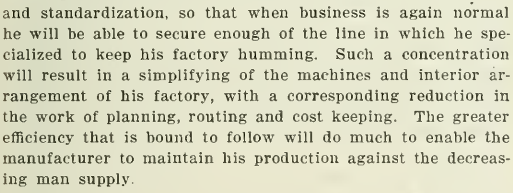


Fig. 1. Tool for finishing Oil-groove in Casting

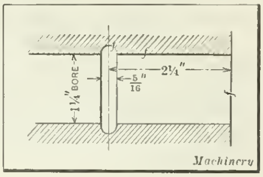


Fig. 2. Oil-groove to be machined

Chicago, Ill. — H. A. Peters

REMOVING IRON PLATE RUST

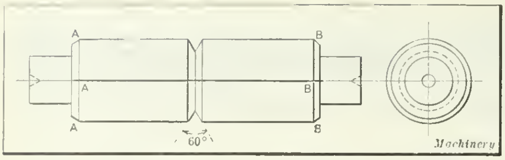
A cheap and effective method of removing rust from corroded and pitted iron plates has recently been evolved as a result of experiments. It consists in applying to the surface of the iron a mixture of two parts of finely crushed sodium bisulphate (sodium acid sulphate, Na_2SO_4, H_2SO_4, $3H_2O$) and one part of common salt, which is moistened just enough to make it cohesive. The moist mixture can be left on until the plate is clean, but the action is more rapid if the mixture is scraped off every two or three hours and the iron scrubbed thoroughly with a wire brush and water; the treatment is repeated until the plate is clean. Usually twenty-four hours is sufficient for a badly corroded plate. When the plate is thoroughly clean it is well washed with an alkaline solution, and dried quickly. A coating of paraffin oil (kerosene) is at once applied to protect the surface against oxidation. The metal is then ready for the paint or other protective covering. This method has been found to be more effective than hammering, chiseling, the use of wire brushes, or even a sandblast.

Liverpool, England — Mark Meredith

HANDY GAGE FOR SETTING UP THREADING TOOLS

The simple tool shown in the accompanying illustration has proved useful for setting up threading cutters in the lathe toolpost, when an accurate thread is required to be cut on a single piece. It consists of a piece of machine steel, about four inches long and one inch in diameter, that has been centered true at both ends and contains a groove with an included angle of 60 degrees turned about its periphery. Four lines *AB* are laid out longitudinally along the gage, 90 degrees apart. Hence, when one line is in allignment with a line on the top of the dead center of the lathe, the next line gives the proper height of the thread-cutting tool. The centers in each end of the gage are sunk deep into it at an angle of 60 degrees, so that it will revolve freely on the lathe centers.

The method of using this gage will be readily seen. The threading tool is put into the toolpost of the lathe, but is not



Handy Gage for setting Threading Tools

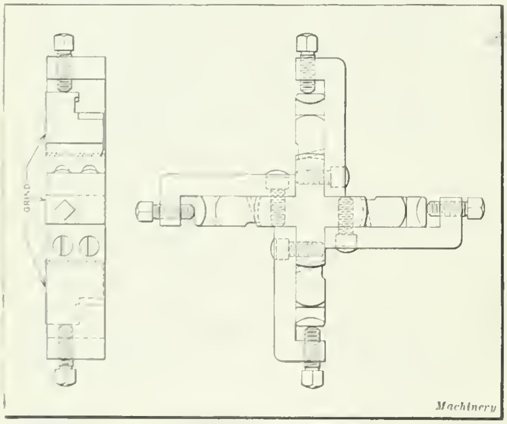
clamped tight; then as the cross-feed is gently fed into the setting-up block, the threading tool takes its proper position. The threading tool is then tightened, the setting-up block taken out of the lathe, and the work to be threaded is put into its place. This tool is most useful when various sizes of V-threads have to be cut.

New Haven, Conn. ERIC LEE

CORRECTION OF CHASERS

In almost every lot of chasers received there are three or four sets that do not line up properly, with results that anybody familiar with machine work knows. The writer does not know the precise cause of this, but the method used to correct the fault may be of interest to those who have similar difficulties. The head in which these chasers are used is of the self-opening style and the chasers are easily slipped into position and held in place by a collar. The style of head in which the chasers are used, however, is not very important, as the correction is equally positive for heads in which the chasers are held in place by screws. The method of correction is simply to grind the back end face of the chaser the necessary amount to bring the cutting points in the proper position in the set.

The grinding fixture consists essentially of a piece of steel properly threaded, out of which sections have been cut. The chasers are arranged in the order in which they go in the die-head with the cutting points engaged with the threads in the center piece. They are held in place by L-shaped brackets having set-screws at the ends. The brackets are held in place on the threaded piece by screws. With the brackets in place, and the set-screws adjusted, a half turn of the wrench will release any chaser or hold it firmly in position for grinding, which is done on the rear end surface or the end that slips back into the die-head. A sweep or two across the grinder and the slight correction necessary is made. As the work can be done very rapidly, it has saved the time of returning chasers to the factory and waiting for them to come back again. With the self-opening type of head, if the chasers are not slipped back to the limit when placed in the head, they will be driven into position when the work is advanced against these, and will be in perfect alignment, as the grinding is done at the rear end of the piece.

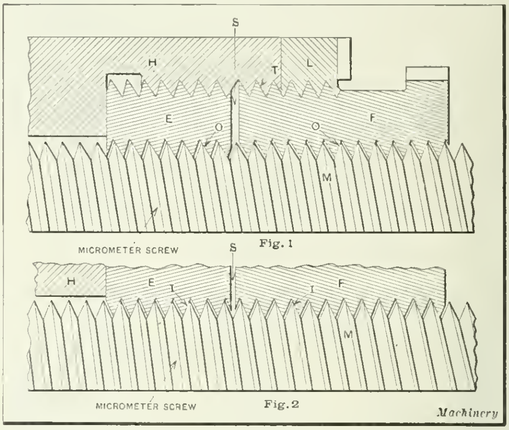


Fixture for grinding Chasers to Proper Alignment

Boston, Mass. JOHN A. SHAND

WEAR OF MICROMETER SCREW AND NUT

The method of compensating for wear of screw and nut in a well-known micrometer introduces an interesting little wrinkle. To the writer, it is especially interesting because of the considerable number of persons, including himself, who overlooked it. The nut *E* is fixed in the hub *H*, its position and inside diameter remaining the same, and the tension, or feel, is obtained by advancing or withdrawing an auxiliary nut *F*. A lock-nut *L* holds the auxiliary nut *F* in position after the tension is adjusted. Moving the auxiliary nut *F*, either toward or away from nut *E* produces friction between the nut and screw *M*. Moving *F* away from *E* produces the conditions shown in Fig. 1; moving *F* toward *E* produces the conditions shown in Fig. 2. The difference is that, as adjusted in Fig. 1, the threads in nut *E* wear on the left-hand side and are free on the right-hand side; while the reverse condition exists when adjustment is made by moving *F* away from *E*, as shown in Fig. 2. When *F* is locked in position, *E* and *F* constitute one nut with provision for altering the lead at *S*. It thus produces friction on the outside sides *O* of the thread or on the inside sides *I*, according to the relative lead of the threads *T* and *M* and the direction in which the auxiliary nut *F* is moved.



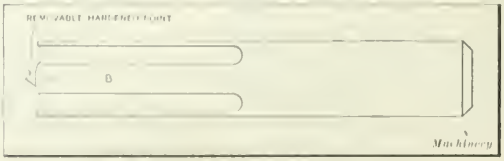
Means of compensating for Wear of Micrometer Screw and Nut

The point that seems to be easily overlooked is that if thread *T* is the same lead and hand as the micrometer-screw *M*, screwing *F* toward or from the hub *H* will make no difference in the tension. Tension is obtained by the lead of the thread *T* being different from the screw *M*. Suppose that the lead of the thread *T* is 1/50 or 0.020 inch. As the lead of the screw thread *M* is 1/40 or 0.025 inch, a whole turn of the auxiliary nut *F* will vary the lead of nut *EF* 0.005 inch at *S*. If *T* were the same hand and faster than *M*, screwing *F* into hub *H* would produce the effect shown in Fig. 2; screwing it out, or away from *E*, would produce the effect shown in Fig. 1.

Wilkinsburg, Pa. WILLIAM S. ROWELL

SELF-CENTERING MARKING PUNCH

In connection with the erection of some tank work, it was necessary to drill a great many ¾-inch holes according to templets or duplicate pieces. In arranging this work, it was therefore customary to scribe the hole first from the templet onto the plate to be drilled and then approximate the center of the scribed circle and center-punch a hole to receive the



Handy Tool for locating Holes before drilling tip of the drill. After the drill was started, it was often found necessary to shift the center because of incorrect location of the first punch hole. To simplify this operation and to eliminate the possibility of the punch hole being off center, the writer made the simple punch here shown. The tool is made of ¾-inch steel and is machined to fit inside the ¾-inch drilled hole on the templet. The lower end is arranged with four wings to hold the tool in the center and a piece of hardened steel is put exactly in the center of the bottom to act as the punch; this part is removable for sharpening and replacement. The templet is placed over the casting and the center-punch is inserted into the templet hole and struck with a hammer, the center-hole impression being made without any further work. This method has cut down the time for laying out the holes by more than one-half and has also saved considerable time because the center is accurately marked.

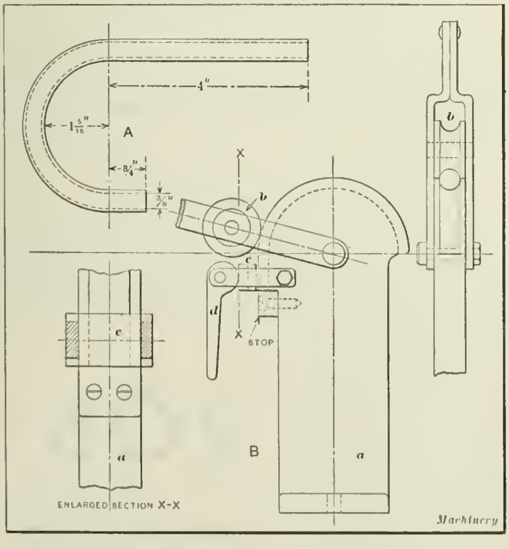
The tool is fluted because, in some cases, the holes in which it is placed are not perfectly round or some rust or a chip may have lodged in them, so that the center-punch will not enter the hole quickly. Therefore, by making four points of contact instead of a continuous contact, the chances for sticking or binding are reduced, for if a chip end should project at any point the flute will readily pass over it.

Philadelphia, Pa. W. A. Lailer

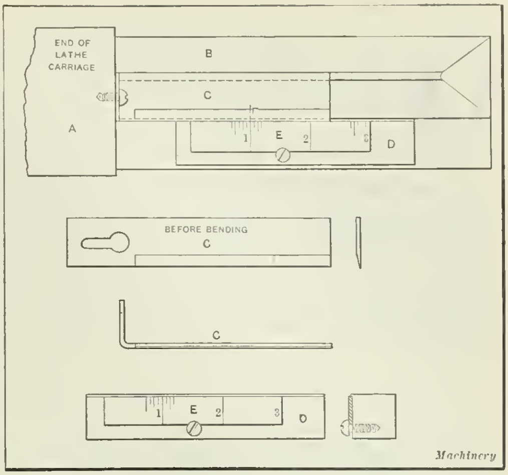
TUBE BENDER

The bending of tubes is always a more or less difficult matter, and the difficulty increases with the thinness of the walls of the tube and the shortness of the radius of the bend. Heavy gage tubes are comparatively easy to bend to a large radius without an excessive amount of flattening, but with a short-radius, thin-walled tube, it is quite a tedious piece of work to make a good-looking bend. The writer designed the tube bender shown in the accompanying illustration for a ⅜-inch tube about 0.010 inch thick, of the shape shown at *A*. The fixture illustrated at *B* consists of a cast-iron body *a* grooved to the proper radius for the bend required, of suitable dimensions to allow the tube to pass freely through the groove, and terminating in a straight portion. The runner *b* is of machine steel grooved to comply with the form of the groove of body *a*. The gripping jaw *c* is also grooved, and in practice is clamped to the end of the tube by means of the eccentric *d*. The device can be fastened to the work-bench or clamped in the vise. The operation is simple and efficient, and has never failed to work.

Brooklyn, N. Y. Ernest Schwartz



Tube Bender adapted for handling Thin Tubing



Gage for determining Desired Depth when performing Boring Operations on Lathe

DEPTH GAGE FOR BORING ON LATHES

The accompanying illustration shows a device that the writer made for determining when the desired depth has been reached when boring on a lathe; this gage may also be used for many similar purposes. At *A* is shown the end of the lathe carriage; *B* is the front V-bearing; *C* and *D* are parts of the gage, part *C* being fastened by a round-headed screw to the end of the lathe carriage, while part *D* is movable and held in place by its own weight. Line *F* on part *C* should correspond with the even inches on scale *E* when block *D* is against the end of the lathe carriage. To explain the use of this gage, suppose you have to bore a hole ⅞ inch deep. Set the boring tool against the face of the work and slide the gage up against the end of the lathe carriage. The boring operation is then started, and when line *F* comes under the ⅞-inch graduation on scale *E*, it indicates that the desired depth has been bored, and the feed is then disengaged. S. C.

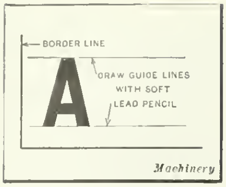
EFFICIENT KNURLING

Good knurling produces an excellent effect on the handles of plug gages and certain jig parts. Kerosene used freely will keep the tool and the work cool, and will also wash away all loose particles, which often cause inferior work. For plug-gage handles and other long knurled work, it is important that the tool be carefully set by testing it against the work before the feed is engaged. The spiral thread sometimes seen on long knurled work is caused by one knurl making a deeper impression than the other, the latter scratching against the top of the spiral thus cut; and is due to the failure to set the tool properly. It is the experience of the writer that two cuts are sufficient; that is, the knurl should be set full depth and a return cut taken without increasing the pressure. In cases where the knurl is a loose fit on the pin, the feed forces it to one side, causing it to cut only on the corner; this condition may be overcome temporarily by setting the tool to the side, and not taking any return cut. Passing over the work several times is unnecessary and only increases the possibility of chips and dirt getting in and producing a bad appearance.

Hartford, Conn. E. J. Higgins

METHOD OF LETTERING TRACINGS

It is a matter of common knowledge that many tracers and draftsmen who are otherwise capable of producing satisfactory work are unable to make good-looking letters and figures. That this is the case will be apparent to anyone who has to look over a lot of blueprints produced in different drafting-rooms. It frequently happens that tracings that would otherwise present a pleasing appearance have letters and dimension



Method of lettering Tracings by applying Black Paper Letters with Gummed Backs

numbers which are poorly made. To overcome this difficulty and also to save time in lettering, I have adopted the practice of using black paper letters and figures, which are gummed on one side so that they may be stuck to the tracing. Guide lines are drawn on the tracing so the lettering will be in proper alignment. This method will be appreciated by all draftsmen and engineers, as it produces a neat, workmanlike looking result and can be finished in a few minutes. These letters and figures can be purchased in any size, and are gummed on one side for attachment to the tracing after they have been moistened.

Flint, Mich. C. C. Spreen

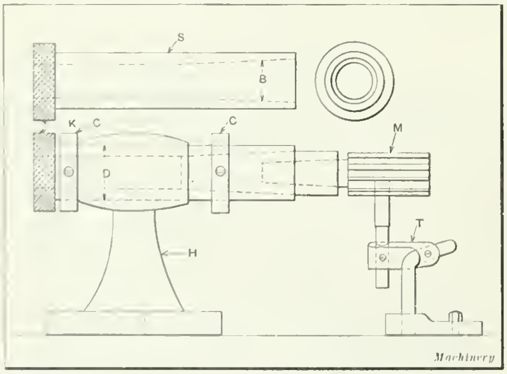
MAKING CHASERS IN THE LATHE

As the writer has made thread chasers at different times, he is always interested when he sees anyone making them, but he has never seen any method that excels the one he learned when an apprentice. A tap, preferably a large one, of the pitch the chaser is to be, is mounted between the centers of an engine lathe and the chaser blank is placed in the tool-post. The chaser is then fed in and the carriage feed-nut engaged the same as when chasing a thread. By this method, the chaser is finished in a short time as compared with the shaper methods the writer has seen tried. It is to be admitted that the circular chasers are better, but they cost more to make than some jobs warrant.

Cleveland, Ohio L. J. Orr

ATTACHMENT FOR GRINDING TEETH OF END-MILLS

The accompanying illustration shows an attachment for grinding the peripheral teeth of end-mills, so that they will be parallel with the axis and will run absolutely true when in use. The steel sleeve *S* has a knurled collar and is bored at *B*, preferably of the same bore as the milling machine arbor, to receive the cutter sockets. This sleeve also has two adjustable collars *C*, that regulate the travel to correspond with the length of the cutter *M* to be ground. The casting *H* may be the regular headstock furnished with some grinders, carrying a sliding sleeve, which, in turn, carries a driving arbor, but if the grinder is not furnished with this design of headstock, or if the bore *D* is not large enough to receive the sleeve *S*, a casting must be made that will answer the requirements. Either spiral or straight flute mills may be ground with an equal degree of accuracy.



Attachment for grinding Teeth of End-mills

Another advantage of this attachment is that the stop-finger may be secured to the table and the proper clearance obtained by simply raising or lowering the table, eliminating the necessity of fastening the finger to the wheel-head, which disturbs the finger setting when the table is raised or lowered. The finger should be somewhat wider than the wheel and should be set in line with the wheel face. By gripping the knurled collar *K* lightly with the fingers, the sleeve is easily fed through its travel.

Bremerton, Wash. Stanley Edwards

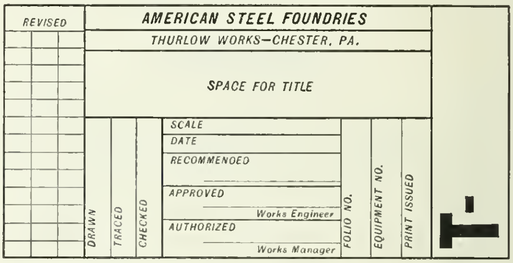
INDISPENSABILITY

The indispensable employe should be discharged as a danger to the employer. Further, he stands in his own light, as "indispensability" is in the way not merely of an occasional extra holiday but also of promotion, for someone must be brought in from outside to fill a higher position.

New York City Robert Grimshaw

DRAWING TITLE

In the accompanying illustration is shown the standard title used on drawings of one large shop; these titles are printed on blank sheets of tracing cloth, ready for the draftsmen. All the drawings are 25½ by 22 inches, or 11 by 17 inches, both of which are multiples of the standard letter size paper, namely, 8½ by 11 inches, and are folded to the letter size when being mailed. A "T" is placed in the lower right-hand corner of the title and in the lower left-hand corner of the tracing; this stands for Thurlow (Thurlow Works). The drawing number is placed next to this letter, so that when finished it will read T-1524, etc.


REVISED
AMERICAN STEEL FOUNDRIES
THURLOW WORKS—CHESTER, PA.
SPACE FOR TITLE
DRAWN
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DATE
RECOMMENDED
APPROVED
Works Engineer
AUTHORIZED
Works Manager
FOLIO NO.
EQUIPMENT NO.
PRINT ISSUED
T

Complete Title for a Drawing

Chester, Pa. George W. Childs

GRINDING-ROOM KINK

If fine cotton is wound on the spindle of an outside micrometer caliper in the small space between the short nut and the frame, the thimble rubbing against this cotton will unfailingly wipe away any particles of emery and prevent their getting near the thread of the spindle.

Hartford, Conn. E. J. Higgins

NUMBERS FOR MACHINES

Sign plates similar to that here shown have been found very satisfactory. They are made by punching the numbers out of iron or steel plates and then painting the plates yellow, red, or some other bright color. As these plates are suspended from the ceiling no time is lost looking for numbers that have been covered or misplaced by the men.

A number plate is hung above each place at which a man is working. Then when the foreman instructs his trucker to transfer material from number 25 to number 110, or if he asks the millwright to fix machine number

Number that may be hung over Machines, Benches, and Assembly Stands

50, the men can find these places without asking. Punching the figures out of sheet iron saves the expense of repainting the plate and the numbers at short intervals; the oil, dust, smoke, grease, etc., soon make painted figures unreadable. With perforated figures, however, it is only necessary to repaint the body of the plate, as the numbers always remain the same.

Flint, Mich. C. C. Spreen

TAPER GAGES

In Fig. 1 is shown a quick method of testing the size and taper of pieces; P are the parallels of the taper gage and G is the gage to be tested. It is first necessary to find the size of a disk that will touch the end of the plug and parallels of the taper gage. The angle of the taper with the center line must be found to get the sizes of the disks for setting the taper gage; it can be taken from a table of tapers or can easily be calculated, knowing the tangent.

The angle ABC is equal to 90 degrees less the angle of the taper with the center line. AB is equal to BC, for the tangents to a circle drawn from an external point B are equal, and a line BO drawn from B to the center bisects the angle ABC, making the angles OBA and OBC equal. BC is equal to one-half BD, which is the given dimension of the small end of the plug gage. OC is equal to BC times the tangent of the angle OBC, and twice OC is equal to the diameter of the disk.

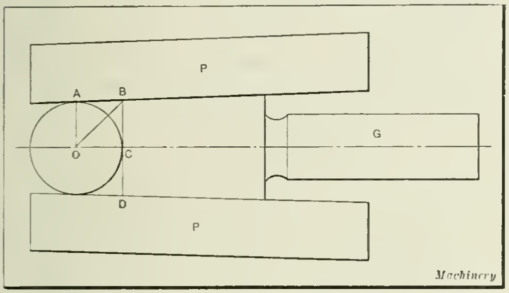


Fig. 1. Gage for quickly testing Size and Taper of Pieces

In Fig. 2 is shown a method of testing the depth of thread in a tapered thread piece. By this method the amount that a wire in a taper thread will increase the size of the small end of the piece is found. From the center of one thread to the center of the next on the taper is equal to the linear pitch divided by the cosine of the angle with the center line. Angle EDF is equal to the thread angle; angle EFD is equal to the thread angle less the angle with the center line; and the angle FED is equal to the thread angle plus the angle with the center line. The width of the flat must be taken from the center to center distance of the thread, which equals, in usual practice, one-twenty-fifth of the pitch, and gives the distance EF. Find one side ED of the thread from the proportion $ED:EF = \sin EFD:\sin EDF$; and find the depth AD of the thread from $AD:ED = \sin AED:\sin EAD$. Angle EAD is equal to 90 degrees less the angle with the center line.

The diameter of the wire corresponds with straight threads, except in large center angles. From the center of wire O to apex D of the thread is equal to the diameter of the wire for a 60-degree thread. Angle COB equals the angle with the center line. OB equals OC, the radius of the wire, divided by the cosine of the angle COB. OA is equal to AD less OD and AB is equal to OB less OA. Twice AB added to the small end of the plug is the diameter of the small end of the plug.

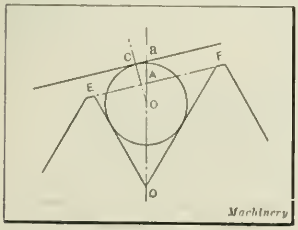
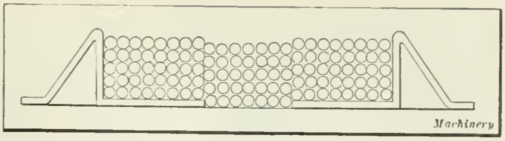


Fig. 2. Testing Depth of Thread of Tapered Thread Pieces

Robert W. Smith
Indianapolis, Ind.



End Irons for piling Bar Stock

U-STAKES FOR PILING BAR STOCK

With regard to the use of U-stakes for piling bar stock, as explained in the August number of Machinery, the writer would say that he has found the method unsatisfactory for round bars. The U-stakes spread out before the space between them is filled, and, of course, two or more stakes cannot be piled on top of one another. The end irons shown in the accompanying illustration may be used with success, however. These irons are made from any scrap that may be at hand.

Cleveland, Ohio L. J. Orr

USE FOR DISCARDED TRACINGS

Old and discarded tracings on cloth are of no value to anyone, but they would make good bandages and handkerchiefs for the soldiers. In every drawing-room there are a great many such tracings that will never be of any use. These could be washed, ironed and turned in to the Red Cross. Any laundry should wash and iron these free of charge, but if these old tracings are sent prepaid to us, we will run them through our shop laundry. After they have been washed, they will be made into handkerchiefs and bandages and turned over to the Red Cross. Now is the time to clean out your old files.

Charles W. Shartle,
Middletown, Ohio President, Shartle Bros. Machine Co.

ONE-REVOLUTION CLUTCH

The two types of one-revolution clutch presented herewith have proved both satisfactory and inexpensive. In Fig. 1, the driving pulley rotates clockwise. Hardened steel bushing A is driven into the pulley; hardened steel collar B is pinned to the shaft; cage C extends between the bushing and collar, and is milled to retain three hardened steel rollers D; it also is provided with a stop-pin E driven into its outer surface, and a spring G tending to pull it in a clockwise direction.

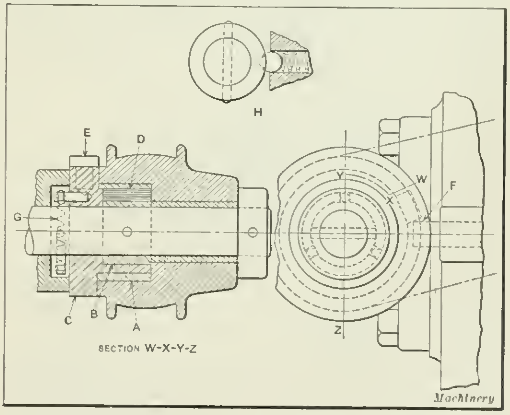


Fig. 1. One-revolution Clutch in which Drive is obtained by jamming Hardened Rollers between Driving and Driven Members

Collar B has three flats milled on its outer circumference, and when it is in the position shown, the space between bushing A and these flats on collar B is sufficient to allow the rollers clearance. However, when rod F is withdrawn, spring G gives cage C a slight twist, jamming the rollers between the bushing and collar, and thus driving the shaft. After one revolution, rod F has returned to the position shown, and

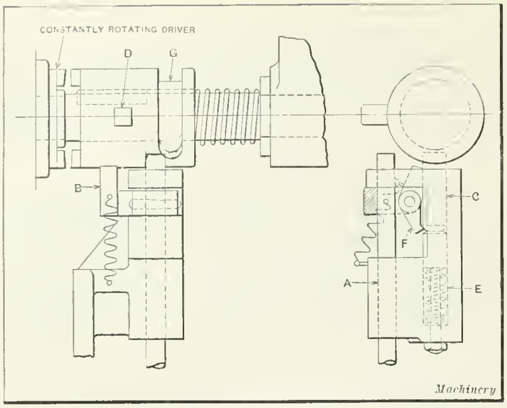


Fig. 2. One-revolution Clutch in which Teeth of Clutch are released by Cam after One Revolution has been completed

striking stop *E* causes the rollers to be thrown back into their former clearance, thus disconnecting the two members. It is necessary to provide the shaft with a corrector, which is shown at *H*, in order to have it stop accurately.

To engage the clutch teeth, rod *A*, Fig. 2, is lowered, drawing pawl *F* and rod *C* downward. This brings pin *D* in line with lever *B*, and groove *G* in line with rod *C*. As the clutch revolves, pin *D* strikes lever *B*, releasing rod *C*, which, by the expansion of spring *E*, is snapped into groove *G* milled in the clutch. This groove is cammed at a certain point, and as the rod is held in its bearings, the clutch teeth are withdrawn at the end of one revolution. C. O. H.

COMPUTATION OF PI

One of the most curious traits of human nature is that which has caused certain individuals in all ages to pursue mathematical and other problems far beyond the point necessary for the use of mankind in general. In the dark ages of medieval history, mathematical research was absolutely dormant. The scientists of those days spent their time in the vain quest of the philosopher's stone and the elixir of life. Indeed it is hard to say that research in connection with these two is dead even at the present day. One sees occasional reports in the papers that someone is trying to turn lead into gold with radium emanations, X-rays, and so forth, while the recent boom of the pituitary gland by the lay press is only a revival of the old idea of the elixir of life. At the same time it behooves one to write cautiously on these matters. During the eighteenth century, mechanical flight was "impossible," but mechanical flight was a dream of the philosopher long ago in ancient Greece and nowadays an aeroplane flight of 500 miles or so scarcely arouses comment.

The three great "fad" problems of the ancient geometricians were the duplication of the cube, the trisection of the angle, and the quadrature of the circle. The last is of interest to the mechanic from the fact that in approaching many mechanical problems he must use the convenient ratio, which he knows as "pi." Looking way back, one can find very little about this ratio, but it appears to have been accepted as 3 by the Chinese and Babylonians. From a lengthy description in the book of Kings, of a commission given by King Solomon to Hiram, a brass worker of Tyre, for the manufacture of a molten sea, one gathers that pi was 3 among the ancient Jews as well, for it states that the molten sea was ten cubits from brim to brim and thirty cubits round about. Among the ancient Egyptians, according to the only reference that has been found, the ratio of the circumference to the diameter is equal to $\sqrt{10}$, or 3.16, a value too large but much nearer the real value than 3.

The first person to give the matter any serious attention, was Archimedes, who proceeded on the following line of reasoning: If two polygons of many sides are constructed, inscribing and circumscribing a circle, the mean value of the sum of the sides of the polygons will give a close approximation of the value of the circumference of the circle. He laboriously constructed many polygons in this manner, ending his researches with one of ninety-six sides, by means of which he conclusively proved that the value of pi lay between 3 10/70 (the circumscribing polygon) and 3 10/71 (the inscribed polygon) times the diameter of the circle. He also stated that the circumference of a circle 4970 feet in diameter lies between 15,610 and 15,620 feet, an exceedingly close value considering the limitations of his day, as the real circumference is 15,613 feet, 9 inches, very nearly.

It is unknown who next attacked the problem, but from Hindu writings about 500 A. D. it is evident that someone had done considerable work on it, for the fraction 3927/1250, or 3.1416 exactly, was in common use, which is the commonly accepted value today, as this fraction complies with ordinary commercial requirements. Another thousand years elapsed before any further attempts to square the circle were made, but then pi computers came thick and fast. The first to effect a closer valuation was Adrian Metius, a Dutch mathematician of the fifteenth century, who succeeded in showing that the real value of pi lay between 3 17/120 and 3 15/106. To him is due the wonderfully close approximation (which represents the limit of any commercial or scientific necessity) 355/113, which he found by taking the mean of the two stated fractions, by simply halving the sum of the numerators and denominators of the two fractions; thus,

$$3\,\frac{(17+15)\div 2}{(120+106)\div 2} = 3\,\frac{16}{113}.$$

He luckily hit upon the value correctly to the sixth decimal place.

Honors did not long remain with Metius, however. He was quickly followed by De Viette, who by the incredible labor involved in investigating polygons of 393,216 sides, published in 1579 the result correctly to the tenth decimal place. This mathematician, however, used a greatly improved method in dealing with the subject, owing to the improvements in mathematical knowledge, which was now advancing by leaps and bounds. Adrian Van Roomen, a Flemish worker of Louvain University, published the ratio correctly to the fifteenth decimal place in 1593. The most famous worker of the middle ages, however, was Ludolph Van Ceulen, who died in 1610, and his life's work was engraved on his tombstone in a Leyden church to the effect that the ratio of the circumference to the diameter of the circle is more than 3.14159265358979323846264338327950288 and less than 3.14159265358979323846264338327950289; truly a wonderful monument of a misspent life. In 1596, he had published the result correctly to twenty decimal places so that the last fifteen places must have occupied at least the most of the remaining fourteen years of his life. No useful purpose is served by naming in detail the many workers on the same subject since, for the problem was attacked by nearly all the famous mathematicians in turn. By 1630, Grienberger had carried it to thirty-nine places; by 1699 Sharp had carried it to seventy-one; in 1702, Machin carried it to one hundred places, and in 1719 De Lagny carried it to one hundred twenty-seven.

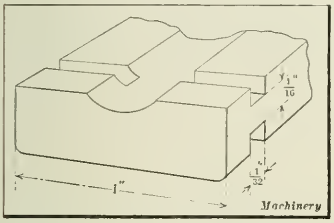
Until 1761, pi was supposed to be a finite quantity, but mathematical reasoning by this time was on such a firm basis that Lambert was able to prove conclusively that it was incommensurable. Notwithstanding this fact, the ardor of the pi computers remained undiminished. Even Hutton (of logarithmic fame) fell under the spell and carried out the ratio to one hundred thirty-six places. The vast amount of work performed on the problem in the last century may be dismissed in a short table:

1842, pi = 3. (208 decimal places), Rutherford
1847, pi = 3. (250 decimal places), Clausen
1853, pi = 3. (318 decimal places), Shanks
1853, pi = 3. (440 decimal places), Rutherford
1853, pi = 3. (530 decimal places), Shanks
1853, pi = 3. (607 decimal places), Shanks
1873, pi = 3. (707 decimal places), Shanks

No doubt even at the present day the race continues for the honor of computing the thousandth place, nine hundred and ninety of which have no practical value whatever. Those who would like to study the mathematical processes on which the results are founded should read the article "Squaring the Circle" in the Encyclopedia Britannica, which also gives an extensive bibliography on the subject. A. C. B.

ROBSON & SORENSEN TWO-PART BALL BEARING

I have read in the September number of MACHINERY the descriptive article on the Robson & Sorensen two-part ball bearing, and have a few criticisms that I would like to make. The conditions described in the first two paragraphs of the article do exist, and it is these conditions that have made the two-part bearing a failure. It is also true that if the load could be relieved from the balls as they pass over the joints in the raceway, practically no damage would result. The statement is made: "Realizing the importance of this point, it was decided to provide means for relieving each ball in the bearing of its load as the ball passes over one of the joints in the raceway." The device invented by the makers of this bearing would tend to produce the desired result provided the section adjacent to the joint were actually deflected, but since it is stated that pressure on the ball is relieved when the ball reaches this section, it is hard to conceive how a deflection can occur without the application of a load.



Approximate Conditions for No. 309 Bearing

If the section near the joint drops 0.001 to 0.002 inch below the section toward which the ball is advancing, there must be a load in order to cause this drop, and the load must be rather heavy, notwithstanding the assertion that deflection is only 0.001 to 0.002 inch. A very simple calculation will show that the load is rather a dangerous one. It is not stated whether the illustrations in Figs. 1 and 2 are to scale, but it appears safe to assume that for a bearing known to the trade as No. 309 the dimensions of this reduced section adjacent to the joint would be approximately as shown in the illustration; width, 1/32 inch; thickness, 1/16 inch; length, about 1 inch. The last dimension is the width of the bearing. We have, therefore, the condition of a simple cantilever fixed at one end and loaded at a point 1/32 inch from the fixed end. The deflection of such a beam is found from the well-known formula:

$$D = \frac{PL^3}{3EI}$$

where P = load;
L = length;
E = modulus of elasticity;
I = moment of inertia of section.

Solving this equation for the load, we get:

$$P = \frac{3DEI}{L^3}$$

Assuming that $E = 28{,}000{,}000$, the remaining quantities have the following values: $D = 0.002$ inch, maximum; $I = \frac{1}{49{,}152}$ (This is an approximate value, since the curvature of the section at the raceway has not been considered); and $L = 1/32$ inch. Substituting these values in the second formula, we find that the load required to produce a deflection of 0.002 inch is somewhat over 110,000 pounds. This is by no means negligible. While the deflection may be rather slight, the fact must not be overlooked that the beam is also quite short. No matter which way the thing is reasoned out, it appears that the device is impracticable. If the load is relieved, as stated, the section adjacent to the joint will not deflect and the bearing will possess the same defects as all other bearings of this type. If the section adjacent to the joint does actually drop a sufficient distance to cause the ball to pass over the joint without damage, then the load is bound to be a dangerous one.

New York City ASHER GOLDEN

Mr. Golden's criticism of our two-part ball bearing has confirmed my impression that there is likely to be a misunderstanding of the features of the split or two-part ball bearing among those who have not made a detailed study of bearings of this type. I trust that the following explanation and illustration will assist in clearing up any possible misunderstanding among readers of MACHINERY concerning the operation of bearings of this type.

Referring to Mr. Golden's letter, I call attention to a quotation in the first paragraph: "Realizing the importance of this point, it was decided to provide means for relieving each ball in the bearing of its load as the ball passes over one of the joints in the raceway." This statement should read that means are provided to relieve each ball in the bearing of a considerable portion of its load as the ball passes over one of the joints in the raceway. How the ball is relieved of a portion of its load is best explained by referring to the illustration, which shows a development of the inner and outer raceways with balls *A*, *B*, *D* and *E* distorted by the load they are carrying; for the sake of simplicity, the outer ring and cone are not shown distorted. Ball *C* is the one in which we are chiefly interested, as it has resumed or nearly resumed its true spherical shape by the following process:

As this ball approaches line *FG*, it is in a distorted condition, due to being rolled between non-yielding (assumed for explanatory purposes) surfaces of the inner and outer raceways of the loaded bearing. When ball *C* reaches line *FG* it rolls forward toward the end of the cantilever beam and deflects this beam by nearly the same amount that the ball has been distorted. Therefore, it can readily be seen that the ball when passing over joint *L* is carrying an infinitesimally small load compared to what it would be capable of carrying. When in such a state it can practically do no harm to itself or the raceways while passing over the joint, although it is our practice to stone a slight "radius" on the ball tracks at the corners *M* and *N*. Assuming that the diameter of the balls in the illustration is 3/4 inch, which is the size chiefly used, the length of the cantilever beam, instead of being 1/32 inch, as Mr. Golden has calculated, would be 47/64 inch, *i. e.*, more than twenty-three times greater. Substituting this value in the equation for the pressure, we find that increasing the value of *L* from 1/32 to 47/64 inch results in reducing the value of pressure *P* to 14.81 pounds. This beam is not of regular cross-section throughout its entire length, as the illustration shows; the width of the slot is 1/16 inch and is milled by convex cutters.

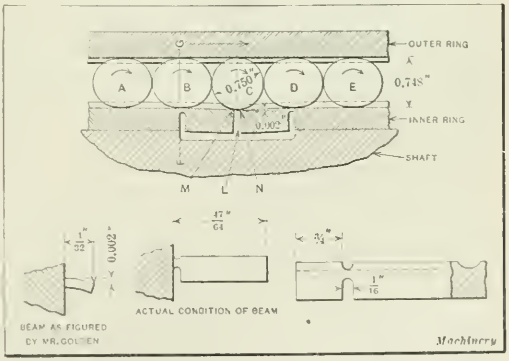


Diagram showing Means provided to relieve Pressure on Balls passing over Joints in Bearing Races

C. E. ROBSON
Spring City, Pa. Robson & Sorensen

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

INDEXING FOR MINUTES AND SECONDS

C. B. B.—I have a vernier scale that I wish to graduate on a dividing head of a milling machine, in the following divisions: twenty spaces in 3 degrees, 10 minutes, or 9 minutes, 30 seconds to each division. What is the ratio of the differential gearing for this operation?

A.—If there is a Brown & Sharpe differential index head available, use the following gears with one idler: gear on spindle, 86 teeth; first gear on stud, 81 teeth; second gear on stud, 34 teeth; and gear on worm, 32 teeth. If the above machine has the Brown & Sharpe equipment, two special gears must be used. Use an index plate with 49 holes, and taking one hole at each indexing, the result will be a movement of the head of 9 minutes, 30 seconds. A method of compound indexing for small angles was published in MACHINERY, August, 1914, page 1062.

CEMENT FLOORS IN BASEMENT

W. A. S.—Are cement floors cold and damp? For example, would it be feasible to use a basement of a building the floor of which is 4½ feet under ground and made of concrete? Should the floor be covered if used for office purposes?

A.—Cement floors have the reputation of being "hard" on workmen's feet. The trouble is not the physical hardness of the concrete, but the heat conductivity that results in abstracting the heat from the workmen's feet, causing them to swell and become painful; in other words, to become rheumatic. If means are provided for heating concrete floors, they are no "harder" than any other floor. The reason that workmen use mats or wooden gratings in front of machines to stand on in shops provided with concrete floors is to secure heat insulation, and not softness. We would advise covering the floor in question with tar paper and then laying linoleum over the paper. The combination of tar paper and linoleum should provide sufficient heat insulation to insure comfortable working conditions.

ROLLING INTERNAL THREADS

J. A. S.—Is it possible to roll an inside thread? Has anyone ever rolled internal threads and if so, what is the formula? We have no trouble in rolling outside threads by using a roll of the same diameter as the work or larger, according to formulas, but for inside threads the roll must be smaller than the work in order to enter the hole. Our problem is to roll a thread in a 1⅜-inch hole, fourteen threads per inch, Whitworth standard.

A.—Internal thread rolling is seldom done and is not regarded as a feasible proposition. The trouble is that very heavy pressure is required of the roll against the work in order to displace the metal, and it is difficult to support the work with the necessary rigidity and to provide a bearing for the roll that will stand up. The thread roll working on external work comes in contact with a comparatively small area, but when working on the inside of a hole the area of contact between the roll and the work is much larger relatively. Hence, in order to displace the metal required to form the thread, a pressure is necessary that is several times that required for rolling external threads of the same pitch. The internal thread roll should be made as small as permissible, having in mind the interference of the thread angles and the necessary diameter of the bearing. The smaller the roll the less the pressure required.

SETTING SHAPER HEAD TO CUT OFF CORNER OF BEVELED WORK

R. E.—We have some ½ by 2 inch pieces with the ends cuts to 20 degrees, and it is desired to cut off the corner at 45 degrees. We do not know how to figure out the setting of the shaper head. By trial, this is found to be about 15 degrees.

A.—The work and the lay-out for finding the angle are shown in the accompanying illustration. The lay-out shows all the lines revolved onto the horizontal plane. First, draw the line *R* for the direction of ram travel. The work is to be set in the vise and revolved horizontally 45 degrees from the setting that was used when cutting the slope of 20 degrees on the end. The ram will then follow the line *AB* across the corner. Then through the upper corner of edge *C* draw the tool feed line *F* at 90 degrees to *R*. The problem is to find the angle of this line with the vertical, so as to set the tool-head properly to follow down the plane of the 45-degree cut-off. First, calculate the horizontal projection *D* of the corner *C* that is to be cut off.

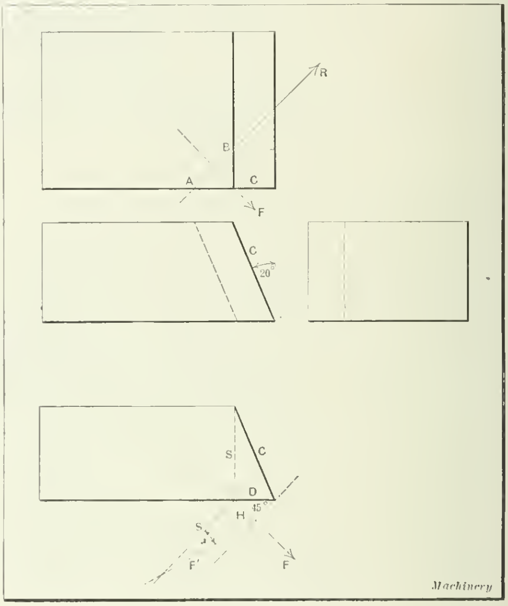


Diagram illustrating Method of setting Shaper Head to cut off Corner of Beveled Work

$$D = S \times \tan 20 \text{ degrees} = \tfrac{1}{2} \times 0.36397 = 0.18108 \text{ inch}$$

Then, having *D*, calculate *H*, which is the horizontal feed of the tool while making a vertical feed of ½ inch. It will be observed that *H* is the intercept on the feed line *F* between parallel lines drawn through the ends of *C* and at 90 degrees to *F*.

$$H = D \div \sqrt{2} = 0.18198 \div 1.4142 = 0.1286 \text{ inch}$$

Finally, having the horizontal feed of 0.1286 inch and the vertical feed of ½ inch, we have *F'* as the actual feed and the angle *x* which was to be found.

$\tan x = H \div \tfrac{1}{2} = 0.1286 \div \tfrac{1}{2} = 0.2572$, and angle $x = 14$ degrees, 30 minutes.

W. F. B.

QUARTER SQUARES

R. A. A.—A book I was recently reading recommends the use of quarter squares or logarithms for making certain calculations. Will you please explain what is meant by "quarter square?"

A.—Quarter squares are sometimes used for performing multiplication, particularly when a series of numbers is to be multiplied by a constant number; in certain cases they are more convenient to use than logarithms. Let *a* and *b* be two factors, the product of which is desired, and assume that *a* is greater than b. Then the following identical equation may be written: $\frac{1}{4}(a + b)^2 - \frac{1}{4}(a - b)^2 = ab$. Hence, a table giving one-fourth the square of numbers (whence the name, quarter square) may be used to find the product of two numbers by simply finding the sum and difference of the two factors and then taking the difference of the quarter squares of the sum and difference. For example, suppose that the product of 747 and 3.14 is required. For the sake of simplicity of calculations, the decimal point may be ignored. Here $747 + 314 = 1061$; $747 - 314 = 433$; $\frac{1}{4} \times 1061^2 = 281430.25$; $\frac{1}{4} \times 433^2 = 46872.25$; and $281430.25 - 46872.25 = 234558 = 747 \times 314$. Therefore, $747 \times 3.14 = 2345.58$. In tables of quarter squares, the fraction ¼ is always omitted, since it always cancels in subtraction. An ordinary table of squares may be used, provided the result is divided by 4. Thus, $\frac{1}{4}(a + b)^2 - \frac{1}{4}(a - b)^2 = \frac{(a + b)^2 - (a - b)^2}{4} = ab$. The table of powers, roots and reciprocals, pages 1–41 of MACHINERY'S HANDBOOK, may be used to find the product of any two factors having three significant figures each or of any two factors whose sum is less than 2000. Thus, in the above example, find the sum and difference of the factors as before; then, $1061^2 - 433^2 = 1125721 - 187489 = 938232$, and $938232 \div 4 = 234558 = 747 \times 314$, as before. The advantage of using quarter squares instead of logarithms in finding the product of two factors is that the operations are simpler and less in number, and there is less likelihood of making a mistake. There is also a saving in time, and there is never any doubt regarding the last figure of the product. The decimal point is placed after the product has been found by the regular rules of arithmetic. Quarter squares cannot be used for division.

J. J.

PRESSURE ON A TOGGLE-OPERATED DISK CLUTCH

H. A. H.—In Fig. 1 is shown a section through a disk clutch operated by a shifting collar and toggle levers. Can you give me a method of calculating the pressure exerted on the disks at point A? The force assumed to act on collar D is 50 pounds and its movement is 1¼ inch.

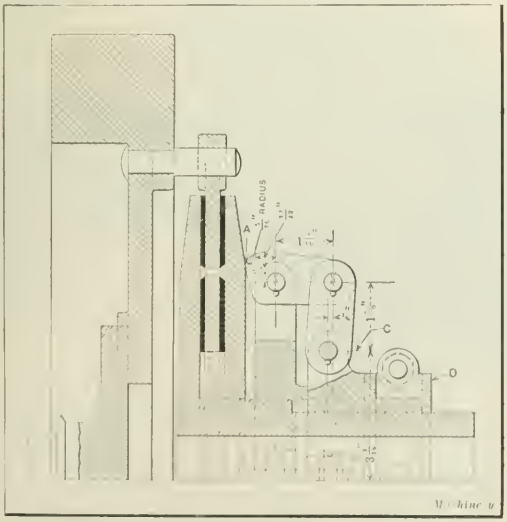


Fig. 1. Clutch shown in Engaged Position

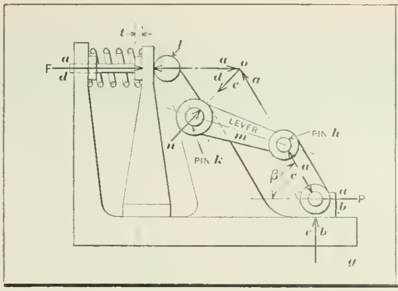


Fig. 2. Toggle Linkage Diagram neglecting Friction

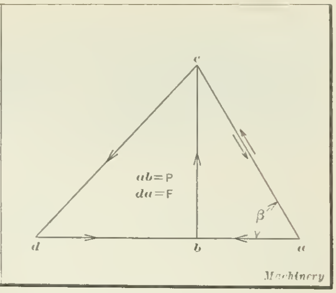


Fig. 3. Graphic Solution of Forces in Fig. 2

Answered by John S. Myers, Philadelphia, Pa.

Considering first the toggle-joint linkage, the simplest solution of such problems is by the graphic method. Fig. 2 represents in diagrammatic form, somewhat exaggerated for purposes of illustration, the elements of the device to be analyzed and Fig. 3 represents the graphic solution of the forces acting. In Fig. 2, the letters on both sides of a force designate it, while in Fig. 3 forces are designated by similar letters placed at the ends of the lines.

The operating force $P = ab$ is held in equilibrium by the vertical force bc and the oblique force ca. If the line of direction go of the force ca is produced until it intersects the line of direction of F at o, it will be obvious that, for this particular location of the linkage, pin h might lie anywhere along line go and have the same normal lever arm about pin k. Also the other end of the lever l might lie anywhere on line Fo and still have the same normal lever arm. It is possible then to consider forces ac and da to be applied at point o. Now if lever m is in equilibrium the resultant of forces ac and da must pass through the center of the fulcrum pin k and also through the point o; hence the line no gives the direction of the resultant force cd. Lay out to some convenient scale, as shown in Fig. 3, $ab = P$ and complete the diagram, drawing the lines parallel to those similarly lettered in Fig. 2. Then $da = F$ is the result sought. An inspection of Fig. 3 will show that as angle β approaches 90 degrees the forces cb cd, and da increase very rapidly, until at $\beta = 90$ degrees they become infinite. The significance of this is that, since no device can be infinitely strong, the load a toggle joint can develop depends not only on the applied force P but on the spring or resilience of the parts. This is represented in Fig. 2 by indicating the force F to be overcome as being applied through a short stiff spring. Now if S = scale of this spring, that is the pounds load per inch of deflection, and t = deflection, this force is then:

$$F = St \tag{1}$$

If the available power P for operating the device is definitely limited, the angle β and the arms of the lever m must be so proportioned that the force P is able to overcome the force F. In the clutch shown in Fig. 1, the spring of the disks, the resilience of the liner, and the deformation of the linkage act in a manner similar to the spring shown in Fig. 2. Friction of the linkage also plays an important part in such problems. This may best be taken care of in the graphic analysis by the method used in connection with Fig. 7, on page 986 of the July, 1917, number of MACHINERY. This method is applied in Figs. 4 and 5. Here any line of force, instead of passing through the center of a pin, is drawn tangent to a circle having a diameter

$$f = JC \tag{2}$$

where J = journal or pin diameter; C = coefficient of friction.

Forces bc and dc are not inclined in Fig. 4 to take into account the sliding friction of the blocks, because in the actual clutch of Fig. 1, three or four, preferably three, sets of links are mounted on collar D and eliminate friction.

A number of stress diagrams similar to Fig. 5 may now be laid out for various positions of the linkage and the results plotted in curves similar to those shown in Fig. 7. The resilience of the parts may be estimated and a line CD, repre-

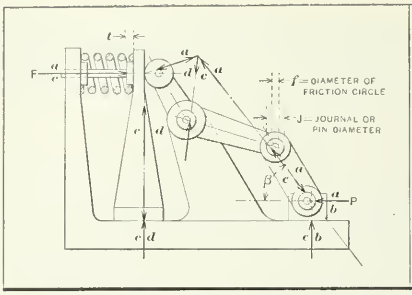


Fig. 4. Toggle Linkage Diagram taking Friction into Account

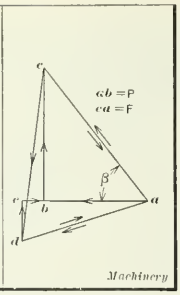


Fig. 5. Diagram of Forces in Fig. 4

senting the spring scale, may be drawn tangent to the curve *AB* This curve *AB* represents the capacity of the linkage to generate force in terms of *P*, but, due to the resilience of the parts, line *CD* represents the actual force developed. There is then an excess of power for all points except where *AB* and *CD* are tangent. The applied force *P* is seldom, however, steady or constant, as the shifter lever is usually operated with a jerk. There is no resistance during the first part of the movement until the disk clearance and link backlash are taken up; so the energy stored in the moving parts during this part of the stroke is given up as the toggle encounters resistance; as a result, some such force may be generated as is indicated by the line *EG*, Fig. 7. The analysis of this part of the problem thus becomes rather complex. What the designer usually does is to assure himself that he has an adequate lever ratio and then adjusts the clearance until the linkage produces the desired results. In order to proportion the parts he investigates, rather, the force required at the disks in order that the clutch may develop the required torque. This may be done by the aid of the following formulas in which all values are in pounds and inches:

D = outside diameter of disks;
D_1 = inside diameter of disks;
F = force pressing disks together;
T = torque or twisting moment developed;
C = coefficient of friction;
n = number of surfaces acting (in Fig. 1, $n = 2$);
p = average unit pressure on disks.

The mean radius at which the tangential frictional forces act is the arithmetical mean radius of the disks, thus:

$$R = \tfrac{1}{4}(D + D_1) \qquad (3)$$

Then

$$T = nFCR = \tfrac{1}{4}\,nFC(D + D_1) \qquad (4)$$

or

$$F = \frac{T}{nCR} = \frac{4T}{nC(D + D_1)} \qquad (5)$$

On a basis of the maximum safe value of the average unit pressure p the maximum torque of the clutch will be:

$$T = \frac{n}{16}\,\pi Cp\,(D^3 + D^2 D_1 - DD_1^2 - D_1^3) \qquad (6)$$

On page 292 of the December, 1910, number of MACHINERY, from which the curves of Fig. 6 are reproduced, it was shown that, with given values of D, C and T, the average unit pressure p becomes a minimum when $D_1 = 1/3\,D$. It was also shown that force F decreases with an increase of D_1, becoming, in theory, a minimum when $D_1 = D$. If it is equally desirable to have both p and F at their minimum values, a proposition which is impossible of attainment, the ideal compromise is to make $D_1 = 0.64\,D$, approximately. The formulas for p and F to be used in connection with the factors y and z from the curves, when applied to a clutch having more than one friction surface, are:

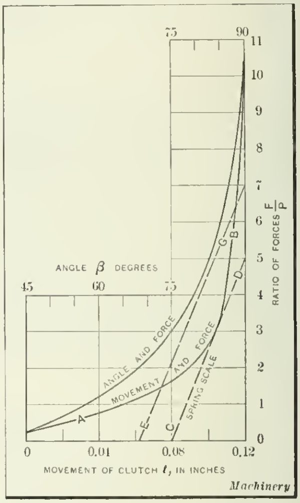


Fig. 7. Force developed by Toggle Linkage

$$p = \frac{yt}{nCD^3} \qquad (7)$$

and

$$F = \frac{zT}{nCD} \qquad (8)$$

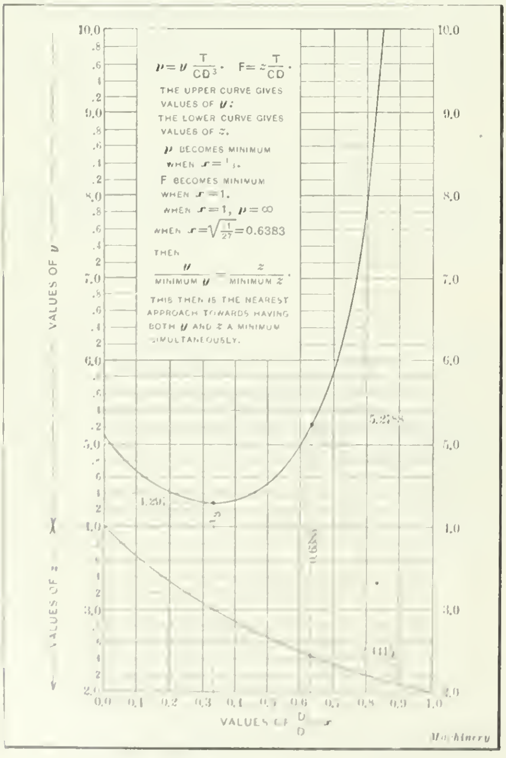


Fig. 6. Curves showing Relation between p and F

The coefficient of friction varies with the materials used and the condition of lubrication, but may be taken about as follows:

Cast iron on cast iron, dry	about 0.20
Cast iron on cast iron, greasy	about 0.16
Cast iron on cast iron, oily	about 0.10
Cast iron on leather, dry	about 0.30
Cast iron on leather, greasy	about 0.25
Cast iron on fibrous liners	0.25 to 0.30
Cast iron on cast iron with cork inserts	about 0.34

In the foregoing the writer's object is to point out methods of analysis rather than the solution of the specific case submitted.

* * *

The Bureau of Mines has prepared specifications for Federal purchases of gasoline in the District of Columbia, according to which the color, which must be water white, is tested by inspection of a column in a four-ounce sample bottle. There must also be a total absence of acidity, which is tested by thoroughly shaking 10 cubic centimeters of gasoline with 5 cubic centimeters of distilled water. The mixture must not color blue litmus paper pink.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

FAY AUTOMATIC FOR RING BEVEL GEARS

This machine is a special modification of the Fay automatic lathe, adapted for machining ring bevel gears for automobile transmissions. A feature of the machine that enables it to attain high rates of production is that the finishing tools follow directly after the roughing tools, so that no time is lost in bringing them into action. The mechanism is extremely simple and of compact design, so that the amount of floor space required is relatively small.

The Jones & Lamson Machine Co., Springfield, Vt., has developed a highly specialized modification of the Fay automatic lathe for machining the large ring bevel gears in the rear axle drive of automobiles and trucks. The design of this machine confines it to the machining of the bevel face and ends and other incidental operations. By thus confining the work, it has been possible to build a machine that is exceptionally well adapted for this particular operation. Fig. 1 shows the front side of the machine, Fig. 2 the back side, Fig. 3 the gear drive headstock with cover removed, and Fig. 4 a typical tool set-up.

Reference may first be made to Fig. 4 in order to get an idea of the operations for which the machine is designed. The front tool-holder moves on an angle, as shown by the arrow, for finishing the bevel on the outer and inner ends. Tool *A* roughs the outside diameter; tool *B*, immediately following in one continuous motion, finishes it; while tool *C* machines the inside end. The rear tool-holder, moving in the direction of the arrow as shown, carries tool *D*, which roughs the bevel face of the blank. Tool *E*, which follows immediately after, finishes it, and tool *F*, in the same continuous motion, rounds the corner at the back side of the blank. It will be noticed that the front and back faces, and the bore by which the blank is held, have been machined by previous operations on the turret lathe.

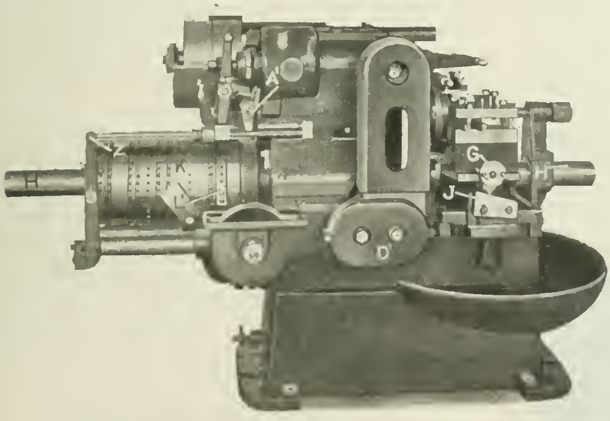


Fig. 1. Front View of Special Fay Automatic Lathe for machining Ring Bevel Gears

Going back again to the description of the machine on which this work is done, at *G* in Fig. 1 is shown the front tool carriage. This carries the tools *A*, *B* and *C*, Fig. 4, and is mounted on bar *H*, which has an endwise motion; the bar and tool-holder together are rocked in the journals of the bar by means of the follower on the under side of the toolpost, which rests on bevel former *J*. This former may be adjusted to any angle required to meet the desired angle for the bevel on the ends of the teeth. The longitudinal movement of bar *H*, by means of which tool-holder *G* and the tools mounted thereon are fed along the work, is effected by cams on the inside of drum *K* operating on a cam roll fastened to a carrier clamped to bar *H* on the inside of the drum.

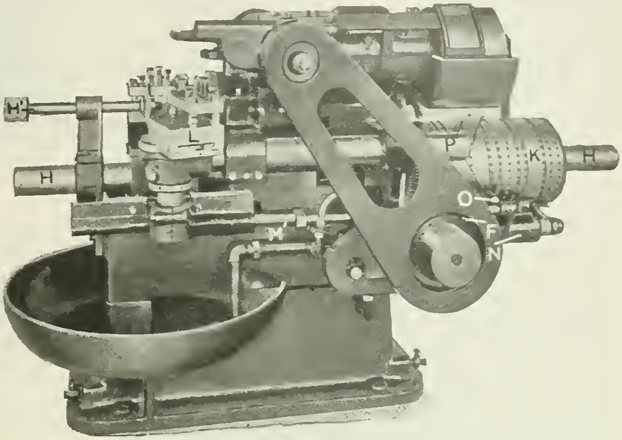


Fig. 2. Opposite Side of Special Fay Automatic Lathe for Ring Bevel Gears

On the rear side of the machine, shown in Fig. 2, is seen the rear tool-holder *L*, which carries the tools *D*, *E* and *F*, Fig. 4. This is a compound rest operated by a strongly constructed rack, gear and pinion device, the pinion shaft extending up through the center of the angular adjustment of the rest. It carries at its lower end a gear meshing with rack *M*, which is, in turn, connected with the cam slide *N* and cam roll *O*, operated by outside cams, of which one is shown at *P* on the drum. The compound rest carrying tool-block *L* can be adjusted to any angle to turn anything from a cylinder to a straight face or even an internal bevel, and will, of course, turn the faces of the gears absolutely straight, so that they can be held properly in the jigs largely used in hardening to prevent distortion.

The movements of both the front and the rear cross-slide are thus seen to be controlled by cams on drum *K*. This drum has a slow motion for feed and a fast motion for idle movements, driven as will be later described, and automatically shifted by adjustable dogs, of which one is shown at *L'* in Fig. 1. The drive of the machine is best shown in Fig. 3, where the headstock is shown with the cover removed. The drive is either from a motor mounted on the headstock, or through the main lineshaft direct to tight and loose pulleys at *Q*. By mounting the tight and loose pulley directly on the drive shaft, it is placed where it can be properly oiled and taken care of, and at the same time the drive is greatly simplified. The drive shaft on which pulleys *Q* are mounted carries a triple sliding gear *R*, shifted by a fork controlled by handle *S*. This sliding gear is set to give any one of the range of three available speeds, depending on the size of ring bevel gear being machined, hardness of the material, etc. In the three different positions it meshes with the three corresponding gears on intermediate shaft *T;* the gears on this shaft, in turn, drive the third shaft *U* either through slow-speed ratchet gear *V*, intermediate clutch gear *X* or the fast-speed gear *W*. This speed change is under automatic control of the machine by means of a clutch collar and speed change lever *Z* shown in Fig. 1.

Lever *Z* is operated by dogs on the drum, which throw the clutch collar either to its intermediate or extreme right or left position, as may be required at any point in the machining of work. In the intermediate position the drive is through silent ratchet gear *V*. This gives a very slow speed used when the cutting tools are below the scale on hard forgings. The clutch collar is next thrown to the right, giving the intermediate speed through clutch gear *X* used for roughing. When the finishing tools come into play the clutch collar is thrown to the extreme left, bringing the drive through gear *W* and giving a high speed for finishing. The spring release mechanism shown at *A'* in Fig. 1 is used in snapping the gears through the neutral position, in getting from the intermediate to the high speed when changing from roughing to finishing speed.

All the gears of this drive are of hardened steel and run in oil. Pinion *B'* on the third shaft (Fig. 3) meshes with spindle gear *C'*. This spindle gear runs in a bath of oil, which it carries up to a scraper, feeding it into the upper reservoir in which the transmission gears revolve. This reservoir, in turn, drains back through the main bearings of the spindle into the lower reservoir, where the spindle gear *C'* again picks it up and returns it over its course, thus giving continuous lubrication. The geared headstock will thus be seen to give nine spindle speeds without change of drive pulley speed, and these speeds are so arranged that there are three groups of three each in the headstock, operated by hand for any one of the three groups, and any one of the three speeds in that group is obtained automatically at any required point in the operation.

Cam drum *K* is driven by a worm-shaft connected through change mechanism at *D'* in Fig. 1, and a belt with a slow-speed driving pulley *E'* in Fig. 3. This, it will be noted, is connected with the third shaft, which receives all the speed variations of the geared head drive. The change-gears may thus be set for any feed in revolutions per inch, irrespective of the spindle speed. The fast motion is through a clutch pulley *F*, shown at the back of the machine in Fig. 2. This is belted to fast-motion drive pulley *G'* in Fig. 3. Pulley *G'*, being geared for a main driving shaft, runs at constant speed, so that fast motions of the cam drum are always at high speed, irrespective of whether the spindle is running slow or fast.

This arrangement, together with the fact that no time is required for turning turrets, or other similar idle operations, reduces the idle moments of the machine to practically nothing. Finishing tools, as shown in Fig. 4, follow immediately after the roughing tools, so that no time is lost in bringing them into action. Another interesting provision possible with some designs of ring gears is shown clearly in Fig. 2. It consists of the wrench shaft *H'*, carrying on its inner end the flange plate by means of which the ring gear is held onto the fixture on the end of the spindle. By this means the flange is always in place on the machine, and it is not necessary to pick it off and set it on a bench with other outside pieces. It only remains to clamp it and unclamp it as the work is put in and removed, leaving the hands of the operator free for handling work.

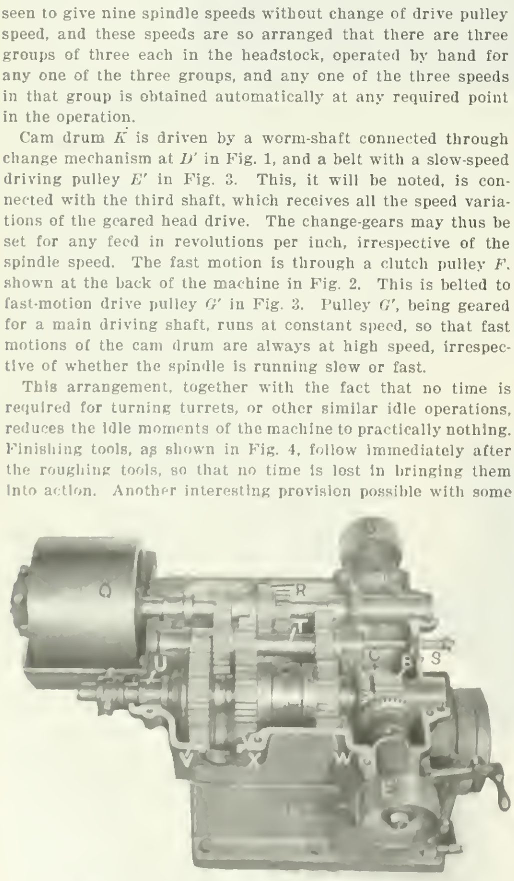


Fig. [illegible] Gear-driven Headstock of Lathe with Cover removed

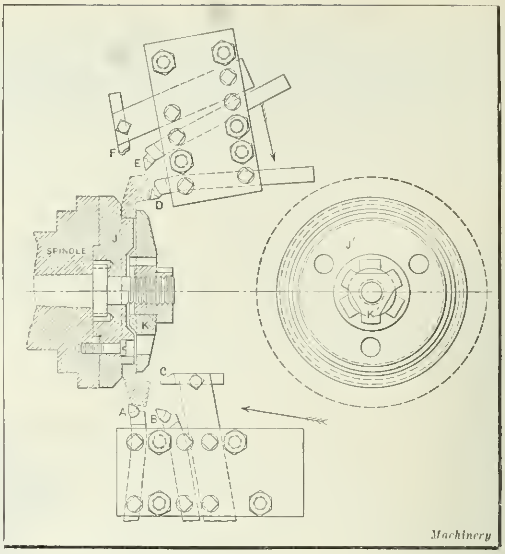


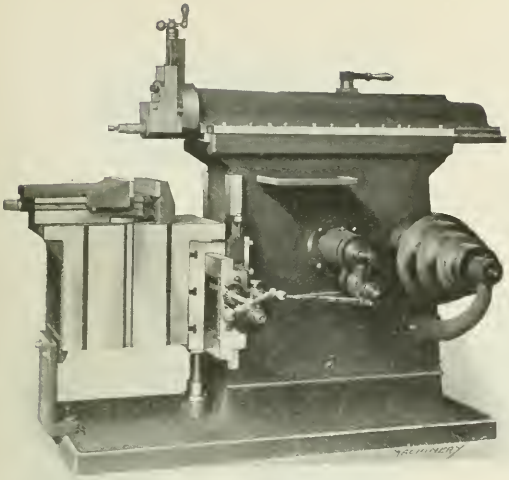
Fig. 4. Typical Tool Set-up for Special Fay Automatic Lathe for Ring Bevel Gears

With other designs of ring gears it is better to use the arrangement shown in Fig. 4, where the flange *J'* is clamped up against the work by nut *K'* with interrupted holding lugs, which are such that when the nut is released the flange may be drawn off past the lugs through its clearance slots, without requiring the nuts to be entirely screwed off and on. Either one of these clamps gives great rapidity in loading and unloading. The compactness of this machine is seen at a glance, as well as the large amount of chip room and the ease of access to the work and tools. A chip guard is provided that comes up high around the machine, giving a large reservoir space for the oil and at the same time permitting the oil to be drained into the base of the machine. The oil-pump has large capacity through direct, unobstructed piping, giving a full flow of cutting compound on the work.

The advantages claimed for this machine are: (1) Continuous production at exactly the right feeds and speeds required for the most efficient cutting without any lost time required for idle movements. (2) Compactness of mechanism for the amount of output per machine, reducing the factory space required for a given production. (3) Extreme simplicity of mechanism and the confining of the machine to single-spindle units, so that in the event of any slight disarrangement in the mechanism but a small part of the production is held up. (4) The low capital cost for a given output, made possible first by high productivity and the low cost of each unit. (5) Low labor cost, owing to quick change of work possible; high speeds and feeds; and quick change from one job to another, the camming being permanent.

HOLLINGWORTH SHAPER

One of the recent products of the Hollingworth Machine Tool Co., Covington, Ky., is a 24-inch triple-geared crank shaper, which is illustrated and described herewith. To provide for taking exceptionally heavy cuts, the machine has been designed on the triple geared principle, with a quick return stroke. The walls of the column, ram and base have also been



Hollingworth 24-inch Triple-geared Crank Shaper

heavily constructed and strongly ribbed, so that ample strength is provided for severe classes of service. The length of stroke can be adjusted while the machine is at rest or in motion, thereby avoiding the necessity of stopping the machine for this purpose. The device for changing the stroke is so arranged that it is possible to make changes while the machine is actually at work. The ram can be quickly adjusted to suit the position of the work, and a short stroke can be taken at any point.

All flat bearings are hand-scraped to surface plates and all wearing surfaces on the machine are provided with gibs for making fine adjustments. The shaft bearings are furnished with bronze bushings that can be readily removed or replaced when necessary. A system of oilers carry lubricant to the shaft bearings; and the same type of oiling device is used throughout the machine. The arm for supporting the pulley shaft provides support at the outer end of this shaft, thereby giving it three bearings. All gears in the machine are cut from solid blanks. The cross-rail is designed with wide bearings, which are carefully scraped to surface plates. The tool-head may be instantly set and rigidly held at any angle, by means of a swivel bolt in the head, which is graduated and may be swiveled to any angle up to 90 degrees. A micrometer dial for the feed movement is graduated to 0.001 inch.

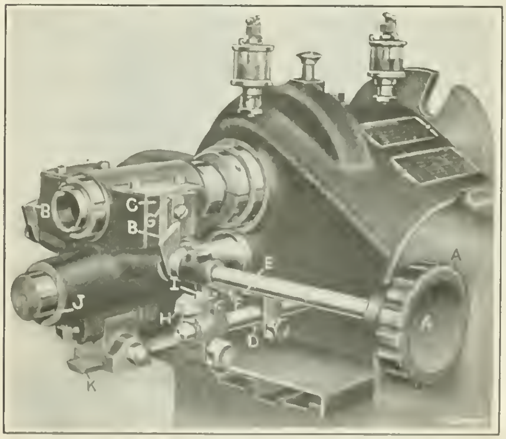
The table is slotted on the top and at both sides, and it may be readily removed to enable work to be bolted to the slotted saddle by which the table is carried. The top of the table measures 16 by 23 inches, and by having it slotted for the entire length, provision is made for a liberal sized clamping surface. The base of the vise is graduated to 360 degrees and the upper jaw is held in position by means of steel gibs. The steel faced jaws for the vise are 2½ inches deep by 12½ inches long, and the vise opens 12½ inches. The elevating screw is of the telescopic type and has a ball-bearing washer below the table, which insures easy operation. The cross-feed mechanism is of simple design and the rate of feed can be varied while the machine is in motion. A lifting and turning pawl is used for engaging or disengaging the feed, which is automatic in either direction. A micrometer dial on the cross-feed screw is graduated to 0.002 inch.

The table support furnished with each machine is of simple design, and there is nothing to get out of order. This support can be quickly adjusted by means of a screw, and is always under the cut. The countershaft has two friction pulleys, 12 by 4 inches in size, and should run 175 and 325 revolutions per minute. In this way two changes of speed are available for each step of the cone pulley. The total range of speeds is 7, 11, 17 and 28 strokes per minute for the slow-speed countershaft pulley and 12½, 20½, 33 and 58 strokes per minute for the high-speed countershaft pulley. The principal dimensions of the machine are as follows: actual length of stroke, 24½ inches; maximum automatic cross-feed, 26 inches; maximum vertical adjustment of table, 14½ inches; maximum feed of tool-block, 8 inches; ratio of gearing, 13 to 1; and width of double machine belt, 3¼ inches.

PORTER-CABLE LATHE SCREW-CUTTING ATTACHMENT

The Porter-Cable Machine Co., Syracuse, N. Y., has added a screw-cutting attachment to the line of labor-saving devices developed for use on its manufacturing lathe. This screw-cutting attachment will handle threading operations on work up to 2½ inches in length, and there are a number of features incorporated in its design that provide for speed of operation and accuracy of the work. All gearing has been eliminated between the spindle and carriage, the latter being actuated directly by the lead-screw through a traveler *J* connected to the carriage by the dovetailed pull-rod *K*. The lead-screw is made in the form of an external threaded sleeve and mounted on an extension at the rear end of the lathe spindle, this extension being accurately screwed onto the threaded end of the spindle in the same manner as the lever chuck closing attachment used on this lathe. Lead-screws and nuts of standard pitches can be furnished to cover U. S. standard threads from ¼ to 1 inch, and also A. L. A. M. and pipe threads, as it is necessary to use a lead-screw and nut of the same pitch as the thread to be cut. These parts are designed to be readily interchangeable and they are comparatively inexpensive.

The set-up and operation of the screw-cutting attachment is as follows: The lathe carriage is located in the position that it should occupy when starting the cut, and the right-hand carriage stop is brought up to it and secured in place. Traveler *J* should be located adjacent to the headstock and secured to pull-rod *K*, which is attached to the carriage by means of a grip screw. While the carriage is in this position knob *A* is turned to the left to bring two arms *B* into the position shown. This simultaneously engages two segmental jaw-like nuts with the lead-screw, one of these nuts being shown at *C*, while the other is diametrically opposite on the lead-screw. Stop *D* should next be positioned and secured so that finger *E* will contact with finger *F*. When the machine is in operation this arrangement enables the operator, when starting a cut, to turn knob *A* quickly to the left until finger *F* stops against finger *E*, which makes it impossible to turn knob *A* too far and insures the proper positioning of arms *B* in order to throw the nuts into engagement with the screw. The knob should next be turned a sufficient amount to the right to allow the nuts to be disengaged from the screw and the carriage to be run forward by hand to the position it will assume at the end of the cut. The knob is turned to the right as far as it will go, or until the square corner of arm *B*



Screw-cutting Attachment for Lathe built by Porter-Cable Machine Co.

strikes the left-hand side of block *G*, and trip latch *H* is then secured so that it engages with trip finger *I*.

The work is now set up and the cycle of operations is as follows: (1) Start lathe. (2) Move carriage by hand toward tailstock until it comes to stop. This brings the tool into the starting position. (3) Feed tool to depth and turn knob *A* quickly to left as far as it will go, which throws nuts into engagement with lead-screw and moves carriage forward. The carriage travels forward until the nuts are automatically disengaged by finger *I* engaging with latch *H*, which rotates arms *B* to the left until the square corners on the arms drop off the square corners on the thrust blocks. This arrangement insures that the carriage will stop accurately in any place at the end of each cut. (4) Withdraw tool, return carriage by hand to starting position and continue cycle of operations until thread is finished. The operation of this thread-cutting attachment is so simple and positive that with a suitable stop on the cross-slide of the lathe, which would limit the total depth of cut, it is claimed that the operator could quickly cut a thread with his eyes shut. The accuracy of the work produced depends only upon the accuracy of the lead-screw, as the work will be an exact duplicate of the lead-screw.

WEIGEL DRILLING MACHINE

The Weigel Machine Tool Co., Peru, Ind., is now building a 25-inch vertical drilling machine, two views of which are shown in Figs. 1 and 2. This machine is built in two grades, one being furnished with babbitted bearings and the other with Damascus bronze bearings. The base is ribbed underneath to provide stiffness, and it has an oil-pan of ample size extending entirely around the outer edge. Four T-slots are milled in the base for clamping work. The column is of tubular section and provides ample bearings for the table arm and sliding head. The table is designed with a heavy face to prevent springing by clamps holding the work, and it is furnished with the usual T-slots for clamping work in place. The table arm is raised and lowered by a rack and pinion actuated through a worm and worm-gear. The bore for the hub on the table is made large enough to enable a compound table to be used without requiring any change to be made. This hole is bored to a plug gage so that a compound table can be substituted for the standard table at any time.

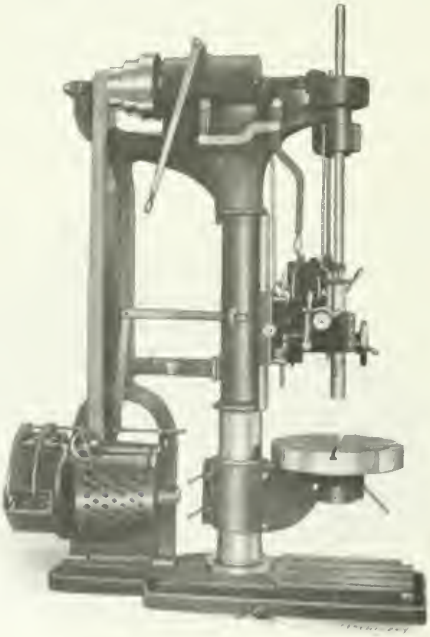


Fig. 1. Weigel 25-inch Vertical Drilling Machine

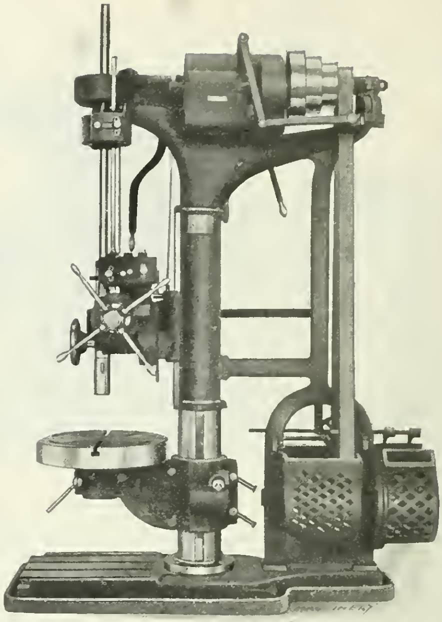


Fig. 2. Opposite Side of Weigel Vertical Drilling Machine shown in Fig. 1

This machine is furnished with either plain sliding back-gears or the Weigel improved friction type of back-gears. The friction back-gears are positive in action and easily operated by a lever conveniently located at the front of the machine. All gears are entirely covered and run in an oil-tight case, which insures perfect lubrication. Eight rates of feed are provided for each spindle speed, the feed changes being obtained by means of sliding gears. Any feed is easily and quickly obtained by convenient levers, the rate being indicated by a plate attached to the machine. For the friction quick-return, the operating levers are placed in the form of a pilot wheel consisting of four levers, any one of which engages or disengages the feed at will. An automatic stop which is positive in its action can be set to throw out the feed at any predetermined depth. The worm operating the quick-return shaft is triple-threaded.

This machine can be furnished with the Weigel improved friction tapping attachment, which is placed directly on the spindle and has a reverse ratio of 2 to 1 for backing out the tap. A long driving key is provided on the spindle to prevent cramping on either the forward or reverse motion. Provision is made for disengaging the tapping attachment when it is not required. Provision is also made for equipping this drilling machine for either direct-geared motor drive or the application of motor drive with transmission through a belt. This machine is said to comply with all state laws governing the provision of means for guarding against accidents to operators. All gearing in the head is entirely covered by housings cast integral with the head, as well as the back-gears on the yoke and gearing on the table arm. The lower cone pulley is entirely covered by a cast housing, and the tight and loose pulleys have an adjustable guard. A belt shifter is furnished on all machines to provide for shifting the belt on the cone pulleys, and as the operator does not have to shift the belt by hand, he will be more likely to change the speed in order to obtain that which is required for the work he is doing

The principal dimensions of this machine are as follows: extreme height with spindle extended, 9 feet, 9½ inches; height to top of drill, 7 feet, 11 inches; distance from base to spindle, 47½ inches; distance from table to spindle, 30½ inches; capacity, for drilling to center of 25⅝-inch circle; traverse of table on column, 13½ inches; travel of head on column, 21 inches; diameter of table, 22 inches; diameter of column, 7½ inches; diameter of spindle above sleeve, 1 9/16 inch; diameter of spindle in sleeve, 1 11/16 inch; diameter of sleeve, 2⅝ inches; taper of hole in spindle, No. 4 Morse; ratio of back-gears, 2.5 to 1; available rates of feed per spindle revolution, 0.0040, 0.0054, 0.0081, 0.0108, 0.0162, 0.0216, 0.0224 and 0.0432; size of cone pulley steps, 6, 8, 10 and 12 inches in diameter by 2¾ inches face width; size of tight and loose pulleys, 12 inches in diameter by 3¼ inches face width; speed of tight and loose pulleys, 500 R.P.M.; available spindle speeds through open belt, 100, 160, 250 and 400 R.P.M.; and available spindle speeds through back-gears, 15, 25, 39 and 62 R.P.M.

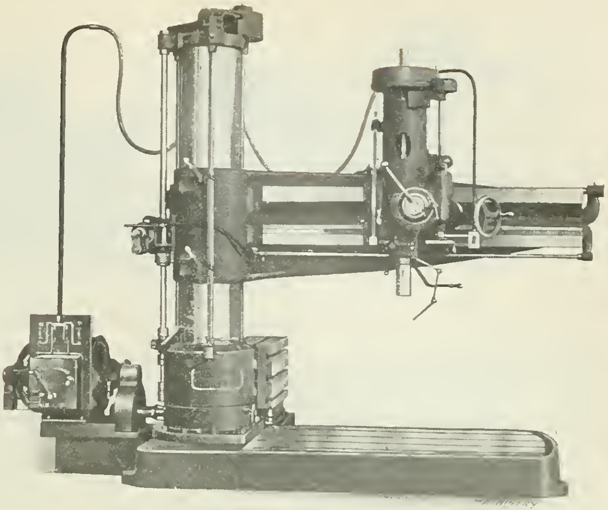


Fig. 2. Cincinnati-Bickford Plain Radial Drilling Machine with Reliance Adjustable Motor mounted on Base

CINCINNATI - BICKFORD MOTOR-DRIVEN RADIAL DRILLING MACHINES

The radial drilling machines manufactured by the Cincinnati Bickford Tool Co., Oakley, Cincinnati, Ohio, are well known to readers of Machinery, but the accompanying illustrations show some recent developments in variable-speed motor drive. These radial drilling machines are furnished with four types of drive, as follows: cone pulley; gear-box; motor drive through gear-box; and variable-speed motor drive. In Figs. 1 and 2 are shown two highly developed forms of variable-speed motor drive.

Fig. 1 shows a Cincinnati-Bickford plain radial drilling machine with a plain table, which is made in four-, five- and six-foot sizes. This machine is equipped with an air column binder and cutting lubricant outfit; it is driven by a 3 to 1 variable-speed motor mounted on the arm and geared direct to the arm-shaft. The controller is placed on the head. The arm is elevated by a constant-speed, reversing, compound-wound motor mounted on top of the column and controlled by a reversing switch and dynamic brake resistance. The switch is operated by a square shaft controlled by the Cincinnati Bickford Tool Co.'s patented interlocking device; and a revolving connection in the base of the column permits wires to enter at this point and run up through the center of the column to the top.

Fig. 2 shows one of the Cincinnati-Bickford radial drilling machines, which is built in four,- five- and six-foot sizes. This machine is equipped with a plain table, cutting lubricant outfit and air column binder. It is equipped with a Reliance adjustable-speed motor having a starter attached. There is also a form R. C. small motor for speed adjustment attached to the large motor and remote speed control by a push-button mounted on the head of the machine.

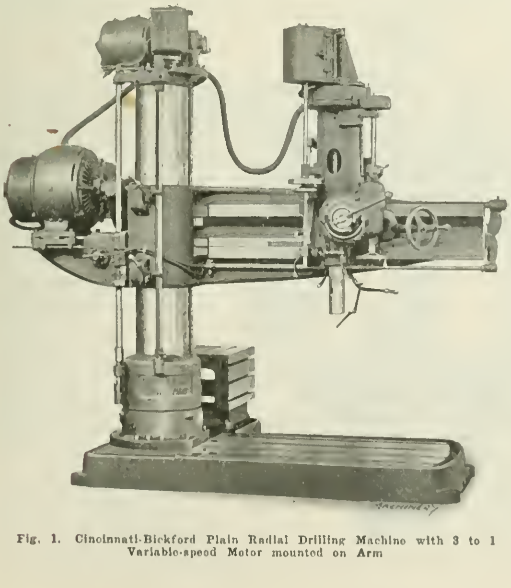


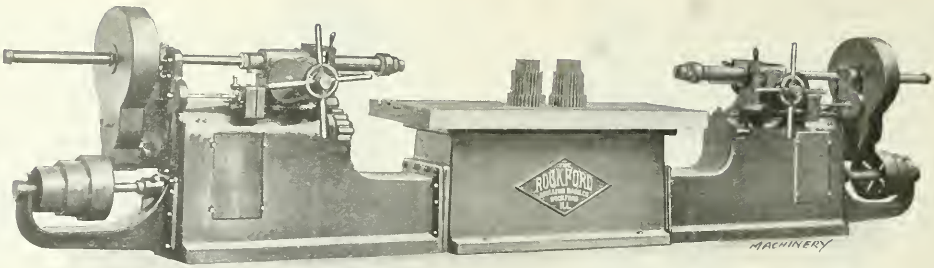
Fig. 1. Cincinnati-Bickford Plain Radial Drilling Machine with 3 to 1 Variable-speed Motor mounted on Arm

ROCKFORD BORING AND DRILLING MACHINE

The Rockford Drilling Machine Co., Rockford, Ill., is now building a heavy-duty horizontal boring and drilling machine, which is especially adapted for use in manufacturing parts in large quantities. This is a single-purpose machine, and is built to customers' specifications in regard to spindle height above table, length of table and distance between spindle ends. The capacity is for driving high-speed drills up to 2½ inches in diameter in steel and for boring holes up to 6 inches in diameter in steel. Several types of machines are built, which include a single-spindle machine, a double-spindle machine with spindles opposed (as shown in the accompanying illustration), a double-spindle machine with the spindles at right angles, and machines with three or four spindles. The bearings are made of phosphor-bronze and are interchangeable. Drive is through a three-step cone pulley, which carries a 4-inch belt, and each spindle has entirely separate speed control, being furnished with its own tight and loose pulley countershaft. All bearings in the countershaft are bronze bushed and equipped with oilers. The speed changes, beyond those furnished by the three-step cone pulley, are obtained by means of interchangeable pick-off gears, and attention is called to the fact that no bevel gears are used in the drive. All gears are of large pitch and wide face to provide ample strength.

There are four available rates of feed, which are taken from the spindle, and any of these four changes is instantly obtainable. The spindle is forged from high carbon steel and fitted with two special ball-thrust bearings. The spindle nose is bored No. 5 Morse taper, and is slotted across the end to provide for driving heavy boring and facing heads. Hand traverse of the spindle is obtained by means of a star lever, which works through reduction gears, giving a powerful hand feed. This machine is especially adapted for the performance of repetition work, such as boring crank-cases, transmission cases and rear axles for automobiles, headstocks and tailstocks for lathes, core drilling, etc. The design is such that the machine lends itself readily to the application of multiple-spindle heads for machining from two to ten holes at one time. On multiple-spindle machines, two or more pieces can be operated upon at the same time, which is the means of conserving floor space and economizing in operator's time.

The principal dimensions of this machine are as follows: capacity for drilling in steel, up to 2½ inches; distance from

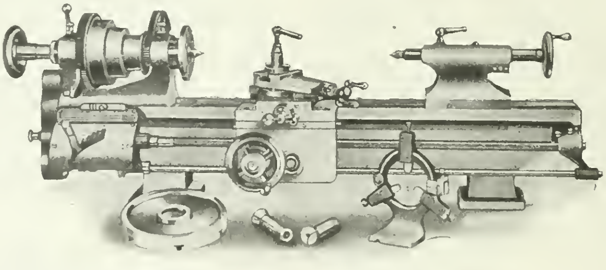


Heavy-duty Horizontal Boring and Drilling Machine built by Rockford Drilling Machine Co.

spindle to table, distance between spindle ends and length of table, made to suit requirements; length of feed, 20 inches; diameter of spindle sleeve, 3⅜ inches; smallest diameter of spindle, 2 inches; taper of spindle hole, No. 5 Morse; width of hardened nickel steel feed rack, 2 inches; diameter of spindle driving gear, 18 inches; size of regular table, 24 by 72 inches; height of table from floor, 30 inches; available rates of feed, 0.010, 0.015, 0.022 and 0.030 inch per spindle revolution; size of driving pulley on countershafting, 14 inches diameter by 6¼ inches face width; speed of countershaft, 500 revolutions per minute; and ratio between drive and spindle, 5 to 1.

WADE PRECISION LATHE

In introducing this toolmaker's precision lathe, attention is called to the fact that it is not a revolutionary product. The design follows established lines that have proved satisfactory in various classes of service. The claims made for the present machine are that it is of sturdy construction, accurately finished and built along lines that will provide durability for the machine and accuracy of the work. This lathe is adapted for handling all kinds of tool and scientific instrument work, and for use in the manufacture of fine gun parts and similar products. The head swings 8½ inches and the lathe is 45 inches long, giving ample room for handling work up to 24 inches in length between centers.



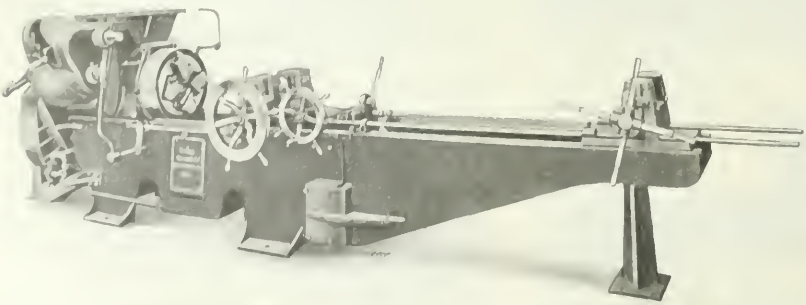
Toolmaker's Precision Lathe built by Walter H. Wade

The bed is in the shape of a hollow square with cross-ribs, giving ample strength and rigidity. The ways are placed forward directly over the supporting sides of the bed, which affords a solid construction and avoids forming a pocket in which dirt and chips are likely to collect. The head is back-geared and the spindle and its bearings are of the cone type, the spindle being made of tool steel, hardened, ground and lapped and provided with means of adjusting for wear. Provision is made for setting over the tailstock for turning tapered work, and the tailstock spindle has a bearing for the full length of the spindle in any position.

It will be seen that this lathe is provided with a quick-change gear-box, and screw threads of twenty-four different pitches can be cut, covering a range from 12 to 120 per inch. The gears are shifted by three levers, and a feed 2.9 finer than the screw feed is obtained through a feed-rod. The lead-screw is ¾ inch in diameter and has eight threads per inch; it is made of crucible steel and the threads are cut with a master lead-screw. The nut that fits the lead-screw is made of bronze and is of ample length to give the desired durability. All gears in the lathe are made of steel and cut from solid blanks. The spring chucks used on this machine are made of steel, hardened, tempered and ground; these chucks are made in eleven sizes, ranging from 1/8 to 3/4 inch by intervals of 1/16 inch. A two-speed countershaft of the wall type is furnished with each lathe. It has pulleys 6 inches in diameter by 2 inches face width. The cone pulley steps are 6½, 5¼ and 4 inches in diameter by 1¼ inch face width. Three treadles furnished with the countershaft operate the spring shippers. This machine is a recent product of Walter H. Wade, 311 Atlantic Ave., Boston, Mass.

LANDIS THREADING MACHINE

The Landis Machine Co., Waynesboro, Pa., has recently designed and built a machine for a large shipbuilding plant, which is used for threading hollow staybolt tubes. These tubes vary from 6 to 8 feet in length and from 2¾ to 3½ inches in diameter. The machine is equipped with an auxiliary bed, which is attached to the main bed, and this extension bed supports an auxiliary carriage fitted with threaded grips employed in timing the threads on the ends of the tubes and also for supporting the tubes. A lead-screw attachment insures obtaining a high degree of accuracy and a perfect start for the thread; there is also a pitch indicator that shows the correct position for engaging the



Threading Machine for Hollow Staybolt Tubes built by Landis Machine Co.

lead-screw nut. The accompanying illustration shows the machine arranged for drive by an alternating-current, constant-speed motor with a mechanical speed-change box and drive through sprockets and a silent chain. The illustration does not show the motor in position.

In threading hollow staybolt tubes on this machine the method of operation is as follows: One end of all the tubes is threaded by gripping them in the vise of the regular carriage. Then a master tube, which has both ends threaded with threads continuous, is placed in the machine and the chasers are closed down on the threaded portion on one end, *i. e.*, the grooves or serrated surfaces of the chasers are fitted in the threads already cut on the master staytube. Next the outer end of this master tube is gripped with the thread grips in the auxiliary carriage; these grips should be sufficiently loose so that they can adjust themselves endwise with the thread on the master tube. After the master tube has been gripped in the extension carriage, the threaded grips should be secured in the auxiliary carriage vise jaws. Next the lead-screw nut of the main carriage is thrown in and the tube is gripped in the regular vise of the main carriage. The chasers, lead-screw and threads on the staybolt tubes will then all be correctly timed. The master staytube is now removed and the tubes, which have already been threaded on one end, are placed in the threaded grips of the auxiliary carriage, the lead-screw nut being engaged when the pitch indicator on the main carriage shows the correct position for engaging this nut. The operation of threading the other end of all the tubes can then proceed, and the threads on both ends of the tube will be continuous. This machine employs the Landis all-steel rotary die-head and long-life chasers.

DAVID A. WRIGHT SCREW MACHINE

David A. Wright, 568 Washington Blvd., Chicago, Ill., is now manufacturing the No. 1½ hand screw machine shown in Fig. 1. It is equipped with an automatic chuck which has capacity for handling round bars 13/16 inch in diameter, square bars of 19/32 inch, and hexagon bars of 23/32 inch; work up to 6 inches in length can be handled on the machine. This screw machine is heavily constructed to adapt it for operation at high speed, and it has an ample swing and plenty of clearance for the cut-off slide. A special turret operating mechanism has been designed to embody features of simplicity and durability; this mechanism is illustrated in Fig. 2. There are individual adjustable stops for each of the six positions of the turret, which has an efficient locking mechanism. Rollers are provided on the wire feed dog; and the gage finger automatically revolves, engaging with respective stop-nuts that travel longitudinally on stationary stop-screws Means are provided to compensate for wear of the turret bearing. There is a triple locking feature for the turret, which, in one position, allows the turret to be turned in either direction when only a few tools are employed.

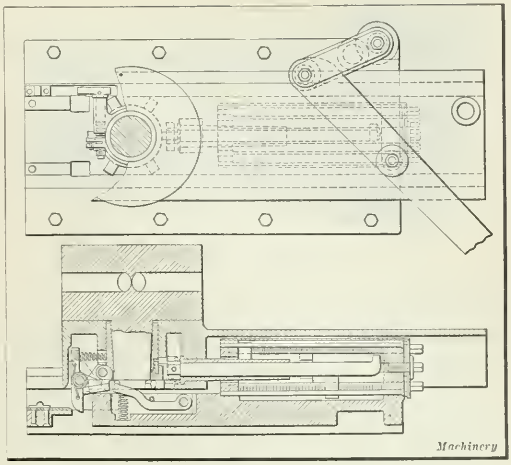


Fig. 2. Plan View and Longitudinal Section of Turret Operating Mechanism

The principal dimensions of this machine are as follows: diameter of hole through chuck plunger, 7/8 inch; diameter of hole through spindle, 1 3/32 inch; diameter of thread in spindle, 2 1/8 inches; capacity for handling threaded work on soft steel, up to 1/2 inch; drilling capacity, up to 3/8 inch; length of work that can be turned, up to 6 inches; maximum distance from end of spindle to face of turret with saddle even with end of bed, 11 inches; swing over bed, 11 1/4 inches; swing over cut-off slide, 6 inches; dimensions of front spindle bearing, 1 3/4 by 3 1/2 inches; dimensions of rear spindle bearing, 1 5/8 by 2 5/8 inches; diameter of round turret, 5 3/4 inches; size of hexagon turret, 5 3/4 inches across flats; diameter of tapped holes in turret face, 3/8 inch; distance from center of turret holes to top of slide, 1 15/16 inch; maximum travel of cross-slide, 6 inches; size of cut-off tools, 7/16 by 1 inch: length of wire feed bar, 33 inches; diameters of cone pulley, 8, 6 1/4 and 4 1/2 inches; width of driving belt, 2 1/2 inches; diameter of countershaft friction pulleys, 10 inches; width of belt, 2 3/4 inches; speed of countershaft, 210 R.P.M.; available spindle speeds, 200, 305 and 500 R.P.M.; power required to drive the machine, one horsepower; floor space occupied, 20 by 54 inches; and weight of machine with countershaft, 750 pounds.

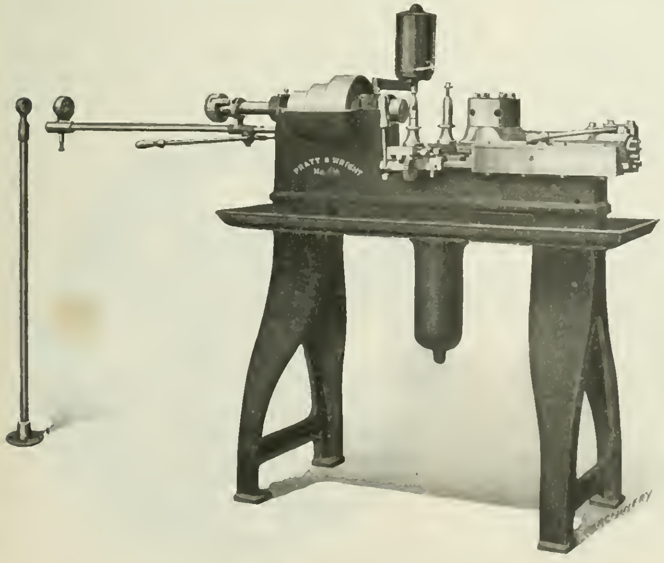


Fig. 1. No. 1½ Hand Screw Machine built by David A. Wright

VICTOR FLOATING REAMER-HOLDER

It frequently happens that users of turret machinery experience difficulty in reaming holes true and to size. This is usually due to an error in the reamer shank or to faulty alignment of the turret and spindle of the machine. With the view of overcoming trouble of this kind, the Victor Tool Co., Inc., Waynesboro, Pa., has developed the Sheuman floating

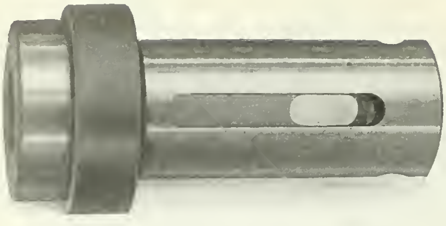


Fig. 1. Victor Floating Reamer-holder for Reamers with Tapered Shanks

reamer-holder; it is stated that this tool has been thoroughly tested in the manufacturer's shops, where it has proved entirely satisfactory. In working out the design of this reamer-holder, care has been taken to simplify its construction as far as possible. The shank of the socket is of smaller diameter than the bore of the socket bushing; and the shoulder of the socket bears on a thrust ball bearing that permits the reamer to adjust itself into perfect alignment with the spindle of the machine, so that it always reams to its actual size and cuts perfectly straight. The pin at the rear serves only to keep the socket from turning in the socket bushing.

It is claimed that when using this tool it is not necessary for the foreman to devote time to setting reamers, as any inexperienced machine operator can set this tool to produce satisfactory work. In times such as the present, when manufacturers are compelled to employ a great deal of unskilled labor, this is an important feature. This reamer-holder is suitable for use on automatic screw machines, turret lathes, horizontal or vertical boring mills, and all other types of turret machines. Holders of this type are made in five standard sizes, as follows: size of hole, No. 2 Morse; diameter of socket bushing, 1¼ inch; size of hole, No. 3 Morse, diameter of socket bushing, 1½ inch; size of hole, No. 4 Morse, diameter of socket bushing, 2 inches; size of hole, ½ inch diameter, straight, diameter of socket bushing, 1¼ inch; size of hole, ⅞ inch diameter, straight, diameter of socket bushing, 1½ inch. Special holders can be made to suit any size of reamer shank, either straight or tapered, and the socket bushing can be made to fit any turret.

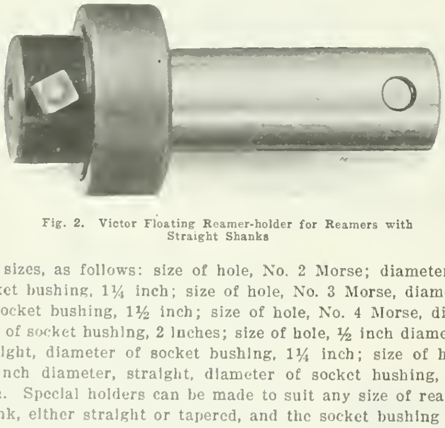
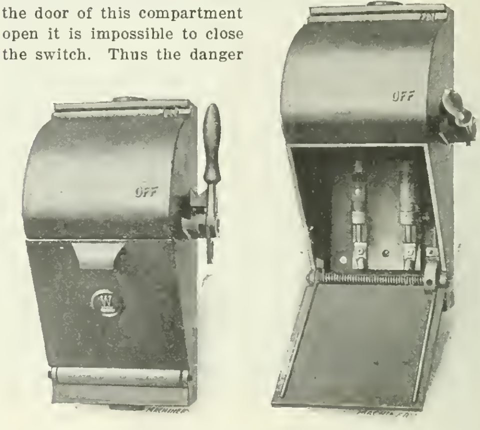


Fig. 2. Victor Floating Reamer-holder for Reamers with Straight Shanks

WESTINGHOUSE "SAFETY FIRST" SWITCH

In steel mills, factories and similar places employing men with practically no knowledge of electricity and its attendant risks, an absolutely safe switch has become a necessity. The really safe switch is one so constructed that all live parts are totally enclosed and inaccessible. Means should also be provided for preventing operation by unauthorized persons. The switch shown, which has been brought out by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., is typical of the real safety switch. Its use assures the maximum protection implied in the word "safety." The complete device consists of an ordinary single-throw knife switch and enclosed fuse-holders mounted in an exceptionally strong cast iron box, with an operating handle outside the housing. The box is designed for conduit connection and has a partition separating the switch blades from the fuse-holders.

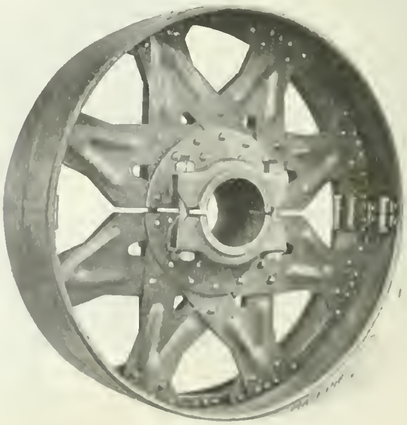
The upper or switch compartment can be opened only by removing two machine screws. This compartment should never be opened except when making connections, or in case of inspection or repairs, as the switch is opened and closed by the operating handle, from the outside, through a shaft and lever inside the box. The lower or fuse compartment, containing the fuses and fuse-holders, is the only part of the switch that need be opened, and then only to replace blown fuses. The door of this compartment is so interlocked with the switch by a vertically acting push-rod engaging a boss on the fuse-compartment door that it can be opened only when the operating handle is in the off position and the circuit broken. Furthermore, with the door of this compartment open it is impossible to close the switch. Thus the danger of a live line is eliminated. The operating handle can also be locked with the switch in the open position, preventing tampering by unauthorized persons.



Figs. 1 and 2. Westinghouse "Safety First" Switch with Cover Closed and Open

AMERICAN STEEL SPLIT PULLEY

Every engineer knows that there are certain drives requiring the use of stronger pulleys than those used for average classes of service. To meet such conditions, the American Pulley Co., 4208-60 Wissahickon Ave., Philadelphia, Pa., has developed a special heavy-duty type of steel split pulley, which is shown in the accompanying illustration. Pulleys of this type are made in sizes ranging from 36 to 84 inches in diameter, inclusive, with either a 6-inch or 8½-inch bore. This type of pulley is particularly suited for driving drop-hammers and other machinery having a heavy intermittent load; they also find application in driving air compressors, rock break-



Steel Split Pulley made by American Pulley Co.

ers, crushing rolls, centrifugal pumps, Beater engines and Jordan engines in paper mills. In fact, they are used for any severe service where a special cast-iron pulley would otherwise be required.

T. R. ALMOND MICROMETERS

The T. R. Almond Mfg. Co., 2 Maple Ave., Ashburnham, Mass., has recently added to its products three types of micrometers, which are shown in Figs. 1, 2 and 3. Each of these is made in two styles for English measurements and metric measurements. It will be apparent from the illustrations that the design of these tools follows quite closely along the lines of standard practice. It is claimed that they are highly accurate, and the manufacturers request that in testing the accuracy of these micrometers Johansson Swedish gages shall be used.

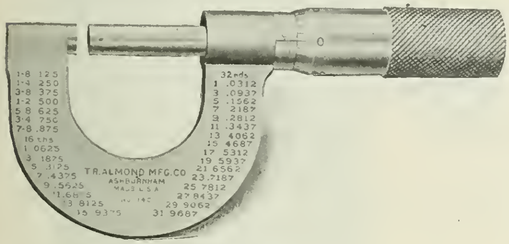


Fig. 1. Almond No. 140 Micrometer for 0 to 1 Inch, and No. 141 for 0 to 25 Millimeters

Fig. 1 shows a micrometer which is made in a No. 140 style for English measurements from 0 to 1 inch. Two types of this style of micrometer are made to read to 0.001 and 0.0001 inch, respectively. This micrometer is also made in a No. 141 style for metric measurements from 0 to 25 millimeters by 0.01 millimeter. These micrometers are furnished with neither a ratchet stop nor lock-nut. It will be seen from the illustration that a table of decimal equivalents is furnished on the frame of the micrometer.

Fig. 2 shows another Almond micrometer, which is also made in two styles for English and metric measurements. The style known as No. 139 makes English measurements, and this style of micrometer is made in two sizes for dimensions from 1 to 2 inches and from 2 to 3 inches. Both sizes are made in two types to read to 0.001 and to 0.0001 inch. This micrometer is also made in a No. 142 style for metric measurements, and two sizes are made for measuring work from 25 to 50 millimeters and from 50 to 75 millimeters. Each size of micrometer reads to 0.010 millimeter, and this micrometer also has neither a ratchet stop nor lock-nut.

Fig. 3 shows a micrometer head for attachment to machines and tools where fine adjustment is necessary. This head is made adjustable for slight variations, and it has neither a ratchet stop nor lock-nut. The distance from the shoulder to the end is 9/16 inch and the diameter is 27/64 inch. This micrometer head is made in a No. 138 style to read from 0 to 1 inch, heads of this style being made in two types to read to 0.001 and 0.0001 inch. This micrometer head is also made in a No. 143 style to measure work from 0 to 25 millimeters; it is graduated to read to 0.01 millimeter.

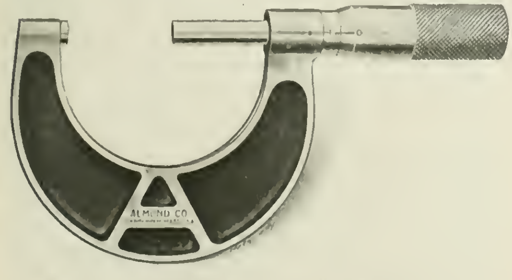


Fig. 2. Almond No. 139 Micrometer for 1 to 2 Inches or 2 to 3 Inches, and No. 142 for 25 to 50 Millimeters or 50 to 75 Millimeters

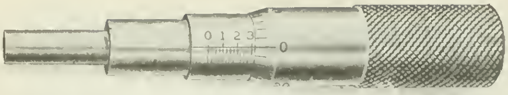
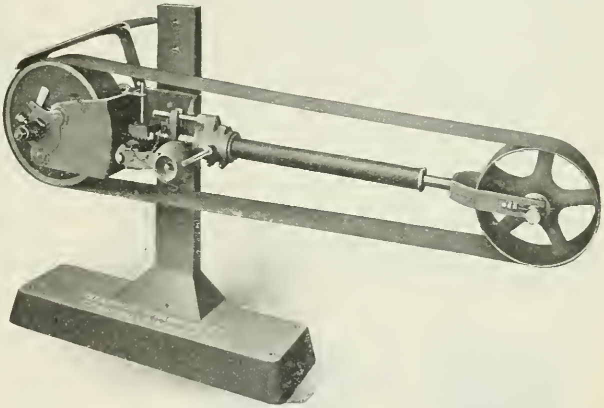


Fig. 3. Almond No. 138 Micrometer Head for 0 to 1 Inch and No. 143 for 0 to 25 Millimeters

BLEVNEY FINISHING MACHINE

In the accompanying illustration is shown one of the recent additions to the line of abrasive belt finishing machines built by J. C. Blevney, 209 Parkhurst St., Newark, N. J. This is known as a Type B-6 machine and takes the place of an ordinary set-up wheel for hand-finishing. It is equipped with a wheel that has a cushion, by means of which roughing operations as well as the finest finishing can be performed by simply changing the abrasive belt. This means that a piece of work roughed with the cushion, which, by the way, is such that no flat or digging-in cuts can be produced, will be followed absolutely with the cutting of finer grit belts. The entire mechanism is mounted on a stand with provision for raising, lowering or setting the belt at an angle.



Type B-6 Abrasive Belt Finishing Machine built by J. C. Blevney

The cushion wheel is made with the face built up from strips of leather held edgewise by clamps, with spaces 1/16 inch wide between the strips. In operation, these strips of leather tend to bend over slightly so that the edges grip the abrasive belt and serve the double purpose of forming a cushion and increasing the grip on the abrasive belt, which is proportionate to the amount of power required for the polishing operation upon which the machine is engaged. In time there is a tendency for these leather segments to assume a permanent set in the bent-over position, and to correct for this condition, means are provided for removing the wheel quickly from its bearings and reversing it end for end. In this composition it will be apparent that the leather segments tend to bend back in the opposite direction to that in which they have become permanently distorted. A counterweight maintains the desired tension on the abrasive belt.

Attention is called to the fact that it takes only a short time to train an operator to use this machine, which is an important condition at the present time, when skilled labor of any kind is extremely hard to get. It is also stated that the cost of abrasives for the performance of polishing operations is reduced nearly 50 per cent, while the rate of production is increased from 40 to 100 per cent.

RIVETT AUTOMATIC RADIAL GRINDER

In previous types of oscillating radial grinders the mechanism imparts a variable rate of travel to the oscillating head and a fixed rate of cross-feed to the work-head. In the present machine these two principles have been reversed, the mechanism imparting a fixed rate of travel to the oscillating head throughout its stroke and an adjustable rate of cross-feed for the work-head. A fixed rate of travel for the oscillating head allows the grinding wheel to remain in contact with each portion of the complete arc for the same period of time, thus tending to produce greater uniformity in the work. The variable cross-feed mechanism enables the operator to remove the metal rapidly while roughing out the groove in the bearing race and then slow down the feed and take a fine cut while finishing.

The Rivett Lathe & Grinder Co., Brighton, Boston, Mass., has developed a new type of automatic radial grinder, intended for all classes of radial grinding in general, and especially for ball races, both external and internal, radial thrust bearings, spherical shapes of large diameter and spherical sockets. As the work-carrying head can be set to swing through an arc of 200 degrees, complete ball and socket shapes may be ground if required. The machine has a capacity for grinding both inside and outside work up to a diameter of 10 inches, and will chuck work up to a diameter of 12 inches. The grinding diameter of 10 inches may be exceeded on certain classes of work, where the shape of the work permits grinding even larger diameters. The minimum size of work for which the grinder is intended is 3 inches grinding diameter. Smaller work may, of course, be ground, but the builders do not recommend it for much smaller work, as they believe that in such cases a hand-operated machine should be used rather than an automatic machine. The machine is known as the "Rivett No. 208 full automatic radial grinder," and was developed by F. H. Halstead, chief engineer of the Rivett Lathe & Grinder Co., under its new management.

The advantages claimed for the new machine are as follows: (1) The oscillating head of the machine has a fixed rate of travel throughout the oscillating stroke. (2) The cross-feed of the wheel-carrying head is variable, so that the operator may remove a larger quantity of stock at the beginning of the grinding than toward the end; this change in the cross-feed is effected automatically. (3) A great range of feeds may be obtained from a maximum to a minimum, and there is an arrangement for any combination of feeds, coarse and fine, as mentioned under (2). (4) Provision is made for automatic stopping of the machine at the point at which the predetermined amount of stock has been removed from the part being ground. (5) The work-carrying head always stops with the work facing the operator, in position for gaging. (6) The wheel-carrying spindle is removed from the work for gaging by a single motion of a hand-lever. This is the case both for outside and inside grinding. (7) The longitudinal slide of the wheel-carrying head has been eliminated, and the cross-slide is mounted directly on the upper base casting of the machine. This greatly increases the rigidity and minimizes wear. (8) The clutch has been eliminated between the oscillating mechanism and the oscillating member. (9) The machine is heavily constructed throughout, especially the oscillating members. (10) An oscillation of 200 degrees is possible, making it feasible to grind all classes of spherical work without additional attachments.

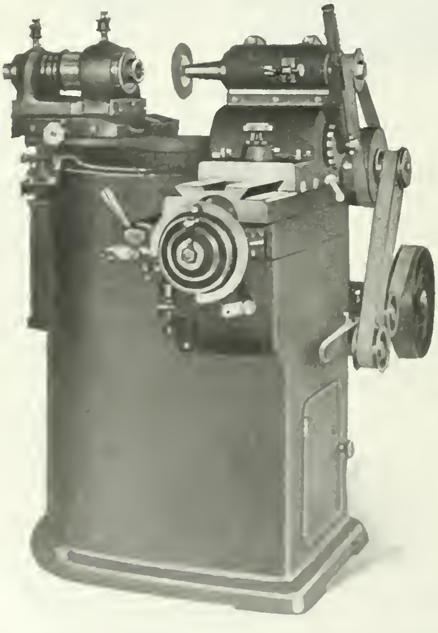


Fig. 1. Front View of Rivett No. 208 Full Automatic Radial Grinder

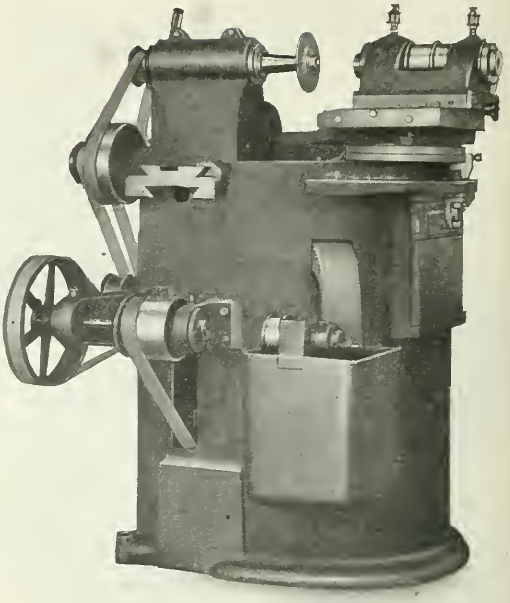


Fig. 2. Rear View of Rivett Grinder, showing Water Attachment

With regard to the construction, attention is called to the following features: All the bearings are ball bearings, except that for the oscillating post, which is solid, and the headstock spindle bearings, which are of the standard Rivett construction. The use of ball bearings has been extended even to the ceiling countershaft, and to all countershaft and pulley bearings on the machine. All parts of the shifting and oscillating mechanisms operate in oil baths. The worm and worm-wheels for the oscillating mechanism are made of machine steel and are casehardened.

The machine consists principally of a wheel-carrying head mounted on a cross-slide and a work-carrying head mounted on an extension from an oscillating post, making it possible to oscillate the work to obtain the spherical form in grinding; means for driving the wheel-spindle; cross-feed for the wheel-carrying cross-slide; means for transmitting and reversing the motion of the oscillating post; and a suitable base or frame for mounting the parts. Power is transmitted from an overhead countershaft to a small pulley at the rear of the machine. On the same shaft with this pulley are mounted two other pulleys, one large and one small. The large pulley transmits power to the wheel-spindle by means of idlers and an intermediate two-step pulley. The small pulley transmits power to a pulley mounted in the base of the machine, from which the power is ultimately transmitted to the oscillating mechanism as follows: By referring to Fig. 3, it will be seen that on the same shaft as that on which the pulley in the base of the machine is mounted there is also keyed a sprocket, from which a link-belt chain transmits motion to sprocket *A*, keyed to the same shaft as gear *B*. The latter gear, in turn, drives two gears *C*, one on each side. These are mounted on the same shafts as worms *D*, which, one at a time, mesh with a worm-wheel and drive it alternately, first in one direction and then in another. This worm-wheel is fastened to the oscillating post, and it is through this mechanism that the work-head is swung, first in one direction and then in the opposite.

The means by which the worms *D* are shifted to engage alternately with the worm-wheel are shown in Figs. 3 and 4. Referring first to Fig. 3, it will be seen that gears *B* and *C* and worms *D* are all mounted on a bracket *F*, pivoted at *G*, and having a limited oscillating movement actuated by the shifting mechanism shown in Fig. 4. As the work-carrying head, carried by an extension of the oscillating post, moves toward one end of its circular arc stroke, a dog engages with a sliding arc on the under side of the upper base flange. This sliding arc is provided with a forked bracket, which, in turn, engages stud *I*, Fig. 4, on shifting plunger *J*. To the lower side of plunger *J* is fastened a piece *K* having cam surfaces at the ends. These cams, in turn, actuate levers *L* (either the one to the right or the one to the left, according to the direction in which plunger *J* is shifted), and levers *L* press upon plunger *M*, compressing a spring, as long as part *O*, which is integral with the oscillating bracket *F*, Fig. 3, is prevented from moving by catch *P*. As cam *K* moves forward, however, it raises end *R* of lever *L* until it engages the upper end of the slot in link *S*, thereby raising catch *P* and releasing part *O*, which is then suddenly thrown over by the spring already compressed by the pressure of lever *L* on plunger *M*. This suddenly shifts the frame of bracket *F*, Fig. 3, so that the worm *D* and the worm-wheel on one side are thrown out of engagement, while the worm *D* on the other side is brought into engagement with the worm-wheel.

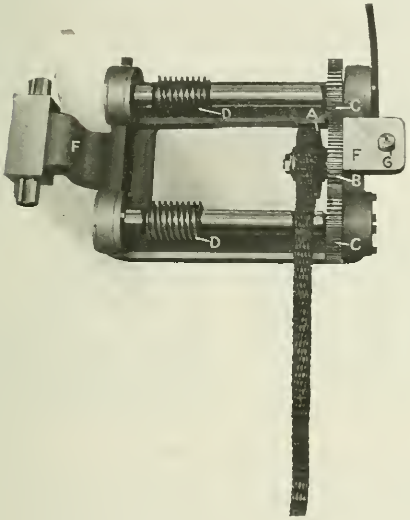


Fig. 3. Details of Oscillating Mechanism for Rivett Grinder

When it is desired to stop the oscillating movement of the machine, a handle, shown to the left in the front view of the machine (lower handle), is operated, by means of which a plunger is brought into play which acts as a stop for the oscillating frame *F*, Fig. 3, and which stops the frame in a neutral position, so that the worm-wheel does not engage with either of the worms *D*. To start the machine again, the upper of the two handles, shown at the front of the machine to the left of the cross-feed mechanism, is operated. This handle withdraws the stopping plunger, and the oscillations continue. An arm from the oscillating bracket *F* connects with a toggle-joint arrangement from which the movement for the cross-feed ratchet wheel is obtained. The cross-feed, which is one of the patented features, is provided in the first place with a simple adjusting collar, by means of which the amount of feed movement obtained from the toggle-joint is adjusted from a maximum to a minimum, and, further, with a device by means of which the amount of feed is automatically decreased as the grinding progresses. The first adjustment directly limits, by means of the adjusting collar, the amount of vertical travel of the plunger, to the end of which the pawl for the ratchet wheel is fastened. In this way, any number of teeth or notches on the feed ratchet may be engaged.

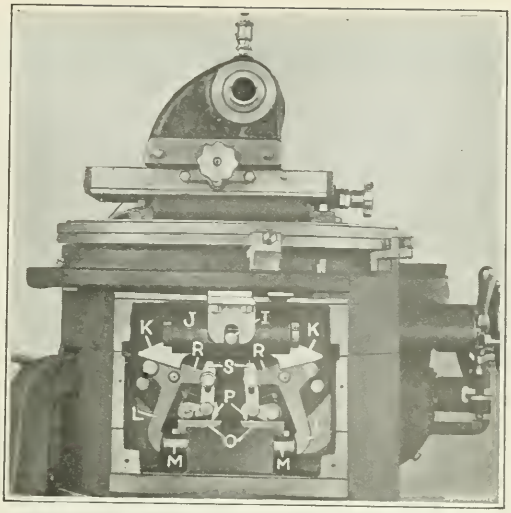


Fig. 4. Details of Mechanism for shifting Oscillating Drive on Rivett Grinder

The second adjustment, for automatically decreasing the feed, is accomplished by operating the vertical plunger also, but through the cross-feed mechanism itself, which can be set for any required decrease. When the required size has been reached, as predetermined by previous gaging and setting, the cross-feed mechanism throws out the feed by engaging the stopping handle at the left of the cross-feed dial shown in the front view. To the right of the machine is a hand-lever for moving the wheel-slide back and forth by hand. The spindle for the wheel is adjusted to the correct position for a given radius by a small adjusting screw on the side of the wheel-carrying head. The work-carrying head is mounted on a cross-slide, which, in turn, is mounted on the extension of the oscillating post. The work-carrying head is adjustable longitudinally, while the cross-slide provides transverse adjustment.

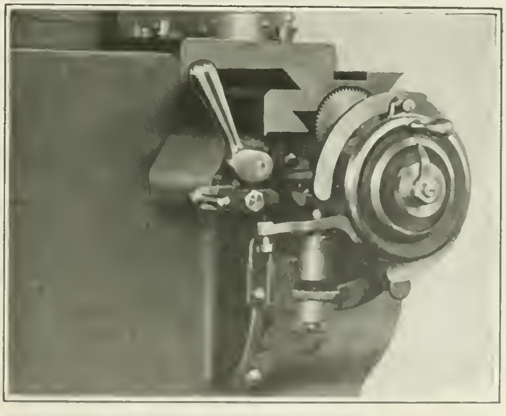


Fig. 5. Cross-feed Mechanism of Rivett No. 208 Automatic Oscillating Grinder

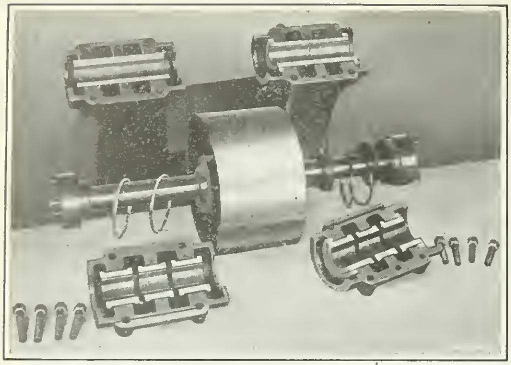


Fig. 1. Spindle and Ring-oiling Bearings of Besly Disk Grinder

BESLY SPINDLE CONSTRUCTION

Charles H. Besly & Co., 120-B N. Clinton St., Chicago, Ill., are now building disk grinders equipped with dustproof, automatic, ring-oiling radial and thrust bearings for the spindle. The bearings are equipped with inserted phosphor-bronze bushings, which are removable. It is claimed that these Besly ring-oiling bearings are so arranged that the spindle literally floats in oil, which results in considerably reducing the power required to drive the machine. Tests conducted to determine the transmission efficiency of these ring-oiling bearings are said to have shown that it is within 2 per cent of the efficiency of a ball bearing. The bearings are dustproof and automatically lubricated, so that a minimum amount of attention is required. Old oil should be drawn off and fresh oil substituted once in three to twelve months, depending upon the amount of service obtained from the machine. The oil-wells are of large capacity; for instance, on the No. 17 Besly grinder with a spindle 2½ inches in diameter, the oil-wells are 7 inches deep.

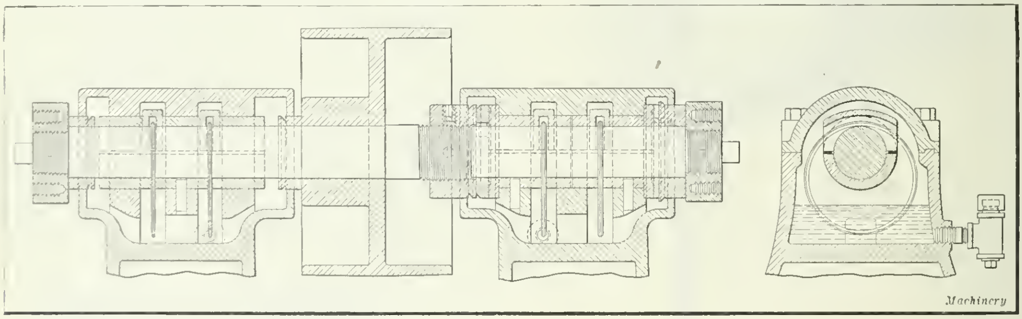


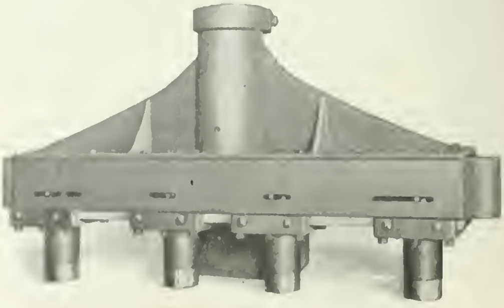
Fig. 2. Section through Spindle and Ring-oiling Bearings of Besly Disk Grinder

Two solid steel oil-rings are provided for each bearing. These rings operate through channels in the bearing bushings and are so designed that it is impossible for the rings to become displaced and fail to function properly. A perfect flood of oil is continually transmitted to the radial and thrust bearings while the grinder is running, and the oil channels in the faces of the thrust bearings are of a special design, which sets up a pumping action that forces oil between the thrust collars. The bearing bushings are split and of the inserted type, so that they are easily renewed. These bushings are made of a special grade of phosphor-bronze, and the bearing surfaces are of large size so that there is practically no wear. End thrust is taken on hardened and ground tool steel collars against the flanged ends of the right hand bushing. End play is taken up by means of adjusting collars threaded onto the spindle and located under the rim of the spindle pulley. Besly grinders may be safely operated with all end play taken up in the spindle. The bronze bearing bushing which receives the end thrust is provided with clearance to compensate for any expansion that may take place in the bushing. Therefore, it is impossible for this bearing to bind between the thrust collars and cause them to seize. This is an important feature, as any looseness or end play in the spindle will naturally affect the accuracy of the work being ground.

HOEFER HEAVY-DUTY DRILL HEAD

One of the recent products of the Hoefer Mfg. Co., Freeport, Ill., is a heavy-duty, four-spindle auxiliary drill head, which is capable of driving twist drills up to 1 inch in diameter. The head is clamped to the machine by a nose reaching up to the spindle sleeve; and the heavy case is amply supported by webs. A taper shank provided with a toothed driver transmits power to the head, after which the transmission is through hardened helical gears on a horizontal shaft which extends the full length of the head. These gears are made of sufficient length to afford the amount of adjustment that is called for. By having bearings of ample size throughout the head, with all bearings bronze bushed, there is no opportunity for the helical gears on the long driving shaft to spring away from the gears on the spindles. Half the helical gears are made of opposite lead from the other half in order to balance the end thrust as far as possible; but as a further precaution against trouble from this source, large ball-thrust bearings are provided at each end.

The spindles of the drill head are made of hardened steel and driven by the helical gears to which reference has already been made. These spindles run in bronze-bushed bearings. A ball thrust bearing is contained in a cupped spindle nut at the lower end of each spindle in order to eliminate as much friction as possible; and this bearing is protected from dirt and dust. Each spindle is carried in an adjustable spindle bearing, which slides in a scraped bearing and is locked by set-screws. As the bearing is faced down on the under side of the head, the thrust is taken directly by the bearing without any tendency to cock the bearing out of alignment. Adequate provision has been made for the lubrication of this drill head. The lower bearing of each spindle is lubricated through oilers appearing through slots on the sides; and the helical gears run in a small pocket filled with oil, which insures perfect lubrication at all times.



Heavy-duty, Four-spindle Drill Head made by Hoefer Mfg. Co.

NEW MACHINERY AND TOOLS NOTES

Oil-cups: Gits Bros. Mfg. Co., 553-557 W. Monroe St., Chicago, Ill. A line of oil-cups furnished with hinged tops that can be opened with the tip of the oil-can spout. In making these cups all parts are brazed together, and it is claimed that they are as strong as cast cups.

Grinding Machine: S. B. Patch & Sons Co., Streator, Ill. A line of double-spindle grinding machines which are equipped with self-oiling babbitted bearings. These machines are built in three sizes for wheels 10, 14 and 18 inches in diameter. The general design of the three sizes of machines is the same.

Machine Vise: Moback Tool & Machine Mfg. Co., 330 Atlantic Ave., Boston, Mass. A line of vises for use on milling machines, drill presses, grinding machines, shapers, planers, etc. These vises are built with either swivel or plain bases, the swivel base being an additional equipment for the plain vise. The swivel base is graduated in degrees.

Sandblasting Machine: Mott Sand Blast Mfg. Co., Inc., Brooklyn, N. Y. A machine equipped with a separate sandblast apparatus for each barrel. Abrasive material is elevated mechanically by a belt and bucket elevator, and passed through a mechanically operated screen. Machines of this type are made in various sizes to meet the requirements of different shops.

Stock Bin: Hobart Bros. Co., Troy, N. Y. A stock bin for storing nuts, bolts, screws and other small parts in the machine shop or tool-room. It contains 120 compartments measuring 6 by 8 by 10 inches. The front partition and the ends of the bin are of oak, while the back is made of sheet steel. Each compartment is furnished with a metal card-holder for indexing.

Forging Hammer: Chambersburg Engineering Co., Chambersburg, Pa. A double-acting steam forging hammer of unusually large size which has been built for the Washington Steel & Ordnance Co., Washington, D. C. This is said to be the largest hammer of its type ever built in the United States. It is known as a 40-ton, double-frame, double-acting steam forging hammer.

Voltmeters and Ammeters: General Electric Co., Schenectady, N. Y. A series of miniature voltmeters and ammeters for use on direct-current circuits. These instruments may be used on circuits from 10 to 150 volts and from 10 to 150 amperes. The light weight moving elements are mounted in jeweled bearings, and to provide complete insulation all parts of the measuring elements are mounted on a bakelite base.

Gang Drilling Machine: Barnes Drill Co., 814 Chestnut St., Rockford, Ill. A three-spindle, 22-inch, all-geared gang drilling machine, which is provided with eight changes of speed and ten changes of feed for each spindle. All changes are under constant control of the operator from the front of the machine and are independently operated. Any or all of the spindles may be equipped with an automatic reversing mechanism.

Paint Spraying Equipment: Spray Engineering Co., 93 Federal St., Boston, Mass. An outfit known as the P-1 painting apparatus, which may be used for applying all kinds of liquid coatings and is portable, thus being adapted for either shop or field use. This outfit is operated by compressed air at a pressure of from 35 to 75 pounds per square inch, the amount of pressure depending upon the material to be applied to the work.

Dump Car: Easton Car & Construction Co., Easton, Pa. A dump car for use on industrial railroads. On this car two sets of wheels are employed and the car is furnished with crane lifting rings attached to the top of the body at each end. In this way the body of the car can be lifted off the carrying truck, which runs on a standard gage track, and be set down on another track of narrow gage on which the second set of wheels runs.

Drilling Machine for Recoil Cylinders: Charles Stecher Co., 1574 Crossing St., Chicago, Ill. A line of machines for drilling holes in recoil cylinders, these machines being a further development of the company's tools for drilling holes in lathe spindles. The drill is mounted in a vertical position and fed upward into the work, which provides for easily clearing chips from the hole. This machine is adapted for boring holes up to 3¾ inches in diameter by 63 inches long.

Variable-speed Pulley: Charles M. Terry, Inc., 25 Broad St., New York City. This pulley was developed by W. B. Dunbar, Sydney, Australia, and Mr. Terry has the American agency. With this mechanism it is possible to vary the velocity ratios between the driving and driven shafts without interrupting the transmission of power. Various arrangements can be provided for operating the mechanism, such as a long lever and notched quadrant, a handwheel or a short lever.

Band Re-saw: Oliver Machinery Co., 7 Coldbrook St., Grand Rapids, Mich. A machine known as a No. 15-R 38-inch combination re-saw and band-saw. The change from re-sawing to ordinary band-sawing is instantly effected by swinging the arm carrying the two corrugated rolls out of the way and changing the saws. The table tilts 45 degrees in one direction and 5 degrees in the other direction, and it is double ribbed and supported on rockers for angle adjustments.

Hardness Tester: Palo Co., 90 Maiden Lane, New York City. An instrument for measuring hardness of metals which was devised by Leonard Waldo, a New York consulting engineer. This instrument may be easily transported from place to place, and its indications are uniform over definite periods of time. The test is made by allowing a plummet weighing 0.10 pound and provided with a hardened steel point to drop one foot upon the material whose hardness is to be tested.

Heavy-duty Engine Lathe: Oliver Machinery Co., 7 Coldbrook St., Grand Rapids, Mich. This company has recently made a number of changes in the 16-inch heavy-duty engine lathe of its manufacture. The headstock is made of the bowl type to afford better protection for the belt, and new gear covers have been provided. The tailstock has been made longer and heavier; and a lubricant reservoir has been placed on the under side of the oil-pan. Oil-wipers are furnished on the carriage.

Hardness Testing Machine: Scientific Materials Co., Pittsburg, Pa. This machine is known as the "Scimatco" Brinell hardness testing machine. It is provided with a hydraulic press having a heavy base in which the hand-power gear for operating a screw to produce pressure is located. The upper part carries the hydraulic piston, upon the ram of which is mounted the standard hardened steel ball to be forced into the material under test.

Extensometer: Riehle Bros. Testing Machine Co., Philadelphia, Pa. An extensometer for measuring the elastic limit of steel. This apparatus has a feature not heretofore provided, namely, means for attaching it to the opposite sides of the test-bar to indicate the actual mean stretch between the two points. There are no electrical contacts, no adjustments of a micrometer screw, and no readings of a micrometer. Readings can be taken from a stress-strain curve at equal increments of load while the machine is running.

Universal Miller: Ford-Smith Machine Co., Ltd., Hamilton, Ontario, Canada. A No. 2 universal miller on which the working surface of the table is 41½ by 10 inches and is provided with three ⅝-inch T-slots. The longitudinal feed is 25 inches; cross-feed, 8 inches; and vertical feed, 18 inches. The available range of spindle speeds is from 12 to 360 revolutions per minute, and the nine available feed changes range from 0.006 to 0.055 inch per spindle revolution. The floor space occupied by the machine is 81 by 98 inches, and the machine weighs 3150 pounds.

Plate Punch Table: Norbom Engineering Co., Denckla Bldg., Philadelphia, Pa. An equipment known as the "Lysholm" plate punch roller table, which is especially adapted for the rapid handling of plates on the punching machines used in shipyards. In using this plate punch roller table, the plate is laid on the table, and from his seat the operator moves the table backward and forward with the aid of an operating lever at his right hand. A lever at the left hand can be operated to move the plate sideways. In this way the desired location is obtained for punching.

Pipe Threading Attachment: Curtis & Curtis Co., 8 Garden St., Bridgeport, Conn. When the attempt is made to thread wrought iron or steel pipe on an ordinary lathe, trouble is likely to be experienced. To meet the requirements of this work where the amount of pipe threading to be done does not warrant purchasing a regular threading machine, a lathe attachment has been developed. This attachment is said to convert a lathe into the equivalent of a power pipe threading machine, and pipe of any length may be rapidly and accurately threaded on a machine provided with this attachment.

Universal Drill Jig: Berggren & Pearson Machine Co., Inc., 221-227 Canal St., New York City. A universal drill jig designed to meet the requirements for a tool that can be rapidly and easily adjusted for handling various sizes and types of work. The device consists of a baseplate and two uprights that are machined with a number of T-slots, by means of which the bushing bars and stops for holding the parts to be machined are fastened in place in the jig. The drill bushings are hardened and ground to size and are furnished in sizes from ⅛ to 1½ inch in diameter, special sizes being made to order. Each jig is supplied with four bushing bars and eight bushings of selected sizes.

Computing and Shell Scales: Computing Scale Co., Dayton, Ohio. Two scales, one of which is a computing scale of the beam type with a capacity for handling loads up to 600 pounds. The tare beam has a capacity of 100 pounds and is sensitive to ½ ounce, while the counting beam is graduated for use when one, five or ten units are placed in the pan. A third beam may also be provided which reads directly in pounds. The other scale referred to is a munition and shell scale; a master or standard weight is placed on one scale pan and a shell is placed on the other pan, and the amount it is over or under weight may be read directly on the scale. The scale is graduated to read in steps of 1/16 ounce for weights up to 4 ounces.

HARRIS LEAD AND ANGLE TESTING DEVICE FOR THREAD GAGES

The thread gage is one of the most difficult gages to make accurately and also to measure accurately. Many mechanics who have attempted to make thread gages have given the proposition up as a bad job for several reasons. One was the difficulty of obtaining machinery accurate enough to do the work, and another was the difficulty of obtaining equipment for measuring thread gages; furthermore, there is a lack of men skilled in the manufacture of thread gages, which is partly due to the fact that many thread gage makers take the first chance they get to find an easier way of making a living. The making of thread gages has been confined to a comparatively few manufacturers; these have made a special study of the requirements and have been fairly successful on account of their familiarity with this branch of work and the lack of familiarity of many of their customers, who simply took what was given to them, and believed that the gages must be right because of the standing of the firm that supplied them. During the last two years, however, there has been considerable education among users of thread gages. Engineering societies, large munitions makers and manufacturing concerns now realize that some of their most difficult problems are connected with the production of screws, taps and tapped holes that are up to the required standards of accuracy. In the manufacture of taps, hobs for hobbing dies, male thread gages and hobs for female thread gages, the question of correct lead and correct angle of the thread has been found to be more important even than the correct diameter measurement, and while a number of gages of different types have been developed for checking the angle or the lead, hardly any of them, if any, are sufficiently accurate and reliable for the accurate checking of angle and lead.

The problem has been to design a screw thread testing device for testing the angle and the lead which is rigid and substantial, thoroughly accurate, and upon which a small degree of error may be easily ascertained. In testing the truth of a flat surface, a knife-edge straightedge is used, as the smallest amount of error (even less than 0.0001 inch) will readily show light between the surface tested and the knife-edge. This principle seems to be the most simple and reliable one to employ in testing lead and angularity. Two curving surfaces coming together on a line of contact will show light through an inequality as readily as a knife-edge gage on a flat surface, and will even show more light. The thread lead and angle measuring machine to be described is based on this principle; that is, of seeing light between two curved surfaces. If they do not coincide, it is claimed that 0.0001 inch can be detected by a person with ordinary eyesight, and with the aid of a magnifying glass, 0.00005 inch can easily be seen.

Arrangement of Lead and Angle Testing Machine

Referring to Fig. 1, which is a general view of the lead and angle measuring machine, the solid and substantial construction will be noted. The machine has a heavy cast bed *A* and a stationary head *B*, which carries a fixed center *O* and is permanently fixed to casting *A*. The sliding tailstock *C* can be clamped positively to the bed *A*, by means of the two clamping screws *Q*, and carries a spring center *P*, which can be withdrawn by the knob *E* or clamped in position by the screw *F*. The gage *H* to be tested is put between centers by placing one center upon center *O*, bringing up the tailstock *C*, clamping it by screws *Q*, and allowing the center *P* to enter the opposite center of the gage, as it is forced outward by a spring inside of *C*. Center *P* is clamped in position by handle *F*. So far the means described are simply to hold the gage true between the centers and in correct alignment with the measuring devices, which are carried on the slide *D*. This slide is carefully fitted to the bed *A* and is clamped into the position required by the thumb-screw *G*. It consists primarily of a compound slide which is carefully and accurately made, so as to be in correct alignment with the axial line through the centers *O* and *P* of the measuring machine, all planes and surfaces being either accurately perpendicular or accurately parallel to this axis.

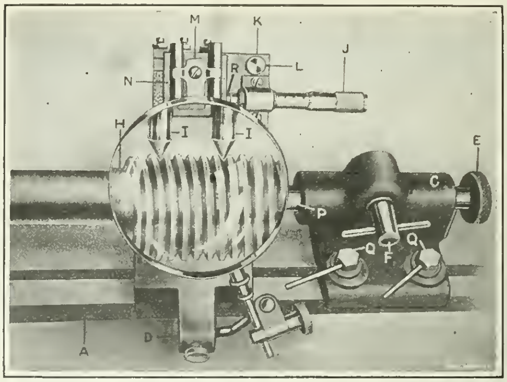


Fig. 2. Detail View, showing Testing Points Magnified

The lower member of the compound slide *K* is adjustable in toward and out from the line of centers through *O* and *P*, and may be clamped by screws *L* in whatever position is suitable for the diameter of the thread gage to be measured. This slide carries a micrometer head *J*, which operates against a hardened stud *R* in the upper member *N* of the compound slide. The upper part *N* is free to move laterally parallel with the axial line through the centers *O* and *P*. This movement can be measured by the micrometer head *J* or by the use of distance blocks or Swedish gages placed between the point of the micrometer (which is clamped in position) and the point *R* on the upper member *N*. The latter carries two angle test-pieces, which are held by the spring clip *M*. This spring clip permits adjustment by finger pressure toward or away from the gage or thread to be tested. The center-to-center distance between the angle test-pieces *I* is just one inch, which is a basis for checking error of lead in gages that are to English measurement and are over one inch long. For metric screw threads or threads less than one inch long, either the micrometer or proper distance gages, such as Swedish gage blocks, are used between the point of the micrometer and the stud *R* on the slide. Fig. 2, which represents a view through a magnifying glass, shows the points of these angle test-pieces on an enlarged scale, and it can be seen how they fit the angle of the threads on the gage, which is shown in position.

Testing Lead of Screw Thread

In testing the lead, the first operation is to turn the thread gage on the centers of the machine until the thread will allow test-

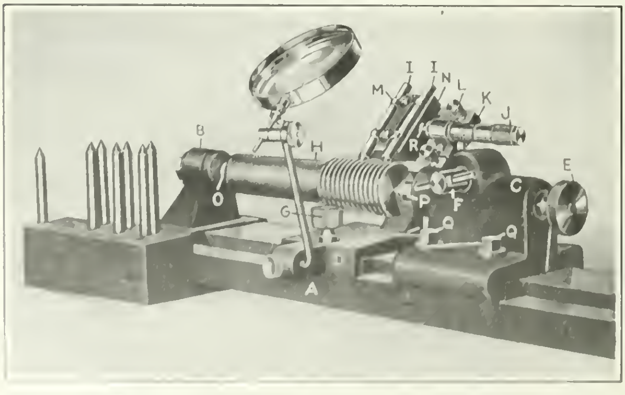


Fig. 1. Harris Lead and Angle Testing Machine for Screw Threads

ing point *a* (see diagram *A*, Fig. 3) to engage it as shown at *B*, thus shutting out light on both sides of the conical point. This is done merely by rotating the gage by hand in between the centers of the machine, and gives it a very fine adjustment. After point *a* has been pressed down lightly in the direction of the arrow, point *b* is brought down in the same direction until it touches the thread. If the lead on the thread gage is short, the effect will be as shown at *C*, which has been exaggerated to illustrate the point clearly. If the lead on the thread gage is long, the effect will be as shown at *D*.

The problem now is to determine the amount that the lead on the thread gage is long or short. With the micrometer adjusted against point *R* (see Figs. 1 and 2) and set at zero, point *a* is drawn back from the threads as shown at *E*, Fig. 3, which permits moving point *b* in either direction. If the lead on the gage is long, as at *D*, point *b* is moved in the direction of the arrow as at *E*, by means of the micrometer screw, and when it is opposite the thread it is moved down in the direction of the arrow as at *F*. The amount that it has moved over (as indicated by *x*) is the extent that the lead of the gage is long in one inch.

If the lead is found to be short, the order of operations is reversed. The amount *x* could be measured either by the micrometer direct or with a Swedish block placed between the micrometer point and the point *R*. If the thread on the thread gage is not over one inch long, only one of the measuring points is used, and in this case either point *a* or *b* is engaged with the screw thread wherever the lead is to be checked. The distance *x* as measured either by the micrometer or Swedish block is compared with the nominal or correct distance, and the difference is the error in lead for that number of threads.

Testing Angle of Thread

The methods of testing the angle of the thread with the angle test gages are indicated by Fig. 4. These views simply show the ends of the angle test gages and the contour of the thread in the gage where it is being tested. Sketch *A* shows a standard test angle gage fitted into a thread that has too large an angle. After testing it with the standard plug, a plug with a greater angle is tried, as shown by the dotted line, and in this way the amount of angular error can be ascertained. Sketch *B* shows a gage having a thread angle that is too small. A thread with unequal angles is shown at *C*, and one having concave sides at *D*. These errors show up prominently by the amount of light that passes between the angle test gage and the thread. Threads are often rounded over near the top, as at *E*, as the result of excessive lapping with an old-style lead lap.

Sketch *F* shows how a thread having unequal angles as at *C* can be tested to ascertain the amount of angular error, by placing different angle test-pieces against each side of the thread walls. The angle test gage shown by the full line serves to test one side of the thread wall, while the angle test gage shown by the dotted line tests the angle on the other side. If the standard angle were 60 degrees and the test-bar shown in full lines were $58\frac{1}{2}$ degrees, whereas the test gage as shown in dotted lines were $61\frac{1}{2}$ degrees, this would show that the thread was "tipped" or leaned over $\frac{3}{4}$ degree, while the included angle of the thread might be or might not be standard. Diagram *G* shows how the angle test gage discloses that the bottom of the thread groove is too wide, the root diameter being too large.

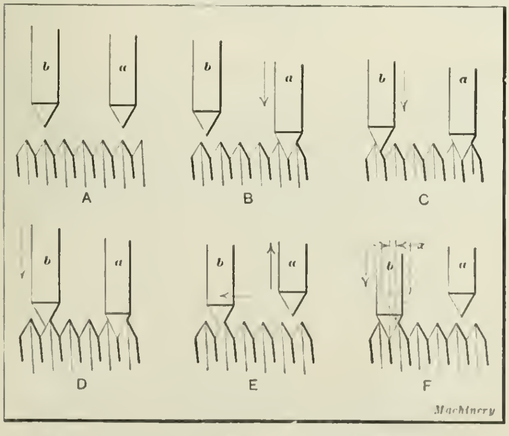


Fig. 3. Diagrams illustrating Methods of adjusting Testing Points and how Lead Errors are detected and measured

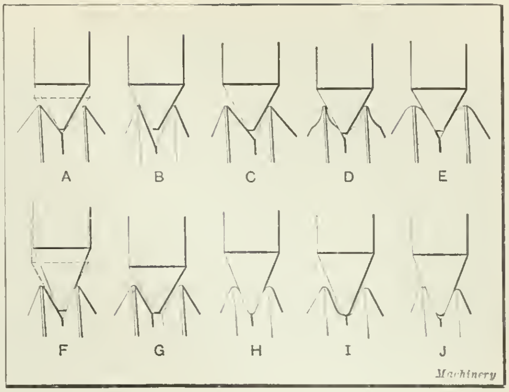


Fig. 4. Various Screw Thread Defects

A Whitworth form of thread is illustrated at *H*, which is correct on the angle and at the bottom. Sketch *I* shows a Whitworth thread that has too large a radius at the bottom of the thread, and *J* shows a Whitworth thread that is correct as to angle, but is cut too deep and has too small a radius at the bottom of the thread groove. Fig. 4 is merely intended to show, in a somewhat exaggerated degree, a few of the diversified defects that this angle and lead testing machine will detect. This apparatus was developed by the H. E. Harris Engineering Co., Bridgeport, Conn. It is used by this company and by the Bureau of Standards.

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AMERICAN GEAR MANUFACTURERS' ASSOCIATION CONVENTION

The American Gear Manufacturers' Association held its semi-annual session in Chicago, September 13, 14 and 15, at the Edgewater Beach Hotel. The association numbers among its members practically all the prominent gear manufacturers in the country. The Chicago session was the largest of any yet convened. The last meeting was held in Pittsburg in May. Special importance was attached to the present meeting because of the members' desire to effect as much standardization in gear products as possible, in keeping with the government's desires for all industry, now that the war is making special demands upon all manufacturers and users of materials.

F. W. Sinram, of Van Dorn & Dutton Co., Cleveland, president of the organization, opened the sessions Friday morning. A paper, "Advertising Don'ts," was then read by J. C. McQuiston, advertising manager of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. W. H. Phillips, of R. D. Nuttall Co., Pittsburg, followed with a talk on the subject "Heat-treating and Hardening of Gears." In the afternoon the convention men were the guests of the Chicago members. An automobile trip of about seventy-five miles through Chicago's huge park system was a feature much appreciated. In the evening a dinner, music, monologues, lantern-slide caricatures and the like provided entertainment for the visitors. All received a first-rate impression of Chicago and enjoyed the day. At the Saturday session, a paper by B. S. Waterman, of the Brown & Sharpe Mfg. Co., "Inspection of Gearing," was read; also one by H. E. Eberhardt, of the Newark Gear Cutting Machine Co., "Spur Gearing by the Rotary or Disk Cutting Process"; and another by F. Schneider, of Van Dorn & Dutton Co., Cleveland, "Spur Gears by the Shaper Method. Lively discussion of the papers brought additional valuable information.

LENGTH OF A WORM OR HOB

BY LUTHER D. BURLINGAME[1]

It is surprising that, after so many years of mechanical development, where worms and worm-wheels have entered largely into the mechanisms used, the question as to the correct length to make the worm should still be one of uncertainty, the rules so far proposed by recognized authorities on the subject giving wide variations. A reason for this uncertainty lies in the fact that there are so many varying conditions affecting the length of contact between the worm and wheel on which the length of the worm depends. Some of these conditions are: diameter of worm and diameter and width of face of worm-wheel, extent of contact on each side of mid-plane, and pitch angle of thread with axis (the extent of contact on the approaching side being increased with increase of helix angle—which is particularly noticeable when a wide-faced worm-wheel is used.) There is also the question of wear in its effect on the length of contact to be considered. Such an authority as George B. Grant, in his "Teeth of Gearing," recommends very short lengths for the worm, claiming that it need not be more than three times the circular pitch, for there are seldom more than two teeth in contact at once. He qualifies this, however, with a statement that: "If the worm is made long it can be shifted when it becomes worn so as to bring fresh teeth into the working position." A rule given by Oscar J. Beale in his "Treatise on Gearing" determines the length of engagement between the threads of a worm and the teeth of its engaging wheel by the intersection of the tops of the threads of the worm with the line of pressure, although he, too, favors, in practice, much longer worms than would result from using this rule.

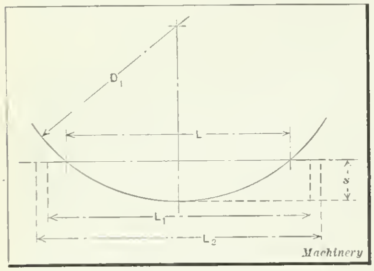

Diagram showing Method of deriving Formula for Length of Worm or Hob

In an analytical paper presented before the British Institution of Mechanical Engineers in 1906, Robert A. Bruce goes into the nature and limitations of tooth contact between worms and worm-wheels, and shows by graphic methods that such contact extends much farther beyond the center line of the worm-wheel in each direction than would be allowed for by following the rules already referred to, as contact extends farther each side of the mid-plane than on it. Mr. Bruce also shows that the path of contact is quite different on the approaching and receding sides, both in nature and extent, his illustration showing that the length of contact may be twice as great as that occurring on the mid-plane only. This length is further increased by wear. This accords with what is found by experience in examples showing the contact produced by actual use.

Investigations made by Ralph E. Flanders and published in MACHINERY for August, 1907, include a rule for the length of worm based on the intersection of a line representing the throat diameter of the worm-wheel with the top of the worm thread. This would insure the worm being sufficiently long, as there could be no additional contact if it were made longer, but such a rule would under some conditions make the worm longer than necessary. In an article on the lengths of worms and hobs, published in MACHINERY for November, 1913, E. Winslow Baxter says that a worm should not be shorter than the length of chord formed by the intersection of the pitch line of the worm wheel with the top of the threads of the worm; but in the formula and table which he gives, he makes the length greater than this; in fact practically the same as that obtained by the Flanders formula. While for worm-wheels with a comparatively small number of teeth, the Flanders and Baxter formulas give lengths which accord closely with good practice, for wheels with large numbers of teeth the lengths produced by these formulas would, as already pointed out, seem unduly great. Making the minimum length dependent on the intersection of the pitch circle of the worm-wheel with the top of the thread of the worm, and adding a constant depending on the coarseness of the teeth, gives a formula from which lengths can be obtained for both the worm and hob, which will bring the length of the worm within practical limits for all ordinary conditions, providing also for wear.

The formula suggested, based on the foregoing, is as follows: Let L equal the length of chord, L_1 equal the required length of worm, L_2 equal the length of hob, D_1 equal the pitch diameter of worm-wheel, and s equal the addendum. Then:

$$L = 2\sqrt{s(D_1 - s)}$$

$$L_1 = L + 5s$$

$$L_2 = L + 5.5s$$

$$D_1 = \text{pitch diameter}$$

It will be sufficiently accurate to carry decimal figures to two places only, or to use a slide-rule. The length of worm or hob should then be made to the nearest even fraction. The length of the worm can be obtained graphically by laying out the pitch diameter D_1 of the largest worm-wheel to engage the worm, and finding its intersection with a line representing the outside diameter of the worm engaging the wheel, as shown at L. To this chord L add $5s$ to obtain the length L_1 of the worm, or if the formula is to be used for determining the length L_2 of the hob, which should be slightly longer than the worm, add $5.5s$ to obtain the length of the hob. If endwise movement of the worm is required for adjustment or traverse, the amount of such movement should also be added, to obtain L_1, but need not be added in this case to the length of the hob. A short worm can be used with a large wheel by having the hob a little longer than the worm, but such use will be at the sacrifice of wearing qualities.

If it is desired to find the length of a worm and of a hob for a worm-wheel having fifty-six teeth of 3/16 inch circular pitch:

$$D_1 = \frac{56}{3.1416} \times \frac{3}{16} = 3.34 \text{ inches} = \text{pitch diameter}$$

$$s = 0.0597 \text{ inch} = \text{addendum}$$

It will be sufficiently close to call $s = 0.06$ inch. Then:

$$L = 2\sqrt{0.06(3.34 - 0.06)}$$

$$3.34 - 0.06 = 3.28$$

$$3.28 \times 0.06 = 0.1968$$

$$\sqrt{0.1968} = 0.443$$

$$2 \times 0.443 = 0.886 \text{ inch} = L = \text{length of chord}$$

$$0.886 + 5s = L_1$$

$$0.886 + 0.30 = 1.186, \text{ or about } 1\ 3/16 \text{ inch} = \text{length of worm } L_1$$

$$0.886 + 5.5s = L_2$$

$$0.886 + 0.33 = 1.216, \text{ or about } 1\ 7/32 \text{ inch} = \text{length of hob } L_2$$

* * *

MAKING JIGS FROM SQUARE CAST-IRON BARS

In the early days of war contracts, a munitions plant found that it could not receive the castings for its jigs and fixtures until two or three months after the order for them was given, or until long after its competitors would have started to fill their orders. So the manager decided to make these tools himself. He accordingly found the section of a square cast-iron bar that would be necessary to make the largest jig or fixture he would need, and ordered from the foundry enough bars of this size to make all the jigs and fixtures from. He received these bars the next day, for the foundry usually keeps them on hand, and at once cut them to the proper lengths. These pieces he worked to the desired shapes on the planer and milling machines and completed his tools by inserting hardened steel bushings where necessary. By this plan he was able to commence the manufacture of his goods some weeks before any of his competitors, many of whom had received their contracts quite a while before this plant; in addition, he saved the time and expense of making the patterns and castings for the parts.

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[1] Industrial Superintendent, Brown & Sharpe Mfg. Co., Providence, R. I.

TIME-RING DISK-SEAT RECESSING MACHINE

BY DONALD A. BAKER[1]

The machine shown in the accompanying illustration is for milling the disk seat *a* in the Type 80 time-fuse ring shown in detail at *A*. The unique features of the machine are the oscillating cutter-spindle, and the method of locating and holding the work in the jig. The frame of the machine is of cast iron. The spindle *B* is hollow and contains a small spring collet for holding the cutters and a draw-rod for tightening the spring collets. It runs in ball bearings, both front and rear. The housing in which it is contained is pivoted at *C* in a bronze bushing, a hardened pin being driven into a boss on the under side of the spindle housing, as shown. The wings *D* of the housing are machined and scraped; they have a bearing on top of the machine frame and are held down by the two straps *E*, which eliminate any tendency of the spindle to lift, but are so made as to allow play sidewise. This movement is what determines the amount of elongation of the disk seat, and it is controlled by an eccentric cam *F*, acting through the link *G* that connects with the arm *H*.

In order to control and adjust the movement, the eccentric cam is made a good fit in an eccentric hole in the shaft *I* that drives it. This shaft has one end enlarged, and a setscrew in it holds the eccentric cam when properly adjusted. The throw of the cam can be regulated by turning it to different positions in the eccentric hole in its driving shaft, because of the difference in eccentricity of the shaft and cam. At the opposite end of the eccentric driving shaft is mounted a grooved pulley for taking a round belt as shown. Shaft *I* is mounted in a bearing that is bolted to a pad on the side of the machine frame and has vertical adjustment. This movement is sufficient to adjust the spindle sidewise, after the proper throw has been obtained by adjusting the eccentric cam.

The jig consists of a cast-iron base *M* shaped as shown. It rests on a knee *J* and is adjusted sidewise by strip *K*. The jig slides on strip *L* when the work is being located. On the top face of the jig is a hardened and ground nose-piece and plate *N* for locating the ring; two finger-levers *O* clamp the work to the jig. A screw passing through a bar *P* across the back end of the jig adjusts for the proper depth of disk seat, bearing against the end of the locating piece *K*.

In operation, the jig is first located on strip *L*, which is made a slide fit in the slot *Q* in the base of the jig. Next a ring is put on over the locating nose *N*, the finger-levers *O* are dropped down over the ring, but no pressure is applied, the jig is pushed forward until the locating pin *R* enters the flash hole, which was made in a previous operation. This locates the ring in the proper position on the jig. Then the finger-levers *O* are held down tightly on the work while the jig is grasped by lugs *S* and placed on strip *K*. It is then slid forward until the oscillating cutter finishes the hole.

The work of the machine is practically perfect, and a production of 2500 to 3000 a day can be maintained. The spindle should run at a speed of not less than 6000 revolutions per minute. The cutters best suited for this work are the usual type of straight-fluted end-mills; six flutes give the best results. Their only difference from the commercial end-mill is that the end teeth have more clearance.

* * *

President Wilson has approved an agreement between the War Industries Board and steel manufacturers fixing the following prices, which become effective immediately and are subject to revision January 1, 1918: steel plates, $65 per ton; steel shapes, $60 per ton; steel bars, $58 per ton; pig iron, $33 per gross ton; and iron ore, $5.05 per gross ton. These prices are for the United States government, its allies and the public, after existing contracts expire, and represent reductions of from 43 to 70 per cent. This announcement is in line with fixing the price of wheat at $2.20 per bushel, bituminous coal at $2 per ton, and copper at 23.5 cents per pound.

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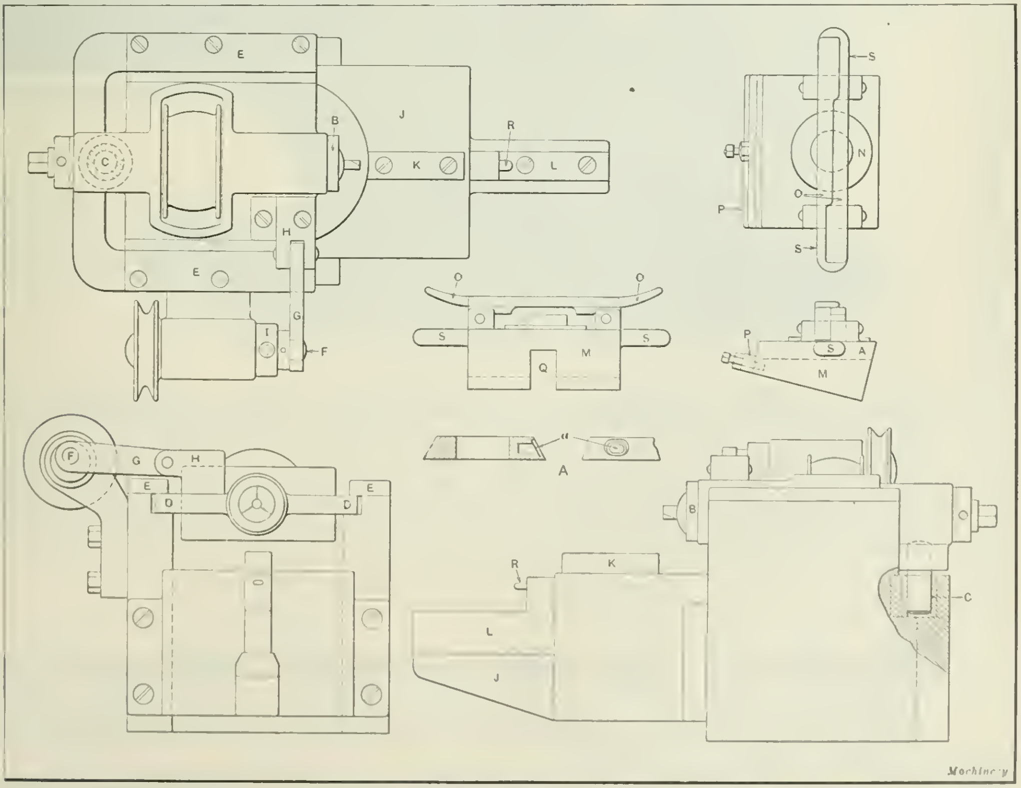
[1] Address: Layman Pressed Rod Co., 1790 Broadway, New York City.

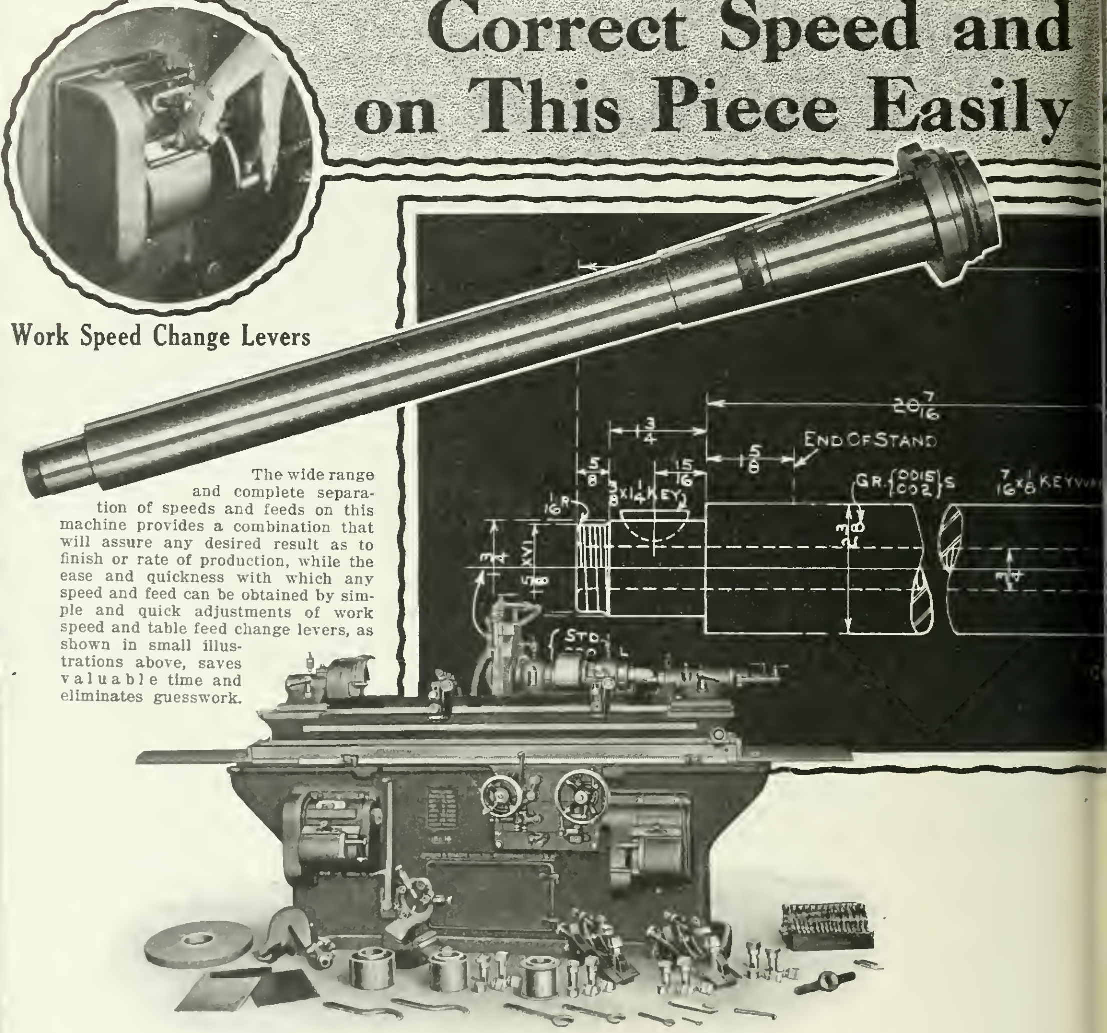


Jig and Machine for recessing Time-ring Disk Seats

Correct Speed and
on This Piece Easily

Work Speed Change Levers

The wide range and complete separation of speeds and feeds on this machine provides a combination that will assure any desired result as to finish or rate of production, while the ease and quickness with which any speed and feed can be obtained by simple and quick adjustments of work speed and table feed change levers, as shown in small illustrations above, saves valuable time and eliminates guesswork.



Brown & Sharpe Plain Grinding Machines

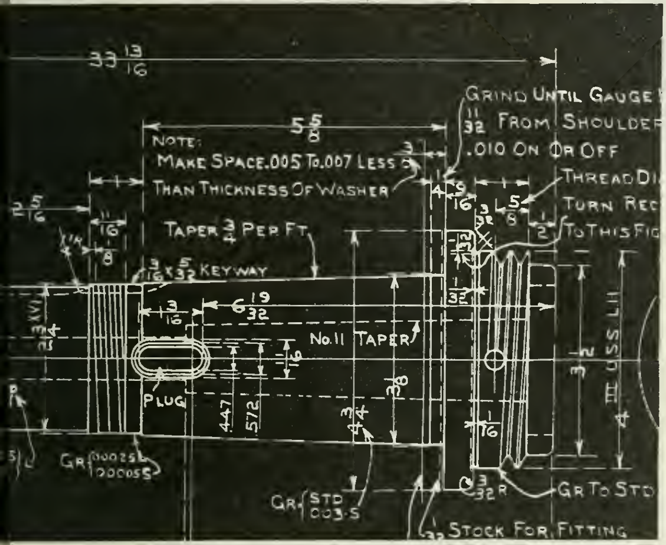
fulfill the various conditions to be met with in handling a wide variety of cylindrical grinding in a way that instantly appeals to both the operator and the production man. Work of large or small diameter, work which includes both large and small diameters, such as the piece shown above, or long slender pieces are all the same to the operator of one of these machines as far as accuracy and fast production are concerned. The wide range, complete separation and ease and quickness of obtaining work speeds and table feeds, while especially important, are but a few of the many features of these accurate and rapid machines.

May we tell you about them in detail? Send for literature and Catalog 136.

Brown & Sharpe Mfg. Co.,

OFFICES: New York, N. Y., 20 Vesey St.; Syracuse, N. Y., Room 119, University Block; Rochester, N. Y., 415 Chamber of Commerce Building; Pittsburgh, Pa., 2538 Henry W. Oliver Building; Philadelphia, Pa., 652-654 The Bourse; Chicago, Ill., 626-630 Washington Blvd. CANADIAN REPRESENTATIVE:. Canadian Fairbanks-Morse Co., Ltd., Toronto, Montreal, Winnipeg, Calgary, Vancouver, St. John, Saskatoon.

Feed for Diameters and Quickly Obtained



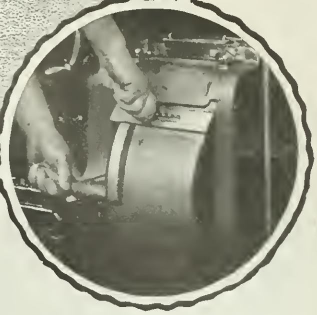
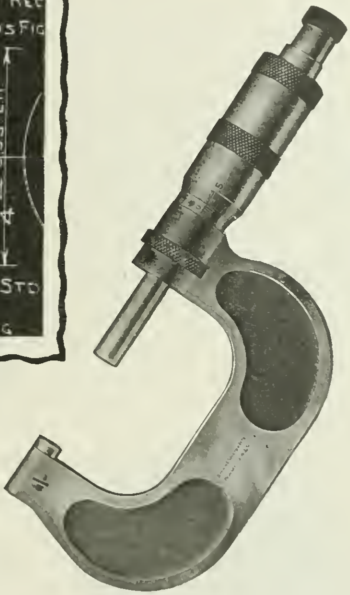


Table Feed Change Levers



The close limits allowed in the work shown above demand the accuracy that Brown & Sharpe Equipment provides. A small but highly important part of this equipment is a careful selection from among the many varieties of

Brown & Sharpe Precision Tools

B. & S. Micrometers of a heavy rugged type for the grinding machine operators and B. & S. Gauges for the inspectors. We recommend the use of micrometers for grinding operators because by their use the operator not only can tell at any stage of an operation that more stock should be removed, but it tells him how much more the diameter of the piece must be reduced.

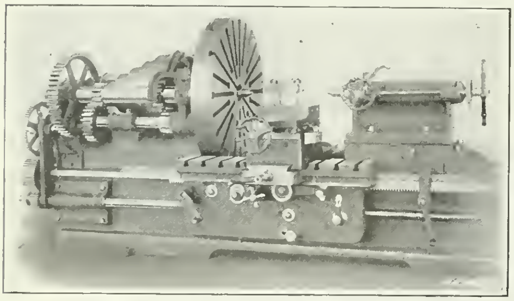
Our Catalog 27 provides a reliable guide for the proper selection of precision tools. Send for your copy today.

Providence, Rhode Island, U. S. A.

REPRESENTATIVES:. Baltimore, Md., Carey Machinery & Supply Co.; Cincinnati, O., and Indianapolis, Ind., The E. A. Kinsey Co.; San Francisco, Cal., Pacific Tool & Supply Co.; Cleveland, O., and Detroit, Mich., Strong, Carlisle & Hammond Co. St. Louis, Mo., Colcord-Wright Machinery & Supply Co.; Seattle, Wash., Perine Machinery Co.; Portland, Ore., Portland Machinery Co.

DAVID A. WRIGHT BUILDING FIFIELD LATHES

David A. Wright, 568 W. Washington Blvd., Chicago, Ill., has taken over the manufacturing rights on the heavy-duty engine lathes formerly built by George W. Fifield, Lowell, Mass. In addition to the manufacturing rights, Mr. Wright has acquired the patterns, jigs, fixtures and other equipment of a similar nature used in the manufacture of these machines. He is building lathes with 34-, 40-, 50-, 60-, 72-, 84- and 96-inch swing.



Fifield Heavy-duty Engine Lathe now built by David A. Wright

* * *

U. S. INSPECTORS FOR ORDNANCE EQUIPMENT

An examination for inspectors of ordnance equipment has been announced by the Civil Service Commission. One class of this examination is for inspectors of hardware and metal equipment, comprising such articles as buckles, rings, fasteners, hand axes, wire cutters, intrenching tools, canteens, cups, meat cans, cutlery and other small articles of brass, iron, steel or aluminum. Men who have had a high school or equivalent education, and in addition four years experience in a manufacturing plant making such articles as those listed, will qualify for one class of inspectors. Another class of inspectors requires men over twenty-five years of age who are graduates from a college or university of recognized standing and who have had one year's experience in a manufacturing plant on the practical end of the work. The duties of inspectors will consist in the organization and supervision of the inspection work in plants where equipment as described above is being manufactured. They will also be responsible for the preparation of the necessary reports covering the inspection, shipment and payment. The positions will be civil service appointments, and the salaries range from $1200 to $2400 a year with allowances for traveling expenses. Further information can be obtained from the Equipment Division, Inspection Section, 1330 F St., N.W., Washington, D. C., or from any office of the United States Civil Service Commission.

* * *

THE MODERN METHODS SCHOOL

Eugene C. Peck, general superintendent of the Cleveland Twist Drill Co., Cleveland, Ohio, long felt the need for trained factory workers, and some years ago started a night school in which his men were instructed in elementary mathematics and other common subjects. He compiled a series of lesson papers that were used with much satisfaction. Some of Mr. Peck's friends conceived the idea of collecting and compiling these papers, and as the result the Modern Methods School Co. was started about a year ago in Cleveland, and now has over 400 factory employes as students studying the Peck booklets.

The school gives a practical course on efficient factory management by correspondence. This is a course that starts with the workman and ends with the factory manager, and is invaluable to the workmen and the executives, as it teaches them to become better and more efficient workmen, foremen, assistant superintendents, purchasing agents, engineers, etc. To the man who has fully developed himself in his trade or profession it is especially useful, as it not only tends to help him in his present work, but prepares him for the position ahead, so that he is thoroughly acquainted with all phases of his new position when the opportunity for advancement arrives.

Mr. Peck, the president of the school and the author of the course, is a man who has had many years' experience as a practical and successful factory manager. All the other officers and members of the faculty are men who have had practical experience in the various courses that they teach, and are fitted as instructors. There is also an advisory board connected with the school, the members of which are practical and successful executives of many of the well-known business enterprises of the country. Any problem coming up in the daily work of the student may be submitted to these men with the assurance of receiving helpful and practical advice on the matter.

* * *

TUNGSTENLESS HIGH-SPEED STEEL

Darwin & Milner, of Sheffield, England, have announced the discovery of a new high-speed steel containing no tungsten, which is said to be equal in durability and hardness to the best high-speed steel containing tungsten. The new steel, called "Cobaltcrom," is suitable for milling cutters, twist drills, reamers, taps, automatic forming tools, screw cutting and finishing tools in general, being guaranteed to give endurance equal to the best tungsten high-speed steel. It is claimed that the "Cobaltcrom" tools produce a better finish and are tougher than those made of tungsten steel. Another valuable quality claimed for the tungstenless steel is the complete absence of cracking risks in hardening the most intricate shaped tools. Shrinkage and deformation during the hardening are practically nil, and the saving in rectification costs alone becomes an important item. The specific gravity of the new tool steel is about 10 per cent less than that of tungsten high-speed steel, which means that, taking weight for weight, a greater bulk of material is obtained, thus resulting in an appreciable gain to the user. Tungsten high-speed steel requires a temperature of 1250 to 1350 degrees C. (2282 to 2462 degrees F.) for hardening, while "Cobaltcrom" is hardened at 1000 degrees C. (1832 degrees F.). Owing to the embargo placed by the British government on the exportation of high-speed steel, the American agent, Darwin & Milner, Inc., New York City, is able to furnish only a limited amount to American customers at present.

* * *

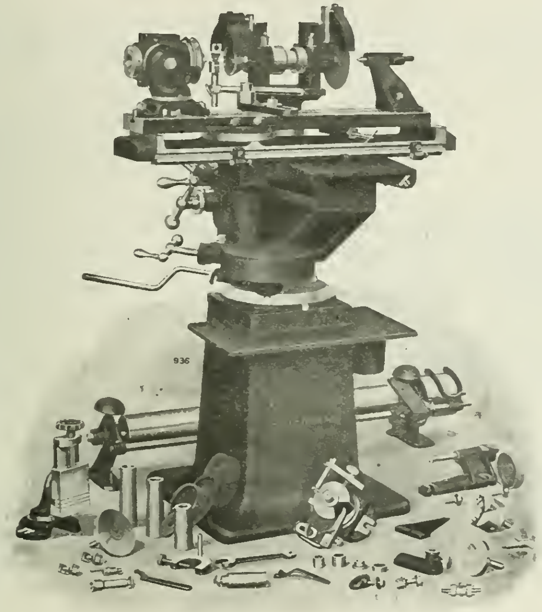
COMPLETION OF THE QUEBEC BRIDGE

During the third week in September, the last span of the Quebec bridge was put into place. When open, this bridge will carry the traffic of eight railroads across the St. Lawrence River and will reduce the rail distance between Halifax and western Canada 200 miles. On September 17, the central span, which is 640 feet long and the keystone of the structure, was floated down to the bridge site on scows and fastened in place. When the scows were removed, the 5000-ton mass was raised in two-foot stages and that night swung twenty-eight feet above the position from which it was started upward. It was raised forty-two feet the next day, and reached its final position on September 20.

Profiting by the disaster of last year, the engineers used all possible precautions against a recurrence. The care with which the calculations have been made can be realized from the fact that the 5000-ton mass of metal varied only five-eighths inch from the computations as to how far it would bring down the cantilevers after the scows had floated from beneath it. After each hoist, the mooring trusses, which ultimately will hold the span in place, were attached in order to hold it still until the jacks were made ready for a new upward thrust. The span was raised in two-foot stages, instead of the three-foot stages used the year before, and on September 19, when the span had reached the middle of its 150-foot ascent, the speed of hoisting was reduced from two feet in eleven minutes to two feet in fourteen minutes. In 1907 a structure of nearly the same magnitude collapsed, causing the loss of seventy lives.

Read This Quotation:

Then Investigate Your Own Cutter-Sharpening Facilities



"It has long been recognized that proper clearance and rake are of vital importance to cutting tools. Unfortunately, milling cutters which are more sensitive and more easily affected by different clearances have received little attention. It may, therefore, be assumed that the great majority of cutters are improperly sharpened. The user can correct these errors in stock tools by proper sharpening. There are cases on record where a cutter, intelligently sharpened for a particular cut, has increased the output of a milling machine 60%."

Our wide experience in milling has proved the necessity of having exactly the correct clearance on cutters. But cutter grinders were too incomplete to insure reproduction of the right clearance on repeated grindings. We set ourselves the task of solving this difficulty. The 40 per cent, 50 per cent or 60 per cent increased output that proper clearance means was certainly worthy of our best efforts. In the No. 1½ UNIVERSAL CUTTER AND TOOL GRINDER we offer you the result—a simple, correct clearance angle feature.

The machine carries a graduated dial on its headstock spindle from which the clearance angle for all cutters may be read direct.

As a result of obtaining this correct clearance angle the feed may be greatly increased, the cutter cuts as it was designed to; the tendency to chatter is removed—and you get greater efficiency from your millers.

Send for this Bulletin and Get the Whole Truth of the Matter

CINCINNATI MILLING MACHINE COMPANY

CINCINNATI **OHIO, U. S. A.**

PERSONALS

Dr. Robert Grimshaw, of New York City, sailed September 1 for Mexico on a short business trip.

H. E. Derbyshire, general manager of the Chambersburg Engineering Co., Chambersburg, Pa., has resigned.

J. B. Laird, until recently connected with the Moore Steam Turbine Corporation, Wellsville, N. Y., has resigned to go into the machine tool business.

R. C. Feltes has been put in charge of the Chicago office of the United States Electrical Tool Co., Cincinnati, Ohio. The Chicago office is located at 545 W. Washington Blvd.

O. P. Hatton has been appointed advertising manager of the E. W. Bliss Co., Brooklyn, N. Y., succeeding J. B. McCann, who has entered the sales department of the company.

Thomas S. Garrett, manager of the machinery department of Gaston, Williams & Wigmore, Inc., New York City, has resigned, and, after taking a much needed rest, will go into business for himself.

Edward Lurker has taken charge of the Chicago office, 1829 Lytton Bldg., of the Haynes Stellite Co., Kokomo, Ind. The territory controlled consists of the states of Wisconsin, Iowa, Minnesota and Illinois.

Robert A. Endebrock, superintendent of the Acme Machine Tool Co.'s plant No. 2, Cincinnati, Ohio, has resigned to become production assistant of the Sechler Co., manufacturer of "Trailmobiles" (trailers for auto trucks).

W. S. Rogers, chairman of the board of directors of the Bantam Ball Bearing Co., Bantam, Conn., gave a dinner to the officers and heads of departments of the company at Phelps Tavern, September 7. Mr. Rogers was the toastmaster.

George W. Wagstaff, formerly in charge of the Detroit, Toledo and Cleveland territory for the Onondaga Steel Co., Inc., Syracuse, N. Y., has been appointed sales manager, and will be located at the general offices of the company in Syracuse.

L. H. Taylor has been made sales manager of the machinery division of the Greenfield Tap & Die Corporation, Greenfield, Mass., succeeding W. S. Howe, who has resigned to become president and treasurer of the new Blevney Machine Co., of Greenfield, Mass.

Freling Foster, until recently advertising manager of the Hughes Electric Heating Co., Chicago, Ill., has joined the advertising staff of the Society for Electrical Development. He takes the place made vacant by the resignation of E. M. Hunt, who has joined the *Review of Reviews*.

Clarence E. Doyle, formerly senior active member of C. A. Snow & Co., and William F. Doyle, formerly of Greeley & Doyle, have formed the firm of Doyle & Doyle, and will continue the general practice of patent and trade-mark law at 420-422 Washington Loan & Trust Bldg., Washington, D. C.

Rene F. Jacops, who for the last eight years has been in charge of the New York export department of the Keystone Driller Co., Beaver Falls, Pa., has been made a manager of the American Machinery Syndicate, Hudson Terminal Bldg., New York City. Mr. Jacops has been almost exclusively engaged in the export business for the past twenty years, and is conversant with foreign market conditions, export methods and the Spanish and French languages.

E. B. Hotchkiss, of the American Steel Export Co., Woolworth Bldg., New York City, sailed for Europe in August. He will visit France, Italy and Spain in connection with a number of engineering problems, and incidentally will make investigations in those countries for the American Steel Export Co. He resided in France and Belgium for over nineteen years, during which time he had charge of a number of important engineering works.

John H. Barker, well known in the electrical trade as salesman and specialist in electrical power applications, has established himself as a manufacturer's representative with an office at 95 Liberty St., New York City. Mr. Barker was connected with the Diehl Mfg. Co., of Elizabeth, N. J., for eight years, the last two of which he was sales manager.

OBITUARIES

George B. Grant, for many years a prominent figure in the gear-cutting industry of the United States and author of a well-known work on gearing, died in Pasadena, Cal., August 17.

Albert S. Smith, president of the Smith & Mills Co., Cincinnati, Ohio, manufacturer of shapers, died of heart disease at his home in Cincinnati, September 3, aged fifty-nine years. Mr. Smith entered the employ of John Steptoe & Co. in his early youth. Ten years later, in 1885, he formed a partnership with the late James Mills.

Russell Dale, manager of sales, Rich Tool Co., Chicago, Ill., died September 22, at Wesley Hospital, from a gun-shot wound, aged forty-three years. Mr. Dale was for five years manager of sales of the Rich Tool Co., and formerly represented the Carpenter Steel Co. at Chicago. Previous to his connection with the Carpenter Steel Co. he was with the Celfor Tool Co.

Major Henry Souther, president of the Henry Souther Engineering Corporation, Hartford, Conn., and a well-known metallurgist and specialist in steel, died in the post hospital at Fortress Monroe, August 15, following an operation, aged fifty-two. He was a past president of the Society of Automotive Engineers and was made a life member in 1915 in recognition of his work as chairman of the standards committee, extending over a period of several years.

COMING EVENTS

October 9-11—Annual congress of Purchasing Agents at Pittsburg, Pa. James H. Robison, chairman, 600 Westinghouse Bldg., Pittsburg, Pa.

October 25—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

October 30-31—Fall meeting of the National Machine Tool Builders' Association in New York City; Hotel Astor, headquarters. Charles E. Hildreth, general manager, Worcester, Mass.

December 4-7—Annual meeting of the American Society of Mechanical Engineers in New York City, Engineering Societies Bldg., 29 W. 39th St., headquarters. Calvin W. Rice, secretary.

NEW BOOKS AND PAMPHLETS

Utilization of Pyrite Occurring in Illinois Bituminous Coal. By E. A. Holbrook. 46 pages, 6 by 9 inches; 14 illustrations. Published by the Engineering Experiment Station of the University of Illinois, Urbana, Ill., as Circular No. 5. Price, 20 cents.

Successful Industrial Management. By Harry Franklin Porter. 63 pages, 5 by 7½ inches; 13 illustrations. Published by the Westinghouse Lamp Co., New York City.

This little book is of value to an enterprising factory manager. It contains chapters on scientific management, common-sense construction of factory buildings, method of procuring a larger production from the machinery, economy of materials, the human factor, the cost and control; and the lighting and industrial efficiency of manufacturing plants.

Increasing and Improving Production. By H. T. [illegible]. 43 pages, 5 by 7½ inches; 17 illustrations. Published by the Westinghouse Lamp Co., New York City.

A discussion of the important factors of plant operation and their relation to the big problem of production is the topic of this book. The lighting system of a plant as an essential factor in the quantity and quality of production is recognized and a description of the methods employed in the management of an actual and efficient manufacturing establishment is given.

Advanced First-aid Instructions for Miners. By Surgeons G. H. Halberstadt, A. F. Knoefel, W. A. Lynott, W. S. Rountree, and M. J. Shields. 154 pages, 4½ by 5¾ inches; 65 illustrations. Published by the Department of the Interior, Bureau of Mines, Washington, D. C. Price in paper cover, 20 cents; bound in buckram, 35 cents.

These instructions, provided primarily for resuscitation of miners, apply to resuscitation and relief work generally, and will be found most useful by all first-aid men connected with manufacturing plants.

Safeguarding Industry. By the National Board of Fire Underwriters, 76 William St., New York City. 24 pages, 5 by 8 inches. Published by the Council of National Defence, Washington, D. C.

This little book relates to the waste due to fires in the United States, calling attention to the fact that during the past year $214,000,000 worth of property was wasted in fires that were largely preventable and therefore inexcusable. In comparing this waste with the necessities required for the successful conduct of the war, attention is called to the fact that this sum of money would have built nearly 30,000 aeroplanes or many hundreds of torpedo boat destroyers.

The Application of Efficiency Principles. By George H. Shepard. 368 pages, 5½ by 8½ inches. Published by the Engineering Magazine Co., New York City. Price, $3.

The author states that this work is an effort to tell how to apply efficiency principles in a manner supplementary to the treatment given by Emerson, on the one hand, and "Ford Methods and the Ford Shops" by Arnold and "Installing Efficiency Methods" by Knoeppel, on the other. It deals with the principles of job analysis, piece rates, application of common sense to job analysis, the value of ideals in an industrial organization, and the importance of hiring the right men for the right place. Organization is analyzed and the principles of planning and despatching. The importance of adapting conditions and work to each other is discussed, and the value of setting a standard is pointed out.

The Economical Purchase and Use of Coal for Heating Homes with Special Reference to Conditions in Illinois. 58 pages, 6 by 9 inches; 22 illustrations. Published by the University of Illinois, Urbana, Ill., as Circular No. 4 of the Engineering Experiment Station. Price, 10 cents.

This pamphlet is a non-technical manual for householders and operators of small house-heating plants, which is being circulated in the interest of fuel conservation and the promotion of more satisfactory results from house-heating system. It deals with the installation of heaters, heating systems, auxiliary equipment, characteristics of fuel for household use, the purchase of coal, and the operation of small heaters. The manual should have a wide circulation in view of the probable scarcity of fuel next winter. Many users of coal for house-heating purposes could no doubt, make two tons do the work of three if properly instructed in firing their heating apparatus.

Dyke's Automobile and Gasoline Engine Encyclopedia. By A. L. Dyke. 896 pages, 6½ by 9¼ inches; 3362 illustrations. Published by A. L. Dyke, St. Louis, Mo. Price, $3, net.

The sixth edition of this work has been rewritten, and many new illustrations and subjects have been added. It presents in a clear, simple form the principles of gasoline engine and automobile construction and operation, and explains in detail what an operator should understand to operate or take care of any make of car. The subjects dealt with include the assembly of a car; engines; carburetion; cooling and lubrication; coil and battery ignition; magneto ignition; storage batteries; operation and care of storage batteries; license laws and salesmanship; tires; digest of troubles and their remedies; trucks and tractors. Repairing is thoroughly reviewed. Supplements are included that give detailed instructions on the principles, operation and adjustments of Ford and Packard cars, and a glossary of motor terms.

The LUCAS

(OF CLEVELAND)

"PRECISION"

BORING, DRILLING AND

MILLING MACHINE

ALWAYS GOOD

and as time goes on

ALWAYS BETTER

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF **CLEVELAND, O., U.S.A.**

NEW CATALOGUES AND CIRCULARS

Link-Belt Co., Chicago, Ill. Book 342, treating of casings and lubrication for Link-Belt silent chain drives.

Charles Ross & Son Co., 148-156 Classon Ave., Brooklyn, N. Y. Catalogue 20 on dry mixing and grinding machinery.

"Fulflo" Pump Co., 126 Opera Place, Cincinnati, Ohio. Leaflet illustrating and describing the "Fulflo" grinder circulating pump.

Hollingsworth Machine Tool Co., Covington, Ky. Circular descriptive of the Hollingsworth 24-inch improved triple-geared crank shaper.

Link-Belt Co., Chicago, Ill. Catalogue 246 of Link-Belt electric hoists, giving tables of lifting capacities, weights, clearances, etc.

Reno-Kaetker Electric Co., 41 Main St., Cincinnati, Ohio. Circular of the "Reliance" swing saw for use in packing-rooms to cut lumber for crates and boxes.

South Bend Lathe Works, South Bend, Ind. Catalogue 51, in Spanish, describing and illustrating South Bend lathes. The prices are given in American money.

Worthington Pump & Machinery Corporation, 115 Broadway, New York City. Catalogue illustrating and describing the different types and uses of volute centrifugal pumps manufactured by Henry R. Worthington.

Walter A. Zelnicker Supply Co., St. Louis, Mo. Bulletin 224, listing new and second-hand equipment, including pressure tanks, storage tanks, car tanks, acid tanks, elevated tanks, stand pipes, reservoirs and vats.

Worthington Pump & Machinery Corporation, 115 Broadway, New York City. Bulletin W-602 of Worthington turbine pumps for high head service. The catalogue treats of the turbine pump, its principle of operation, and characteristics.

American Emery Wheel Works, Providence, R. I., is distributing a convenient table of grinding wheel speeds and grades. The table is mounted in a celluloid envelop, with "windows" which make the reading for any speed or grade convenient.

Universal Valve Co., Burlington, Wis. Booklet on non-packing, high-pressure "Kno-Pak" valves and joints for steam, air, gas and ammonia. The joint contains a cast-iron spring, which keeps the bearing parts closely in contact and thus eliminates the need of packing.

Titanium Bronze Co., Inc., Niagara Falls, N. Y. Booklet of die-cast titanium-aluminum bronze, showing a number of castings that have been made from titanium-aluminum bronze. The booklet gives the composition of titanium-aluminum bronze and its physical properties.

International Machine Tool Co., Indianapolis, Ind. Catalogue of the "Libby" turret lathe, containing set-up drawings for railroad locomotive pins. These drawings comprise a complete tooling layout for machining crosshead, knuckle joint and other heavy pins and bar work on the "Libby" turret lathe.

Lansing Stamping & Tool Co., Lansing, Mich. Folder descriptive of the "Capital" internal grinder, for which high efficiency, rapid production and a high degree of accuracy is claimed. Specifications including the diameter of grinding wheel spindle, speeds of grinding spindle, capacity, etc., are given.

Ready Tool Co., Bridgeport, Conn. Catalogue 15 of inserted cutter "Red E" tools for lathes, planers and shapers, comprising turning, threading, facing and cutting-off tools; also lathe dogs, milling machine dogs and drivers, grinder dogs, milling machine vise hold-downs, "Safety First" belt sticks, etc.

Titanium Bronze Co., Inc., Niagara Falls, N. Y. Booklet treating of the characteristics of titanium-aluminum bronze and the applications for which it is especially suited. The booklet contains photomicrographs of manganese bronze, phosphor bronze and aluminum bronze, showing the relative structure of each.

Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York City. Catalogue 537 of hand screws, clamps, etc. The line of clamps made by the company includes the wooden-spindle hand-screw clamp, steel-spindle adjustable hand-screw clamp, rapid-acting all-steel clamp, clamps for cabinet-makers, carpenters, toolmakers, machinists, etc.

Sponsel Co., Inc., 617 Main St., Hartford, Conn. Circular of the "Sponsel" calibrating and straightening machine for gun barrels, which provides for measurement of the bore, straightening of the bore, determination of reamer pockets, determination of eccentricity of outside of barrel with bore, location of sighting marks and measurement and straightening of bore after rifling.

Reliance Electric & Engineering Co., 1056 Ivanhoe Road, Cleveland, Ohio. Bulletin 1011 of Reliance adjustable-speed, direct-current motors of the armature shifting design, describing the principle of operation, mechanical details, and giving table of ratings. The bulletin shows applications of these adjustable-speed motors to various types of machine tools.

Fellows Gear Shaper Co., Springfield, Vt., has issued for distribution a sheet of instructions for truing and clamping 3-inch and 4-inch gear shaper cutters. The sheet carries illustrations of correct and incorrect mountings of cutters for "pull" and "push" strokes. Users of the Fellows gear shaper should secure copies of these instructions for the use of their operators in order to insure that the machines are being tooled efficiently.

N. Y. Revolving Portable Elevator Co., 344 Garfield Ave., Jersey City, N. J. Bulletin 43, entitled the "Steel Giant," describing the uses of the revolvator. The revolvator is shown in use erecting overhead motors and taking them down for repairs, erecting and repairing overhead shafting, in overhead drilling, loading heavy cases, bales, etc., from sidewalks on the trucks, loading freight into cars, storing sheet iron, and elevating heavy dies onto presses.

Acieral Co. of America, 26 Cortlandt St., New York City. Circular of "Acieral," a light-weight alloy composed chiefly of aluminum, which is claimed to have the strength of steel, the lightness of aluminum, nearly, and to be non-corrosive. Its color is silver white; fracture is similar to that of steel; specific gravity, 2.82; melting point, 1382 degrees F.; tensile strength in castings, 30,000 pounds per square inch; and tensile strength in rods and sheets, 28,000 to 64,000 pounds per square inch.

Whiting Foundry Equipment Co., Harvey, Ill. Blueprint bulletins on food conservation and the Liberty loan. These bulletins are in the form of the shield of the United States, and the first reproduces the request of Mr. Hoover to eat one wheatless meal per day; to eat two meatless meals per day; to economize in the use of butter and sugar; to eat more vegetables, fruit and fish; and to economize in the use of all foods. The second is a request to invest in the second issue of the Liberty loan and help win the war.

New Departure Mfg. Co., Bristol, Conn., publishes a house organ known as "New Departure News." The August 25 number contains biographical sketches of DeWitt Page, E. B. Case, Robert Muzzy, Napoleon Dube, George Scheer, Christopher O'Connell, William O'Connell, Jeremiah T. O'Connell, George Breshnahan, Frank C. Wilcox, Henry C. Huhn, John Iles, William R. Coe, William G. Atkins, Herbert A. Barnum, G. P. Bennett and Joseph D. Brown, who have been in the company's employ more than twenty years. Mr. Page, the president, started as a receiving clerk in 1892.

TRADE NOTES

T. P. Walls Tool Co., 75 Walker St., New York City, has been incorporated with a capital stock of $50,000. T. P. Walls is president.

Herman A. Holz, 1 Madison Ave., New York City, was awarded the Edward Longstreth Medal of Merit by the Franklin Institute, for his portable Brinell meter.

Bay State Saw & Tool Mfg. Co., formerly of Roxbury, Mass., has removed to Winchester, Mass., where better facilities have been provided for the manufacture of hacksaws.

Atcheson & Barck Die Tool Co., Peters Power Bldg., Columbus, Ohio, has opened a shop fully equipped for making tools, dies, jigs, fixtures, gages, metal patterns and special machinery.

Gisholt Machine Co., Madison, Wis., manufacturer of turret lathes, boring mills and other machine tools, has moved its New York office from 50 Church St. to Rooms 1723-1725, 30 Church St.

Teck Screw Machine Products Corporation, Long Island City, N. Y., has erected a two-story brick factory at 199-203 Eighth St., which will be devoted to the manufacture of screw machine products of all kinds.

Hyatt Roller Bearing Co., Newark, N. J., has opened a branch office in Pittsburg at 1272-1273 Frick Annex. The new office will serve as headquarters for E. E. Eby and J. M. Kelly, who represent the company in the Pittsburg district.

Charles H. Besly & Co., 120-B N. Clinton St., Chicago, Ill., are again located in their old quarters at 118-124 S. Clinton St. The building, guttered by fire in January, has been rebuilt and provided with all conveniences required to make a modern store for the sale of machinery and tools.

Advance Machinery Co., manufacturer of "Advance-Toledo" ball-bearing disk-drive shapers and "Advance Wetmore" glue room machinery, has moved its plant from Toledo to Van Wert, Ohio, where a new factory has been provided that affords facilities modern in many respects for the manufacture of machinery.

Windau Tool Co., Cleveland, Ohio, recently moved to 1565 E. 17th St., where a new and larger brick factory, having a floor space of 35 by 100 feet, has been provided. The number of machine tools has been doubled, all being new and of the best make. The company makes spiral milling cutters, form milling cutters, circular tools and special small tools.

Samuel Swott, 149 Broadway, New York City, has been appointed the exclusive agent in the United States for George Cradock & Co., Ltd., of Wakefield, England, whose steel works, rolling mills, wire drawing mills and wire rope works are located in that place. The company manufactures steel wire ropes, ship cables, strands, cables and tension wires used in the building of aircraft, etc.

Bradford-Ackermann Corporation, 42nd St. Bldg., New York City, has been appointed Eastern sales representative of Young Bros. Co., Detroit, Mich., manufacturer of japanning and drying ovens. Young Bros. Co. has installed many large electric and gas heated ovens in the Middle West, and their success in that district has prompted the opening of an eastern office for the convenience of the trade.

McCarthy Drill & Tool Corporation, Toledo, Ohio, with executive offices at 30 Church St., New York City, has purchased the Toledo Drill & Tool Co. The Toledo Drill & Tool Co. has just moved into a new fireproof two-story structure where facilities have been provided to turn out large quantities of high-speed drills and a full line of cutters and reamers. The drills will be furnished in both English and metric sizes.

J. R. Stone Tool & Supply Co., Detroit, Mich., distributor for the Manufacturers Equipment Co., Chicago, Ill., and the Nelson-Blanck Mfg. Co., Detroit, Mich., has opened an office at 30 Church St., New York City, under the management of James R. Stone, president of the company. Several salesmen will be put on the road from this office to travel through the Eastern states, introducing "MEC" air chucks and Buhr drill heads.

J. C. Glenzer Co., 3 Fourteenth St., Detroit Mich., has recently been organized for the purpose of salvaging and reclaiming milling cutters, reamers, end-mills, etc., and will also manufacture new cutters, reamers, and other small tools. Mr. Glenzer has had eighteen years' experience in the manufacture of tools and has been in charge of this work at the Studebaker Corporation for six years. The new company solicits orders from any part of the country.

Federal Engineering & Mfg. Co., 411 Frankfort Ave., Cleveland, Ohio, announces that William Eckert has become a stockholder and has been elected secretary-treasurer of the company. The officers are H. O'Donnell, president; M. F. Klein, vice-president; and William Eckert, secretary-treasurer. The company has enlarged the floor space in its factory and added new machinery. It is now fully equipped to manufacture special machinery, tools, dies, jigs, etc.

Warren F. Fraser Co., maker of the Fraser universal grinders, special tools and gages, has moved to Westboro, Mass. The factory is conveniently located close to the center of the town adjoining the Boston & Albany Railroad. The factory plot provides room for additions to the building. The present building is one-story and is well lighted throughout, giving excellent facilities for manufacture and special work. The company has a branch office at 201 Devonshire St., Boston, Mass.

Titanium Bronze Co., Inc., 504 Marine Bank Bldg., Buffalo, N. Y., is a concern recently organized to operate the bronze department of the Titanium Alloy Mfg. Co., located at Niagara Falls, N. Y. The company makes a specialty of worm-gear blanks for worm-driven truck axles, and is successfully introducing titanium-aluminum bronze in this field, where formerly only English gear bronze or a similar phosphor-bronze was used. The company is also successfully die-casting titanium-aluminum bronze in a variety of small pieces, such as windshield parts and small spur, bevel and miter gears, etc.

Cleveland Milling Machine Co., 18511 Euclid Ave., Cleveland, Ohio, has purchased the plant and business of the Cleveland Machine Tool Works of Cleveland. The plant will be operated under the name of the Cleveland Machine Tool Co. The business has been incorporated with a capital stock of $200,000. The officers are Frank S. Shields, president; John A. Camm, vice-president; and L. M. Richards, secretary, all of whom are officers of the Cleveland Milling Machine Co. James A. Whitelaw is the treasurer. Plans have been made for greatly increasing the capacity and output of the present plant.

Dann Products Co., Cleveland, Ohio, recently made a test of "Dannite" bushings for sash pulley bearings to determine their probable durability. The "Dannite" used was 22-gage bronze, specially treated, impregnated and surfaced with graphite. The test was made with a plain axle pulley, the pulley having a diameter of 2½ inches, and the pin a diameter of ¼ inch. A weight representing a load of 534 pounds per square inch was carried on the pin, and the pulley was operated for 91½ hours, the weight being raised and lowered 219,000 times. At the end of the test the pulley bore showed an enlargement of only 0.001 inch, and the pin was found to be bright, smooth and practically unworn.

Peerless International Corporation, New York City, has opened an office at 50 Pine St. for the purpose of carrying on an export and import trade and general engineering and contracting business in foreign fields. The corporation is capitalized at $800,000. Affiliated with the concern is the L. K. Comstock Co., which will be represented on the board by its president, L. K. Comstock. Another director is Walter W. Birge, president of the Air Reduction Co. The president of the company is Alfonso Kaufman, formerly engaged in consulting engineering work in New York and Chicago. The vice-president is S. Weiner, and the treasurer, William M. Blain. The secretary, Frederick A. Beardsley, has been actively engaged in engineering and exporting for a number of years.

Blevney Machine Co., Greenfield, Mass., has been organized to take over the business of John C. Blevney, Newark, N. J., manufacturer of grinding, polishing and finishing machinery and friction clutches. The company was organized under the laws of Massachusetts by W. S. Howe, general manager of the machinery division of the Greenfield Tap & Die Corporation, including the F. E. Wells & Son Co., Nutter & Barnes Co., and the machinery departments of the other concerns in the corporation, and his associates. The capitalization is $150,000 preferred stock and $150,000 common stock, all paid in. Mr. Howe has resigned to become president and treasurer of the new concern, which has taken over the entire business, patterns, patents and good will of John C. Blevney. A modern factory has been purchased in Greenfield. The Blevney line of grinding and polishing machinery is distinctly original and is covered by many patents. The new concern will expand the business and fully develop its possibilities.

NOVEMBER MACHINERY 1917

Making Cold-Drawn Shafting

by Edward K. Hammond[1]

The manufacture of cold-drawn shafting is essentially wire drawing on a large scale. The shafts are pulled through dies by draw-benches or bull-block machines. The preparation of the stock, pointing of the bars, draw-benches and bull-block machines, speed of drawing, power required for cold-drawing, dies used for drawing wire and small sizes of screw stock and shafting, dies for drawing square, rectangular and other shapes, lubricants for drawing, speed of production, straightening, and other features of practice are treated in the following article.

THE terms "cold-drawn" and "cold-rolled" are indiscriminately applied to all grades of shafting and screw stock with a bright finish; but as a matter of fact these two processes are entirely distinct. Cold-drawn shafting and screw stock are made by drawing the steel bar through a die, which reduces the diameter to exactly the required size and imparts a high finish to the surface of the metal; and cold-rolled shafting is made by turning the bar to just about the required diameter and then obtaining the final reduction and finish by passing it through a machine equipped with burnishing rolls. It will be evident from this that the rolling process is very different from the method of treatment to which steel is subjected when it is rolled hot to reduce the diameter and increase the length of the bar. Either cold-drawing or cold-rolling imparts a hard surface to the steel and increases the tensile strength of the bar. In addition to cold-drawing and cold-rolling, there is a third method which finds general application in the production of shafting over three inches in diameter; this consists of simply turning the bar down to the required diameter, taking particular care to take a light finishing cut that will leave the surface as smooth and uniform as possible. Most shafting and screw stock up to three inches in diameter is cold-drawn, and shafting above that size is generally turned.

Raw Material of the Industry

Cold-drawn shafting is made from an open-hearth steel containing about 0.15 per cent carbon, which is similar to the grade commonly known as "machinery" steel. In most plants engaged in the manufacture of cold-drawn shafting, the raw material is purchased from the steel mill in the form of bars having a diameter from 1/32 to 1/8 inch larger than the shafting to be drawn, the amount of excess metal increasing with the size of the work; but as the production of this raw material is an important part of the shafting industry, a brief description of the method employed will be given.

Molten steel, which has been brought to the required chemical composition by refining in an open-hearth furnace, is poured into ingot molds that produce ingots ranging from 16 to 20 inches square by 4 to 5 feet in length, weighing approximately 3200 to 6250 pounds. These are the regular steel works ingots that might ultimately be worked up into a variety of other products in addition to cold-rolled shafting. After being removed from the mold, the ingots are transferred to a blooming mill, in which they are rolled down into billets from 2 to 5 inches square, according to the size of the shafting to be made.

The next step in the process will depend upon the kind of shafting that is to be produced; but in any case the billets produced in the blooming mill are cut up into pieces of such a length that they can be rolled out into bars of the same length as the shafting to be drawn. In most cases the length of billet is such that the rolled bars will be from 30 to 40 feet in length, as this is the greatest length that can be handled in an ordinary freight car. The billets are reheated and then rolled down into bars of this length, of a diameter slightly larger than the required size of the shafting.

Pickling Hot-rolled Bars

The steel bars that the shafting factory purchases from the steel mill have been rolled hot, and as a result they are covered with an oxide scale, which must be removed before the bars can be converted into cold-drawn shafting. The reason for this is that the oxide scale is extremely hard and would rapidly destroy the drawing dies; also, cold-drawn shafting is required to have what is known as a "bright" finish, and this can only be obtained when the metal is free from oxide. Another reason for removing every particle of scale from the bars before they are drawn is that, if it were not removed, small pieces of scale would be driven into the steel by the die pressure and cause flaws that would seriously reduce its strength. The first step in cleaning or "pickling" the metal is to place the bars of steel in wooden troughs containing a 5 per cent solution of commercial sulphuric acid, which has a

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[1] Associate Editor of MACHINERY

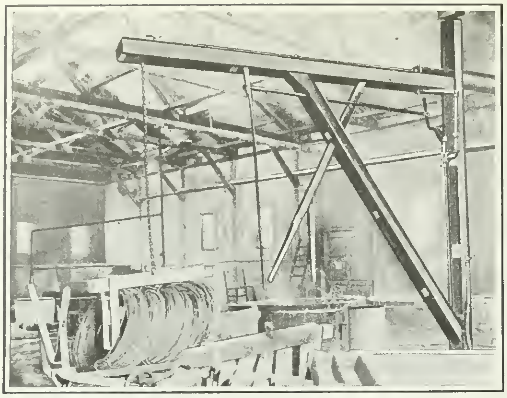


Fig. 1. Jib Crane with Yoke for holding Bundles of Wire to be dipped into Pickling Vats. Built by Morgan Construction Co.

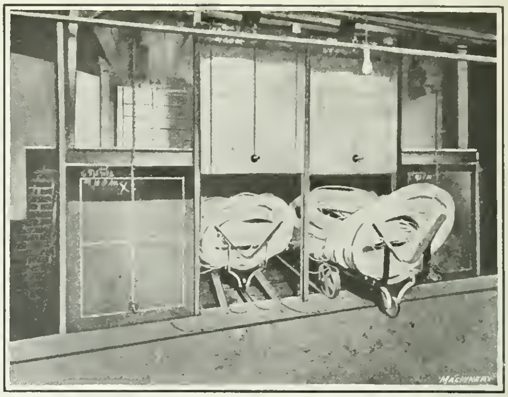


Fig. 2. Oven in which Truck-loads of Wire are dried after leaving Pickling Department. Built by Morgan Construction Co.

specific gravity of 66 degrees Baumé at a temperature of 60 degrees F. The scale is removed by a combined chemical and mechanical action; the acid reacts with the iron and liberates hydrogen, which collects under the oxide scale and develops sufficient pressure to tear away the scale in small plates. As the chemical action is accelerated by heat, the temperature of the acid bath is raised to about 180 or 200 degrees F. by means of pipes which deliver live steam into the trough.

A very little thought will make it evident that the shafting must be left in the acid bath only long enough to remove the scale, as, if it were left in longer than required, the steel would be eaten away and the diameter of the bars reduced so that they would be too small for making shafting of the size for which they are intended. It is particularly important to regulate the length of time the steel is left in the acid bath in the case of high-carbon steel, as experience has shown that the acid tends to decarbonize the steel at the surface. Low-carbon steel can be left in the bath for from twelve to fifteen minutes, and sometimes twenty minutes will not be too long; but high-carbon steel must not be exposed for more than four or five minutes. After being removed from the acid bath, the steel bars are rinsed in troughs containing pure water, after which they are transferred to troughs containing a solution of limewater, which has the property of neutralizing the acid and preventing further action of any slight trace of acid that may still adhere to the bars. The dipping of the bars in limewater also has a further valuable purpose: when removed from the bath the bars are covered with a solution of limewater, and after the water has dried off, this solution leaves a deposit of lime which protects the steel from oxidation by the oxygen in the atmosphere.

In order to prevent the steel from rusting, it is of the highest importance that the bars be dried quickly after they are removed from the limewater bath, and for this purpose the bath is maintained at a temperature of about 200 degrees F. by pipes which deliver live steam to the baths in the same way as in the acid bath. In the case of bars over 5/16 inch in diameter, the metal absorbs sufficient heat in the bath to evaporate the limewater solution rapidly and leave the dry coating of lime; but bars of smaller diameter than the size mentioned are put on a rack and heated by coils containing high-pressure steam so that the water is rapidly evaporated. In any case, it is absolutely necessary to have the lime "bone dry" at the time the bars are drawn through the dies, because if there is any moisture it will result in rapidly wearing out the dies and scoring the surface of the shafting so that its finish will not be satisfactory. Before being drawn, the bars are carefully inspected for seams and other surface defects, and those showing imperfections of this kind are rejected.

In pickling small sized stock, which is handled in coils, the method of procedure is somewhat different. Usually about eight coils are suspended on a yoke and dipped into a tub containing the pickling acid. Each bundle contains from 125 to 300 pounds of metal, and as the yoke loaded with eight coils is quite heavy, it is necessary to provide a crane for handling the metal. A jib crane is usually placed at the center of a circle of tubs. As in the case of straight bars, the steel is first pickled in acid, after which it is rinsed in a tub of water and immersed in limewater. Upon coming out of the lime bath, the bundles are placed on a truck and the yoke is removed. The truck load of steel is then run into a baking oven maintained at a temperature of 325 to 375 degrees F. and left there for a sufficient length of time to dry the metal completely. The steel is then removed from the oven and allowed to cool preparatory to being drawn.

Pointing Bars preparatory to Drawing

Before the cleaned steel bars can be subjected to the cold-drawing operation, it is necessary for them to be pointed at one end so that the point can be passed through the drawing die and gripped by the tongs of the draw-bench. The method of pointing varies according to the size of bars that have to be drawn, and practice in this connection also varies according to the shop in which the work is done. The general state-

Fig. 3. Steam-heated Rack on which Straight Bars are dried after leaving Pickling Department

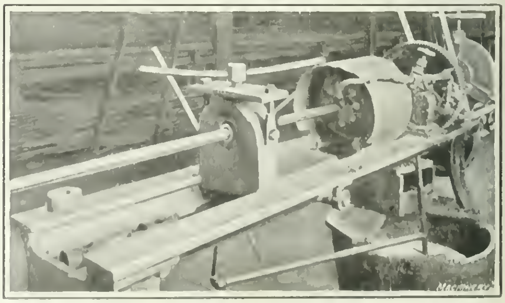


Fig. 4. Machine with Rotary Cutter-head for pointing Bars up to One Inch in Diameter Ready for Drawing Operation

ment may be made, however, that bars of the larger sizes are pointed in a machine equipped with a cutter-head that actually removes metal from the end of the bar. On smaller sized bars the pointing is done in a swaging or rolling machine, which hammers or rolls down the end of the bar to reduce its diameter sufficiently so that it will pass through the die and enable the tongs to take hold.

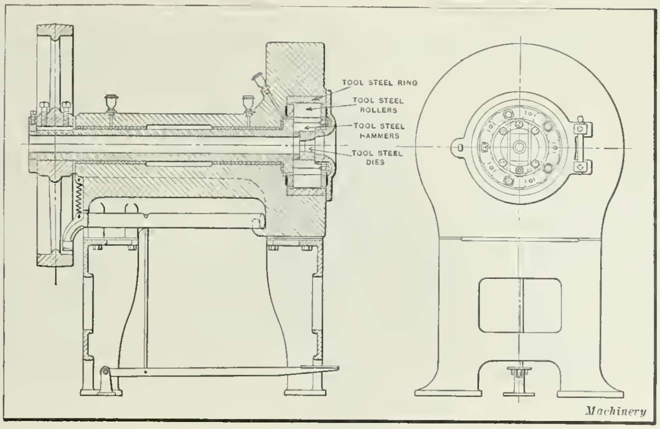


Fig. 5. Swaging Machine built by Standard Machinery Co. for pointing End of Bars Ready to start drawing

Rotary Swaging Machines

In Fig. 5 is shown a rotary swaging machine built by the Standard Machinery Co., Auburn, R. I. In this machine the dies are adjustable relative to each other and are carried in a revolving spindle. These dies are held between a pair of blocks with round faces or ends, the arrangement being shown in the illustration. Outside of the head end of the spindle there is an annular rack fitted with hardened tool-steel rollers, and the revolution of the spindle causes the dies and hammers to pass the successive pairs of rollers which are situated opposite each other. This action forces the dies inward through the slot in the spindle and causes them to come together on the work. The spindle is bored from front to back to enable the long steel bars to be fed through in order to have their ends pointed. The dies revolve rapidly around the work, which is held stationary, while the rollers revolve slowly, being moved only slightly during their contact with the blocks. On this account the blows of the hammers are evenly distributed over the work to be swaged.

Pointing Bars of Special Shape

Pointing round bars ready for the cold-drawing operation is a simple matter, because the shape of the work offers no particular difficulty; but it is necessary for the shape of the point to be the same as that of the bar which is to be drawn, so in the case of square, hexagon, flat and V-shaped bars, the point must be of the same shape as the finished bar. In order to secure this result special methods must be employed. One of the most satisfactory processes consists of heating the end of the bar and then gripping it on each side of the heated section by clamps on a machine which provides for pulling the bar sufficiently to "neck in" the heated section and point it. Probably few readers of MACHINERY have seen this method used, but there are many who have conducted tests on either the Riehle or the Olsen testing machine who will recall that in stretching hexagon and other shaped sections the neck produced holds the shape of the original bar. Where this method is employed for pointing bars ready for drawing, it is important not to exceed the elastic limit of the material, as such a condition would result in a rapid reduction of diameter. To overcome this condition, the operator of the machine has a sponge soaked in water, and as soon as he notices any tendency for the diameter of the bar to reduce rapidly at some point, he drops a little water on the metal so that the temperature is lowered and the metal hardens sufficiently to prevent further reduction in diameter at the point where the elastic limit has been exceeded.

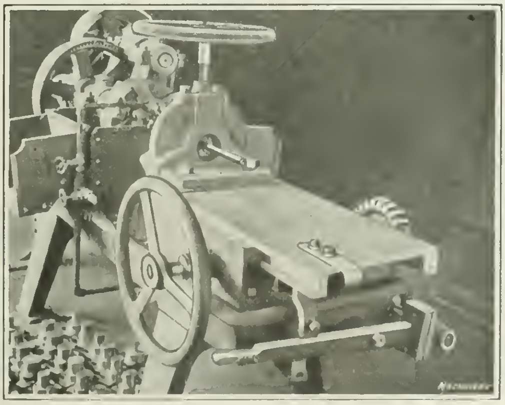


Fig. 6. Pointing Machine built by Brightman Mfg. Co.

Starting Bar through Die by Pushing

The carriage on a draw-bench is furnished with two serrated jaws that grip the work. These jaws are tapered on the outside and fit into a tapered holder on the carriage; the result is that when the jaws are pressed against the work and the carriage starts forward, they are drawn back in their tapered holder, which forces them to secure a firm grip on the work. For drawing stock over one inch in diameter, some manufacturers have their draw-benches equipped with an auxiliary carriage located behind the die-holder, which is fitted with a pair of tapered serrated jaws that can grip the work. Attached to this carriage is a yoke that drops over the die-holder so that a bar at the front end of the yoke may be gripped by the jaws of the regular draw-bench carriage. When the main carriage is started, this yoke draws the auxiliary carriage forward, which results in pushing the front end of the bar of steel through the die. Fig. 9 shows the apparatus after the bar has been pushed through the die and the yoke released from the jaws of the main carriage and raised by means of the cable and counterweight furnished for that purpose. The operator will now draw the main carriage back and grip the projecting end of the bar between its jaws; he will then release the jaws of the auxiliary carriage from the work and start the draw-bench, to pull the bar through the die. This is the means of saving the crop end of steel, which results through the customary practice of pointing the end of the bar so that it may be threaded through the die. On bars less than one inch in diameter this method cannot be used, because the bar buckles instead of being pushed through the die.

Cold-drawing Bars

Two important advantages are secured from the process of cold-drawing: First, the metal does not oxidize, because the work is done cold, and as a result the steel retains a so-called "bright" finish. Second, it is possible to hold the material within very close limits, the diameter of good cold-rolled shafting or screw stock being within 0.0005 inch of the specified diameter. The clean and extremely smooth finish produced in this way enables a high transmission efficiency to be obtained with cold-drawn shafting, as friction losses in bearings are reduced to a minimum. Advantage is taken of this method in producing material used for various other purposes, such as the manufacture of parts in automatic screw machines, etc., as it is found that the smooth finish and uniform diameter of cold-rolled drawn bars enable them to be handled by automatic machinery with much better results; and advantage may also be taken of the high finish of the bar to avoid the necessity of further machining of surfaces where the original diameter of the bar meets all requirements. In this way a considerable saving is made in both material and production time.

In conducting the cold-drawing operation, the entire reduction is obtained by one passage of the steel through the drawing die. The amount of reduction obtained varies according to the diameter of the shafting which is being drawn, but for sizes 1/2 inch in diameter and over, a reduction of 1/16 inch may be obtained; and for smaller sizes of shafting the reduction is about 1/32 inch. In drawing some large sizes of shafting, a reduction as high as 1/8 inch is obtained. As a result, the bars of steel ordered from the rolling mill are specified to have a diameter which exceeds that of the shafting to be produced by the amount of reduction which may be obtained by one passage through the drawing die. The reductions referred to are for steel containing 0.15 per cent carbon; for high-carbon steel used in the manufacture of drill rod and certain other products, the amount of reduction possible by one passage through the dies is much less, as it is found that where the reduction is too great there is a tendency for the fibers of the metal to break and thus cause a serious reduction in the strength of the bars. As a result, the drawing of drill rod is conducted in such a way that a number of reductions are obtained by successive passages of the steel through the drawing dies until the diameter of the bar has been reduced to exactly the required size.

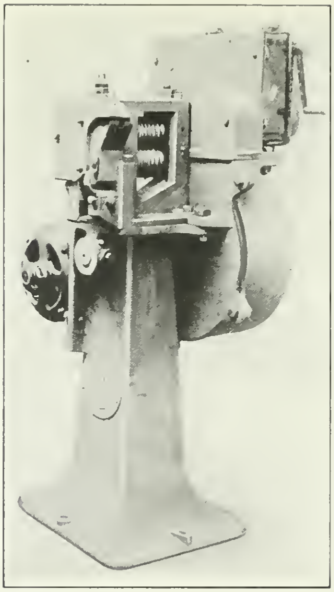


Fig. 7. Pointing Machine of Roll Type built by Morgan Construction Co. and equipped with Westinghouse Motor

Types of Draw-benches Used

Two types of machines are generally used for drawing shafting and screw stock. The first of these is known as the "straight draw-bench," on which a straight rod is drawn through the die by means of tongs on a head which travels straightways on the draw-bench, power being furnished by an endless sprocket chain or by hydraulic pressure. The second type is the bull-block machine, on which the rod is in the form of a coil that is carried on a reel at one end of the machine; the end of this rod is pointed and threaded through the drawing die and gripped by tongs carried on a second reel, which rotates in such a way that the rod is drawn through the die and wound up on the second reel. Both types of machines have points in their favor. The straight draw-bench is generally used for shaftings and rods from 7/8 inch diameter up; the most obvious advantage claimed for it is that the material is always straight, and consequently requires little treatment after the drawing operation has been completed. In contradistinction, the bull-block machine winds up the cold-drawn steel in a coil, which must be carefully straightened to prepare it for use. This takes time and involves an additional item of expense in the process of manufacture; but there are a number of factors in the bull-block machine that offset this expense, if they do not actually introduce a material factor of saving. In the first place, the material in coils is much more convenient to transport through the plant, as the stock can be carried on trucks and the plant does not have to be laid out in such a way that long bars can be handled conveniently. In the second place, it is possible to draw coils of steel weighing from 300 to 400 pounds and

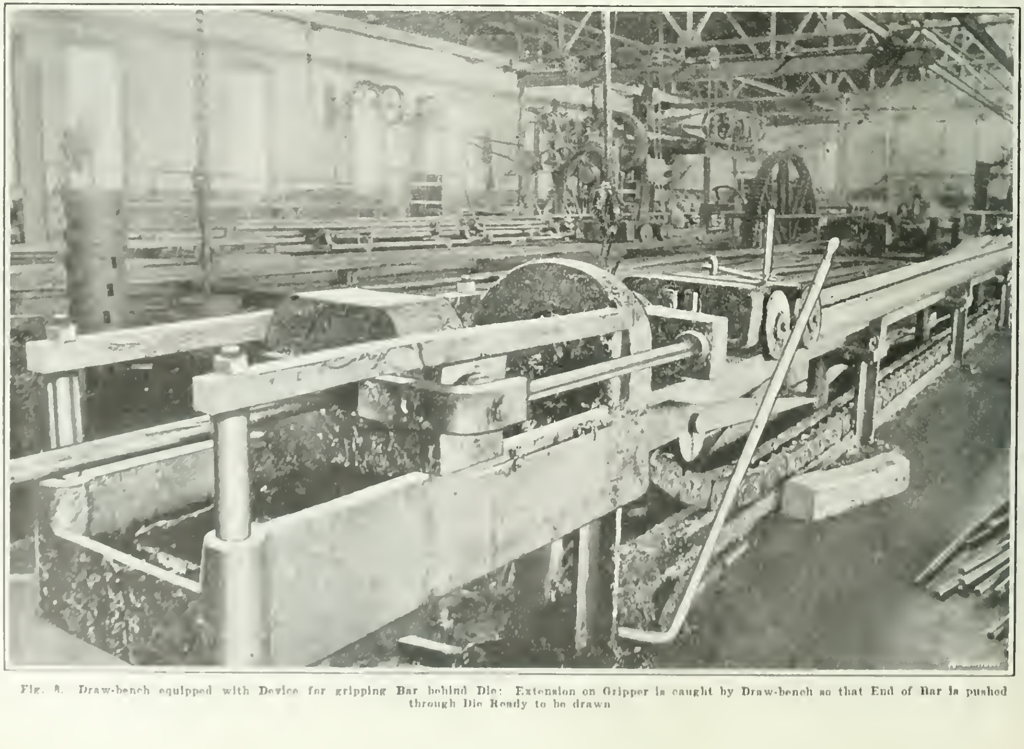


Fig. 8. Draw-bench equipped with Device for gripping Bar behind Die: Extension on Gripper is caught by Draw-bench so that End of Bar is pushed through Die Ready to be drawn

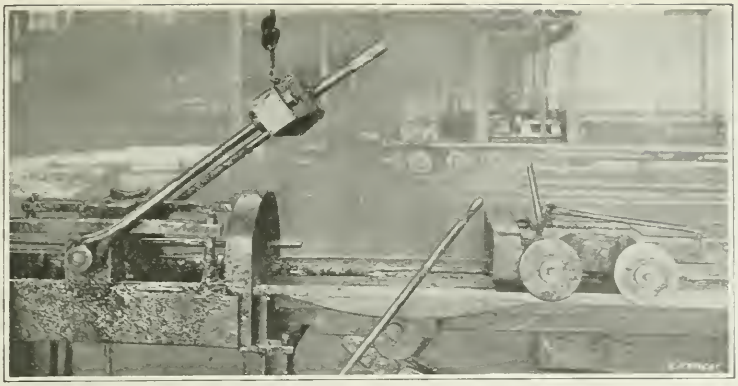


Fig. 9. View of Die from Front after End of Bar has been pushed through Die

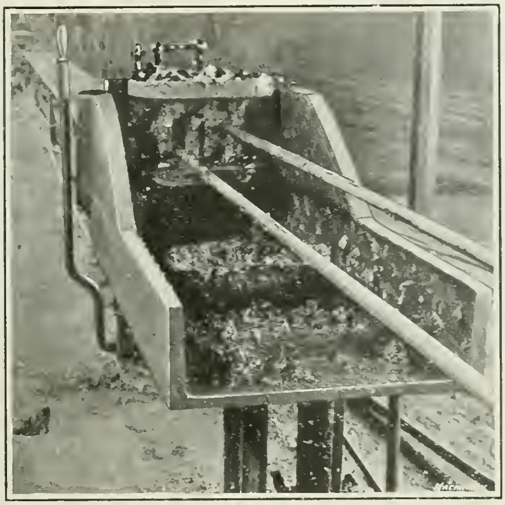


Fig. 10. View of Straight Draw-bench, showing Dies and Container for Supply of Lubricant

containing anywhere from 300 to 600 feet of rod, according to the diameter. This is the means of effecting a material saving in the cost of production, because the number of crop ends is materially reduced and the amount of metal going to the scrap pile is cut down to a minimum. In fact, this is the most important claim made for the bull-block machine, and at the present time many manufacturers are working on the idea that it may prove feasible ultimately to use coils containing as much as 1000 pounds of steel, so that scrap will be further reduced. The rate of production is also higher, because the time spent in setting up the machine is less where these long coils can be drawn at one continuous operation. Practice varies in different plants, but the general statement may be made that straight draw-benches are used for handling stock from 1/2 inch in diameter up, while bull-block machines are used for stock up to 1/2 inch. However, there are a number of cases in which bull-block machines have been successfully employed for drawing bars up to 7/8 inch diameter. Squares, rectangles, hexagons, octagons and other irregular shapes are being drawn on bull-blocks in addition to round stock.

Where the attempt is made to draw stock larger than 7/8 inch in diameter, trouble has sometimes been experienced through the tendency for the cross-section to be slightly distorted. For instance, in round stock the tendency is for the cross-section to become slightly elliptical. This is due to the fact that the material is being coiled on a comparatively small drum, and trouble of this kind is especially likely to happen when low-carbon steel is being drawn. Sometimes it has been found possible to compensate for this in the shape of the die or by employing special methods of straightening the stock. There is a wide difference of opinion, however, as regards the maximum diameter of stock that can be safely handled on rotary drawing machines. As previously stated, some manufacturers will not attempt to draw work over 1/2 inch, while others are successfully using machines of this type for drawing work up to round bars 7/8 inch in diameter.

Speeds at which Drawing is Done

The speed at which cold-drawn steel stock or shafting is pulled through the die varies considerably with the size of the stock being drawn. The larger the diameter, the lower must be the rate at which it is drawn through the die. Bull-blocks or draw-benches are not arranged to give a variable speed, but the gearing and diameter of the blocks on a bench may be varied, thereby accomplishing the same results. Most steel mills drive their blocks with electric motors, a motor driving from one or two blocks up to any number within the range of its pulling capacity. At present the most approved practice seems to find thirty-six as the maximum number of blocks that can be pulled by one motor, but it must be borne in mind that this applies to the drawing of relatively small wire. About six blocks per motor represents the average number for wire 3/8 inch in diameter. The actual drawing speed varies from 250 to 375 feet per minute, according to the diameter of the wire and the character of the steel being drawn.

The following represents the practice of the Pennsylvania Shafting Co., Spring City, Pa., in drawing steel shafting on straight draw-benches. On a bench handling four bars at once, ranging from 7/16 to 1 inch in diameter, the speed at which the steel is drawn through the dies is 16 feet per minute. For stock from 1 1/16 to 2 inches in diameter, drawing one bar at a time, the speed is 16 feet per minute. When drawing steel from 2 inches in diameter to 3 1/4 inches, with one bar drawn at a time, the speed is 8 feet per minute. So much for the speeds of drawing round bars. Let us now turn our attention to the drawing of flats. In the case of bars ranging in size from 1/4 by 5 to 1 by 5 inches, and hexagons of about the same cross-sectional area, the speed of drawing is 11 feet per minute. In drawing bars

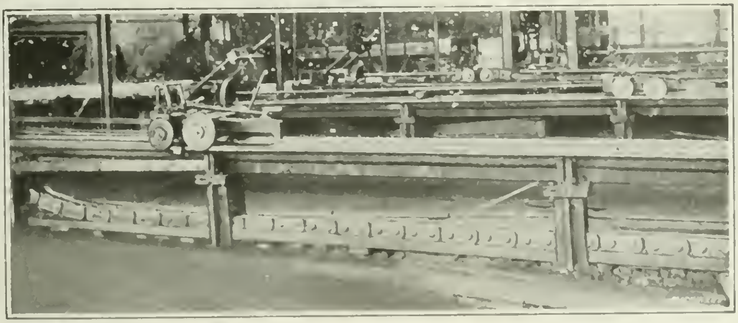


Fig. 11. Straight Draw-bench pulling Four Rods simultaneously

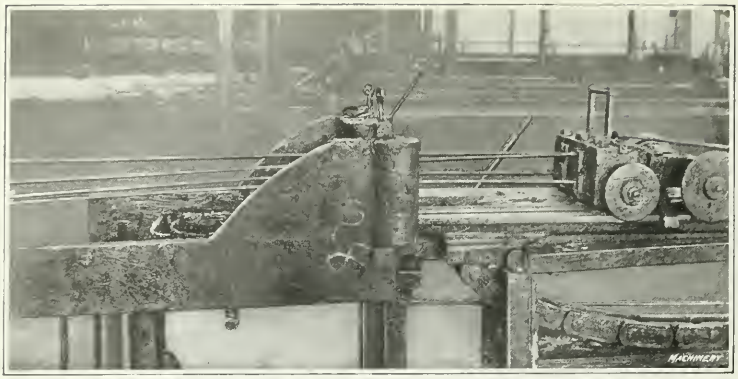


Fig. 12. Close View of Carriage and Die-head on Machine shown in Fig. 11

from 1/4 to 1 1/8 inch square or 1/2 by 1 3/4 inch flat, a drawing speed of 16 feet per minute will give satisfactory results. Reference has already been made to the amount of reduction per draw for different sizes of bars, but it will not be out of place to give some detailed information on this point at the present time. For bars up to 1/2 inch in diameter the amount of reduction at one draft is 1/32 inch; for bars from 9/16 to 3 inches in diameter the amount of reduction per draft is 1/16 inch; and for bars from 3 1/16 up to 6 inches in diameter the amount of reduction per draft is 1/8 inch. Bars over 3 inches in diameter can be most profitably finished by turning.

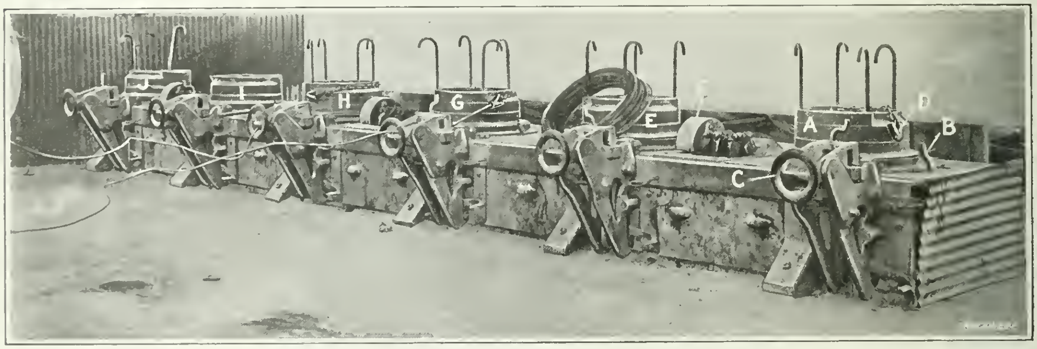


Fig. 13. Rotary Draw-bench built by Humphrey & Sons and installed at Youngstown Sheet & Tube Co.'s Plant. Attention is called to Safety Devices provided on this Equipment

Power Required for Cold-drawing Operation

The amount of power required to pull a bar through the die varies considerably according to the size of the material being drawn and the nature of the steel. A general idea of the amount of power required, however, will be obtained from the following figures: In drawing four bars 5/8 inch in diameter, it has been estimated that a pull of 45 tons is required. In another plant it has been estimated that for a single bar 1 1/4 inch in diameter, a pull of 7 tons is necessary. It is the practice to hot-roll the stock which is to be cold-drawn as close as possible to the size to which the steel is to be cold-drawn. The cold reduction can then be made in one draft, using comparatively little power. On the other hand, the heavier the draft the smoother and cleaner the surface of the cold-drawn steel; but extremely heavy drafts require more power, and in the case of alloy steels or steels containing a high percentage of carbon, such heavy drafts may disturb the structure of the steel and make it unsuitable for the desired use, although a superior finish is obtained.

Fig. 13 shows a rotary type of draw-bench built by Humphrey & Sons, Joliet, Ill., and installed in the plant of the Youngstown Sheet & Tube Co., Youngstown, Ohio. The capacity is for drawing steel up to 1/2 inch in diameter. Attention is called to the fact that the first block *A* at the right-hand end of the bench is not in operation, although it is in position to be threaded up ready to start work. Just at the right of this block and projecting up through the bench there is a lever *B* which is so arranged that if a man is caught by the wire between the die and the block while feeling the wire to see if the die is working properly, his body is drawn up on the bench and strikes this lever, which automatically stops the block rotating and prevents a serious accident. Accidents of this kind are by no means uncommon among wire mill operators, and unless means are provided for stopping the machines the accident is likely to be a severe one.

At the front of the die-stand or die-holder there will be seen a guard ring *C*, which is a further device to provide for the operator's safety. In case he is caught by the wire between the reel-stand which holds the coil of steel and the

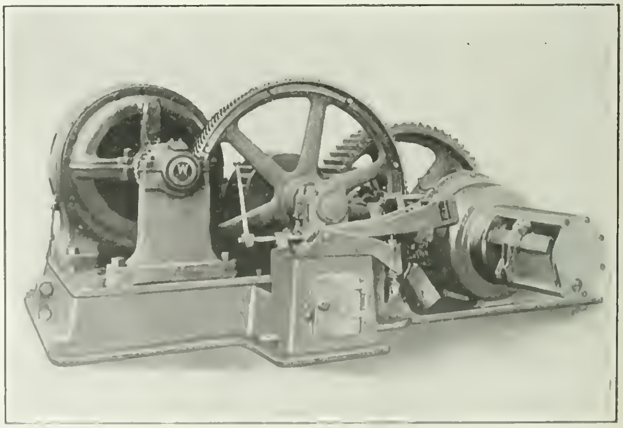


Fig. 14. Two-block Bull Frame built by Morgan Construction Co. for drawing Square, Hexagonal and Round Sections from 7/16 to 1 Inch in Size. This Machine is equipped with Westinghouse Motor

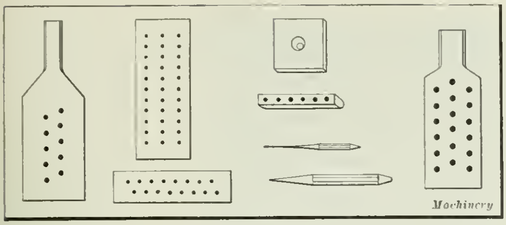


Fig. 15. Steel Die-plates for drawing Small Sizes of Wire and Screw Stock

die, his body is drawn up against this guard ring, which automatically operates an air valve that stops the bull-block from rotating. In designing these machines the effort has been made to employ safety features wherever possible, and the use of compressed air facilitates this. Where reliance is placed upon the man at the next block stopping a block after the operator has been caught by the wire, experience shows that in about ninety-nine cases out of a hundred he is too late to save the man from serious injuries. The blocks are not only air operated, but they are also furnished with individual friction drives which enable them to be stopped quickly and easily.

On top of block *A* at the right-hand side there will be seen what are known as "pullers" *D* hanging down at the side of the block. These are drawn forward with the right hand and attached to the point of the steel that projects through the die, after which the block is ready to be started rotating to draw the steel through the die and wind it up on block *A*.

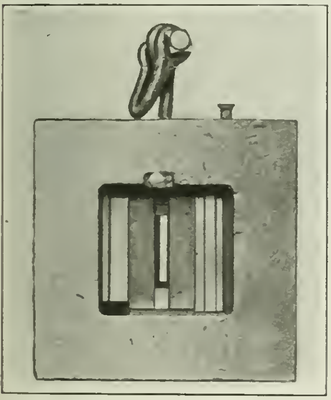


Fig. 16. "Turk's Head" or Combination Die

Between blocks *A* and *E* is a pointing machine *F*, which is used for pointing the end of a coil of steel so that it may be threaded through the die to be gripped by the pullers. This pointing machine is driven by a chain drive from the line-shaft and is of the continuous type, *i. e.*, the pointing rollers always run in the same direction instead of oscillating as they do in another type of machine for pointing stock. In the rollers there are cut grooves, the cross-section of which is gradually reduced so that as the wire is drawn through, its diameter is reduced sufficiently so that the point may be threaded through the die in the manner described.

One difference between the work done by continuous pointing rollers and rollers of the oscillating type is that with the continuous rollers a tapered point is produced, while with the oscillating type of pointer the end of the rod is merely reduced to a shoulder, which is likely to cause the point to break off instead of starting the wire through the die in the desired manner. With the tapered point it is much easier for the wire to be started through the die, and there is less strain on the die while starting to make a draft. Bull-block *E* is shown after the wire has been finally drawn through the die and the bundle has been partially stripped off the block. Block *G* has a wire threaded up through the die and the block is ready to start making the draft. Block *H* is shown engaged in the operation of drawing wire, and is partially covered with drawn wire. Blocks *I* and *J* are not shown in any special position.

After the drawing operation has been started the wire is gaged to see that it is true to size; and when the operator of the draw-bench is satisfied that this is the case, he starts the bull-block again and draws all the wire through the die. After the steel has been drawn through the die it is known as "wire," and it is ready for the market as soon as the pointed end has been cropped off and the bundle of wire has been gaged at both ends to see that the variation in size between the two ends is within the required limit of accuracy. In both cold-drawn shafting and cold-drawn wire this limit will not exceed 0.0005 inch if the work is properly done. Some variation is bound to exist due to wear of the die, and the amount of error will usually depend upon the quality of the die and the care with which the steel and die are lubricated during the drawing operation. Other factors that affect the degree of accuracy obtained are the amount of reduction required from the rod to the finished steel, quality of the steel, care taken in the pickling operation, and care taken in drying the stock after it has been immersed in the lime bath.

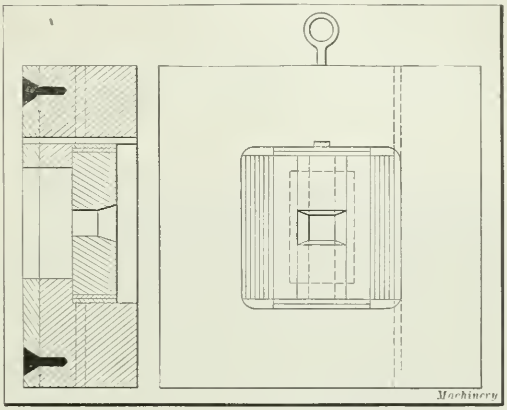


Fig. 17. Front and Cross-sectional Views of So-called "Turk's Head" or Combination Die

Types of Dies Used for Drawing Wire and Small Sizes of Screw Stock

There are two general classes of dies used for drawing screw stock. These are, first, the chilled cast-iron die, and, second, the so-called "steel die-plate." Cast-iron dies are made with one opening for drawing a specified size of steel, while in the die-plates there are a number of openings, which are used in succession until all have been worn over size. Although the method of drawing steel through these types of dies is the same, the practice in maintaining the dies in proper condition for use is quite different. In drawing steel through either type of die it will be obvious that friction gradually wears the die over size, and when the limit of over size for drawing a given diameter of steel has been reached, the methods of putting the two types of dies into condition for further use are quite different. In the case of a cast-iron die that has reached the limit of over size allowable, the

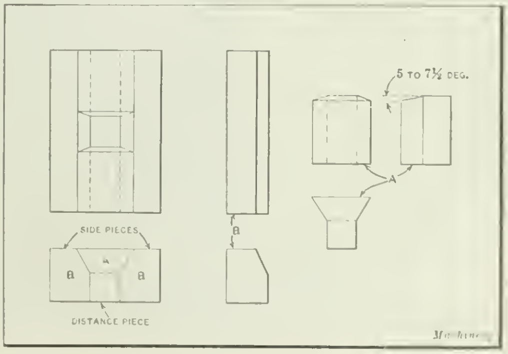


Fig. 18. Parts of Combination Die shown in Fig. 17

method of procedure is to remove the die from the draw-bench and ream out the hole to the minimum diameter allowable for drawing the next larger size of steel made in the mill where this die is used. The reaming operation is performed with a square tapered reamer, and a plug gage is used to ascertain whether the hole has been increased to the proper diameter for drawing the next larger size of steel.

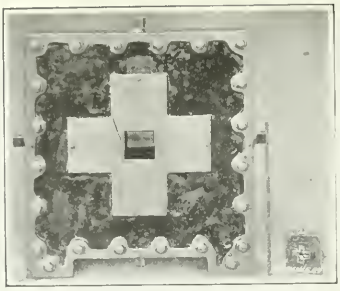


Fig. 19. Roller Die built by Standard Machinery Co. for drawing Square Bars

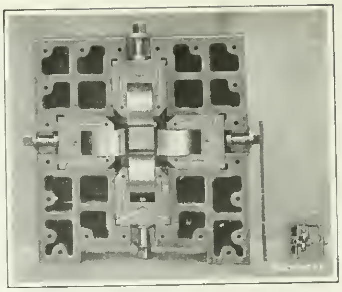


Fig. 20. Opposite Side of Roller Die shown in Fig. 19

With steel die-plates an entirely different procedure is followed. The die-plate is heated and hammered on the "leaving" or back side of the die, so that the steel is forced inward around the hole, reducing its diameter slightly more than the required amount. It then goes to a man known as a "plate setter" who uses a tapered punch which he hammers into the hole in the die while the metal is cold, thus compressing the steel around the hole and at the same time enlarging the hole to the minimum diameter which is allowed for drawing a given size of steel. From the preceding description it will be apparent that aside from the methods used for bringing the two types of dies into condition for subsequent use, there is another point of distinction, namely, that in the case of a cast-iron die the reaming operation converts this die to a size suitable for drawing the next larger diameter of steel, while in the case of the steel die-plate the hammering and punching operations simply bring all the holes in the die back into condition for drawing the same size of steel on which the die-plate was formerly engaged.

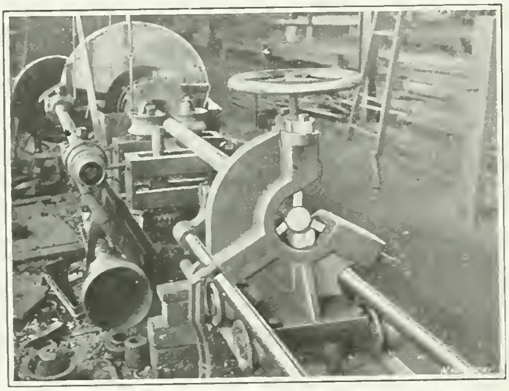


Fig. 21. Special Lathe used for turning Large Sizes of Shafting

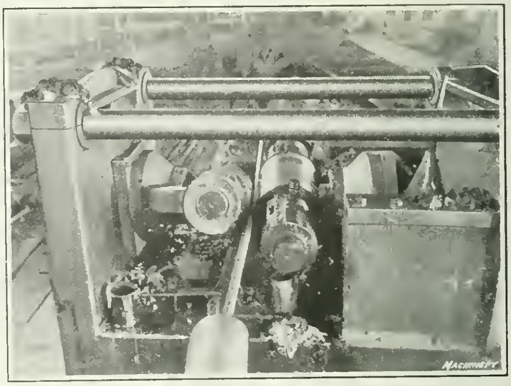


Fig. 22. Medart Shaft Straightening Machine in Operation

In making cast-iron dies the die opening is cast against a "chill," which results in the production of white cast iron, which is extremely hard and quite durable. Steel die-plates are sent to the steel mill with the holes in the condition known as "three-quarters pricked," which means that the holes extend only three-quarters of the way through the thickness of the die-plate. In preparing the plate for use, the holes must be pricked the rest of the way through, which is done by heating the plate and driving the punch through the remainder of the metal at the bottom of each hole. After this has been done the plate is reheated and hammered or battered around the back side of each hole—as previously explained in connection with the repairing of die-plates—after which the plate setter reduces the diameter of the holes to exactly the desired size by following the procedure described. Ten or fifteen years ago steel die-plates were used almost exclusively in this country for drawing steel wire and small sizes of screw stock, but at the present time cast-iron dies are more extensively employed for drawing round wire. For shapes other than rounds, *i. e.*, ovals, half rounds, squares, hexagons, etc., it is probable that steel die-plates will continue to be used because of the difficulty that would be experienced in maintaining cast-iron dies in suitable condition for operation. This is, of course, due to the fact that irregular shaped die openings cannot be reamed. In Europe and especially in English wire mills, steel die-plates are still generally used.

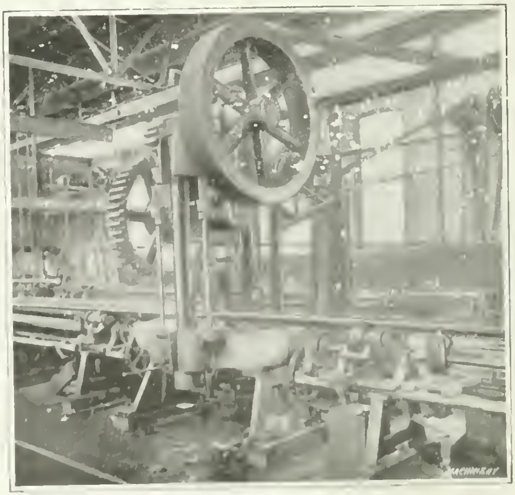


Fig. 23. Brightman Straightening Press for straightening Shafting turned on Machine shown in Fig. 21

Although steel plates can be used repeatedly for drawing wire of the same sized hole, while cast-iron plates have to be reamed out for a new size of wire each time they are used, the original cost of the steel plates and the labor expense involved in setting them back for drawing the same size wire are greatly in excess of the cost of the cast-iron die and labor charge involved in reaming it out to permit a larger size wire to be drawn. Chilled cast-iron dies and steel die-plates are usually made for drawing stock up to 1/2 inch in diameter; in some cases larger stock is drawn in these dies.

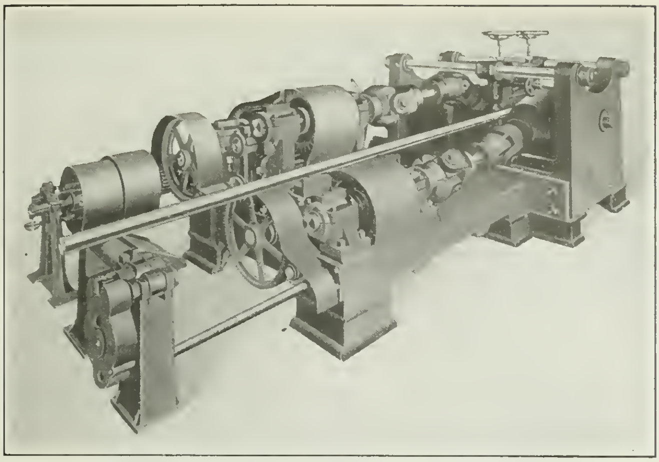


Fig. 24. Continuous Automatic Shaft Straightening Machine built by Medart Patent Pulley Co.

Dies for Drawing Shafting and Larger Sizes of Screw Stock

For drawing the larger sizes of screw stock and all sizes of shafting, there are several types of dies that are commonly employed. For drawing round stock the most commonly used die consists of a disk of high-speed steel — "Red Cut Superior" steel is one brand that gives satisfactory results—with a round opening which is bell-mouthed, tapering gradually down to a straight throat of the same diameter as that of the steel which it is desired to draw. For steel from 1 1/16 inch to 2 1/8 inches in diameter, the die-block is 6 inches in diameter by 1 1/2 inch thick; and for steel from 2 1/8 to 3 1/8 inches in diameter the die-block is 8 or 10 inches in diameter by 2 inches thick. For round stock the hole in the die is drilled and the required taper opening or "bell-mouth" is bored, after which the straight throat of the die is carefully reamed to size. Dies for drawing hexagon and octagon shaped bars are first drilled, after which the flat sides are worked out with a "punch bar" in the shaper, and then the die is finished to size by hand filing. The dies are heat-treated according to instructions given by makers of the particular class of steel from which they are made.

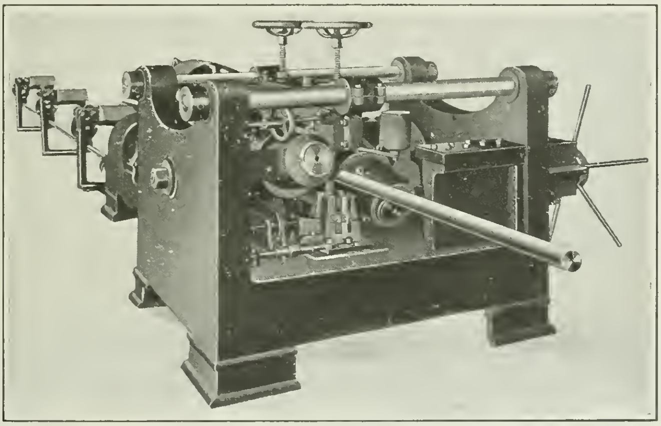


Fig. 25. Opposite Side of Medart Straightening Machine shown in Fig. 24

There are two types of drawing dies in general use which are known as the "hard" die and the "soft" die. As their names imply, the steel in these two types is hardened or left soft as the case may be, and each form has certain points in its favor. The hard die is made to exactly the required form and size, after which it is heated and quenched by passing a stream of cold water through the opening. This results in hardening the metal so that the die is able to draw from 500 to 1500 40-foot bars according to the nature of the steel in the bars and in the dies through which they are drawn. In soft dies, the steel is left in a soft condition and these dies have a capacity for drawing only 12 to 15 40-foot bars. At first sight, it would appear that this difference shows an overwhelming superiority in the hardened die, but this need not necessarily be the case, as the soft dies are easily put back into condition for further service. This is done by hammering the dies at the "leaving" side, which results in causing the metal to flow in and reduce the diameter of the opening, after which the hole is reamed out to exactly the required size. This work can be done with great rapidity.

In the case of the hard die it is necessary to heat it above the critical temperature and then pass a stream of cold water through the opening, which causes it to shrink sufficiently to reduce the diameter of the hole beyond the required size, after which the die is lapped out to secure the correct diameter. This is necessarily a slow and costly operation, so that, although the hard die has a far greater capacity as regards its productive life, the cost of putting it back into condition after it is worn out is much greater than in the case of the soft die. In connection with the method of reducing the hard die to size after it has been worn, it must be borne in mind that the shrinkage of the metal around the hole at the time the steel is quenched results in drawing in the plastic steel sufficiently, and as the amount of wear in any case will not exceed 0.001 inch the results obtained in this way are highly satisfactory.

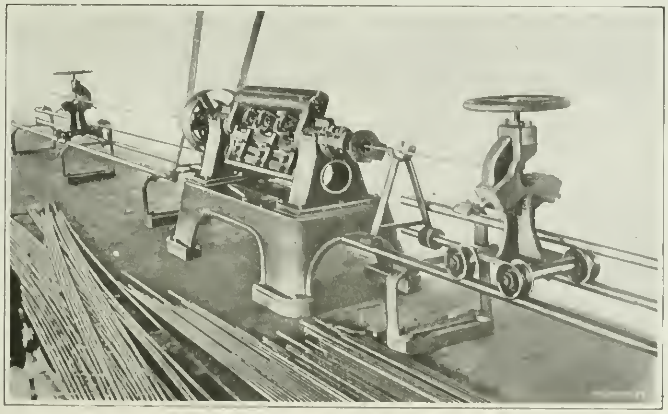


Fig. 26. Rotary Type of Shaft Straightening Machine built by Brightman Mfg. Co.

Dies for Drawing Squares, Rectangles and Other Irregular Shapes

Different methods must be followed in designing dies for drawing irregular shaped bars from those used in making dies for round stock. This necessity arises from the fact that trouble would be experienced in maintaining solid dies of these shapes in the required condition. Some dies for drawing squares, hexagons and octagons are made from solid blocks, but it is probably better practice to use either a die of the type known as a "Turk's head" or one ot the special dies constructed with rollers that engage the stock to be drawn. Figs. 16, 17 and 18 show the Turk's head type of die, and Figs. 19 and 20 show one of the rolling mill type of dies.

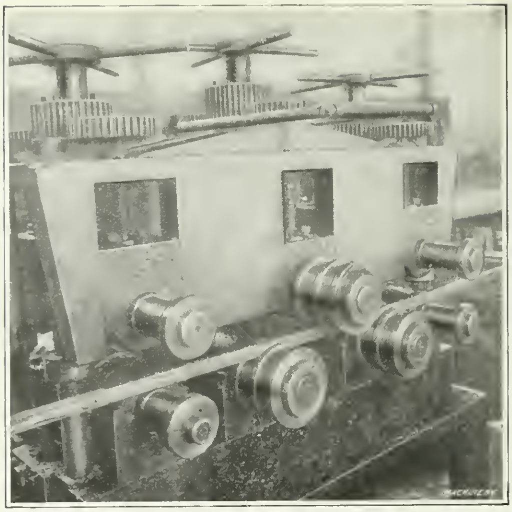


Fig. 27. Machine for straightening Square, Hexagonal, Octagonal and Flat Bars

It will be seen that the Turk's head die (Fig. 18) has a steel frame in which are supported two pieces *A*, known as "distance pieces," and two side pieces *B*, these four parts being securely wedged in place in the frame, so that the die opening is kept exactly the desired size. Compensation for wear of the die is made by adjusting the position of the side pieces and distance pieces with wedges in the die frame. From the detail views of the distance pieces and side pieces it will be seen that these parts are fitted together in such a way that the pressure applied in drawing the steel through the die cannot result in pulling either of the die members out of place. The die opening is arranged with a bell-mouth tapered from 5 to 7 1/2 degrees according to the hardness of the stock to be drawn. In addition to making dies of this type for drawing squares and rectangles, the same type of die may be employed for drawing bars with straight sides and semicircular sections at the top and bottom. For drawing hexagons and octagons, sectional dies of this type are made with the sections adjusted radially by means of screws.

In Figs. 19 and 20 are shown front and rear views of one of the rolling mill dies made by the Standard Machinery Co. of Auburn, R. I. This particular die is for drawing square-shaped stock, and it will be apparent that four hardened steel rollers are arranged to bear against the four sides of the stock and reduce it to the required diameter. Obviously the form of the rollers provides a die opening corresponding to the bell-mouth of either a solid or a "Turk's" head die. The opening in the die can be adjusted to any size within its limits without changing the rolls, by simply turning the square-headed screws provided for that purpose. These screws are furnished with graduated dials to facilitate setting.

Lubricants Used on Drawing Dies

Lubrication of the steel and drawing dies is a matter of the utmost importance. If even a small area of steel is drawn into the die without being properly coated with lubricant, it will "seize" and do much damage through scoring the surface of the die opening. A variety of different lubricants are used on drawing dies, and each manufacturer of cold-drawn screw stock and shafting has certain lubricants of which he speaks in high terms. At the plant of the Pennsylvania Shafting Co. two different mixtures are used for lubricating the dies. One of these is compounded from tallow, heavy machine oil

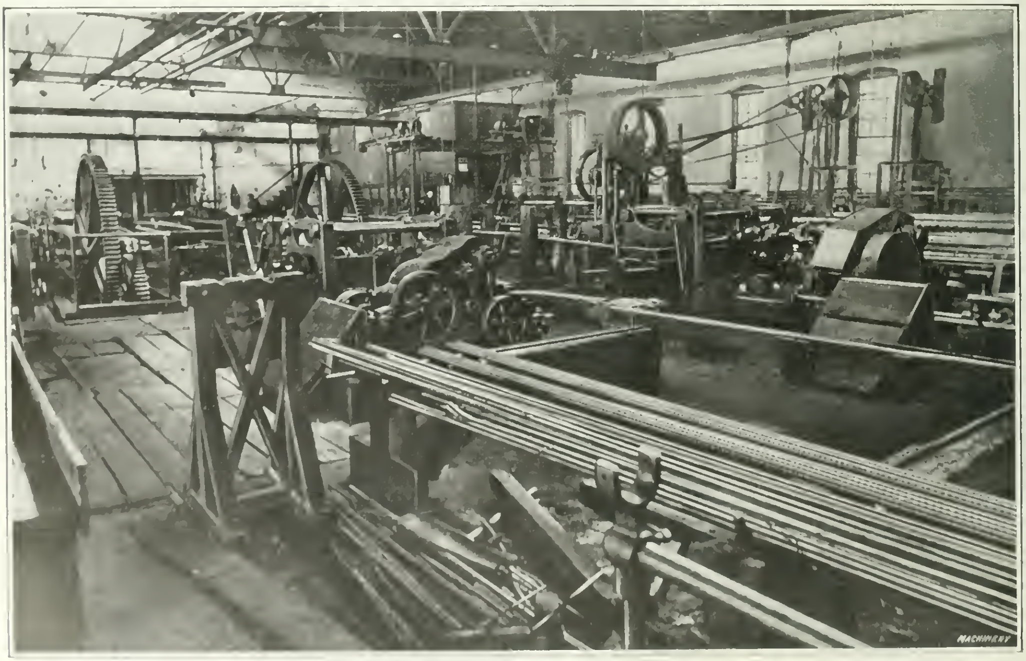


Fig. 28. General View in Mill of Pennsylvania Shafting Co., showing Part of Department in which Round Shafting is drawn

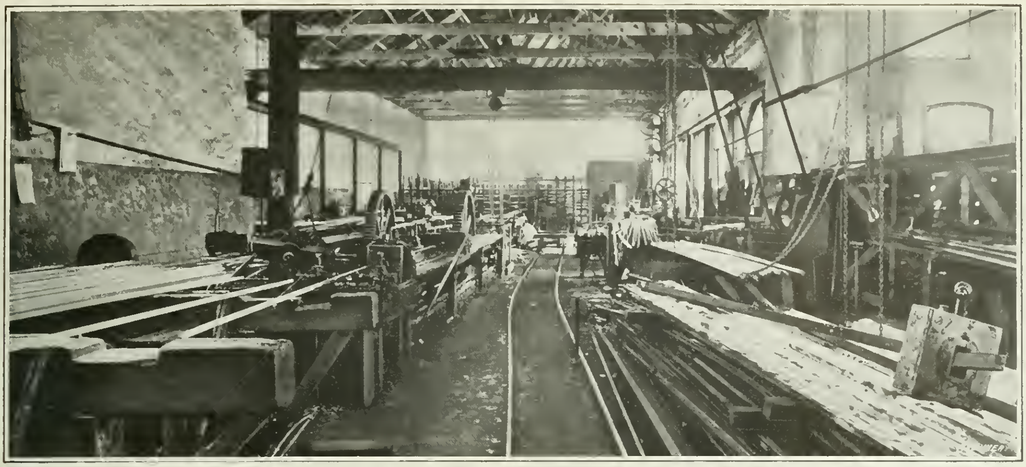


Fig. 29. General View in Mill of Pennsylvania Shafting Co., showing Department in which Square, Hexagonal, Octagonal and Flat Bars are drawn

and soap powder. These constituents are mixed in such proportions that when heated and thoroughly stirred together the resulting lubricant will be of such consistency that it can be easily rubbed onto the bars by hand as they are being drawn through the die. The other standard lubricant used by this firm is made of a mixture of cup grease, heavy machine oil and soap powder. As in the preceding case this mixture is heated and thoroughly stirred, and should be of suitable consistency to be easily rubbed onto the work.

Liquid lubricants are also used in some wire mills. An advantage resulting from their use is that means are devised for applying the lubricant to the steel bars and dies through which they are being drawn without requiring the workmen to apply grease by hand. One way is to take a large bundle of waste and soak it thoroughly in oil, after which the waste is wrapped around the steel bar and allowed to be drawn up against the die. In this way the waste is held in place against the "entering" side of the die and keeps the bar thoroughly lubricated as it is being drawn through. The selection of the proper type of lubricant is probably largely a matter of individual opinion, and the results obtained vary with the care that is taken in applying the lubricant to the work and die. Care in its application will probably have a greater effect upon the cost of lubricant used and the efficiency with which it operates than the selection of any particular type of oil or grease.

Production of Turned Shafting

It is general practice in the production of shafting to turn bars from three inches in diameter up to the largest size instead of obtaining the desired finish by the cold-drawing process. In Fig. 21 is shown a special lathe used for this purpose. It will be seen that this consists of two rotary cutter-heads, which perform rough- and finish-turning operations on the shafting. Feed is secured by means of rollers which are clamped against the work by adjusting screws. These rollers are geared to the lathe and their rotation results in feeding the shafting through the cutter-heads. As bars from thirty to forty feet in length are frequently turned on machines of this type, it is necessary to provide means for supporting the ends of the work. Such means are furnished by carriages at each side of the central part of the machine that carries the cutter-heads; these carriages run on tracks and the ends of the steel shafting are supported by them. The carriages are not geared to the machine; they simply run along the tracks as the shafting is fed through the cutter-heads, and provide the required support so that the shafting is not unduly distorted. After being turned, the shafting is straightened on the so-called "flyer" type of straightening machine shown in Fig. 26, which imparts a burnished finish to the steel in addition to straightening it ready for use. The extreme end of bars straightened in this type of machine is bent out of true alignment, and this is corrected on a punch press with a three-point support for the work, as shown in Fig. 23.

Some steel mills report that there is a decided increase in the demand for turned shafting for classes of service where cold-drawn shafting was formerly employed. Several reasons are advanced for this preference. For one thing, it is claimed that during the process of hot-rolling steel bars that are later to be cold-drawn, there is a tendency for the bars to be decarbonized at the surface. Where the cold-drawing process is employed, the scale is removed by pickling and the bars are then cold-drawn, with the result that this decarbonized surface of the steel is not removed and results in leaving a somewhat softer metal at the surface of the shafting, which is likely to cause it to wear quite rapidly. When shafting is turned, it will be obvious that this decarbonized metal is removed from the surface so that trouble of this kind cannot result. Some users of shafting also claim that during the process of cold-drawing the structure of the steel is disturbed and there are likely to be undue strains set up, which may result in trouble from breaking of the shafting. The same cause may result in trouble from automatic screw machine products made from cold-drawn screw stock, one reason being that where some sections of the stock are left the full diameter and others are turned, the internal strains may result in a tendency to spring the work out of shape. These theoretical considerations are quite interesting, although attention must be directed to the fact that they are theories and not certainties. There is a great diversity of opinion regarding the relative merits of cold-drawn and turned shafting, and many advocates of cold-drawn shafting are prepared to claim that it is a far superior product to that produced by turning.

Straightening and Cutting Up

The practice followed in straightening cold-drawn bars naturally differs according to the diameter of the bar and whether it was drawn in a straight draw-bench or a bull-block machine. In the case of shafting and bars drawn on the straight bench, the bars are passed through a straightening machine, which consists of a rotary cradle that supports staggered rolls. While the shafting is being drawn through the cradle, the latter rotates around the work, with the result that it is left in a perfectly straight condition. The rollers also impart a fairly high polish to the steel drawn through them. In the case of long coils of metal that have been drawn on a bull-block, a similar form of straightening machine is used, but, in addition, provision is made for cutting the work into pieces of standard length. For this purpose the bar is drawn through the rolls carried in the rotary cradle, and when the end has been drawn through the required distance it comes into contact with the trip or trigger on the machine, which results in actuating a shear blade that cuts off a piece of standard length. The position of this trigger may be adjusted to provide for cutting off bars of any required length, which may be as short as two or three inches or up to practically any desired length.

Another type of machine for straightening round bars, which has been found to give very satisfactory results, is the Medart straightener built by the Medart Patent Pulley Co. of St. Louis, Mo., shown in Figs. 24 and 25. This machine has only two rollers, one of which is a straight cylinder and the other slightly concave. It will be seen that these rollers are set with their axes at a slight angle to each other and that the rollers are driven in opposite directions by means of universal joints and shafts. One end of the bar to be straightened is inserted between the rollers, and the angular position of the rollers, combined with the fact that they rotate in opposite directions, results in drawing the bar through the machine at a rate of from twenty to thirty feet per minute. A little thought will make it apparent that the action of rolling a bar between the straight and concave rollers effects practically the same result as drawing the bar through a set of staggered rollers on the type of straightening machine to which reference has just been made. The Medart straightener is adapted for handling bars up to three inches in diameter, and one feature claimed for it is that a particularly high polish is produced.

For straightening square, rectangular, hexagonal and octagonal bars, it will be obvious that a different type of straightening machine must be employed from those that have been described. The type of machine used for this purpose is shown in Fig. 27. It consists of two sets of five pairs of staggered rollers, those for straightening the bars sidewise being located between the housings of the machine, while the rollers for straightening the bars edgewise are located outside the right-hand housing, as shown in the illustration. Work is passed through the machine at a rate of about twenty-five feet per minute. The bars are given two passes through these rollers for each pair of opposite sides of the bar, *i. e.*, a square bar receives a total of four passes, while an octagon shaped bar requires eight passes to completely straighten it.

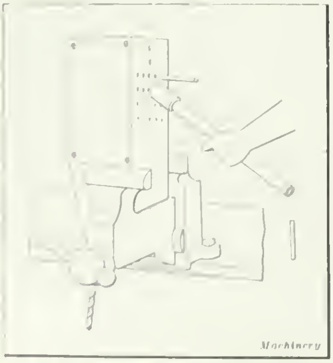
Packing and Shipping

After being straightened and polished, the steel is usually wrapped in wax paper and then in burlap, so that adequate protection is provided against rusting in transit. As one of the important advantages obtained by the cold-drawing process is that the steel is given a bright finish, it would be the height of folly to ship the metal in any way which did not afford adequate protection against oxidation. In some cases the burlap bundles of steel are packed in wooden boxes so that they are held straight, thus assuring delivery to the purchaser in the best possible condition.

* * *

AN EFFICIENT DRILL BREAKER

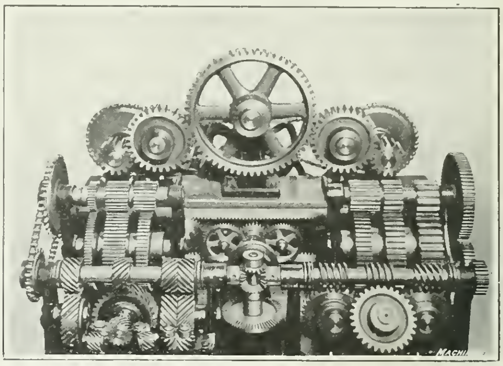
Separating the high-speed part of drills from the shank or machine steel portion is a profitable practice, for high-speed steel can be sold as scrap now at a very good price provided it is not mixed with other grades. The illustration shows a method used in the Ford plant for breaking off the drill ends that is both efficient and safe. The hard part of the drill is inserted in the holes as shown and a section of pipe is placed over the projecting shank. A slight pressure serves to break the two sections apart, the shank slipping down the handle while the other part falls into a box below the vise.



Device for separating High-speed Steel Part of Drill from Shank

STOCK GEAR EXHIBITION MACHINE

The Boston Gear Works, Norfolk Downs, Boston, Mass., have on display at the store of Patterson, Gottfried & Hunter, Inc., New York City, an exhibition machine made entirely of stock gears. It includes an assembly of sixty-three spur, bevel, spiral and worm gears driven by a 1/30-horsepower motor, the driving pulley being 3/4 inch in diameter, which shows that friction is comparatively negligible. A special feature is two right- and left-hand spiral gears, placed on the same shaft, driving two spirals that mesh with gears whose axes are placed at right angles; these gears, in turn, mesh with each other, thus forming a complete cycle.



Machine of Stock Gears made by Boston Gear Works

* * *

PITCH, LEAD AND THREADS PER INCH

While the terms "pitch," "lead" and "number of threads per inch" as applied to screw threads are defined in nearly every machine shop handbook and text-book on shop practice, there are apparently many mechanics who do not clearly understand the distinction between the three terms. In nearly every manuscript relating to thread gages and screw threads submitted for publication, these terms are incorrectly used. The distinction between "pitch" and "lead" seems to be fairly well understood, the "pitch" being the distance from the center of one thread to the center of the adjacent thread, while the "lead" is the distance that a nut will advance on the screw if turned around one complete revolution. In single-threaded screws, of course, the pitch and lead are equal, but in multiple-threaded screws the lead is a multiple of the pitch.

The most common error, however, is that of confusing "pitch" with "number of threads per inch." If a screw has eight threads per inch, the pitch is 1/8 inch, and while the expression "8 pitch" is frequently used in the shop, it is erroneous and has become sanctioned only because mechanical writers have repeatedly made use of this faulty expression. The proper mechanical definition of pitch, according to Webster, is "distance apart of two things, especially consecutive ones in an equidistant series." To apply the term to the number of threads in a unit length is erroneous according to this definition, even though common usage and mechanical writers in general have so often misapplied the term.

The necessity for calling attention to the distinction between "pitch" and "number of threads per inch" is obvious when we consider that in formulas involving the pitch it is required to multiply by the pitch, when we divide by the number of threads per inch, and if the term "pitch" is not properly understood, a serious error would be made in the application of formulas that contain this term. As an example, a case may be referred to where a trained engineer recently changed the multiplication sign in a formula containing the term pitch to a division sign, simply because he confused the terms "pitch" and "number of threads per inch." Hence these two facts should be kept constantly in mind: Pitch is the distance in inches from thread to thread. It is always the reciprocal of the number of threads per inch—that is, if the number of threads per inch is sixteen, the pitch is 1/16 inch; if it is twelve, the pitch is 1/12 inch.

ON TESTING MATERIALS

NOTES ON THE INTERPRETATION OF RESULTS OBTAINED FROM VARIOUS TESTS

BY WILLIAM KNIGHT[1]

THE object of this article is to describe in a general way different methods of testing materials and to call attention to a few considerations bearing upon the correct interpretation of the results obtained from tests. Of all tests, that most generally adopted is the tensile test, which allows one to plot a stress-strain diagram from which the strength, elasticity and ductility of a given material can be determined. The usual criteria of the ductility of a metal are the percentage of elongation and the contraction of the cross-sectional area in a test-piece fractured by tension. Of the two, probably the percentage of elongation is the better; smaller elongation is sometimes accompanied by greater constriction of area. The per cent elongation of a test-piece originally L inches long, and L_1 inches long after fracture has taken place, is given by the following equation:

$$100 \times \frac{L_1 - L}{L} = \text{per cent elongation}$$

In stating that a given material has a certain per cent elongation, the original length of the test-piece must always be stated. The dimensions of the section of the test-piece will also influence the per cent elongation, because the local contraction of the section at points adjacent to the point where fracture occurs will extend over a longer portion of a test-piece of larger section than it will in a test-piece of smaller section, thus adding more to the per cent elongation of the thicker test-piece. From what has been said, it is evident that the adoption of an international standard for both length and section of test-pieces would be highly desirable in comparing results of tests of the same material. The German practice is to use test-pieces geometrically similar, and this is obtained by keeping the gage length of the test-pieces in constant relation to the area of the cross-section:

$$\frac{\text{Length}}{\sqrt{\text{Cross-section}}} = 11.3$$

A test-piece 8 inches long and 0.5 square inch section will meet the above specifications. This practice, however, has not been followed either in England or the United States, on account of the increase in cost of preparing the test-pieces. The British practice is to use a gage length of 8 or 10 inches, irrespective of the area of the section. The total elongation E of a test-piece of section A and length L is made up of an amount taking place all over the gaged length (and consequently proportional to it) and another amount taking place locally at the point of fracture, and proportional to the square root of the cross-section. Professor Unwin shows that for the same quality of metal the following relation exists:

$$\text{Per cent elongation} = 100\left(\frac{C\sqrt{A}}{L} + B\right)$$

For any value of A and L, C and B are two constants, and may be easily determined for a metal of a given quality by measuring the elongations of two test-pieces of any dimensions, finding the per cent elongation for both, and substituting the values in the above formula. Two simple equations will be obtained with two unknowns C and B, from which the values of C and B can be easily obtained. After calculating C and B for any particular grade of a given metal (and it is better to average the values obtained from more than two test-pieces), the per cent elongation of any other test-piece of the same material, for any value of A and L, can be predicted by substituting the calculated constants and the known dimensions of the test-piece in the preceding formula. The per cent contraction of the section, reckoned on the original area, in a test-piece of perfectly plastic material (a uniform contraction taking place all over the length), provided that the volume before and after breaking does not change, is equal to the per cent elongation reckoned on the final length at the time of measurement.

When, instead, the material does not draw uniformly throughout the length, and at the point where fracture takes place presents a neck, the per cent reduction in section at that point is greater, and this will be taken as a criterion of the maximum possible reduction in section of the material tested. When testing a material, the intensity of the stress corresponding to a given elongation of the test-piece is generally reckoned on the original area of the section. Actually, however, the intensity of the stress in the test-piece is greater than the nominal value obtained by dividing the load applied by the original area of the cross-section. This is due to the reduction of area taking place in a ductile material stressed in tension. We have seen before that, if the density of the material of the test-piece does not change during the test, the volume before and after breaking does not change. Calling L and L_1 the gaged length before and after breaking, and A and A_1 the area of the cross-section before and after breaking, we have:

$$L_1 A_1 = LA$$

from which:

$$\frac{L_1}{L} = \frac{A}{A_1}$$

This ratio of the intensity of the actual stress and the nominal stress can be expressed (calling P the applied load):

$$\frac{P \div A_1}{P \div A} = \frac{A}{A_1}$$

Hence we have:

$$\frac{\text{Intensity of actual stress}}{\text{Intensity of nominal stress}} = \frac{A}{A_1} = \frac{L_1}{L}$$

Knowing $L_1 = L +$ elongation, as obtained from test for a given load P producing a nominal stress $\frac{P}{A}$, it is easy to obtain the actual stress $= \frac{L_1}{L} \times \frac{P}{A}$. In this way it is possible to find the intensity of the actual stress in a test-piece when the reduction of area takes place nearly uniformly throughout the gaged length. When contraction begins to be prominent at one spot (where fracture finally occurs), the relation $\frac{L_1}{L} = \frac{A}{A_1}$ is not true any more, and the actual stress cannot be obtained from L and L_1 and $\frac{P}{A}$. Actual measurement of A_1 will be necessary in order to find $\frac{P}{A_1}$. We have pointed out before the influence on the per cent elongation of varying the section of the gaged length of a test-piece, and the desirability of keeping the length and the section of different test-pieces in a constant relation, in order to be able to compare the results of different tests. It remains to state the effect of reducing the length of the gaged length which is of a smaller section in the middle than at the ends of the test-piece.

A test-piece of a ductile material with a reduced section extending over a short portion, with two enlarged sections at the ends, will show in test a reduction in section and an elongation smaller than the reduction in section and the elongation measured over the same length at the center of a test-piece with a reduced section extending over a longer portion of the total length. The yield point stress and the ultimate strength, reckoned on the original area of the section, will be higher in the short test-piece than in the longer one. This is probably due to the fact that in a ductile material failure occurs by slippage along planes of shear at 45 degrees with the direction of the pull, and in a short test-piece, the proximity of the section where breakage occurs to the larger sections at the ends will offer a larger sectional area resisting shear in a short test-piece than in a longer one, where the section of breakage is far from the enlarged ends of the test-piece. In order to avoid misleading results of tests, due to the influence of the enlarged sections at the ends, the length of the reduced section in the middle should not be less than nine times the diameter, and the gaged length at least eight times.

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Sharp angles and abrupt changes of sections in test-pieces must be carefully avoided, their influence being to lower the nominal ultimate strength of the test-piece. This is particularly true for brittle materials like cast iron and hard steel. Tensile tests are the most common and the most practical tests to which metals are ordinarily submitted in order to gain some knowledge of their physical properties. Other mechanical tests—compressive, shearing, bending, torsional—either applied gradually or suddenly, and work-shop tests—bending double, bending single, hammering down, punching, etc.—are sometimes used for measuring the resistance of materials to various forms of stress. Tensile tests, however, are the ones that yield the most useful information regarding the behavior of metals. The necessity of using for tests of this nature accurate and very costly machines, of taking rather large test-pieces from the materials to be tested, of subjecting these test-pieces to most careful and therefore somewhat expensive preliminary treatment, and of entrusting the tests themselves to an expert staff, renders the expense and the time required for such tests relatively large.

Many inventors have sought to supersede them by more rapid and cheaper methods, even at the expense of sacrificing some degree of accuracy. Among such methods may be mentioned the hardness test. In 1900 Brinell suggested the use of a very hard steel ball pressed against a surface of the metal to be tested, and measuring the area of the depression produced on that surface. If a ball of constant diameter is used (generally 10 millimeters), and a constant pressure is applied (generally 3000 kilograms for iron and steel), the hardness of different specimens of the same material tested will be inversely proportional to the surface of the depression produced. The ratio $\frac{\text{pressure}}{\text{surface of depression}}$ is called the "coefficient of hardness," or "hardness number." By comparing the results of numerous tensile tests on steel with the hardness numbers obtained from the test-pieces used, Brinell concluded that a definite relation exists between the ultimate strength and the hardness number, and that, by multiplying the hardness number by various coefficients, according to the grade of steel tested, and according to the impression made in the direction of rolling or across the grain, in case of rolled materials, the ultimate strength could be predicted very closely.

The importance of this process is readily understood, and the possibility of making a Brinell test on finished parts without injuring them offers a decided advantage over the tensile test, if only the ultimate strength of the material is to be investigated. Unfortunately, other experimenters, such as Mr. Breuil, have found that this method may result in erroneous results. At the Copenhagen Congress of the International Society for Testing Materials, Mr. Ludwik, of Vienna, who had been deputed to report on hardness tests, concluded, on the evidence of all the previously published data, that no simple relation existed between the elastic limit, the breaking stress and the hardness number, but that this did not exclude the possibility of deducting the elastic limit and the ultimate stress from hardness tests, by means of certain empirical coefficients. By determining the coefficient for each group of sufficiently similar materials, a fairly satisfactory approximation can be arrived at. Mr. Ludwik further notes that for a metal that displays constriction, the breaking strain does not yield an exact idea of the specific strength. The Copenhagen Congress came to no decision as to ball tests.

Other methods less frequently employed, but by no means devoid of interest, are frequently used instead of the Brinell method. We may specifically refer to the scleroscope method described by Shore and Breuil, which consists in measuring the height to which a steel ball, falling through a given distance onto the surface of the metal tested, rebounds; and Martel's method, which consists in measuring the volume of the impression produced by a pyramidal point falling from a certain height; and, finally, the sclerometers, which measure the depth of a scratch produced by a steel point loaded with a predetermined weight. Of all tests, however, the most conclusive for obtaining accurate data on the strength of a structure is that which consists in subjecting the structure itself to the maximum effort that it is designed to withstand, or even to a greater one, insuring in this way a factor of safety in the construction. Several methods have been devised for measuring the deformation of structures when subjected to a given load, and reference should be made to those of James Howard, which have been adopted by the Bureau of Standards in Washington and were made in September, 1912. Mr. Howard's apparatus consists of telescopic calipers, furnished with points beveled to an angle of 55 degrees, which can fit into cavities tapering at an angle of 65 degrees in the pieces undergoing test. Mr. Howard has used this apparatus to investigate the deformation and stresses in the elements of bridges, flood-gates, skyscrapers, steam boilers, etc.

Before concluding these notes on different methods of testing materials, it is well to mention the thermal methods of measuring stresses which in the last few years have attracted the attention of many experimenters. The determination of the elastic limit by means of a thermo-couple has been undertaken by several investigators. Magnus was the first one to point out that changes in stresses were accompanied by slight changes of temperature. Below the elastic limit a metallic bar absorbs heat when subject to tension, while above the elastic limit, due to friction of the particles gliding over each other, heat is generated in the bar. It has been stated that the thermal limit of proportionality is slightly lower than the true elastic limit and that below the thermal limit the variation of the temperature is directly proportional to the effort. Lord Kelvin was the first one to deduce the following connection between the change of temperature and the change of stress:

$$\delta T = -\frac{TA}{JSD} \times \delta P$$

where δT = change in temperature corresponding to change of stress;
δP = change of stress;
T = absolute temperature of specimen;
A = coefficient of expansion by heat;
J = Jule's equivalent;
S = specific heat of material under constant pressure;
D = density of material.

In the case of steel, taking the density as 7.5, the specific heat as 0.11 and $A = 1.2 \times 10^{-5}$ we have:

$$\delta T = 0.000012\delta P$$

The following will better illustrate the application of the above formula:

Stress in Pounds per Square Inch	Temp., Deg. C., Tension	Temp., Deg. C., Compression
0	20.00	20.00
10,000	19.88	20.12
20,000	19.76	20.24
30,000	19.64	20.36

It will be noted that during compression, up to the elastic limit, the phenomenon is the reverse of that observed when the material is subject to tension; instead of a drop in temperature, an increase in temperature of an equal amount is observed. Kelvin's law was tested by Jule and was found to be true for a considerable number of materials. Prof. Coker also made a number of verifications of the above law, and an interesting feature of his experiments was that he did not find any variation of temperature in specimens subject to shearing stresses. On the other hand, if a specimen was simultaneously subjected to two tensions at right angles to each other, the temperature change was found to be the sum of that due to each one acting separately. When we consider that every shearing force can be replaced by a tension and a compression, we can easily explain the reason why no indication of shearing stress can be obtained by the use of thermal methods. The maximum shear theory will explain the results of experiments made on a specimen subjected to two tensions at right angles.

With the object of applying the phenomenon of temperature changes produced by variation of stresses as a method of determining the elastic limit of small and other samples which do not permit of the application of the ordinary methods, J. R. Lawson and J. A. Copp (see *Revue de Métallurgie*, January, 1913) have tested several steels, cast iron and various copper alloys. Tests were made in an ordinary tensile testing machine, the stretch being observed by an extensometer and the temperature variation measured by means of a copper-constantan couple, pressed into contact with the specimen by a rubber band and connected to a sensitive galvanometer. Examination of the large number of curves reproduced shows that in every case there is a discontinuity in the temperature curve in the region of the yield point, but that, generally speaking, the thermal limit is somewhat higher than the true yield point. Below the yield point some of the thermal curves are inexplicably irregular, but in no case are they represented by straight lines.

* * *

SIMPLE RELIEVING ATTACHMENT

All manufacturers know that a good lathe equipped for relieving the teeth of milling cutters, hobs, taps, etc., is an expensive tool, and unless the amount of work to be done is sufficient to yield a fair return on the investment, it would not be wise to buy an equipment of this type. In the shops of the T. C. M. Mfg. Co., Hunterton and First Sts., Harrison, N. J., the need arose for a machine for backing off the teeth of thread milling cutters. Only a moderate amount of such work had to be done, and before investing in a new relieving lathe it was decided to attempt to build an attachment for one of the machines in the shop. A very simple type of equipment was designed, and it has given such satisfactory results that the idea of purchasing a regular relieving lathe has been given up.

Fig. 1 shows the head end of a lathe equipped with this attachment, and a close view of the mechanism is shown in Fig. 2. The cutter to be relieved is mounted on centers in the usual way, and the cross-feed mechanism is disengaged from the slide so that the latter is free to be moved by a link *A*, which makes connection between the cross-slide and a shaft *B* carried in brackets at the back of the lathe bed. An oscillating motion is imparted to this shaft by means of an arm *C*, which is actuated by cam *D*, secured to the lathe spindle.

In designing a relieving attachment of this kind it was obviously necessary to provide means for handling cutters of different diameters and also for obtaining the desired amount of relief on a given size cutter. To provide for handling cutters of different sizes it will be seen that holes are drilled at various points along link *A*, and in this way the link can be slipped through the slot in link *F* so that pin *E* may be pushed into the proper hole to locate the cross-slide in the desired position for a given size of cutter. Similarly, to furnish means of obtaining the desired amount of relief on a cutter, it will be seen that a number of holes are drilled in link *F*. Link *A* can be connected by pin *E* to any of these holes in order to vary the effective radius of link *F*. In this way the desired amount of relief is obtained on the cutter. It will, of course, be apparent that bellcrank *G* and weights *H* provide for taking up lost motion in the mechanism and keeping arm *C* constantly in contact with cam *D* on the spindle of the lathe.

E. K. H.

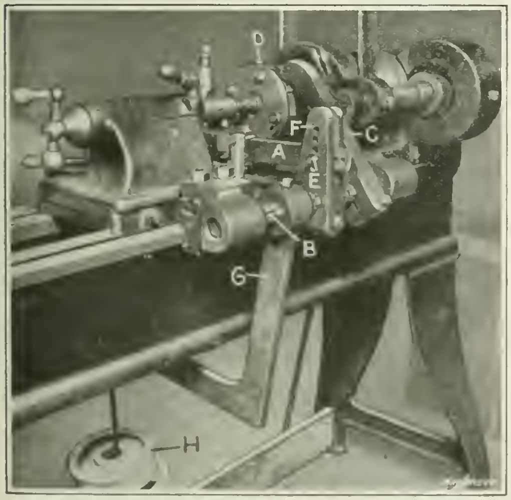

Fig. 1. Head End of Lathe equipped with Simple Relieving Attachment

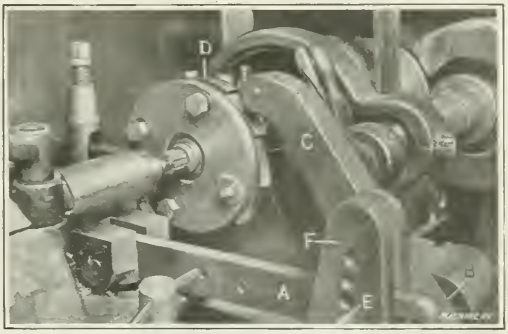

Fig. 2. Close View of Relieving Attachment shown in Fig. 1

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EFFECT OF HEAT ON STRENGTH OF WROUGHT IRON[1]

For metals at ordinary temperatures the use of a proper factor of safety brings the stress for which the piece is designed well within the elastic limit. But results of tests indicate that at higher temperatures this design factor will need to be greatly modified or the work will have to be designed wholly on the basis of the elastic limit. Temperatures of superheated steam vary from 450 to 550 degrees, and the strength of tubes, valve stems, etc., as affected by these temperatures is worthy of consideration. Other examples of the same condition are encountered in boiler construction, the metal rigging above large crucibles, and ladles carrying molten metal, etc.

In a series of tests with wrought iron it was found that the physical properties are materially affected by high temperatures. The ultimate tensile strength increases as the temperature increases from 70 degrees F. until a maximum is reached between 350 and 550 degrees F., while the tenacity diminishes rapidly with the increase in temperature. The elastic limit appears to decrease from 70 degrees F. to about 270 degrees F., showing a maximum decrease of about 13 per cent, and from that temperature suddenly increases to about 350 degrees and then gradually drops. In reference to elongation under stress, it is noticed that greater rigidity exists under certain stresses at intermediate temperatures than at either higher or lower temperatures. The contraction of area at the place of rupture varies with the temperature of the bar, and it appears that the contraction of area of wrought-iron bars is a great deal less between 200 and 600 degrees F. than at 70 degrees F., and within this range of temperature there is a tendency to fracture obliquely across the bar. The results obtained for the modulus of elasticity have little value, except that they indicate a gradual decrease. The metal is very brittle between 150 degrees F. and about 1100 degrees F., and, of course, it is impracticable to work it at these temperatures, as it might fracture without warning.

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[1] Abstract of an article published in "Metallurgical and Chemical Engineering," September, 1917.

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

THE TECHNOLOGY OF MANUFACTURE

The manufacture of metal goods comprises a great variety of processes, many of which are quite special, limited in their application and suitable only for a comparatively narrow range of products. The common machine shop operations are turning, planing, milling, grinding, drilling, threading, tapping, reaming, chipping, filing and punching. These are fundamental processes and are well-nigh of universal application to cold metals. Common hot processes are forging, welding, rolling, brazing, soldering, melting and casting. These also are fundamental and universally employed. The specialized processes of manufacture include die-casting, extrusion, sheet metal press forming, spinning, gas and electric welding and cutting, cold-rolling, wire drawing and cold-drawing. The technology of manufacture is vast, and its development so rapid that the published record is never abreast, but, strangely, some of the developments that were practically perfected years ago have never been completely described. An example is the cold-drawing of shafting and shapes. Cold-drawn rounds, flats and squares are among the most useful forms in which steel is marketed today. The article in another part of this number, "Making Cold-drawn Shafting," illustrates and describes dies, draw-benches and practice that is being followed substantially by several well-known producers of cold-drawn products. The article should be valuable to machinists who for years have used cold-drawn products, but have never had an opportunity to see how they are made.

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DEFECTS IN THE MANUFACTURE OF WAR MATERIALS

In going about the country the engineering observer cannot fail to note the enormous waste involved in the methods pursued by the government in the manufacture of war materials. It appears, to the casual observer at least, that the Ordnance Departments at Washington lack competent engineering advice; or, when such advice is freely given, are incapable of appreciating its value and thereby saving enormous sums now wasted by methods of manufacturing munitions and other war materials that no private corporations would countenance. We make this statement in order to call the attention of the Ordnance Departments to the fact that engineers throughout the country do not approve of their peculiar methods; and we do not base the statement on general observation but upon specific facts. We can point to instances where the government has engaged and maintains men as inspectors who, by ordinary engineering standards, are utterly incompetent for the purpose. We can point to a specific case where the officers of the Ordnance Departments were offered without cost, the use of a method for manufacturing certain parts in connection with rifle-making that expert engineers believed would save at least 50 and possibly 75 per cent of the present cost of manufacture; but the officer in charge refused to investigate thoroughly or test the method.

We can point to a case where identical war material is manufactured in seven different plants, each of which is required to make a complete set of jigs and fixtures at the cost of many hundred thousands of dollars, and a considerable delay in deliveries. The wise policy from an engineering point of view, would have been to distribute the contract in question between the same seven firms, but to have required each firm to make certain parts only, which could then have been assembled at one plant. By this method, one set of tools would have been sufficient, and as all the shops could have worked on subdivisions of the total contract, the time for the completion of the whole would have been considerably reduced. We can point to a case where four inspectors were employed for several weeks at a plant where there was not enough work to keep one inspector busy. We can point to cases where the designs furnished by the Ordnance Departments required finish to 0.001 inch on parts that are used only for clamping purposes, and where a finish of this degree is entirely unnecessary and involves only useless expenditure.

These are only the instances that have come under our personal observation. It is likely that others occur in many other shops. It is the duty of an engineering journal like MACHINERY to call attention to any waste connected with engineering work, particularly when this waste concerns us all and has to be sustained by the enormous taxes necessary on account of the war. The Ordnance Departments at Washington should avail themselves of competent engineering assistance when qualified engineering talent is apparently lacking within the Army and Navy organizations themselves. Officers high in rank should not ignore the help they could obtain from men who are in close contact with the industries of the country, and particularly with the machine industries engaged in interchangeable manufacture.

* * *

THE END OF WAR?

The placing of United States Government contracts for building 20,000 airplanes to be used by the American army in France, directs attention to the progress that has been made in aviation during the past three years. The stage has now been reached where the heavier-than-air flying machine is capable of long flights at great heights and tremendous speed. Further developments undoubtedly will make the airplane a still more formidable arm for offensive warfare. It will be possible with a fleet of airplanes to invade an enemy country no matter how strongly fortified its frontier. It is hazardous to predict the end of war, but many see that end in the ultimate development of the airplane, which will involve a complete and radical change in the settlement of international differences. No nation can afford to take the risk of being invaded by a fleet of airplanes and having its principal cities destroyed in a night.

Machine guns, heavy howitzers, high-explosive shells, the armored tanks and airplanes, all the product of the fertile mind of the engineer, have made the modern battlefield a veritable hell of destruction. The logical outcome of future mechanical engineering development is to render warfare impracticable. This war, begun for conquest with the expectation of loot, has proved a failure. If war is made not only terrible but unprofitable, it is not unreasonable to expect that future differences will be adjusted by arbitration, and understandings reached in conference by business men rather than diplomats.

A JONES & LAMSON MAN IN RUSSIA DURING THE REVOLUTION

BY GEORGE H. BRIGHAM[1]

George H. Brigham

Conditions in Russia last year, when I began arrangements to leave Paris for that country, were very different from what they were when I arrived. It took me some time to get everything in connection with my work in France in good shape, so that it was December 2 before I left Paris for Petrograd. Bergen, Christiania and Stockholm were full of tourists and business men of all kinds. I arrived at Haparanda and Tornea, which are, respectively, on the Swedish and Russian sides of the line, on an arm of the Gulf of Bothnia, on December 14, and the temperature was moderate; but a few days later winter arrived, the mercury dropped to 60 degrees below and stayed there quite a time. Those cities are only a few miles from the Arctic circle, and it was hardly daylight at 9 A. M. and dark again by 3.30 P.M. The Russian winters are, after all, not much more severe than ours in Vermont. For a few days the mercury dropped to 35 or 40 degrees below, but the average was 0 to 10 or 15 degrees below. They have, perhaps, a steadier cold than we have; but in Petrograd, where there is considerable dampness, zero weather is much more uncomfortable than 15 degrees below in Vermont. The Russians wear all their heavy clothes outside, because the houses are kept so warm that heavy underwear is unbearable.

Soon after I arrived in Petrograd that infamous self-styled monk, Rasputin, was murdered, and that was really the start of the revolution. About the middle of January I left Petrograd, going to Moscow, Briansk, Kiev, Taganrog, Nijni-Novgorod, and other towns; and on this trip had some experience in wartime railroad accommodations. Sometimes I got comfortable accommodations at night, and other times I had to pass the entire night in the corridor of the sleeping car, sitting on a suitcase, jammed in a crowd of Russians and others. The hotels were always crammed full, and it was often necessary to spend an hour or two hunting for a room, which sometimes I didn't succeed in finding. In Petrograd I slept two nights on a couch in the room of another American, and in Moscow I spent three nights in a bath-room, with a resulting attack of tonsilitis. In Taganrog, a city of 75,000 inhabitants on the Azoff Sea, I stayed at what was supposed to be the best hotel in town, which sported electric lights but lacked even one sheet on the bed. Most Russians carry their own bedding, but not having acquired that habit, I had to use my fur coat to sleep in. During my second trip to Moscow we began to hear of riots in Petrograd; and as the situation grew worse, exaggerated reports of the number killed were circulated. It was only after the second or third day of the revolution in Petrograd that we saw anything of it in Moscow. First the electric cars stopped, then the cabs, and then all public and private conveyances disappeared. Crowds began to collect and discuss the situation, a condition so contrary to the old regulations that one unconsciously looked to see why the police didn't break up the gatherings. Then it was discovered that the police, too, had disappeared, having learned that nearly all their comrades in Petrograd had been killed or made prisoners. About noon on the second day of the revolution the red flag appeared in Moscow, and then all but the active manifestants disappeared as if by magic and were not seen again until it had become evident that there would be no resistance.

As soon as things quieted down a little I decided to return to Petrograd to get my passport put in order so that I might leave Russia, which I succeeded in doing after a good deal of hard work. In Petrograd everything was in chaos; every hotel was guarded by soldiers, each of whom wore a red ribbon, and thousands more were parading the streets with their red banners proclaiming the freedom of Russia. At one time there were 60,000 deserters in Petrograd alone. The casualties among the officers of the army and navy during the revolution were very heavy, but it was said that many of them got no more than they deserved, as the average Russian officer treated his soldiers like dogs. At Helsingfors and Kronstadt, the headquarters of the Baltic Sea fleet, 250 naval officers were killed, including the admiral and rear-admiral. Some statements of excesses committed by the revolutionists that have been published here may have sounded like exaggerations, but I know that at Kronstadt the admiral in charge of the Baltic fleet was arrested in his office, both arms and legs were broken, and he was then taken out on the ice, where a hole was cut, a rope was tied around him, and he was lowered into the water till he was unconscious, after which he was brought back to the surface, fed brandy until he revived, and lowered again; this was continued until he was dead beyond recall. Other examples of a similar kind could be given if space were available. Practically no work was done anywhere for about a month after the revolution began; then in many factories the workmen turned out the foremen and entire management, seized the factory and tried to run it themselves. Every prison in the country was broken open and criminal and political prisoners alike turned loose. The first of May was declared a general holiday and was the most thorough one I ever saw. No one was allowed to work. There were no electric cars, no cabs, no autos, either public or private. All restaurants were closed, and in hotels all there was to eat was cold food ordered the night before and left in the rooms. Bread had practically disappeared several weeks before, and in all Petrograd no one expected to work, because it was supposed that everybody would go back to work the next day and settle down to carrying on the war and fulfilling their pledges to the Allies.

Unfortunately, about this time Lenine returned to Petrograd, having come through Germany from Switzerland, and installed himself in a palace, as you have doubtless read in the papers. He immediately started a propaganda for seizing the property of all the nobles and rich land owners, and dividing it among the people, and favoring a pro-German peace. There was someone speaking from the balcony of his palace from morning until late in the evening, and in a short time he had the provisional government in a difficult position. It was dangerous to allow him to continue and equally dangerous to arrest him. Finally, as you know, they took steps to arrest him and he disappeared.

About 50 per cent of all munitions manufactured in Russia were made in the Petrograd district—in the city and suburbs. As elsewhere in Europe, a great many women and unskilled labor were employed, the work being split up into single operations and done on simple machines. Automatics were used to some extent, but the Russian steel bars are so irregular that they must be drawn before they can be used in automatics; consequently many shops cut up the bars and did the work on engine lathes that should have been done on bar machines. As far as possible, imported steel bars were used on the automatics, but the supply was always uncertain. Workmen and women were making quite good wages at piece rates. The best factories had all been built by German engineers and were quite well lighted and often overheated.

Before the revolution the men were working ten, twelve and sometimes fourteen hours a day, but afterward, when they finally began to think of going to work, in some places they seized the factories, turning out the foremen and directors; and when that was not done, or where it was done and proved to be a failure, they struck for an eight-hour day and 15 per cent to 40 per cent increase in wages. A month later they struck again, that time for a six-hour day and a wage increase from 40 per cent to 220 per cent. Machine tools from all countries could be seen in the factories, but they were largely American, German and Swedish. A great many American machine tools built by irresponsible firms were practically a dead loss. Some tools were built by concerns that evidently knew no more about building machine tools than they did about manufacturing watches. The ——— was one. I saw twenty machine tools in one shop, not one of which would work to within 0.020 inch, and they were continually breaking. Even engine lathes had to be rebuilt. The reliable American manufacturers were sending a good class of machines, but were so far behind in their deliveries that the Russians took others on which they could get prompt delivery. It is a safe guess that some of these newly formed American machine companies will do no more business with Russian concerns.

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[1] Address: Jones & Lamson Machine Co., Springfield, Vt.

Before the revolution arrangements were being made to turn out large quantities of munitions in Russia. A combination of capitalists and bankers had established a factory known as the Lisvensky Zavod (Lisvensky shop) at Lisva, about fifty miles southeast of Perm in the Urals, where munition work is now being done. A big factory for munitions was being built at Kharkoff in the southeast of European Russia; another at Rostoff-on-the-Don, at the mouth of the river Don where it flows into the Azoff Sea. The Russo-Baltic Mechanical & Shipbuilding Co., whose main works are at Revel, on the Baltic, have built a factory at Taganrog, on the Azoff Sea. The works of the International Harvester Corporation at Lubertsy, near Moscow, were running about 5000 men and they had bought a neighboring plant. Various manufacturing enterprises were being developed in other parts of Russia, nearer the sources of supply for raw material, in the Urals and in the south; and if they ever get settled down to a stable form of government with an intelligent policy for helping the development of the country, there is almost no limit to the business that we can do over there. It is possible when that time comes the average Russian will have become honest enough so that business can be done without paying out so many bribes. Men selling machines there told me that unless they sold to personal friends, they had to count on about 25 per cent of the selling price for graft to foremen and others.

I had my ticket on the Trans-Siberian express for about two weeks, and when I left, all tickets for that train had been sold out for at least two months in advance. There is but one through train a week to Vladivostock on which berths can be reserved and which carries dining-cars. I was mighty glad to get away from Petrograd, especially as at every stop there was an argument with soldiers and deserters who insisted on getting into the train and filling up the corridors; but the porters, knowing that the tips at the end of the line depended on their passengers getting through, kept the doors locked and informed the soldiers that there was an American and Japanese mission on board hurrying back to their countries to get aid for New Russia, and that statement helped us to get through. We finally arrived at Vladivostock twenty-five hours late, after ten days of continuous traveling in the same train, the longest train ride without change in the world. We were relieved on arriving to find there had been no change in the government since we left Petrograd, so that our passports, as viséd before leaving the capital were still valid for leaving Russia. There were various regulations in regard to what one could take out of the country—five hundred rubles being the limit for money—but when I came to pass out no one asked me about money at all, as everything was in a complete state of disorganization.

Japan was a wonderful contrast to Russia, the officers were alert and courteous and the baggage was soon examined. Everywhere we saw evidence of organization, energy and activity, and could readily understand the reason for the outcome of the Russo-Japanese war. In my travels around Japan visiting factories and dock yards I was surprised to see how modern and up-to-date their equipments were. Nowhere did I see any hostility to the United States. On the contrary, the Japanese have such a good opinion of us that in the development of their country they are using almost entirely American methods. Their train service is excellent, their roadbeds are rock-ballasted and dustless, most of the locomotives are American, and their express trains compare favorably with ours.

You ask me what is the machine tool future of Russia? If you will tell me the political future, I will try to guess at the other. If the radical socialists and anarchists get the upper hand, as I am afraid they will, the future will be dark in every way. Everyone knows that there are limitless possibilities in Russia, but many Russians returning from America organized anti-American demonstrations, saying that America is not a country of freedom, for everyone has to work!

* * *

STANDARD ARMY TRUCK

October saw the completion of the first Class B standard army truck, which is a combination of the best features of various motor trucks and those features that military experience has shown desirable; it is thought to be far in advance of anything yet produced. Although in outward design it represents no radical departure from the usual army motor truck, every part has been so standardized that all parts are interchangeable, which is expected to give added efficiency at the front. It has a two-wheel drive and is able to make twelve or fourteen miles an hour. The engine weighs 1012 pounds; the rear axle, 1592 pounds with hubs and brake-drums; the front axle with hubs, 352 pounds; the transmission, 233 pounds; the clutch and case, 103 pounds; the frame without castings, 663 pounds; the front springs, 148 pounds; the rear springs, 544 pounds. Early tests of the engine showed 58 horsepower at 1350 revolutions per minute.

The completed truck is said to be the strongest, compared with the load it is designed to carry, ever turned out in this country. Every part has been enormously strengthened to withstand the rough usage of war. It carries more than 1000 pounds of dead weight in excess of commercial trucks of corresponding capacity. Owing to its increased weight, it is unsuited for normal use because of the large amount of gasoline and oil required for its operation; also, factories that have given free use of their patents have stipulated that the new truck was to be for government use only. Deliveries are expected to begin in January, and 35,000 trucks are to be made in the first half of the year.

Roughly, there were four major divisions of the engineering work—those relating to the engine, the transmission, the axles, and the other chassis parts. Each was manned by a corps of engineers and each unit represents a composite of the best features contributed, rather than the work of any one individual. In developing the engine, four or five makers cooperated by dividing the different parts between them, one making several parts not only for itself but for the other engine makers. The Continental Motor Mfg. Co. made the cylinders, gear-case cover and many small parts, such as pumps, bushings, etc. The Waukesha Motor Co. manufactured the cylinder heads, crank-case, intake and exhaust manifolds, roller push-rods, etc. The Wisconsin Co. made the lower part of the crank-case.

The Continental Motor Mfg. Co. received blueprints on September 9, and had an engine running within 19 days, 18 hours later, while the Waukesha Motor Co. had its first engine running within 11 days, 7½ hours from the time the blueprints reached its factory. These companies did not have to make all the patterns for castings or the dies for forgings, some of these having been made previously, but they had to do most of the machining and other operations on the parts. To make possible the completion of the units in record time, the Park Drop Forge Co. sank the dies for the crankshaft in seven days, an operation which is rarely completed in peace times in less than three weeks. The Werra Aluminum Castings Co. produced the pattern for the main crank-case and the first casting in five days, though usually from three to four weeks is required on much smaller jobs. The Continental pattern shop completed the pattern for the cylinder pairs in five days.

FORGING MACHINE DIE DESIGN[1]

RULES GOVERNING THE LENGTH OF UPSET IN TERMS OF BAR DIAMETER

EXPERIENCE shows that at least three-fourths of the failures in forging machine die design can be attributed to disregard of one or more of the fundamental laws. The only apparent way to make such a subject clear is by illustration; hence this information is presented in graphic form, with the hope that it will be of value to men in the shop, and will serve to reduce the expense for dies, the failure of which might be anticipated. Throughout this article the plan is followed of not taking into consideration unusual methods; trick heats; welding operations; or, in fact, any laboratory methods which, while possible under certain conditions, are impracticable in average shop practice. Consequently, while certain statements may appear to be too limited, they will, in the main, be found as applying to average conditions. It is possible to classify the majority of forging machine die problems under three rules or headings, which are as follows:

RULE 1. The limit of length of unsupported stock that can be gathered or upset in one blow without injurious buckling is not more than three times the diameter of the bar.

As an example, by reference to Fig. 1, if the diameter of the bar *A* to be upset is one inch, then the length of unsupported stock *B* which may be successfully gathered, cannot be more than three inches. This rule applies on all diameters of stock. As three diameters, however, is practically the limit, it is best to keep the actual working limit within two and one-half diameters; and where it can be done, a limit of two diameters is even better, as then less attention need be paid to the squareness of the end of the bar. On such upsets, as the heading tool advances, as indicated in Fig. 2, the stock will swell uniformly in all directions from the axis of the blank, and it can be carried to practically any thickness, as shown in Fig. 3, without any serious tendency to upset unevenly. It is immaterial whether the stock overhangs the face of the dies, as in Fig. 1, or whether part of the stock is gathered in the dies and part in the heading tool, as shown in Fig. 4; whether it is all upset in the gripping dies, as in Fig. 5, or all in the heading tool, as in Fig. 6—the fact must be kept in mind that such conditions represent cases where the stock is unsupported, and hence Rule 1 applying to three diameters or less of unsupported stock will apply. Many simple forgings come under this ruling, such as the bevel pinion forging shown in Fig. 7; the grease cup spring shackle bolt, Fig. 8, or the ring forging Fig. 9. In each case, the distance from the heated stock to the inner surfaces of the gripping die impression or the heading tool, is such that the stock is in reality unsupported.

In order to prove the dependability of Rule 1, if an effort is made to upset a length of stock longer than three diameters, instead of upsetting uniformly, as shown in Kigs. 2 and 3, the stock will buckle at a point near the middle, and result in more of the upset forming on one side of the center of the bar than on the other. As an example, in Fig. 10, assuming that the diameter of the bar *C* is one inch, and the length of unsupported stock *D* is four inches, then when the heading tool advances the stock will start to buckle, as shown in Fig. 11, and after it has once started, will, of course, continue, as illustrated in Fig. 12. It is merely an application of the general principle that under pressure given lengths of any material will either crush or bend. It is impossible to correct this condition by varying the point in the die where the upsetting takes place, as it will be readily seen in Figs. 13, 14 and 15, that the stock will buckle regardless of whether it is upset in the gripping dies, in the heading tool, or part in the gripping dies and part in the heading tool.

RULE 2. Lengths of stock more than three times the diameter of the bar can be successfully upset in one blow, provided the diameter of the upset made is not more than one and one-half times the diameter of the bar.

This rule while fairly well recognized requires a clear understanding in order to develop its practical possibilities. By reference to Fig. 16, assuming that the diameter of the bar *E* is one inch, the length of stock *F* to be upset is six inches, and that the diameter of the hole *G* in the die is not more than one and one-half inch, then when the upsetting begins, as in Fig. 17, the stock will at once buckle, but on account of the limited diameter of the hole *G* the stock soon comes in contact with the sides of the die. This prevents further buckling in this direction, and any additional upsetting must take place at some other point. The stock will frequently be found to buckle at several points, as in Fig. 17; but as the heading tool advances, the stock will gradually fill the impression in the die, as shown in Figs. 18 and 19, resulting in an upset, as in Fig. 20, the only objection being a fin around the end of the upset. If a forging is produced in a die in which the diameter of the hole, as at *H* in Fig. 21, is greater than one and one-half times the diameter of the bar, then when the upsetting begins the buckling effect at some point, generally near the middle of the unsupported stock, as at *I* in Fig. 22, is sufficient so that when the heading tool continues its advance, the stock on the opposite side from the buckled portion, as at *J*, Fig. 23, will "fold in," and leave a defect in the upset.

As in the case of Rule 1, while it is possible to make forgings in which the diameter of the opening in the die is as much as one and one-half times the diameter of the bar, nevertheless, this is very close to the limit, and in practice it is much better to keep the diameter of the upset not more than one and three-tenths times the diameter of the bar. The practical application of this law is in the ability to gather large amounts of stock by repeating the principle, as indicated in Fig. 24. In the first, or top impression, the diameter *K* of the recess in the die is not more than one and one-half times the diameter of the bar *L*. In the second impression, the diameter of the recess *M* is not more than one and one-half times the diameter of the previous upset *N*. In the last impression, the length of the upset *O* is well within the limit of Rule 1 regarding unsupported stock, so that no limit need be put on the diameter *P* of the last die impression. This principle is clearly shown in Fig. 25, in which, in both the first and second operations, the diameters of the impressions have been kept within this limit. The same principle applies to the first two operations in the upsets shown in Fig. 26. In upsets where the length of stock in the first operation is excessive it is generally necessary to keep the end of the bar at a lower temperature. Where it is desirable to hold carefully the size of some upset in which the stock requirement is not materially over three diameters in length, if the diameter of the impression in the die is made not more than one and three-tenths times the diameter of the bar, as in Fig. 27, the upset formed will be free from fins on the end of the upset, even if no special care is taken in heating. This is on account of the fact that where the length of the stock is not more than three diameters, the upsetting takes place quite uniformly throughout its length, and any buckling being limited, the friction of the stock along the side of the die does not become a factor. The forgings shown in Figs. 28, 29 and 30 come in this class. In handling all upsets requiring more than three diameters of stock the fact must always be kept in mind that the stock will first start to buckle at the middle of the unsupported portion, and as a result somewhat more than one-half the stock to be upset, as at *Q*, Fig. 31, must be inside the impression in the die. It can equally well be in a taper or straight hole in the heading ram, as in Figs. 32 and 33; but it is useless to attempt to make part of the impression in the gripping die and part in the heading tool, as in Fig. 34, because when the upsetting begins, as in Fig. 35, the stock will buckle, leaving a defective forging as shown in Fig. 36. To attempt to support the end of the bar in the heading tool, as in Fig. 37, does help, but the final result will be a defective forging as indicated in Fig. 38 on account of the

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[1] Paper read before the fourth annual convention of the American Drop Forge Association at Cleveland, Ohio, by E. R. Frost, general manager, National Machinery Co., Tiffin, Ohio

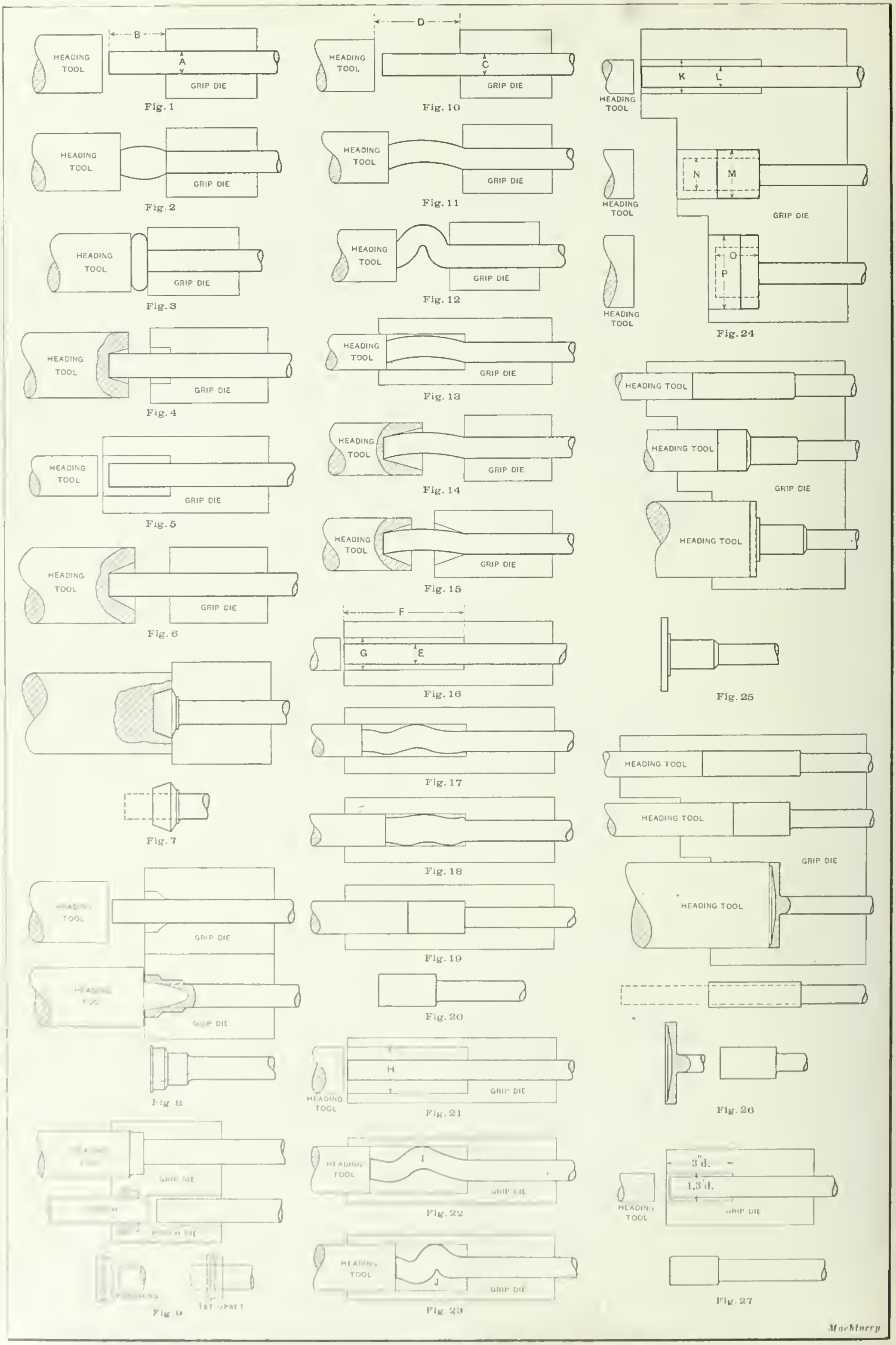
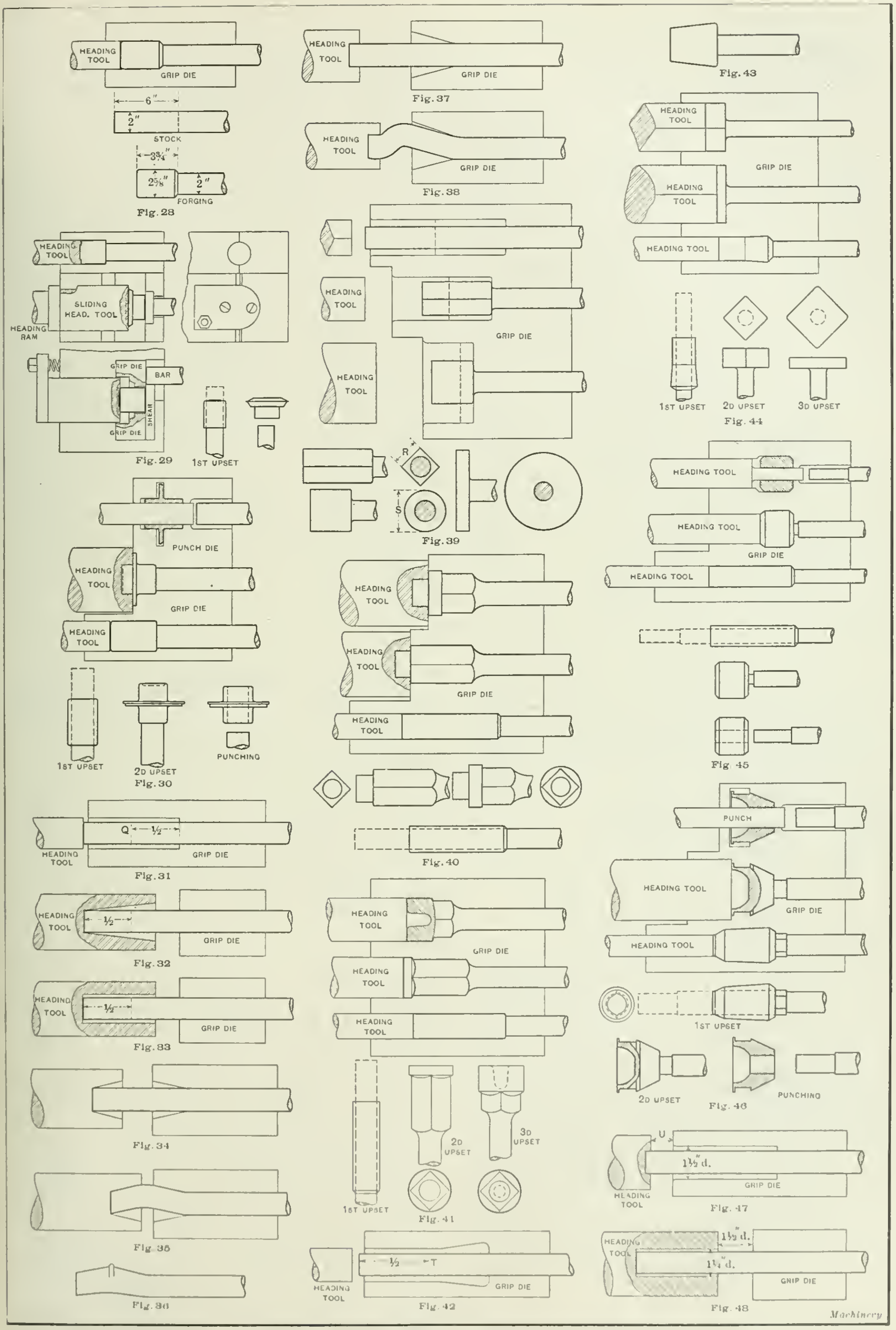


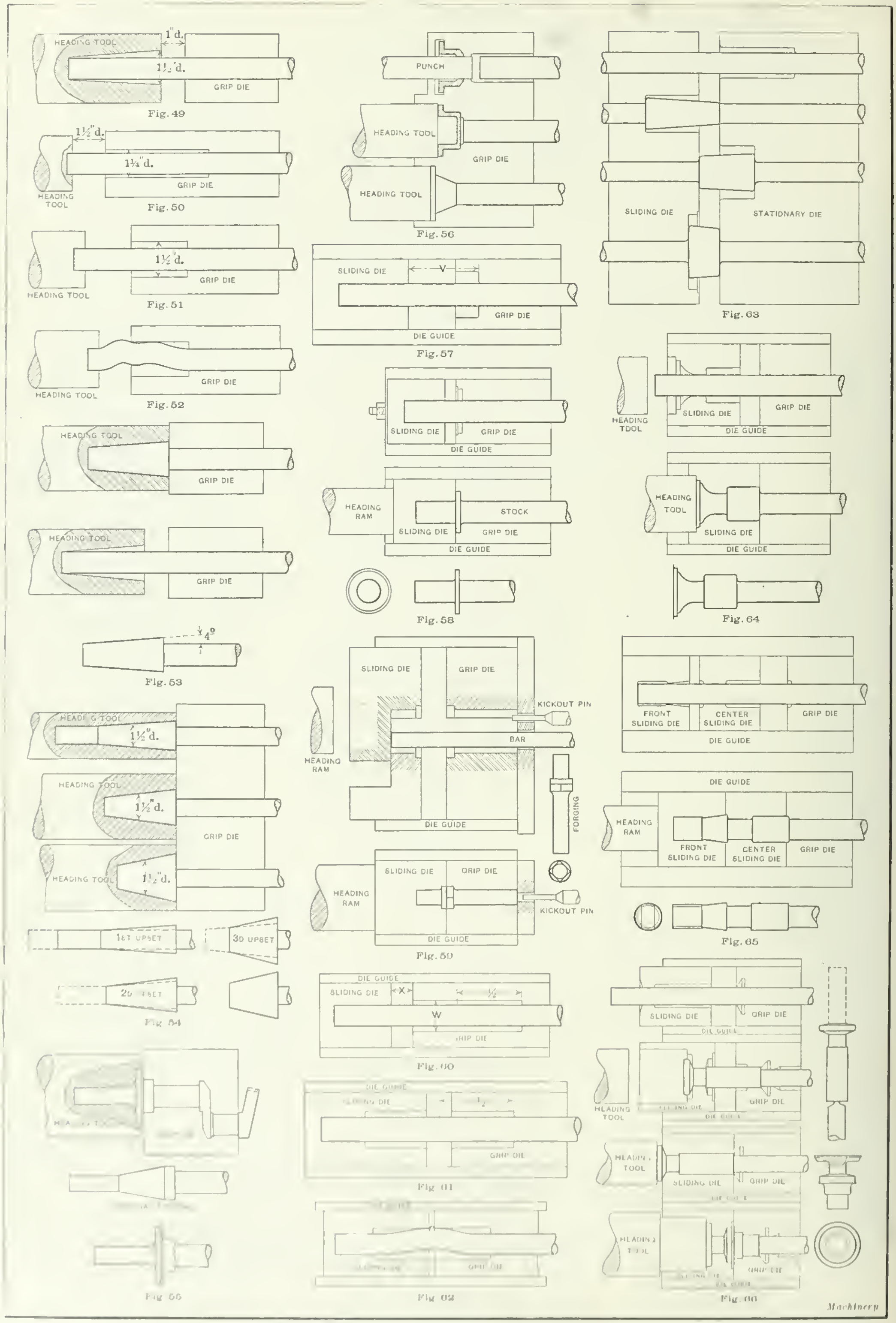
Fig. 1 Fig. 2 Fig. 3 Fig. 4 Fig. 5 Fig. 6 Fig. 7 Fig. 8 Fig. 9 Fig. 10 Fig. 11 Fig. 12 Fig. 13 Fig. 14 Fig. 15 Fig. 16 Fig. 17 Fig. 18 Fig. 19 Fig. 20 Fig. 21 Fig. 22 Fig. 23 Fig. 24 Fig. 25 Fig. 26 Fig. 27

Machinery

Figs. 1 to 27. Illustrating Points in Design of Forging Machine Dies



Figs. 28 to 48. Illustrating Points in Design of Forging Machine Dies



Figs. 49 to 66. Illustrating Points in Design of Forging Machine Dies

lack of support near the middle of the upset, as suggested in Fig. 31.

Among the various ways to reduce the number of operations required to make large size upsets on small diameter bars, attention is called to the square hole scheme as shown in Fig. 39. Here an extra amount of stock is obtained in the first upset by making the first impression square, instead of round. The short diameter of the square hole *R* is made within one and one-half times the diameter of the bar. Consequently, the sides of the square impression in the die support the bar, and keep it from buckling; but the greater area of the square hole enables a larger amount of stock to be gathered than would be possible were the hole round. The next impression is made round, and the diameter of this impression *S* can be one and one-half times the long diameter, or in other words, the diameter across the corners of the previous square upset. The square corners, by coming in contact first with the sides of the die impression, also prevent the bar from buckling and allow a large amount of stock to be gathered. If the length of the stock as it leaves the second operation has been shortened sufficiently to come within the requirements of Rule 1, it can be formed in the last operation into any desired shape without regard to the diameter of the die impression. The practical application of such a method is shown in Figs. 40 and 41. Another method of increasing the amount of stock that can be gathered in one operation, is to keep the diameter of the impression in the die within the limit of Rule 2 for a distance of slightly more than one-half the length of the stock, as indicated at *T*, Fig. 42, and then to increase the size of the opening as shown. When the heading tool begins to upset the stock, it will, of course, buckle at *T*, but being supported by the die at this point, and by virtue of the fact that the friction along the side of the die will cause the forward end to upset first, the stock will gradually carry back in the die and produce a uniform upset, as shown in Fig. 43. The use of this method is also indicated in Figs. 44, 45, and 46.

RULE 3. In an upset requiring more than three diameters of stock in length, and in which the diameter of the upset is one and one-half times the diameter of the bar, the amount of unsupported stock beyond the face of the die must not exceed one diameter of the stock.

This rule, as will be noted, is a combination of Rules 1 and 2. As an example, if the stock to be upset, as in Fig. 47, is one inch in diameter by six inches long, and the diameter of the hole in the die is one and one-half inch, then the amount of stock *U* extending beyond the face of the die must not be more than one inch. However, if the diameter of the hole in the die, as in Fig. 48, is reduced below one and one-half diameter, the length of the unsupported stock beyond the face of the die can be correspondingly increased. If the diameter of the hole in the die is not over one and one-fourth times the diameter of the stock, the amount of stock beyond the face of the die may be increased to one and one-half times the diameter of the bar. This rule also applies to cases where the upsetting takes place in either straight or taper holes in the heading tools, as in Figs. 49 and 50. If an effort is made to allow a greater amount of stock to extend unsupported beyond the face of the dies, as in Fig. 51, the stock will buckle outside of the dies, as shown in Fig. 52. It will be readily seen that such a limited travel of the heading tool as at *U*, Fig. 47, would not provide sufficient stock to fill entirely the impression in the die; hence in view of the limited heading tool travel on account of Rule 3, many upsets can, to advantage, be made tapering, as indicated in Fig. 53. The taper upset possesses many valuable qualifications, particularly in that if the angle of the taper is approximately 4 degrees on each side, as indicated in Fig. 53, the increased diameter of the upset, as the heading tool advances, increases the pressure in the direction of the bottom of the impression in the taper tool, and more fully insures a uniform and well filled upset. Fig. 54 shows how progressive taper upsets can be made, keeping in mind in each case that the diameter of the taper hole near the middle of the unsupported portion of the stock must be kept within the requirement of Rule 2. A large amount of stock can be gathered in a few operations by this method, for while the first die impression is limited to the size of the bar, thereafter it is the dimensions of the taper upset that governs the size of the next die impression and not the diameter of the bar. The taper upset is also valuable in distributing the stock properly at the desired points, such as at the base of final upsets, in more easily filling a large flange, as in Fig. 55, or, by inverting the taper in securing the advantage of filling the outer flange, and enabling the second forming tool to more easily place the stock, as in Fig. 56.

Another form of die having great possibilities, but whose limits are more frequently misunderstood, is the sliding die, as shown in Fig. 57. Such dies are, of course, in quite general use, and are invaluable in upsetting stock at a considerable distance from the end of a bar. Rule 1, however, is still with us, as the total length of unsupported stock, measured from the bottom of the die impressions as at *V*, must not exceed three diameters of the bar. The practical application of this form of die is shown in Figs. 58 and 59. In case the length of unsupported stock is more than three diameters, as shown in Fig. 60, then both Rules 2 and 3 must be kept in mind as applying to the relative diameter of the upset, as at *W*, and the length of stock extending beyond the face of the die, as at *X*. Fig. 61 represents a failure in a sliding die, as the middle of the stock being beyond the face of the die, and hence unsupported, would buckle as indicated in Fig. 62.

In any extensive application of the sliding die, it is generally necessary to gather stock in several impressions, and here not only must Rules 2 and 3 be kept in mind, but it must also be remembered that the friction along the side of the die will cause the upsetting to take place near the front end of the die. For this reason, if the first upset is formed in the rear half of the dies, the second impression should be in the front half; the third impression in the rear half; the fourth impression in the front half, etc., in order in each case to bring that portion of the upset which naturally swells the most, into the bottom of the next impression where it is more difficult to carry it. The idea is shown in Fig. 63.

In the application of the sliding die, Fig. 64, an upset is made in the sliding portion of the die, and another at the front face of the die at the same stroke of the machine. Fig. 65 represents a double sliding die, in which two upsets are formed in the sliding portions of the dies, and in which the extreme front end of the stock is squeezed flat at the same time. Fig. 66 represents a double-deck sliding die in which the stock is gathered in the first impression, and the forging is practically cut from the bar. Upon being lowered to the final impression the upsetting is completed, and as the bar is turned one-fourth revolution, the forging is severed completely from the bar.

* * *

THE ALUMINUM INDUSTRY

According to a paper by F. A. Lidbury in the *Journal of the Western Society of Engineers*, the most important single electrochemical industry in point of power requirements, and also in point of value of product, is the aluminum industry. So far as can be ascertained, there is something like 130,000 kilowatts of capacity installed in this country at present for the purpose of making aluminum. In addition to these, there appear to be about 60,000 kilowatts either being installed at present or contemplated. This indicates that the requirements of the aluminum industry alone in this country lie between 100,000 and 200,000 kilowatts. The demand for aluminum seems to be increasing every year, and this is not, to a great extent, a war demand, but the increase has come about by the rapid extension of the general uses of aluminum, as, for instance, in the automobile. Its use in the automobile is not only direct, but indirect, and includes the manufacture of certain steels and of steels of a nature that enables small light parts to be used in places demanding great strength in the automobile where a few years ago carbon steel of much greater dimensions had to be used.

* * *

Brazil's exports of manganese have increased from 122,300 tons, in 1913, to 503,130 tons, in 1916.

EFFICIENCY IN TOOL DESIGNING

MAKING TOOL DESIGNS—SATISFACTORY DRAWING PAPER—CHECKING A DRAWING

BY F. B. JACOBS [1]

To the average man, "efficiency" brings to mind an elaborate series of motion and time studies, by means of which production is increased by eliminating all useless motions and routing the work to the best advantage. The selection and maintenance of suitable tools and the type of individual entrusted to perform specific operations are, of course, equally important factors.

In the drafting-room, however, it is impossible to adopt time and motion studies, because the human element is the all-important factor to consider, as the work is of a creative instead of a productive nature. For instance, how impracticable it would be to limit an inventor to a specified amount of time in which to design a machine for a specific purpose. Such a theory would be impossible to put into practice, as the action of the human mind, as far as originating ideas is concerned, cannot be governed by hard and fast rules, aside from the fact that a healthy individual is capable of putting forth his best efforts when not under the influence of an artificial stimulant of any kind or laboring under mental unrest of an abnormal kind caused by unpleasant home or other social surroundings. Efficiency in the drafting-room is practicable, however, if we confine our efforts along reasonable lines wherein efficient results are the outcome of the systematic handling of the work in question instead of attempting to set a stated time limit for the production of a given amount of work.

The opinion seems to be prevalent that any old place where a few drawing tables can be spread is good enough for the draftsman. Why this idea is accepted it is hard to say, but an inspection of the tool-drafting departments of many large concerns shows that a poor location is often chosen. One tool-designing department where the men were compelled to work by artificial light day in and day out, notwithstanding the fact that the concern in question had acres of idle floor space that could be utilized, was located in this place because it was near the chief engineer's office and the tool-room. But why cause the tool designers to suffer continual eye strain simply to accommodate the chief engineer and the tool-room foreman? A little time was occasionally saved in one way, to be sure, but it was greatly offset by the inefficiency that was bound to result from the tool designers continually working under the glare and heat of electric lights. Locating the tool-designing department near the production department is another detriment to effective work; the continual noise and disturbance is nerve racking, to say the least, to the man who is endeavoring to concentrate his mind on mathematical and other obtruse problems that are a necessary part of the tool designer's work.

After selecting a suitable location for the tool-designing department, where unnecessary noise and other confusion is eliminated and where the light is good, the next question to consider is the means of getting and holding the best tool designers obtainable. While a comparatively inexperienced man, a trade- or correspondence-school graduate, for instance, can be readily broken in as a tracer or detail draftsman, a good tool designer cannot be thus obtained. To carry on this class of work successfully calls for long experience and broad training, which is best acquired by working in several manufacturing centers. Good tool designers are scarce and are not to be had by simply putting an advertisement in a daily paper. Besides, it costs from $100 to $500 to break in a man in a responsible position, so that the surest way to retain good men who can be depended on is to make their surroundings as pleasant as possible and to pay the maximum wages for a given locality. It is well known that competent machinists and toolmakers will not stay in a dark, dirty shop any longer than is absolutely necessary, and the same rule holds good with the tool designer, for, like his brothers in the shop, he has generally roamed around a bit and knows what constitutes good surroundings. As a result, the concern with uncongenial surroundings is bound to retain only the incompetents, while the better workmen seek pleasanter situations. Of course, all men should be loyal to their employers, this being one of the fundamental principles of successful cooperation between labor and capital; nevertheless it is much easier to remain loyal where conditions are good.

Methods of Making Tool Designs

If three tool designers, each of recognized ability, are given a similar piece of work with the injunction to design a jig or fixture for it, three totally different designs, all practicable no doubt, will be the result. This is caused, of course, by each one following his own inclinations, and if a fixed standard of design is desired, the several tool designers should work under the supervision of a chief whose ability and record are known. It is not the intention to convey the thought that all the designer's original ideas should be ignored, but when the average tool designer is thrown wholly on his own resources he is inclined to introduce too much originality in his efforts simply for the purpose of stamping his work with a mark of personal distinction, as it were. He wishes his work to stand out in a class by itself. Thus one man might use tapered dowel-pins, while another prefers straight ones. Again, one man might use flat-head screws, while another designates hexagonal-head cap-screws. One designer might favor light ribbed construction for jig bodies, while his neighbor insists on heavy, plain construction. One designer may prefer to fasten guide blocks on the bottom of milling fixtures by means of screws, while another designs the blocks integral with the base, and so on. It is evident that this variance of ideas is bound to lead to confusion, notwithstanding the fact that all practicable ideas have their good points, so where it is desired to maintain any kind of standard it is necessary for the chief designer to formulate a fixed standard, as far as possible, and insist that the men stick to it.

The work of the tool designer consists of designing tools and fixtures to facilitate the duplication of machine parts, it being understood, of course, that his drawings are for the purpose of conveying full and clear instructions to the toolmaker. It has been truly stated that a man can produce almost anything if given time enough, but as tool designing is an expensive branch of engineering work at best, wherein slight errors often have far-reaching results, it is necessary for the designer to proceed along practical lines, bearing in mind the fact that he is not the only person to be suited.

To change a drawing several times during the course of its completion is an expensive proceeding, especially if the lines have been drawn in heavily; and, besides, the appearance of the finished drawing looks far from satisfactory and often makes a poor print in cases where the blueprint is made directly from the designer's drawing. To the end that unnecessary work may be avoided, it is a good plan for the designer to make his original lay-out with light lines, which can be easily erased if necessary, and after a plan and two elevations and perhaps a section have been sketched in, the work should be examined by the chief tool designer.

If the acceptance of the design rested wholly with the tool designer and the chief draftsman, they could, no doubt, easily come to a quick agreement as to what was suitable. However, the head toolmaker, efficiency engineer, production engineer, shop foremen, and perhaps a few others are also interested in the tools that are to be made for certain purposes. Thus, where harmony is to prevail, which, by the way, is absolutely necessary if efficient production in the shop is desired, everyone concerned should be given an opportunity to pass on the tool designs submitted before the drawings are detailed and billed out to the tool-room. These tool-committee meetings consume time, to be sure, but when several men get together around a table for the sole purpose of passing on the merits of several tool designs, the general discussion of the various points involved nearly always results in the acceptance of efficient designs and the rejection of poor ones.

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Satisfactory Drawing Paper

The proper kind of paper to use for making tool drawings is a question upon which there is a great diversity of opinion. Heavy white or buff paper is sometimes used; and while this produces a very neat drawing, especially if it is inked in, there is the extra cost of making a tracing from which the blueprint for the tool-room is taken. The original drawings are sometimes given a coat of white shellac and then sent to the tool-room; while this eliminates the work of making the tracing and blueprint, the original drawing is often nearly ruined in the tool-room through contact with dirty hands and from other causes. In addition, the shellac coating makes it difficult to change the drawing later. The original drawing is sometimes made directly on tracing paper, but this material is easily torn, and as tool drawings should be filed away for future reference, they should be made on more serviceable material. In many up-to-date drawing-rooms, tool drawings are made on vellum paper, from which a blueprint is taken. This material is expensive, compared with some papers, and to the beginner it is a little difficult to work on. It is quite transparent, however, exceedingly tough, and can be handled repeatedly without tearing, that is, of course, if a little care is used in handling it. The drawings can be made either in pencil or in ink, and in either case the material stands erasure well in case changes are necessary. Ink does not seem to penetrate it, so that inked lines are readily removed with an ordinary eraser such as is used for rubbing out pencil lines. It is the general practice, however, to make the drawing in pencil only, and if a medium grade of lead is used, say 2 H, the lines will be heavy enough to make a good blueprint.

Checking a Drawing

After a tool drawing is completed, it should be checked for errors, for a slight error on the draftsman's part often entails a heavy expense. On first thought it would appear that a competent workman should not make mistakes, but the draftsman, like any other worker, is bound to make an error once in a while. Roughly speaking, there are three methods used in checking tool drawings. The simplest method, perhaps, is for the tool draftsman to check his own work, being guided by a simple series of printed or typewritten questions that cover the errors generally made by the average draftsman. This method is not very satisfactory, when taken as a whole, owing to the fact that we all are prone to overlook mistakes on our own part. For instance, the draftsman might use the wrong formula in his calculations, in which case no amount of checking will disclose the error until the correct formula is applied. Mistakes of this kind, by the way, are of common occurrence. Another method is to have one man's work checked by one of his fellow-workers, whose work, in turn, is checked by another, and so on. While this is a little better than individual checking, it leaves much to be desired, owing to the fact that in every drafting-room there are a few who consider themselves a little smarter than their fellow-workers, and when given a little authority for the time being they make themselves obnoxious. It can be truthfully said that this system of checking often causes hard feelings among the men, which state of affairs has a tendency to lower efficiency, for the individual has yet to be borne who can do his best work while feeling grouchy, whether the cause is real or imaginary.

The most satisfactory method is to employ men to do nothing but checking. One checker for every ten tool designers is a reasonable ratio in cases where the checkers devote all their time to checking and where the designers can be depended upon to make the minimum amount of errors. A reliable checker should be a draftsman of wide experience. Not all draftsmen, however, make good checkers, as this work calls for qualifications not possessed by every draftsman. The checker must be thorough and accurate, fond of detail by nature, and above all he must possess diplomacy to a marked degree to hold the good will of the men whose drawings come under his inspection. Since the checker is held responsible for errors that pass him, he should check systematically, being guided by accepted rules. There are many systems for checking tool drawings; the following is successfully used by one of the largest automobile manufacturers of the Middle West:

1. Check size of sheet.
2. Check projections.
    A. Check center lines.
    B. Are sections properly labeled?
    C. Is drawing perfectly clear?
    D. Is drawing neat, are figures plain, and will it make a good print?
3. Check design.
    A. Check for weight.
    B. Check for weakness.
    C. Check for molding, forming, or forging.
    D. Check for cheapness.
    E. Check for machining.
    F. Check for interferences.
    G. Check for assembling.
    H. Check for under-cuts, fillets, and chamfers.
    I. Are bosses large enough?
4. Check for dimensions.
    A. Check for correct dimensions.
    B. Check for arrowheads.
    C. Check for scale.
    D. Check for duplicate dimensions.
    E. Check for standard drills and reamers.
    F. Are all necessary dimensions given?
    G. Are all necessary finish marks given?
5. Check title block.
    A. Check title of drawing.
    B. Check material.
    C. Check number of parts required.
    D. Check order number.
    E. Check operation intended for.
    F. Check machine to be used on.
    G. Check date.
    H. Check draftsman's signature.
6. General notes.
    A. Are all parts necessary to complete unit detailed?
    B. Can any detailed parts, such as nuts, screws, etc., be purchased?
    C. Are chucking rings, pot castings, or machining lugs necessary?
    D. Is necessary material called for in stock?

The checker should order all necessary changes by writing them on a slip, which is handed to the draftsman together with the drawing that has been checked. The draftsman then makes the necessary changes, checking off the items on the slip as he makes his alterations. While the checker should have the authority to order such changes as are necessary, he should exercise diplomacy not to abuse this authority. As an illustration, the heading "Check design" does not imply that the checker has unlimited authority to order the draftsman to change the design for one that happens to suit him a little better.. If the design approved by the chief draftsman and tool committee is practicable, the checker should let it stand, bearing in mind the fact that it is sometimes a good plan to let well enough alone. While it goes without saying that a reliable checker does as much as any one other person in the tool-drafting room to promote efficiency, he should not take himself too seriously. He has a certain amount of authority, to be sure, but he should not abuse this authority by ordering slight changes just for the sake of making others obey orders.

A whole book on efficient tool designing could, no doubt, be written if one could spare the time and were reasonably sure of finding a publisher who would consider the manuscript. After all is said, however, efficiency in the tool-designing department consists mainly in having a fixed system, working to the same, and following a few simple details as illustrated in this article.

* * *

The British government has decided that the construction of the proposed tunnel under the British channel is not to be proceeded with until after the war. The tunnel could not be completed so as to be of any particular assistance during the war. Had such a tunnel been ready at the beginning of the war, however, it might have been of considerable value; but the present time would be inopportune for the beginning of so great an undertaking.

OPERATING INSTRUCTIONS FOR HOBBING MACHINES

INSTRUCTIONS FOR GOULD & EBERHARDT 72- BY 20-INCH AUTOMATIC SPUR AND HELICAL GEAR HOBBING MACHINE

BY ROBERT E. NEWCOMB[1]

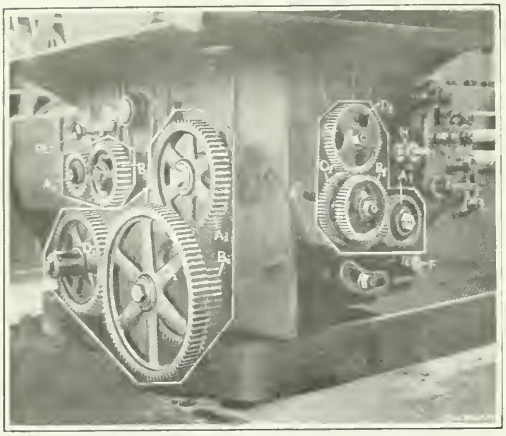

Fig. 1. A_i, B_i, C_i, D_i, Index or Dividing Gears: A_f, B_f, C_f, D_f, Feed Gears; A_s, B_s, Cutter Speed Gears; F, Pin to set Machine for cutting Spur and Helical Gears (Pin in Upper Hole for Spur Gears); H, Crank Handle for imparting Hand Movement to Stanchion; RL, Knob for reversing Direction of Cutter Rotation

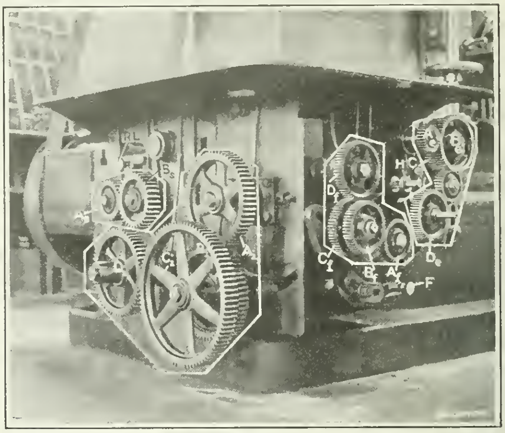

Fig. 2. A_i, B_i, C_i, D_i, Index or Dividing Gears; A_f, B_f, C_f, D_f, Feed Gears; A_e, B_e, C_e, D_e, Lead Change-gears; A_s, B_s, Cutter Speed Change-gears; F, Pin in Lower Hole for hobbing Helical Gears; H, Crank Handle for Hand Movement of Stanchion; RL, Knob for reversing Direction of Cutter Rotation

DETAILED instructions for the guidance of operators of the Gould & Eberhardt 72- by 20-inch automatic spur and helical gear hobbing machine are given in the following article. These instructions were developed at the Deane Steam Pump Works of the Worthington Pump & Machinery Corporation at Holyoke, Mass. They have been found sufficiently explicit so that men with no experience in the operation of gear-hobbing machines, but with average mechanical ability, have been able to produce satisfactory results.

1. Place the hob cutter on the cutter-arbor and secure it by means of the nut. Set a space of the cutter central and to coincide with the cutter-setting gage in the swivel slide (Fig. 10). Setting the space of the cutter central is very important, especially when cutting gears having less than thirty teeth. It is good practice to set a different space central for each gear, as this will eliminate uneven wear.

2. To set the cutter, the nuts on the spindle bearing are loosened. The cutter-spindle bearings are then adjusted lengthwise by means of small adjusting screws, until the space matches exactly with the cutter-setting gage. Then the spindle bearing bolts are securely fastened and the cutter-setting gage withdrawn from the cutter.

3. The swivel slide is now adjusted to the proper angle for the gear to be cut, according to instructions in Figs. 3 and 4. These charts give the proper position of the cutter in relation to the perpendicular, which depends upon whether the cutter is right or left hand, and whether the gear is a spur gear or a right or left hand helical gear.

4. The gears to rotate the cutter in the forward direction are then engaged by shifting the cutter reverse knob *RL* at the back of the machine, Fig. 12. For position of cutter knob for spur gears, refer to Fig. 4, and for helical gears, refer to Fig. 3.

5. The work-mandrel is now inserted in the work-table, and the blank placed on it and securely fastened, care being taken to see that the hole and the face of the blank by which it is clamped are entirely free from all dirt and burrs, and that the blank is of proper diameter. For gears of small diameter, use the outer support arm shown in Fig. 8. For gears of large diameter, remove the outer support arm, and support the gear blank rigidly at the rim, using the segment rim supports.

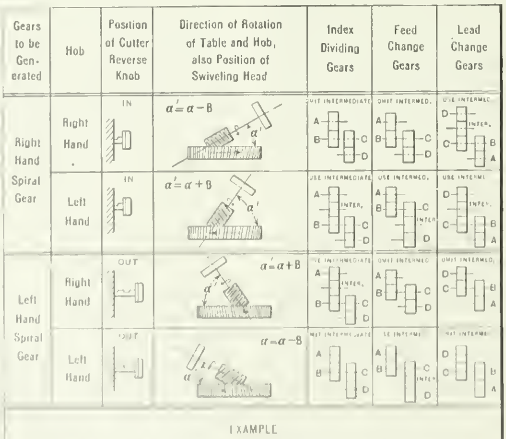
Gears to be Generated
Hob
Position of Cutter Reverse Knob
Direction of Rotation of Table and Hob, also Position of Swiveling Head
Index Dividing Gears
Feed Change Gears
Lead Change Gears
Right Hand Spiral Gear
Left Hand Spiral Gear
Right Hand
Left Hand
IN
OUT
α′ = α − B
α′ = α + B
OMIT INTERMEDIATE
USE INTERMEDIATE
OMIT INTERMED.
USE INTERMED.
INTER.
A
B
C
D
EXAMPLE
Problem: Right Hand Spiral Gear, 110 teeth, 1" Normal dia. pitch or pitch of Hob
30° Spiral Angle of Gear, Right Hand Hob (B = 4°) Feed = 0.12" per revolution of table.

Fig. 3. Data and Diagrams for Arrangement of Cutter-head, Hob and Gears for cutting Helical Gears. Note: For cutting Helical Gears, Pin F, Fig. 2, on Feed Gear Arm is inserted in Lower Hole

6. Now test the gear blank for concentricity with a test indicator, and make sure that the periphery revolves perfectly true with the hole. This is important, and is necessary to obtain smooth running gears.

7. Lower the cutter-slide by power until the center of the cutter is opposite the face of the gear blank. This is accomplished by moving lever *C* on the right-hand side of the machine, Fig. 12, to engage the cutter traversing mechanism and then operating lever *D* at the right of the machine to connect with the power mechanism.

8. Adjust the stanchion toward the gear blank, until the outside diameter of the cutter just grazes the periphery of the gear blank. This is accomplished by moving lever *C* to engage the stanchion traversing mechanism and then operating lever *D* to connect with the power of the mechanism. Take care that the blank is not cut by

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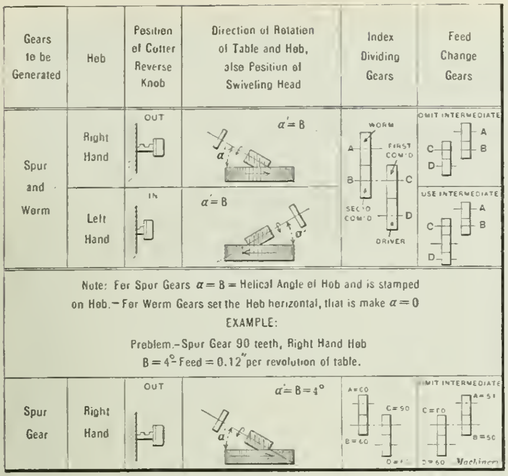
[1] Superintendent, Deane Steam Pump Works of the Worthington Pump & Machinery Corporation, Holyoke, Mass.



Gears to be Generated	Hob	Position of Cutter Reverse Knob	Direction of Rotation of Table and Hob, also Position of Swiveling Head	Index Dividing Gears	Feed Change Gears
Spur and Worm	Right Hand	OUT	$\alpha' = B$	WORM A FIRST COM'D B C SEC'D COM'D D DRIVER	OMIT INTERMEDIATE A B C D
	Left Hand	IN	$\alpha' = B$		USE INTERMEDIATE A B C D

Note: For Spur Gears $\alpha = B$ = Helical Angle of Hob and is stamped on Hob.—For Worm Gears set the Hob horizontal, that is make $\alpha = 0$

EXAMPLE:

Problem.—Spur Gear 90 teeth, Right Hand Hob

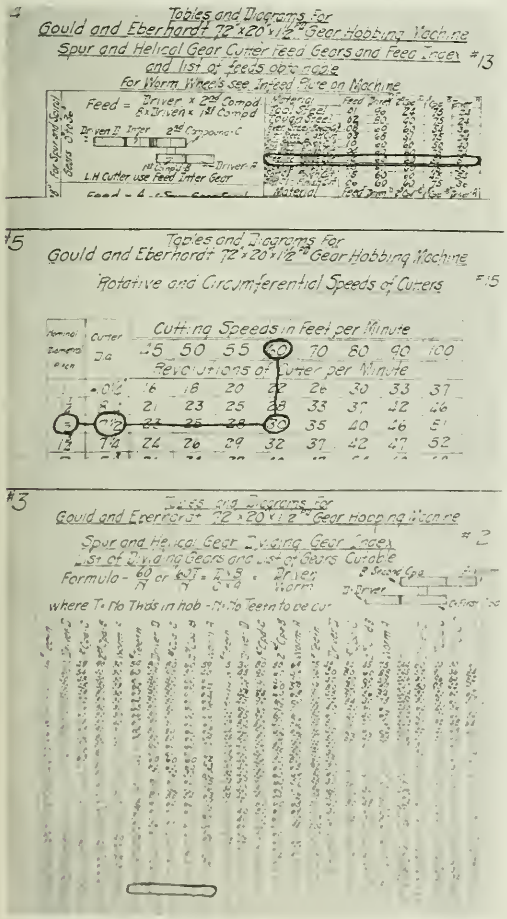
$B = 4°$—Feed = 0.12" per revolution of table.

Spur Gear	Right Hand	OUT	$\alpha' = B = 4°$	A=60 C=90 B=60 D=...	OMIT INTERMEDIATE A=51 C=60 B=50 D=60

Fig. 4. Data and Diagrams for Arrangement of Cutter-head, Hob and Gears for cutting Spur Gears. Note: For cutting Spur Gears, Pin F, Fig. 1, is inserted in Upper Hole

the cutter while making this adjustment. Loosen stanchion bolts before adjusting stanchion.

9. The cutter is now raised above the upper edge of the gear blank similar to the way in which it was lowered, as described under Step 7. The stanchion is now adjusted for the proper depth of tooth by means of crank handle *H*, Fig. 2, on the right-hand side of the machine. The proper depth can be read from the dial provided near the lead gears at the point marked *H*. The setting of the gear blank for the proper depth as outlined should not be relied upon to give the proper thickness at the pitch line. The thickness of tooth at the pitch line should be carefully calipered with a tooth gage or a Brown & Sharpe gear-tooth caliper. This measuring should be done when the center of the cutter has just passed the upper edge of the blank. When the stanchion has been adjusted to give the proper thickness of tooth at the pitch line, it should be rigidly secured to the base by the bolts provided for the purpose.



#4

Tables and Diagrams For
Gould and Eberhardt 72"x20"x1/2" Gear Hobbing Machine
Spur and Helical Gear Cutter Feed Gears and Feed Index #13
and list of feeds obtainable
For Worm Wheels see InFeed Plate on Machine

Feed = Driver × 2nd Compd / 8 × Driven × 1st Compd

Driven D Inter 2nd Compound-C
1st Compd-B Driver-A
L.H. Cutter use Feed Inter. Gear

#5

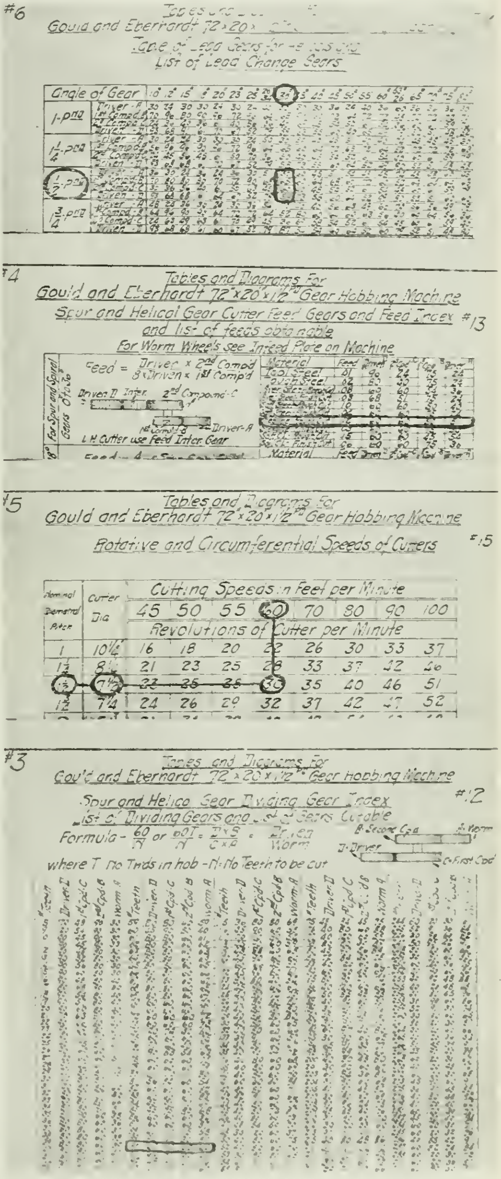
Tables and Diagrams For
Gould and Eberhardt 72"x20"x1/2" Gear Hobbing Machine
Rotative and Circumferential Speeds of Cutters #15

Nominal Diametral Pitch	Cutter Dia	45	50	55	60	70	80	90	100
1	10¼	16	18	20	22	26	30	33	37
1¼	8½	21	23	25	28	33	37	42	46
1⅓	7½	23	25	28	30	35	40	46	51
1½	7¼	24	26	29	32	37	42	47	52

#3

Tables and Diagrams For
Gould and Eberhardt 72"x20"x1/2" Gear Hobbing Machine
Spur and Helical Gear Dividing Gear Index #2
List of Dividing Gears and List of Gears Cutable
Formula - 60/N or 60T/N = D×B / C×A · Driver / Worm
where T = No Thds in hob - N = No Teeth to be cut

Fig. 5. Diagram showing Proper Selection of Index or Dividing Gears, Feed Change-gears and Cutter Speed Change-gears for the Spur Gear Problem



#6

Tables and Diagrams For
Gould and Eberhardt 72"x20"x1/2" Gear Hobbing Machine
Table of Lead Gears for Helical Gears and
List of Lead Change Gears

Angle of Gear
Driver
1st Compd
2nd Compd
Driven

#4

Tables and Diagrams For
Gould and Eberhardt 72"x20"x1/2" Gear Hobbing Machine
Spur and Helical Gear Cutter Feed Gears and Feed Index #13
and list of feeds obtainable
For Worm Wheels see InFeed Plate on Machine

Feed = Driver × 2nd Compd / 8 × Driven × 1st Compd

Driven D Inter 2nd Compound-C
1st Compd-B Driver-A
L.H. Cutter use Feed Inter. Gear

#5

Tables and Diagrams For
Gould and Eberhardt 72"x20"x1/2" Gear Hobbing Machine
Rotative and Circumferential Speeds of Cutters #15

Nominal Diametral Pitch	Cutter Dia	45	50	55	60	70	80	90	100
1	10¼	16	18	20	22	26	30	33	37
1¼	8½	21	23	25	28	33	37	42	46
1⅓	7½	23	25	28	30	35	40	46	51
1½	7¼	24	26	29	32	37	42	47	52

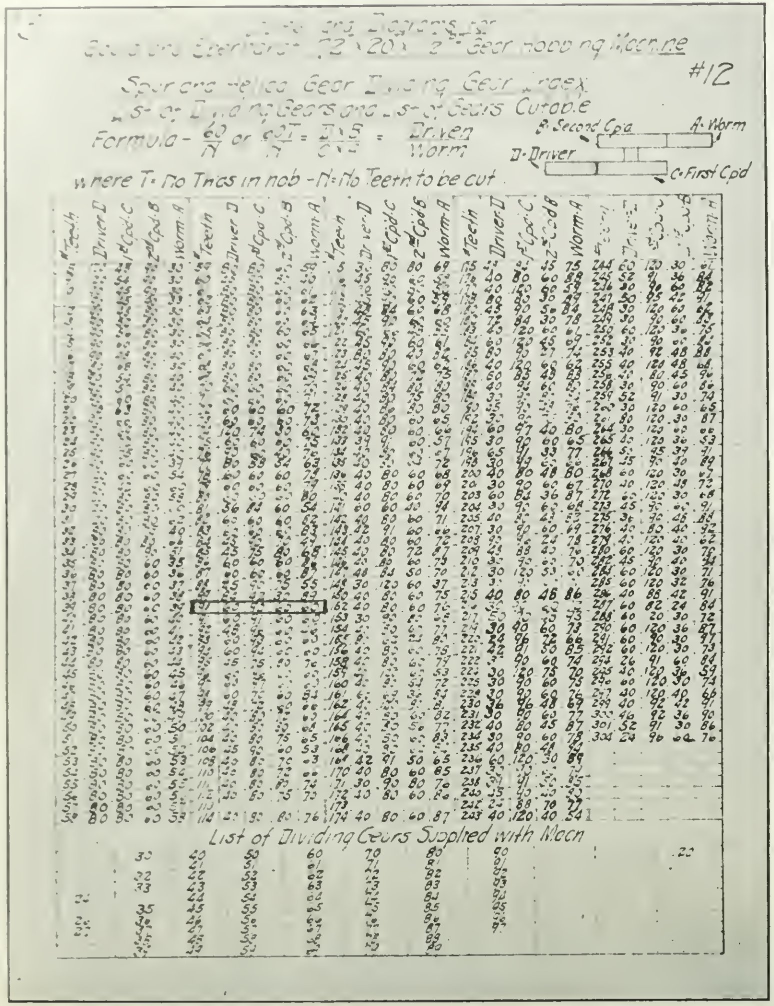
#3

Tables and Diagrams For
Gould and Eberhardt 72"x20"x1/2" Gear Hobbing Machine
Spur and Helical Gear Dividing Gear Index #12
List of Dividing Gears and List of Gears Cutable
Formula - 60/N or 60T/N = D×B / C×A · Driven / Worm
where T = No Thds in hob - N = No Teeth to be cut

Fig. 6. Diagram showing Proper Selection of Index or Dividing Gears, Feed Change-gears and Cutter Speed Change-gears for Helical Gear Problem

10. The feed gears are now selected, as per instructions in Table 2, and located with proper relation to each other, as

TABLE 1. SPUR AND HELICAL GEAR DIVIDING GEAR INDEX



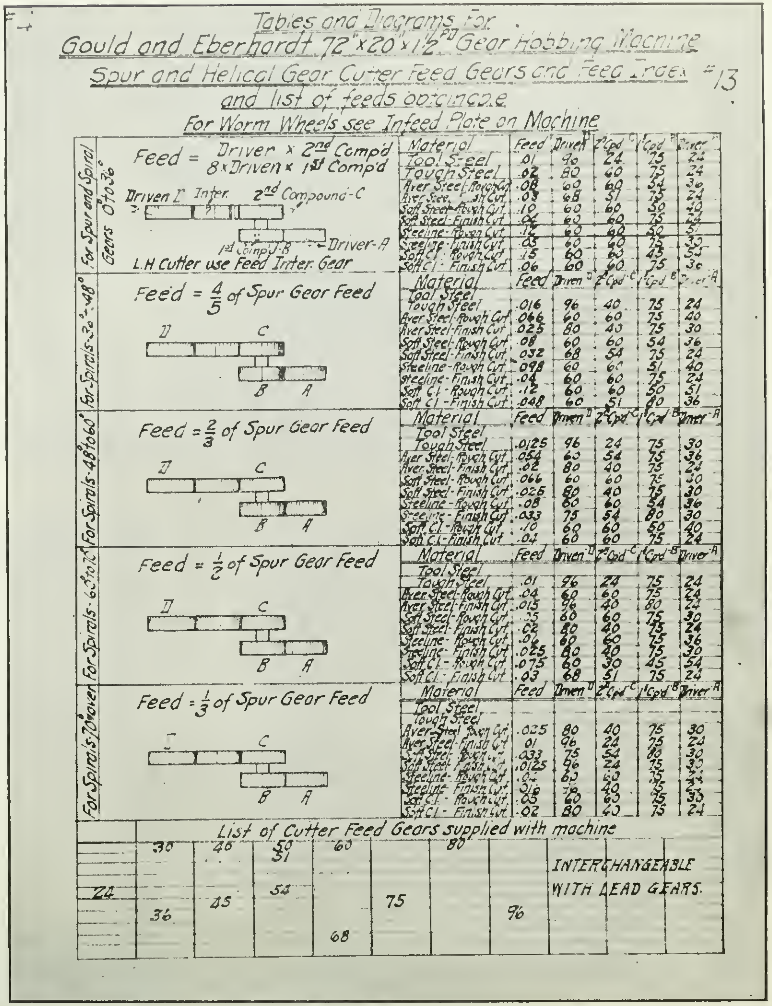
#12

where T = No. Thds in hob - N = No. Teeth to be cut

D-Driver
C-First Cpd
B-Second Cpd
A-Worm
Teeth
Driver D
1st Cpd C
2nd Cpd B
Worm A

List of Dividing Gears Supplied with Mach

TABLE 2. SPUR AND HELICAL GEAR CUTTER FEED AND FEED INDEX GEARS



Tables and Diagrams for
Gould and Eberhardt 72" × 20" × 1½" Gear Hobbing Machine
Spur and Helical Gear Cutter Feed Gears and Feed Index #13
and list of feeds obtainable
For Worm Wheels see Infeed Plate on Machine

For Spur and Spiral Gears 0° to 36°

$$\text{Feed} = \frac{\text{Driver} \times 2^{nd}\ \text{Comp'd}}{8 \times \text{Driven} \times 1^{st}\ \text{Comp'd}}$$

Driven D
Inter.
2nd Compound-C
1st Compd-B
Driver-A

L.H. Cutter use Feed Inter. Gear

Material	Feed	Driven D	2nd Cpd C	1st Cpd B	Driver A
Tool Steel	.01	96	24	75	24
Tough Steel	.02	80	40	75	24
Aver Steel-Rough Cut	.08	60	60	54	36
Aver Steel-Finish Cut	.03	68	51	75	24
Soft Steel-Rough Cut	.10	60	60	50	40
Soft Steel-Finish Cut	.04	60	60	75	24
Steeline-Rough Cut	.12	60	60	50	51
Steeline-Finish Cut	.05	60	60	75	30
Soft C.I.-Rough Cut	.15	60	60	45	54
Soft C.I.-Finish Cut	.06	60	60	75	36

For Spirals 36° to 48°

Feed = $\frac{4}{5}$ of Spur Gear Feed

Material	Feed	Driven D	2nd Cpd C	1st Cpd B	Driver A
Tool Steel Tough Steel	.016	96	40	75	24
Aver Steel-Rough Cut	.066	60	60	75	40
Aver Steel-Finish Cut	.025	80	40	75	30
Soft Steel-Rough Cut	.08	60	60	54	36
Soft Steel-Finish Cut	.032	68	54	75	24
Steeline-Rough Cut	.098	60	60	51	40
Steeline-Finish Cut	.04	60	60	75	24
Soft C.I.-Rough Cut	.12	60	60	50	51
Soft C.I.-Finish Cut	.048	60	51	80	36

For Spirals 48° to 60°

Feed = $\frac{2}{3}$ of Spur Gear Feed

Material	Feed	Driven D	2nd Cpd C	1st Cpd B	Driver A
Tool Steel Tough Steel	.0125	96	24	75	30
Aver Steel-Rough Cut	.054	60	54	75	36
Aver Steel-Finish Cut	.02	80	40	75	24
Soft Steel-Rough Cut	.066	60	60	75	30
Soft Steel-Finish Cut	.025	80	40	75	30
Steeline-Rough Cut	.08	60	60	54	36
Steeline-Finish Cut	.033	75	54	80	30
Soft C.I.-Rough Cut	.10	60	60	50	40
Soft C.I.-Finish Cut	.04	60	60	75	24

For Spirals 60° to 70°

Feed = $\frac{1}{2}$ of Spur Gear Feed

Material	Feed	Driven D	2nd Cpd C	1st Cpd B	Driver A
Tool Steel Tough Steel	.01	96	24	75	24
Aver Steel-Rough Cut	.04	60	60	75	24
Aver Steel-Finish Cut	.015	96	40	80	24
Soft Steel-Rough Cut	.05	60	60	75	30
Soft Steel-Finish Cut	.02	80	40	75	24
Steeline-Rough Cut	.06	60	60	75	36
Steeline-Finish Cut	.025	80	40	75	30
Soft C.I.-Rough Cut	.075	60	30	45	54
Soft C.I.-Finish Cut	.03	68	51	75	24

For Spirals 70° over

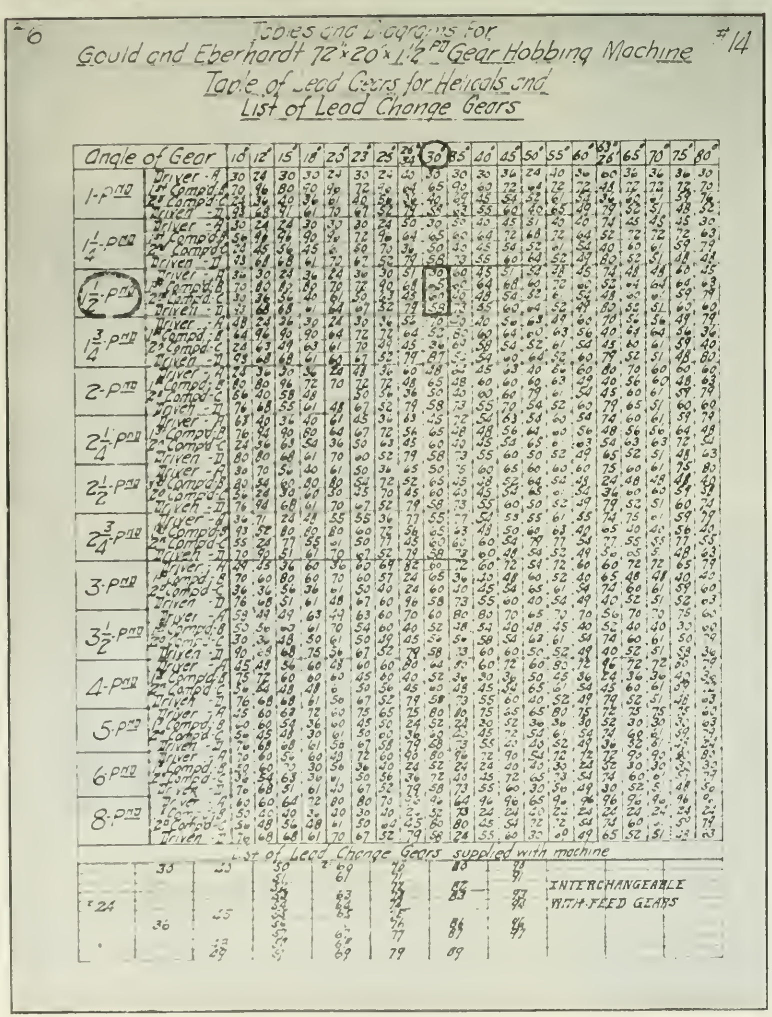
Feed = $\frac{1}{3}$ of Spur Gear Feed

Material	Feed	Driven D	2nd Cpd C	1st Cpd B	Driver A
Tool Steel Tough Steel					
Aver Steel-Rough Cut	.025	80	40	75	30
Aver Steel-Finish Cut	.01	96	24	75	24
Soft Steel-Rough Cut	.033	75	54	80	30
Soft Steel-Finish Cut	.0125	96	24	75	30
Steeline-Rough Cut	.04	60	60	75	24
Steeline-Finish Cut	.016	96	40	75	24
Soft C.I.-Rough Cut	.05	60	60	75	33
Soft C.I.-Finish Cut	.02	80	40	75	24

List of Cutter Feed Gears supplied with machine

24	30 36	48 45	50 51 54	60 68	75	80 96	INTERCHANGEABLE WITH LEAD GEARS	

TABLE 3. LEAD GEARS FOR HELICAL GEARS AND LIST OF LEAD CHANGE-GEARS



-6 #14

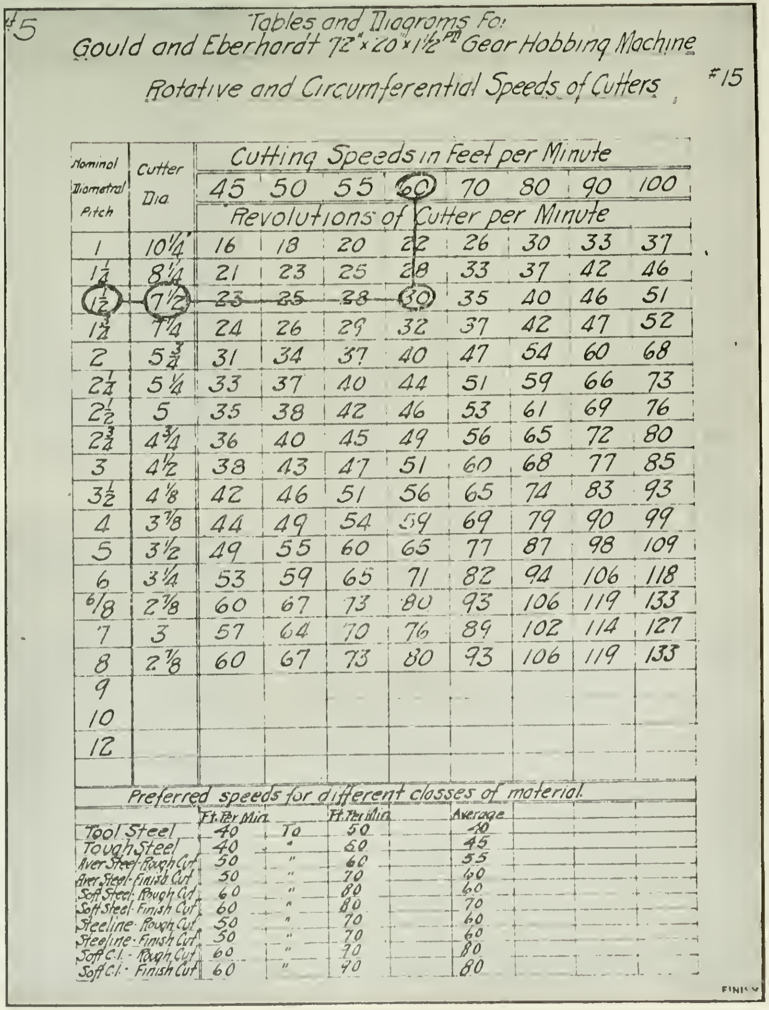
Tables and Diagrams for
Gould and Eberhardt 72"×20"×1½ P.D. Gear Hobbing Machine
Table of Lead Gears for Helicals and
List of Lead Change Gears

Angle of Gear		10°	12°	15°	18°	20°	23°	25°	26°34'	30°	35°	40°	45°	50°	55°	60°	63°26'	65°	70°	75°	80°
1-P.D.	Driver - A	30	24	30	30	24	30	24	40	30	30	30	36	24	40	36	60	36	36	36	30
	1st Compd - B	70	96	80	90	90	72	90	64	65	90	60	72	64	72	72	48	72	72	72	70
	2nd Compd - C	24	36	40	36	61	40	56	36	40	69	45	54	52	61	54	36	60	61	59	76
	Driven - D	93	68	91	61	70	67	52	79	58	73	55	60	40	65	49	79	52	51	48	52
1¼-P.D.	Driver - A	30	24	24	30	30	30	24	50	30	50	40	45	51	40	40	74	45	45	45	30
	1st Compd - B	56	96	96	90	90	72	96	64	65	60	64	72	68	72	64	52	72	72	72	63
	2nd Compd - C	24	45	56	45	60	60	70	36	50	40	45	54	52	61	54	40	60	61	59	79
	Driven - D	93	68	68	61	72	67	52	79	58	73	55	60	64	52	49	80	52	51	48	48
1½-P.D.	Driver - A	36	30	24	36	24	36	30	51	30	60	45	51	54	48	45	74	48	48	60	35
	1st Compd - B	70	80	80	80	70	72	90	64	65	60	64	68	60	72	60	52	64	64	60	63
	2nd Compd - C	30	36	56	40	61	50	63	45	60	40	48	54	52	61	54	48	60	61	59	79
	Driven - D	93	68	68	61	64	67	52	79	58	73	55	60	64	52	49	80	52	51	60	60
1¾-P.D.	Driver - A	48	24	36	30	24	30	36	56	70	60	40	56	63	49	60	70	56	56	49	79
	1st Compd - B	64	96	90	90	64	72	72	64	52	60	60	64	60	63	56	40	64	64	56	36
	2nd Compd - C	24	63	49	63	61	70	49	45	36	60	58	54	52	61	54	45	60	61	59	40
	Driven - D	93	68	68	61	60	67	52	79	87	[illegible]	54	60	64	52	60	79	52	51	48	80
2-P.D.	Driver - A	24	36	30	36	24	48	36	60	48	60	45	63	40	64	60	80	70	60	60	60
	1st Compd - B	80	80	96	72	70	72	72	48	65	48	60	60	60	63	49	40	56	60	48	63
	2nd Compd - C	56	40	58	48		50	56	36	50	40	60	60	79	61	54	45	60	61	59	79
	Driven - D	76	68	55	61	48	67	52	79	58	73	55	70	54	52	60	79	65	51	60	60
2¼-P.D.	Driver - A	63	40	36	40	61	45	36	63	45	72	54	63	54	60	54	74	60	61	59	79
	1st Compd - B	76	94	90	60	64	67	72	56	65	48	48	56	64	60	56	48	56	56	64	48
	2nd Compd - C	24	36	63	54	36	50	63	45	60	40	45	54	65	61	63	54	63	63	72	54
	Driven - D	80	80	68	61	70	60	52	79	58	73	55	60	50	52	49	65	52	51	48	63
2½-P.D.	Driver - A	30	70	56	40	61	50	36	65	50	75	60	65	60	60	60	75	60	61	75	80
	1st Compd - B	40	54	60	80	80	54	72	52	65	45	48	52	64	54	49	24	48	48	48	40
	2nd Compd - C	56	24	30	60	30	45	70	45	60	40	45	54	65	61	54	36	60	60	59	58
	Driven - D	76	94	68	61	70	67	52	79	58	73	55	60	50	52	49	79	52	51	60	74
2¾-P.D.	Driver - A	36	71	24	48	55	55	36	77	55	77	54	53	55	61	55	74	75	61	59	79
	1st Compd - B	93	52	80	80	80	60	72	56	65	63	48	50	60	63	40	65	40	40	56	40
	2nd Compd - C	55	24	77	55	61	50	77	45	60	60	60	54	79	77	54	77	55	55	77	55
	Driven - D	70	90	51	61	70	67	52	79	58	73	60	48	54	52	49	56	65	51	48	63
3-P.D.	Driver - A	49	45	36	60	36	60	69	82	60	72	60	72	54	72	60	60	72	72	65	79
	1st Compd - B	70	60	80	60	70	60	57	24	65	36	40	48	60	52	40	65	48	48	40	40
	2nd Compd - C	36	36	56	36	61	50	40	24	60	40	45	54	65	61	54	74	60	61	59	60
	Driven - D	76	68	51	61	48	67	60	96	58	73	55	60	40	54	49	40	52	51	52	63
3½-P.D.	Driver - A	59	49	49	63	49	63	60	70	60	80	80	70	65	70	70	56	70	70	75	60
	1st Compd - B	50	56	60	61	70	54	60	40	52	48	54	40	48	45	40	52	40	40	30	60
	2nd Compd - C	30	36	48	50	61	50	49	45	56	56	58	54	63	61	54	74	60	61	50	79
	Driven - D	90	68	68	75	56	67	52	79	58	73	60	60	50	52	49	40	52	51	58	36
4-P.D.	Driver - A	45	48	56	60	48	60	60	80	64	90	60	72	60	80	72	96	72	72	60	79
	1st Compd - B	75	72	60	60	60	45	60	40	52	36	30	36	50	45	36	24	36	36	40	36
	2nd Compd - C	56	64	48	48	[illegible]	50	56	45	60	49	45	54	65	61	54	45	60	61	59	[illegible]
	Driven - D	76	68	68	61	56	67	52	79	58	73	55	60	40	52	49	79	52	51	40	63
5-P.D.	Driver - A	45	60	63	72	60	75	65	75	80	80	75	65	65	80	75	72	75	75	75	60
	1st Compd - B	60	60	54	36	60	45	50	24	52	24	20	52	36	36	30	52	30	30	30	63
	2nd Compd - C	56	45	48	30	61	50	60	36	60	40	45	72	54	61	54	74	60	61	59	79
	Driven - D	70	68	68	61	56	67	58	79	68	73	55	40	40	52	49	36	32	61	[illegible]	24
6-P.D.	Driver - A	70	60	56	60	48	72	60	90	80	96	72	90	54	72	72	72	90	90	[illegible]	80
	1st Compd - B	50	60	70	30	56	36	40	24	52	24	24	40	40	30	24	52	30	30	[illegible]	30
	2nd Compd - C	36	54	63	36	61	50	56	36	72	40	45	72	65	73	54	74	60	60	51	77
	Driven - D	70	68	51	61	40	67	52	79	58	73	55	60	30	56	49	30	52	51	48	50
8-P.D.	Driver - A	60	60	64	72	80	80	70	[illegible]	96	64	96	96	65	96	96	96	96	96	96	96
	1st Compd - B	50	40	40	36	40	30	40	24	52	73	24	24	40	24	24	24	24	24	24	24
	2nd Compd - C	56	48	56	48	61	50	60	45	60	80	45	54	72	72	54	73	60	[illegible]	50	79
	Driven - D	76	68	68	61	70	67	52	79	58	24	55	60	30	60	49	65	52	51	[illegible]	63

List of Lead Change Gears supplied with machine

2 24	33 36	25 25 29	50 51 52 53 54 55 56 57 59	2 60 61 63 64 65 67 68 69	70 71 72 73 74 75 76 77 79	80 82 83 86 87 89	90 91 93 94 96 97	INTERCHANGEABLE WITH FEED GEARS

TABLE 4 ROTATIVE AND CIRCUMFERENTIAL SPEEDS OF CUTTERS



#5 #15

Tables and Diagrams For
Gould and Eberhardt 72"×20"×1½ P.D. Gear Hobbing Machine
Rotative and Circumferential Speeds of Cutters

Nominal Diametral Pitch	Cutter Dia	Cutting Speeds in Feet per Minute							
		45	50	55	60	70	80	90	100
		Revolutions of Cutter per Minute							
1	10¼	16	18	20	22	26	30	33	37
1¼	8¼	21	23	25	28	33	37	42	46
1½	7½	23	25	28	30	35	40	46	51
1¾	7¼	24	26	29	32	37	42	47	52
2	5¾	31	34	37	40	47	54	60	68
2¼	5¼	33	37	40	44	51	59	66	73
2½	5	35	38	42	46	53	61	69	76
2¾	4¾	36	40	45	49	56	65	72	80
3	4½	38	43	47	51	60	68	77	85
3½	4⅛	42	46	51	56	65	74	83	93
4	3⅞	44	49	54	59	69	79	90	99
5	3½	49	55	60	65	77	87	98	109
6	3¼	53	59	65	71	82	94	106	118
6/8	2⅞	60	67	73	80	93	106	119	133
7	3	57	64	70	76	89	102	114	127
8	2⅞	60	67	73	80	93	106	119	133
9									
10									
12									

Preferred speeds for different classes of material.

	Ft. Per Min.		Ft. Per Min.	Average
Tool Steel	40	To	50	40
Tough Steel	40	"	60	45
Aver. Steel - Rough Cut	50	"	60	55
Aver. Steel - Finish Cut	50	"	70	60
Soft Steel - Rough Cut	60	"	80	60
Soft Steel - Finish Cut	60	"	80	70
Steeline - Rough Cut	50	"	70	60
Steeline - Finish Cut	50	"	70	60
Soft C.I. - Rough Cut	60	"	70	80
Soft C.I. - Finish Cut	60	"	90	80

indicated in Fig. 4 for spur gears, and in Fig. 3 for helical gears. Make sure the index and lead gears are properly set before feed stop and start plunger *E*, Fig. 12, is engaged.

11. The feed to the cutter is now engaged by raising the feed stop and start plunger *E* at the right-hand side of the machine. Take care to have lever *C* in its proper position for feeding the cutter-slide. The feed stop and start plunger *E* should not be raised with lever *C* in the position for the stanchion traverse (except as stated later for worm-wheel hobbing) until the bolts on the stanchion are loosened.

12. The feed trip-dog *G* at the left of the machine is next adjusted to stop the machine when the teeth in the gear blank have been completed. The feed trip-rod operates a clutch in the pulley and stops the entire machine. To again connect the clutch, lever *B* is operated to the left and the belt moved by hand until the clutch teeth engage. Do not try to throw the clutch lever *B* into engagement while pulley is revolving rapidly.

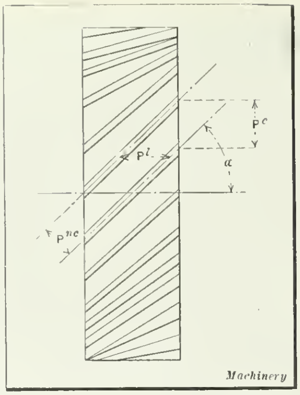


Fig. 7. Diagram explaining Nomenclature

Instructions for Cutting Spur Gears

The following gives instructions for setting the hob, cutter-arbor, index dividing gears and feed change-gears for cutting spur gears. For example, suppose it is required to cut a "steeline" spur gear of 90 teeth and 1½ nominal diametral pitch, with a right-hand hob having an angle $B = 4$ degrees.

1. Refer to Table 1 for index dividing gears; find for 90 teeth the dividing change-gears and arrange as indicated in Figs. 1 and 4.

2. Refer to Table 2 for feed change-gears and find for a steeline spur gear the feed change-gears and arrange as indicated in Figs. 1 and 4.

3. Throw lever *F*, Fig. 1, into spur gear position.

4. Refer to Table 4 for cutter speeds, and assume that the cutter diameter corresponds to that given in the table for 1½ nominal diametral pitch, namely, 7½ inches; assume that 60 feet per minute is the desired cutting speed. Then the hob should make 30 revolutions per minute. Now refer to the cutter-speed index-gear tag located to the left of the cutter-speed change-gear studs and select the change-gears that will give revolutions of the cutter corresponding closely to 30 revolutions. In this instance, we select change-gear *A* with 24 teeth and change-gear *B* with 36 teeth. For convenience, the cutter-speed gear table is given below:

Cutter Speed Table
Gears for Cutter Speeds

R.P.M.	Driver A	Driven B
16	16	44
19	18	42
22	20	40
26	22	38
30	24	36
35	26	34
41	29	31
48	31	29
57	34	26
68	36	24

5. Refer to the third column in Fig. 4 for the position of the cutter reverse knob.

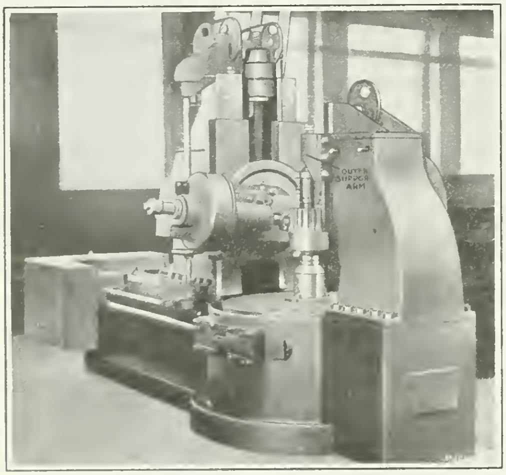


Fig. 8. General View of Gould & Eberhardt 72- by 20-inch Automatic Spur and Helical Gear Hobbing Machine taken from Front of Machine

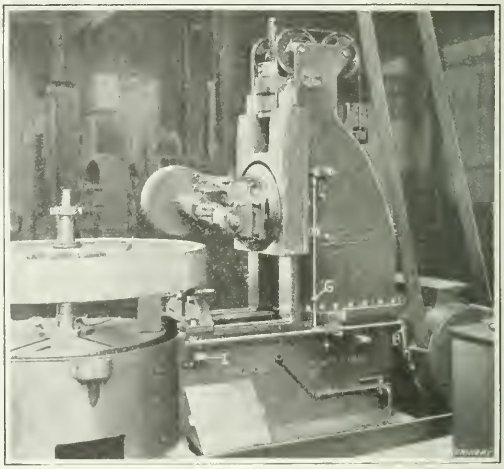


Fig. 9. View of Machine shown in Fig. 8 taken from Side and showing Location of Pulley Clutch Lever B, Feed Trip-dog G and In-feed Trip-dog I

Nomenclature (See Fig. 7)

N = number of teeth to be cut;
P^d = diametral pitch of gear;
P^{nd} = normal diametral pitch of gear;
P^c = circular pitch of gear;
P^{nc} = normal circular pitch of gear;
P^l = linear pitch;
α = angle of helix with axis;
B = angle marked on helical cutter;
α' = angle to set cutter;
a = addendum of tooth;
T = number of threads in hob;
E = difference between 1 and the result of proof formula;
V = ratio of lead gearing;

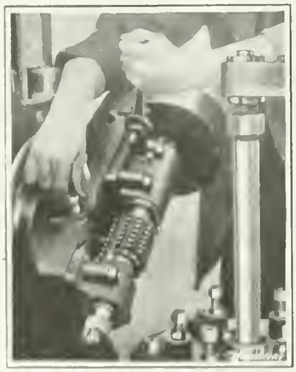


Fig. 10. Method of using Hob-setting Device on 84-inch Gould & Eberhardt Automatic Gear-hobbing Machine

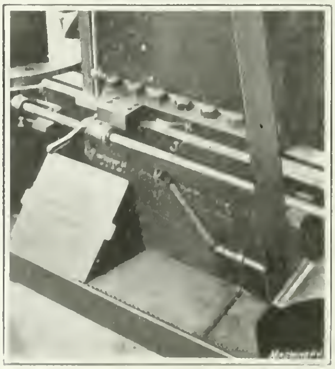


Fig. 11. View of Machine showing Positions of In-feed Trip-dog I, Vernier Scale J and Vernier K

6. Refer to the fourth column in Fig. 4 for the position of the swiveling cutter-head and hob, and also for the direction of rotation of the work-table and hob. In this case the swiveling cutter-head must be set on the left side, making an angle with the plane of the work-table that is equivalent to the angle of the thread of the hob and is generally found stamped on the end of the hob. Angle *B* in this case is 4 degrees.

7. Set cutter-feed trip-dog *G*, Fig. 12, so that the cutter feed will be disengaged when the gear has been cut through.

Instructions for Cutting Worm-gears

In hobbing worm-wheels, the hob cutter should be an exact duplicate of the worm except in outside diameter. The hob is set with its axis perpendicular to the axis of the worm-wheel blank and then fed toward the blank until the full depth of the tooth is reached. The method of cutting worm-gears by the above process is the same as employed for spur gears with the following exceptions:

1. The swiveling cutter-head must be in a horizontal position so that the axis of the hob will be perpendicular to the axis of the worm-wheel blank, instead of occupying the position required by Step 6 under the spur gear instructions.

2. To operate the stanchion feed, disengage the vertical feed of the hob cutter by throwing lever *C* into the stanchion traverse position.

3. Throw lever *F*, Figs. 1 and 12, into spur gear position.

4. The stanchion feed is engaged by raising the feed stop and start plunger *E*. Note that the stanchion binding bolts must be loose when feeding the stanchion.

5. To feed toward the work, select feed per revolutions as dictated by best judgment for the material to be cut and then approximate that as closely as possible, selecting the change-gears from the "in-feed plate" tag located to the left of the driven feed gear on the feed-gear side of the machine.

Worm-gear Cutter Feed Gear

In-feed per Revolution of Blank	Driver A	1st Comp. B	2d Comp. C	Driven D
0.0030	24	24	96	97
0.0040	24	24	96	75
0.0052	24	30	96	75
0.0067	24	48	96	90
0.0085	24	51	96	75
0.0105	24	63	96	75
0.0127	24	60	96	60
0.0152	24	57	75	60

6. Set stanchion trip-dog *I*, Figs. 9, 11 and 12, to automatically stop stanchion feed at the proper center distance.

7. A scale and vernier is provided at *J*, Fig. 11, to determine the center distance between the work and arbors. It should be recalled that feeding the hob toward the worm-wheel blank in this manner does not form a theoretically correct tooth, because the theoretical helix angle is constantly changing, due to the changing center distances. Since the helix angle is constantly changing, the hob cuts away portions of the tooth that are necessary to give perfect contact with the worm. Theoretically correct worm-gears may be generated with a fly cutter or with a straight or taper hob, preferably a taper hob, fed in a plane perpendicular to the axis of the worm-wheel blank. For a complete description of methods of cutting worm-wheels, see Chapter X of "Spiral and Worm Gearing," published by The Industrial Press, New York City. When proper hobs are not available and emergency requires prompt cutting of a worm-wheel, an approximation may be cut by using the ordinary spur gear hob, provided it has the proper rack tooth section. To use the ordinary spur gear hob, set the machine the same as usual for cutting worm-gears, but the swiveling cutter-head must be set with relation to the axis of the work so that the helix of the hob is parallel with the helix angle of the worm measured at the pitch line. For example, assume the helix angle of the worm measured at the pitch line $= \alpha = 30$ degrees and the helix angle of the spur gear hob $= B = 4$ degrees; then the swiveling cutter-head should be set at an angle with the work-table equal to $\alpha' = \alpha - B = 30 - 4 = 26$ degrees.

Instructions for Cutting Helical Gears

The following gives instructions for setting the hob, cutter-arbor, index dividing gears, feed change-gears and lead change-gears for cutting helical gears. For example, suppose it is required to cut a right-hand 30-degree steel helical gear of 90 teeth and 1½ normal diametral pitch, with a right-hand hob having an angle $B = 4$ degrees.

1. Select and arrange the index dividing gears the same as for spur gears, Step 1.

2. Select and arrange the feed change-gears the same as for spur gears, Step 2, but base feed on steel instead of "steeline," and also select a feed corresponding to the proper spiral angle.

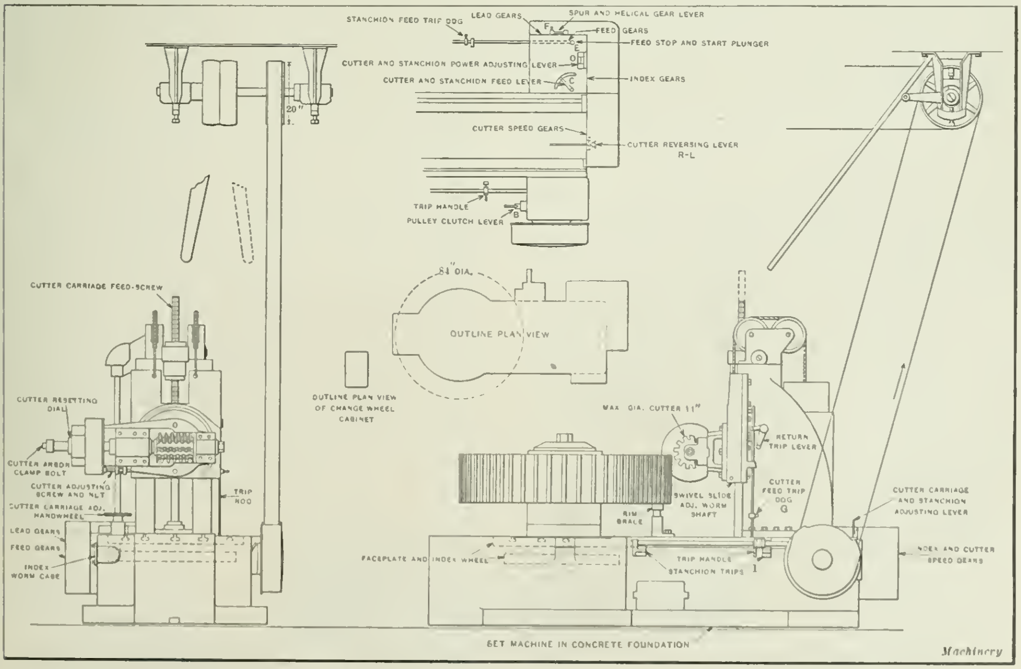

STANCHION FEED TRIP DOG
LEAD GEARS
SPUR AND HELICAL GEAR LEVER
F
FEED GEARS
FEED STOP AND START PLUNGER
E
D
CUTTER AND STANCHION POWER ADJUSTING LEVER
CUTTER AND STANCHION FEED LEVER
C
INDEX GEARS
CUTTER SPEED GEARS
CUTTER REVERSING LEVER R-L
TRIP HANDLE
PULLEY CLUTCH LEVER
B
20"
84" DIA.
OUTLINE PLAN VIEW
OUTLINE PLAN VIEW OF CHANGE WHEEL CABINET
CUTTER CARRIAGE FEED-SCREW
CUTTER RESETTING DIAL
CUTTER ARBOR CLAMP BOLT
CUTTER ADJUSTING SCREW AND NUT
CUTTER CARRIAGE ADJ. HANDWHEEL
LEAD GEARS
FEED GEARS
INDEX WORM CASE
TRIP DOG
MAX. DIA. CUTTER 11"
RETURN TRIP LEVER
CUTTER FEED TRIP DOG G
SWIVEL SLIDE ADJ. WORM SHAFT
RIM BRACE
CUTTER CARRIAGE AND STANCHION ADJUSTING LEVER
FACEPLATE AND INDEX WHEEL
TRIP HANDLE
STANCHION TRIPS
I
INDEX AND CUTTER SPEED GEARS
SET MACHINE IN CONCRETE FOUNDATION
Machinery

Fig. 12. Front, Side and Plan Views of Machine showing Locations of Pulley Clutch Lever B. Cutter and Stanchion Feed Lever C. Cutter and Stanchion Control Lever D, Feed Stop and Start Plunger E, Spur and Helical Gear Lever F, Cutter Feed Trip-dog G, Stanchion Trips I, and Cutter Reversing Knob RL

3. Refer to Table 3 of lead change-gears, and select for 1½ normal diametral pitch, 30-degree spiral gear angle the lead change-gears and arrange as shown in Fig. 3.

4. Select and arrange the cutter speeds the same as for spur gears, Step 4.

5. Throw lever *F*, Figs. 2 and 12, into helical gear position.

6. To set cutter reverse knob, refer to Fig. 3, third column from left.

7. To set swiveling cutter-head, refer to Fig. 3, fourth column from left, where will also be found instructions for direction of rotation of work-table and hob. In this case the swiveling cutter-head must be set on the right side, making an angle with the plane of the work-table which is equivalent to the spiral angle of the gear = a less the thread angle of the hob = B.

8. To cut a left-hand helical gear with the same hob, the swiveling cutter-head must be set on the left side, making an angle with the plane of the work-table which is equivalent to the spiral angle of the gear = a plus the thread angle of the hob = B.

* * *

CRITICIZING THE DESIGNER

BY DONALD A. HAMPSON[1]

It seems to be one of the fundamental traits of human nature to criticize, and men engaged in the machine business are no exception to the general rule. Criticism is all right in its place; indeed, it is often the whip that spurs us on to better efforts and finally brings success out of our failures. To criticize poor workmanship is but just to all concerned; to criticize a person's best efforts without qualifying the remarks or considering the obstacles that it may have been necessary to overcome is certainly unjust. In line with the latter the designer of tools and machinery comes in for his full share of unfairness. Every day we hear someone say in criticism of some piece of machinery, "Why didn't he do it this way?" or, "If he had only made a different kind of latch, a man could get the pieces in and out of the jig," and the remark is usually ended with, "I would have made it so and so at the start and avoided that trouble." Now the truth is the designer is up against more than he is given credit for. The man who can see in his mind the completed device while making the first pencil marks is exercising his brain to a far greater extent than the man who calmly suggests a minor change after he has seen the other's work. And yet unconsciously we put the critic down as a smart man and the designer as a sort of botch. When a piece is completed, the preliminary work does not show, the conditions under which the designer labored are not apparent, the lack of data and time given him and the absence of similar work in the same line with which to make a start are not considered. A typical case of criticism will show just these points. It is one that is familiar to designers who develop for inventors. An inventor conceived the idea of a machine for wrapping, folding and addressing magazines, printing the names from a celluloid stencil that was to be handled by means of suction applied at definite points and set to suit the particular issue. The one thing really "invented" was the air handling of a stencil of a given material. With this as a basis, the inventor went to a designer with instructions to lay out the machine—nothing else. The designer had little to work from outside of these meager instructions and the knowledge picked up, by good luck, from the failures of several other machines built to do practically the same work. In the course of six months, the blueprints were ready to go to the shop.

The machine, when built, was a model of good designing, and if it had worked as well "loaded" as when running "light," it would have been a complete success. Also it would have surprised any man of experience in the special machinery field; but not the inventor. He could not understand why his stencils did not handle properly, why a magazine would be skipped sometimes, why the wrapping paper got tangled up. He was sure his scheme was all right, but he was afraid the designer had bungled the arrangement. The designer suggested certain changes after seeing the machine run which, with many others, were tried out, and in the course of two years the machine was ready for the market. Today that machine is the best in the field, taken all around, and does its work to a purchaser's satisfaction. But an examination will show that the celluloid stencil has given place to a steel one and the air handling to mechanical means. Nothing remains of the original machine but the lay-out and the frame and drive; the designer's work is practically all there and the inventor's is not. Many details, of course, had to be changed entirely, and a healthy scrap pile was acquired in the changing. But the unfair part is that the inventor gazes fondly at the machine as he shows it to a friend and says: "It's all mine—most of Smith's work had to be thrown away—mine, that I and the boys in the shop built out of the wreck. You know, a thing that looks good on paper doesn't always work out that way." Yes, and even the boys in the shop had been heard to criticize Smith for the feed that clogged and for numberless other constructions that would have been better another way. However, a remarkable thing about Smith's work was its correctness, and the shopmen cannot fail to admire secretly the man who could design a machine of such magnitude and not have a single interference anywhere or leave off a couple of bosses.

Smith's is just another instance of a job well done for which no credit is given, but on which criticism is freely bestowed. He represents a class whose only reward may be the consciousness of having done well and of knowing that it is far easier to criticize than to create; they are the real mechanical pioneers.

* * *

LOCOMOTIVE FEEDWATER HEATING[1]

Heating the feedwater of a locomotive by heat otherwise wasted is a fairly general practice in all the more progressive European countries, but experiments along these lines have been spasmodic in this country up to a recent period. By investigating the general distribution of heat in a locomotive, it was found that 65.2 per cent of the total heat of the coal is discharged in the exhaust steam, mostly in the form of latent heat. The exhaust steam, of course, does some work in producing draft and cannot be considered as a total loss, but calculations can be made which will easily show that it is largely loss, and that a small proportion of this heat could perform the work of producing draft satisfactorily. It is evident that if any part of this heat is reclaimed and returned to the boiler, it will allow a reduction of the same amount in the quantity of heat supplied by the coal to produce the same cylinder horsepower. The most natural and feasible method of collecting part of this waste and delivering it into the boiler is by using as much of it as is practicable to heat the feedwater before it enters the boiler.

Another feature of the subject is the effect of feedwater heating on the boiler efficiency. As the rate of combustion is decreased the boiler efficiency increases, and when a feedwater heater is applied to a locomotive it allows the production of the desired amount of steam with a reduction in the amount of coal fired, which increases the boiler efficiency. In the case of a large passenger locomotive, a reduction of ten pounds of coal per square foot of grate area per hour gives an increase in boiler efficiency of about 3 per cent, which should be credited to the heater. A rule of thumb that has long been used in stationary and marine practice is that for each 11 degrees that the feedwater is heated by a source otherwise wasted, there will be a 1 per cent saving in fuel. Such experiments as have been made on locomotives indicate that this amount is conservative and can be easily attained. When the maximum capacity of the locomotive is being used, savings considerably in excess of this are indicated. It appears that an economy of at least 10 per cent can be reasonably expected even at light rates of working.

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The present price of gasoline in Sweden is about 85 cents a gallon. This indicates the scarcity of motor fuel in the neutral countries and incidentally in the Central Empires.

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[1] Address: 21 Hanford St., Middletown, N. Y.

[1] Abstract of a paper read before the Minnesota section of the A. S. M. E. on March 10, 1917, by George M. Basford, New York City

TAPS AND TAPPING EQUIPMENT[1]

MODERN DEVELOPMENTS IN DESIGN OF TAPS AND TAPPING APPLIANCES—IMPORTANT FACTORS AFFECTING ACTION OF TAPS—VARIOUS TYPES OF TAP-HOLDING CHUCKS

BY FRANKLIN D. JONES[2]

THE relation between taps and other tools that may be used for cutting screw threads in holes is similar to the relation between dies and the various classes of equipment that are adapted for cutting external threads. The principal points of similarity between taps and dies pertain, first, to the extent of their application, and, second, to the factors that govern their use. Taps are employed for most internal thread cutting operations, just as most external threads are cut with dies, but the extent to which taps are applied for internal threading gradually diminishes as the diameter of the threaded part increases above a certain size, which applies also to the use of dies in cutting external threads. While practically all small holes that are to receive machine screws, studs, bolts, etc., are threaded by means of taps, tools of this class are not suitable for cutting a great many of the larger screw threads. It is impracticable, of course, to draw a definite dividing line on the basis of diameter alone, since there are frequently other important conditions that affect the problem. Whether or not taps may be used to advantage often depends upon: (1) number of parts requiring screw threads or amount of work; (2) diameter and pitch of thread; (3) relation between thread-cutting and other machining operations. If cutting the thread is the principal or only operation, and especially if the parts are required in large numbers, a tap might be used even for quite large diameters in order to cut the threads quickly. Pipe fittings, which have comparatively fine threads, are an example.

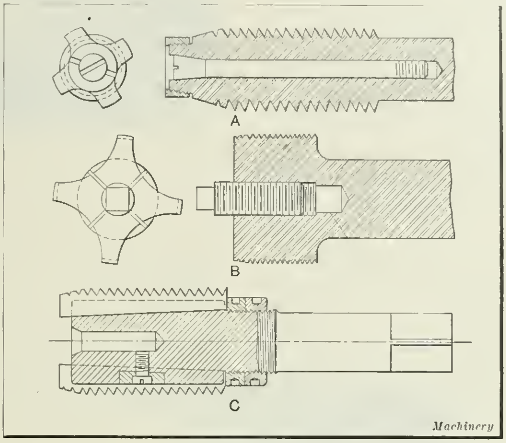

Fig. 1. Taps that can be adjusted to compensate for Wear or for varying Size

The equipment that is available in a shop is another important point, since there is often a close relationship between investment and method. No experienced manufacturer or shop superintendent would consider making or buying high-priced taps for a certain job unless the number of parts to be tapped were large enough to warrant the expenditure. For cutting a few threads, the engine lathe might be more economical and often preferable regardless of the quantity, either because of the diameter of the thread, pitch, or relation to other machined surfaces. In one sense, every tap is a special tool, since it can only be used for cutting one pitch of thread, and is usually intended for only one diameter, although in some cases a slight adjustment may be made above or below the standard size. For that reason, we find that taps, as well as dies, are used principally on machine tools that are designed more especially for producing duplicate parts in quantity than for handling a large variety of work. For instance, practically all the internal thread cutting on turret lathes or automatic screw machines is done by taps, just as most of the external thread cutting is done by dies.

Non-collapsing Taps

The fixed or non-collapsing tap is the most important class if judged by the extent to which it is used. Non-collapsing taps may be divided into three general types, as follows: (1) solid taps, or those formed of one solid piece of steel; (2) adjustable taps, which usually have inserted blades that can be adjusted a certain amount radially; and (3) inserted-blade non-adjustable taps. All these taps may also be further classified according to whether they cut straight or tapering screw threads, and also with reference to their intended use. For example, there are hand taps for use when tapping holes by hand; tapper taps for tapping nuts in regular tapping machines; staybolt taps for tapping the inner and outer sheets of steam boiler fireboxes; pipe taps for tapping holes for standard pipe sizes; screw machine taps for use on automatic screw machines; and various other classes.

While solid taps are the cheapest and are used the most, a great many adjustable taps are found in modern shops and are applied especially when accuracy is essential. A solid tap is liable to slight changes in diameter due to hardening, and there is, of course, some reduction in diameter due to wear. By using a tap that is adjustable, a standard size may readily be maintained. The adjustable tap may be made from a solid piece of steel and may be split so as to permit expanding it sufficiently to compensate for wear, or it may have inserted blades or chasers arranged for radial adjustment. With an adjustable tap of the inserted-chaser type, the body of the tap may be made of a comparatively low-priced material, and this main part of the tap may be used indefinitely, the chasers being replaced when necessary.

Examples of Adjustable Tap Design

Several different forms of adjustable taps are illustrated in Fig. 1. A one-piece split type is shown at *A*. The tap is split through the center, and it is expanded by the conical-headed screw shown. A nut engaging the tapering thread at the end of the tap serves to hold the two sections firmly together. One serious defect of a tap of this kind is that the tap is not expanded uniformly, and for that reason does not cut an accurate thread; the inaccuracy, however, would be very slight for adjustments that might be necessary in order to compensate for wear and maintain a standard size. Another form of split adjustable tap is illustrated at *B*. The tap is split through the center of each flute and it is expanded by the screw shown, which is slightly tapering. The smaller taps of this kind have slotted screws for screwdriver adjustment. While these types are superior to the solid form for tapping large numbers of duplicate parts to a given size within close limits, the inserted-blade type of tap is preferable and is used considerably, especially on accurate work. When extreme accuracy is necessary, it is common practice to use a hand-operated inserted-blade

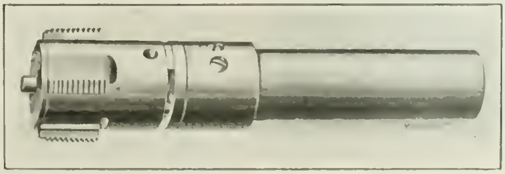

Fig. 2. "Namco" Collapsing Tap

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[1] For additional information on this subject, see "Screw Thread Cutting with Dies," in the October number of MACHINERY.

[2] Associate Editor of MACHINERY

tap for finishing holes previously tapped on a machine. Taps of this kind should be so designed that the blades are held rigidly to the body of the tap and preferably in such a way that the means for locking or adjusting the blade does not interfere with the use of the tap.

The adjustable tap shown at *C* is so designed that it can pass clear through a hole or tap to the bottom of a "blind" or closed hole. The blades are located in longitudinal grooves or slots which taper on the bottom, so that any change in the lengthwise position of the blade increases or decreases the tap diameter. The tap blades are securely held in position by binder plates in the center and thrust and locking nuts at the inner ends. Each blade has a small groove in one side, which forms a shoulder and a bearing surface for one side of the binder plate which is tightened by a screw. When the binder plates are tightened and the nuts at the inner ends are screwed tightly against the ends of the blade, the latter are held rigidly in their slot. This tap is made by the Pratt & Whitney Co., Hartford, Conn.

Removal of Non-collapsing Taps from Tapped Holes

The removal of a solid or non-collapsing tap from a hole in which a thread has been cut is usually done by backing the tap out of the hole, but in some cases the tap either passes completely through the tapped hole or else the work passes over the tap. Taps may be backed out of holes either by reversing the rotation of the spindle which holds and drives the tap or, by reversing the part being tapped when the tap has advanced in the hole to whatever distance may be required. When the machine spindle is reversed this may be effected either by means of the regular driving mechanism of the machine or by a special attachment applied to the tap driving spindle. If the tap remains stationary while tapping, as on turret lathes and many automatic screw machines, the work-spindle reverses for backing out the tap.

Another method of removing a tap that is common in screw machine practice does not require a reversal either of the tap or of the part being tapped. When cutting the thread, the tap revolves in the same direction as the work, but at a slower speed; consequently the work tends to screw itself onto the tap just as though the tap were stationary and the work were revolving at a speed equal to the difference between the speed of the tap-spindle and the work-spindle. The opposite effect is obtained by revolving the tap faster than the work, which causes it to back out of the hole at a rate equal to the difference between the tap-spindle and work-spindle speeds. (This same method is applied to dies). These changes of speed are, of course, controlled automatically.

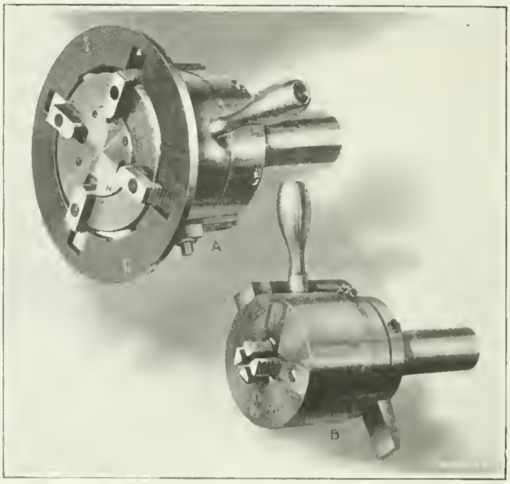

Fig. 5. Other Designs of Geometric Collapsing Taps

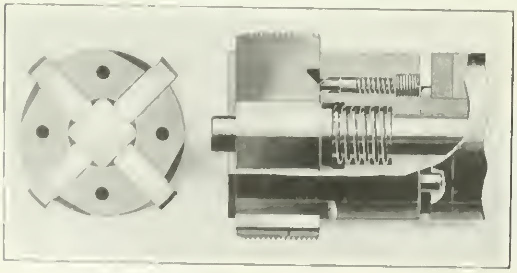

Fig. 3. Mechanism of "Namco" Collapsing Tap

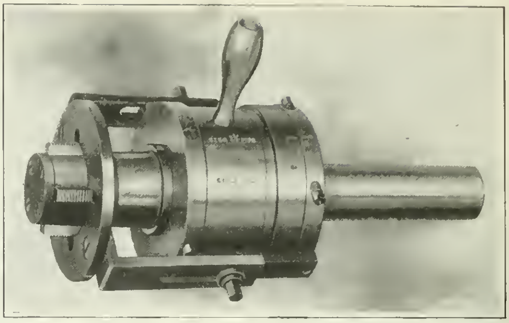

Fig. 4. Geometric Collapsing Tap

For some tapping operations it is desirable to screw the tap clear through the tapped hole. There are three conditions under which this general method may be applied: If the tapping is being done on a vertical drilling machine and there is a clearance space beneath the tapped hole which is large enough to receive the tap, the latter is sometimes screwed completely through the hole and is then replaced in the spindle driving chuck for tapping the next hole. The chuck, in this case, is ordinarily in the form of a socket that fits the tap shank, so that the tap is free to fall as soon as it clears the thread formed in the work. When tapping small parts, such as nuts, another common method of removing the work without screwing it back over the tap is to allow successive parts tapped to pass onto the tap shank; when the shank is full the tap is taken out of the chuck and the work removed. To avoid removing the tap periodically in order to take off tapped parts such as nuts, an ingenious form of tap has been devised which has a curved shank and is so mounted in the tapping machine that parts like nuts pass over the shank so that the tapping can be done continuously. The practical application of these methods will be considered more in detail later in connection with tapping machines and attachments.

Advantages of Collapsing Taps and Variations in Design

The advantages of collapsing taps, as compared with the solid or non-collapsing type for machine tapping, are similar to the advantages of self-opening dies in contrast with the non-opening type. When a solid tap is removed by reversing either the tap or work, the threads cut by the tap are often injured by the chips which wedge in between the tool and the finished thread. The time wasted while the tap is backing out often greatly reduces the rate of production, and the power at the instant of reversal, as well as the strain on the machine used for tapping, may be considerable, especially when tapping comparatively large holes in tough material. On the other hand, solid taps cost less and are applicable for tapping numerous studs, screws and bolt holes that are too small for taps of the collapsible type.

The collapsing of taps may be done either automatically by the engagement of a collar, gage-plate, or lever on the tap with the surface of the work or a fixed stop; the collapsing action may also occur soon after the travel of the turret-slide is discontinued as the result of relative motion between parts of the tap similar to that which occurs when a stop is used. Collapsible taps are similar in principle to self-opening dies,

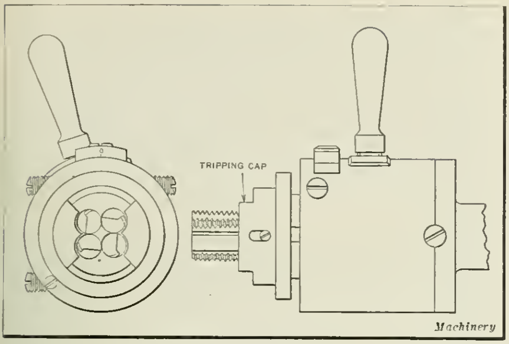

Fig. 6. M. E. C. Collapsing Tap

except that the action is reversed, the tap chasers moving inward in a radial direction instead of outward.

The collapsing tap illustrated in Fig. 2 is of the type that collapses soon after the turret stops. The chasers are withdrawn from the thread in practically the same way that a gear would be thrown out of mesh. When the forward movement of the turret stops, the tap continues to cut until the continued advance due to the action of the chasers in the tapped hole causes the driving pins to disengage; the chasers then begin to revolve with the work and are at the same time automatically withdrawn from engagement with the thread. When the chasers are in position for cutting they are supported by the corners of a central stationary core piece. As soon as the driving pins are disengaged and that part of the tap carrying the chasers begins to turn around with the piece being tapped, the chasers move around opposite the flat sides of the central core so that they naturally disengage themselves from the work. The small conical pointed plunger at the rear of each chaser (see Fig. 3) is simply a safety device to prevent the chasers from dropping back into contact with the thread. The end view shows the chasers in the collapsed position.

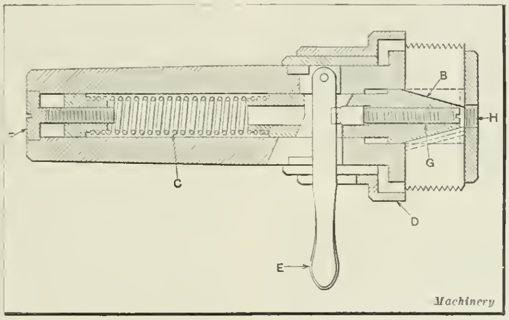

Fig. 7. Victor Collapsing Tap

An important feature of this tap is the fact that the tap body and shank will pass through the tapped hole, so that the tap can be used for tapping exceptionally long holes or holes that are only slightly smaller than the diameter of an opening through which the tap must be inserted to reach its work. The tap may be adjusted for cutting either tight or loose fitting threads by simply turning two binding screws and revolving the square core in either direction. The adjustments for the maximum or minimum diameters is shown by a graduated scale on the hub of the tap. A "Namco" tap of the outside trip type is so arranged that when the tap has entered the hole to the required depth, the outer tripping ring strikes the face of the work, thus causing the chasers to be collapsed. The tap is reset by means of a lever. This tap is particularly adapted for pipe threads or short straight threads. The "Namco" tap is made by the National Acme Co., Cleveland, Ohio.

One design of collapsing tap made by the Geometric Tool Co., New Haven, Conn., is shown in Fig. 4. This particular tap (Class NL) is made in sizes varying from 1 to 12 inches. The tap may be attached to a revolving spindle or to a turret. An adjustable gage controls the collapsing action by coming into contact with the work. The chasers are expanded by means of the handle shown projecting from one side of the tap body. Slight adjustments to compensate for wear may be made by means of micrometer adjusting screws. Another Geometric tap of a type (Class P) intended especially for tapping shallow holes and threads of fine pitch or flush to the bottom of a hole is shown at *A*, Fig. 5. This particular style of tap is furnished for cutting standard pipe threads from 4 to 10 inches, inclusive, and for tapping actual diameters varying from 4½ to 11 inches when the threads are not coarser than eight per inch, and the depth of the hole does not exceed 1½ inch. It will be understood that these taps are subject to more or less variation in design because of different working conditions. This tap has an end plate trip, as the illustration shows. The lever type of trip applied to the tap shown at *B* in Fig. 5 is particularly suited for certain classes of work. An adjustable screw-stop attached to the cross-slide of the machine engages the tripping lever and controls the point at which the collapsing action occurs. The Geometric collapsing tap may be fitted with a roughing and finishing attachment similar to that employed on the self-opening die-head, when tapping exceptionally accurate work. The tap chasers are adjusted outward for taking a light finishing cut by turning a small lever. None of the taps illustrated are equipped with this attachment.

A collapsible tap having chasers that operate with a rolling action is shown in Fig. 6. The four chasers are in the form of round bars except at the outer ends, where they are cut away to form clearance spaces in front of the teeth. Each chaser bar has a lug that engages a radial slot in a chaser controlling ring or collar within the tap body. When this controlling ring is turned in one direction the chasers roll so as to move the cutting teeth inward as when collapsing the tap. By turning the ring in the opposite direction the chasers are returned to the working position and size. The controlling collar is held in place by a suitable stop while the tap is cutting. When the tap has entered the hole to the required depth, the tripping cap comes into contact with the work, and as the tap continues to advance, the controlling collar is disengaged. A spring then turns the collar quickly and withdraws the chasers. The tap is reset to the working position by means of the hand-lever shown projecting from the side. The distance that the chasers project beyond the tripping cap, or the depth to which a hole is tapped, is regulated by an adjustable screw in the shank of the tap, which serves to move the chasers in or out. This tap is the product of the Manufacturers Equipment Co., Chicago, Ill.

The sectional view, Fig. 7, illustrates the arrangement of collapsible taps made by the Victor Tool Co., Waynesboro, Pa., for diameters of 2 inches and larger. The chasers, which are

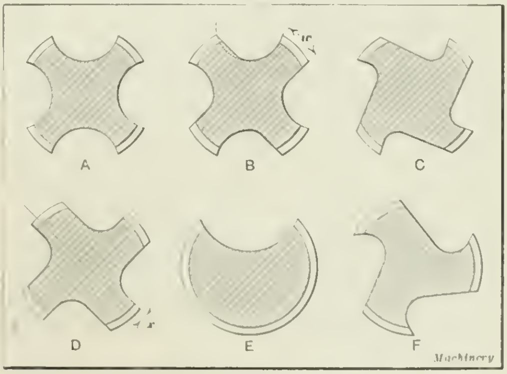

Fig. 8. Different Forms of Tap Flutes

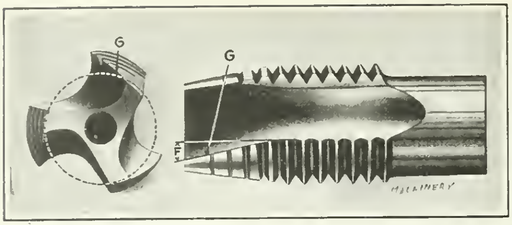

Fig. 9. "Gun" Tap having Cutting Edges on Chamfered End ground at an Angle to Axis for deflecting Chips and causing them to curl out ahead of Tap

inserted in radial slots in the body of the tap, bear against a hardened steel plunger or central plug *B*. This plunger is ground to an angle of 14½ degrees from the axis (29 degrees included angle) and the inner ends of the chasers are beveled to correspond. This plunger is attached to a closely wound tension spring *C*, which is elongated when the tap is set for cutting. The depth at which the tap collapses automatically is regulated by the trip-collar *D*, which can be adjusted for varying the tripping position. When this trip-collar strikes the face of the part being tapped, a latch is forced to release the tripping lever *E*, and then the tension spring immediately draws the plunger *B* back, thus permitting the chasers to recede along the angular surface of the plunger. The tap is reset in the cutting position by moving lever *E* forward to the position shown in the illustration, which forces the chasers outward and locks them in position. The tension on the spring may be regulated by the screw *F* at the rear of the tap shank. The size of the tap may be varied by means of a hardened set-screw *G* in the front end of plunger *B*. This screw has a very fine thread, so that minute adjustments may be obtained, and it is protected by the safety screw *H*. Collapsible taps that are less than 2 inches in diameter are similar to the design described except that the adjustment for size is secured by changing the position of a threaded collar.

Form of Tap Flutes or Cutting Faces

The location of the front cutting faces of taps, relative to the axis, or the shape of the flutes, in the case of solid taps, may affect the action of the tap decidedly. It is essential to have flutes that are large enough to provide room for the chips, but not so large as to weaken the tap excessively. The flutes should also be so formed and located relative to the axis of the tap that the front cutting faces will have whatever rake may be needed to secure good cutting action. To obtain ideal results, taps should be fluted so that the angle of rake will be in accordance with the material to be tapped; while this can be done to some extent, a great many taps are intended for general work and must be made to suit average conditions as far as possible. In general, taps used principally or exclusively on steel should have positive rake, the plane of the cutting face being a little back of the tap center. The rake angle or the inclination of the teeth, with a radial line, usually varies from about 8 to 12 degrees. Solid taps are given this rake by using a cutter that is either convex, so as to undercut or form a hook-shaped flute or cutting face, or a cutter having straight angular sides and a rounded point may be used, the amount of rake being controlled by the adjustment of the cutter relative to the axis of the tap blank. Various modifications of these two general types of tap fluting cutters are in use.

Plain convex flutes are shown at *A*, Fig. 8. The front and rear faces of the tap lands are similar. If the tap has to be backed out of the hole, the rear edges prevent chips from wedging between the teeth of the tap, which is an advantage, but since the rear sides of the lands are the same as the front, there is likely to be some cutting or scraping action as the tap revolves backward when removing it from the hole. The amount of rake that can be obtained with a convex cutter is also limited, and by undercutting the rear sides of the lands the tap is weakened.

The form of flute illustrated at *B*, Fig. 8, gives a tap greater strength than one fluted with a plain convex cutter. The front faces of the lands are undercut to obtain positive rake, the same as though a convex cutter were used, but the rear sides are straight instead of following the curved arc shown dotted. This feature strengthens the tap, and the rear sides are also steep enough to prevent chips from wedging in between the teeth and thread. Of course, there is likely to be more or less wedging of chips between the flutes and the tapped thread with any non-collapsing tap when rotation is reversed for backing the tap out of the hole. The width *w* of the land of this kind of tap should equal one half the width of the space or one twelfth the tap circumference in the case of a four-fluted tap.

The form of flute shown at *C*, Fig. 8, has been used extensively with some modifications as to the radius of the bottom of the flute and the angle of rake in front of the lands. This flute is milled with a double-angle cutter and the tap may easily be given any amount of positive rake within practicable limits. If the rear sides of the lands have a gradual slope, as shown in the illustration, difficulty is often caused by the wedging action of the chips, which may either mar the thread or result in breaking the tap. The flutes illustrated represent the shape obtained with a cutter having an angle of 30 degrees on one side of the center line and 55 degrees on the other. Some angular fluting cutters have an included angle of 90 degrees, with each cutting edge 45 degrees from the center line.

The amount of positive rake that a tap should have to work satisfactorily in steel should preferably be such that slightly curling chips will be produced. These chips should break up into short lengths and not be so long as to jam tightly in the flute, which might occur if the tap had too much rake. On the contrary, insufficient rake prevents a free cutting action and the metal is pushed ahead of the teeth and compressed until in some cases the tap breaks. Taps that are hook-fluted, or provided with positive rake, cannot be used to advantage for tapping cast brass and cast iron, and either a radial cutting face or negative rake is preferable. Taps that are intended exclusively for brass generally have cutting edges that are ahead of the center as illustrated at *D*, Fig. 8. The plane of the cutting face is usually ahead of a radial line a distance *x* varying from 1/16 to 1/10 of the tap diameter, which gives negative rake. The tap illustrated at *E* has been extensively used for tapping copper. This is such tenacious material that ordinary taps do not cut it satisfactorily. The tap shown at *E* has but one flute, so as to leave as much bearing surface as possible and prevent the tap from tearing the thread. Another form of tap intended for copper is illustrated at *F*. In this case the flutes are so shaped that the tap has considerable positive rake. If a commercial tap is used on copper, the form of flutes illustrated at *B* is preferable to the plain convex shape shown at *A*, because a tap for any tenacious material such as copper should not have lands that are undercut on the rear side.

Chamfer on End of Tap—Cause of Reaming Action

The length of the chamfer on the leading end of the tap may depend almost entirely on the class of work for which the tap is intended. If threads are to extend close to a shoulder or the bottom of a blind hole the chamfer may be confined to the first annular row of teeth or even be omitted en-

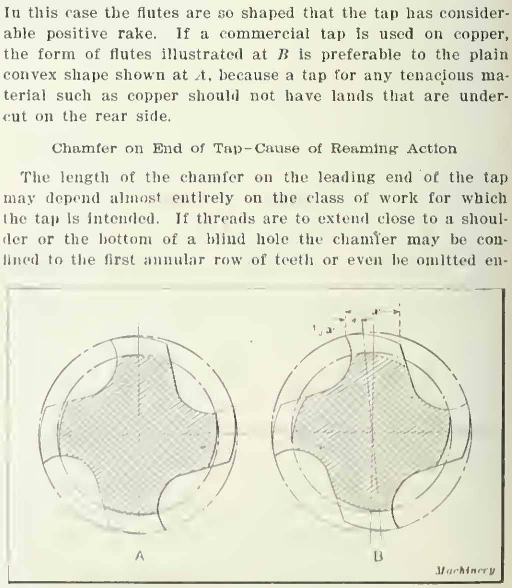

Fig. 10. (A) Tap relieved both on Top and in Angle of Thread. (B) Type of Relief known as "Con-eccentric"

tirely, especially when tapping cast brass or some other material that is easily cut. When the tap can pass clear through the hole or a full thread close to the bottom of the hole is not necessary, it is preferable to chamfer several of the end teeth, the number of teeth often varying from four or five to ten or twelve. If the chamfer is too gradual or extends over too many teeth, the tap may not screw itself into the hole, but may act somewhat like a reamer and merely enlarge the hole as the teeth revolve without advancing along a helical path as when cutting properly. This is due to the fact that each tooth cuts such a shallow groove that it does not offer sufficient bearing surface to force the following teeth to advance; consequently they simply rotate in one position and cut away the metal like a reamer instead of forming a helical thread groove. It is important, however, to chamfer taps for through holes back as far as practicable, because less power is required to drive such taps, and therefore they are subjected to less torsional strain and are less likely to break. Repeated tests made by the Greenfield Tap & Die Corporation show that approximately 25 per cent more power is required to drive a tap having a chamfer extending back over only four threads than one having a chamfer extending over six threads. The four-thread chamfer in the case of a four-fluted tap divides the work between sixteen teeth, whereas the six-thread chamfer divides it between twenty-four cutting teeth. The tap having the longer chamfer also has the advantage of producing a much smoother thread and cuts more closely to size.

The reaming action previously referred to and the failure of the tap to start or catch the thread is usually caused by the use of a tap drill that is too small rather than by an excessive amount of chamfer. In some cases, holes to be tapped are actually smaller in diameter than the root diameter of the thread, so that the end of the tap must ream out the hole. This additional work imposed on the tap prevents it from advancing along a helical path, because the increased resistance to this forward movement is so great that the teeth will not follow along the thread groove as they naturally tend to do, but simply revolve and cut away the metal like a reamer. Even if the tap should begin to advance after being forced partly through the nut, the thread formed in the remainder of the hole would be thin and weak.

An unusual form of tap is shown in Fig. 9. The chamfered edges are ground at an angle *F* to the axis so that they will cut with a shearing action. The object of this inclined cutting edge is to cause the chips to curl out ahead of the tap instead of collecting in and clogging the flutes, and for that reason the manufacturer (Greenfield Tap & Die Corporation) refers to it as a "gun tap," the name signifying that the tool shoots its chips straight ahead in long curls. Because of this cutting action, two or three flutes which are comparatively shallow may be used, thus increasing the strength of the tap. All the cutting is done on the first few teeth and the rest of the teeth act as a lead-screw for guiding the tap. The grinding is done on the angular cutting edge instead of in the flutes. This tap is especially adapted for difficult conditions or the tapping of tough material.

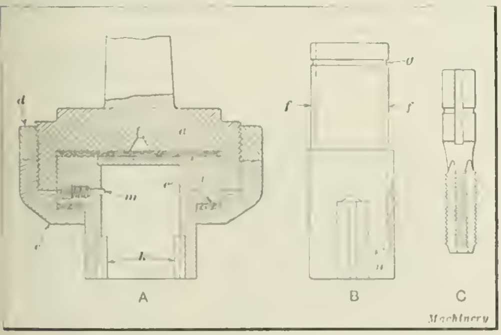

Fig. 11. Beaman & Smith Frictional or Safety Tap-holder

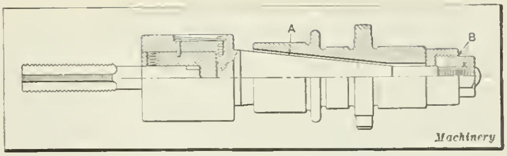

Fig. 12. "Wizard" Friction-drive Tap-holder

Clearance or Relief for Tap Cutting Edges

There are several ways of providing clearance for tap cutting edges so that they will cut freely. We shall consider first taps intended for straight threaded holes. The teeth of such taps may be backed off or relieved like the teeth of a form milling cutter, as shown at *A*, Fig. 10. In this case, the teeth are relieved on the top and angular sides and also at the root. A tap relieved in this way will cut freely, but it has been objected to on the ground that there is not sufficient support while cutting to produce round, smooth holes; moreover, there will be a reduction in diameter as soon as the front cutting faces are ground for sharpening the tap. To secure better support than is obtained from the points of the teeth relieved as shown at *A*, taps for threads having flat tops, like the U. S. standard, have been made with teeth that are concentric on the outside but relieved on the angular sides. While such taps cut freely and are well supported by the concentric teeth, both the pitch diameter and the width of flat are reduced by repeated grinding.

The disadvantages of relieving straight taps as previously described led to the introduction of a tool that was given clearance not by relieving the teeth from front to back, but by making the tap a little larger in diameter on the leading end (say, 0.001 to 0.002 inch) than at the shank end. The effect of this slight back taper is to make the tool cut more freely, and a great many taps have been given clearance in this way. Taps without eccentric relief (except on the chamfered end) are preferable for use on automatic screw machines of the type which reverse for backing out the tool, because chips are less likely to wedge between the teeth and mar the thread or break the tap.

Another method, which is regarded by some as the best form of relief, is illustrated at *B*, Fig. 10. This is known as the "con-eccentric" relief because the teeth are concentric for a distance equal to one third the width of the land, and the rest of the tooth is eccentrically relieved. The object of this form of relief is to provide enough clearance to make the tap cut freely, and at the same time give adequate supporting surface. The tap teeth can also be ground back for sharpening without changing the shape of the cutting edge or the tap diameter. The top of the thread is relieved across the entire width of the land on the chamfered part of the tap to secure a keen cutting edge. The chamfered end is also given greater relief than the straight part to improve the cutting qualities. The angular sides of the teeth on the chamfered part have the regular relief.

Taps for cutting threads in tapered holes must have teeth relieved across the entire width of the land, both on the top and angular sides. If a tapered tap were not relieved in this way, the rear ends or "heels" of the teeth would be higher up on the taper than the cutting edges owing to the inclination of the teeth relative to the tap axis. In other words, the rear end of any tooth would coincide with a larger circular section of the tap than the cutting edge; consequently the cutting edge would not form a space large enough for the rear end of the tooth.

Diameter of Hole before Tapping

The diameters of holes to be tapped may seriously affect the tapping speed, the power required for tapping, the loss of taps as the result of breakage, and the quality of the work. The hole should be somewhat larger than the root diameter of the thread, the amount depending to a certain extent upon the class of work and the kind of material. For ordinary manufacturing, 75 to 80 per cent of the standard thread depth is sufficient, and for some classes of work not more than 50 per cent of the thread depth is required. Tests have demonstrated that a U. S. standard thread cut to one half the standard depth in an ordinary cold-punched nut will not strip. The tops of the bolt threads also resist the stress, and it is the bolt that breaks.

Tests made by the Greenfield Tap & Die Corporation have demonstrated that a full depth of thread in a nut is practically no stronger than a 75 per cent depth of thread; furthermore, a thread depth equivalent to 75 per cent of the standard is only 20 per cent stronger than a thread of 50 per cent depth. As the thread depth increases beyond 75 per cent, the power required to drive the tap rapidly increases as the full depth of thread is approached. Soft tough material, such as Norway iron, drawn aluminum, copper, etc., should be drilled larger for tapping than hard crystalline materials, such as cast metals. If the holes in the soft tough materials are too small, the tops of the threads will be torn off when tapping, thus decreasing the effective thread depth. When a larger tap drill is used, the tapping action tends to draw the metal toward the top of the thread and increase the effective depth, especially after the tap has been slightly dulled.

If, for any reason, a full depth of thread is required, serial taps should be used. Taps of this kind progressively increase in diameter from the first to the last tap in a set in order to distribute the work more evenly between them. In general, tap drills giving a 75 per cent depth of thread are recommended. As commercial drill sizes will not always be just right, the next larger commercial size will give satisfactory results. The proper selection of tap drills is very important, and if properly attended to, may result in a great reduction in the number broken. The diameter of tap drills for U. S. standard or V-threads may be determined by the following formula, which is intended for a 75 per cent thread depth:

$$\text{Tap drill diameter} = T - 0.75 \times 2D$$

in which T = external diameter of tap or thread;

D = depth of thread.

The depth of a U. S. standard thread = 0.6495 × pitch of thread, and the depth of a sharp V-thread = 0.866 × pitch.

Tapping Square Threads

While the Acme screw thread has replaced the square thread to a large extent because it is stronger and more easily cut, square threads are still of sufficient importance to merit some attention; moreover, those who are responsible for producing good square threads are not always in a position to substitute the superior Acme form. A satisfactory method of cutting square threads by means of taps is to form the threads by a progressive cutting action. This method, which may not be necessary for very fine pitches or comparatively rough threads, involves the use of a set of taps varying in size so as to distribute the work properly. For the finer pitches there may be two taps in a set or as many as four or five if the pitch is relatively coarse. Each tap should have a pilot or extension beyond the chamfered end, as this steadies it and improves its cutting qualities. The pilot of the first tap of the series is simply a smooth cylindrical end from 0.003 to 0.005 inch smaller than the hole to be tapped. The pilots of the following taps have teeth and should be of the same diameter as the body of the preceding tap. It is also advisable to have the teeth in the different taps of a set increase progressively in width. For instance, the teeth of the first tap of a set may have a width of, say, 0.247 inch; the teeth of the second, a width of 0.250 inch; and the width of the finishing tap, 0.253 inch. If the outside diameter of the finishing tap is 1.5 inch, the two preceding taps might have diameters of, say, 1.420 and 1.250 inch, respectively. When such taps are used, the thread groove is gradually made deeper or larger in diameter and wider, so that the final tap of a set serves to take a finishing cut over the entire surface of the thread groove, which is given a smooth finish. If the taps of a set increase in diameter but do not have teeth which progressively increase in width, the sides of the thread groove will not be finished as smoothly. The flutes of square thread taps should be at right angles to the cutting teeth in order to improve the cutting qualities, particularly if the taps are for coarse pitches and must cut away considerable metal. The teeth on the chamfered part of all the taps in a set should be relieved or backed off on top. If square-threaded taps are to be used for machine tapping, the teeth of the chamfered part should be relieved on the sides as well as on top.

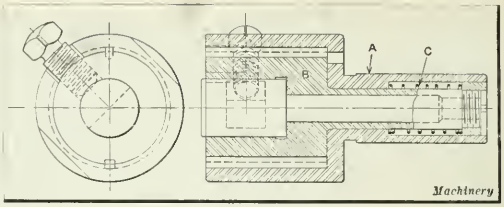

Fig. 13. Tap-holder of Draw-out Non-releasing Type

Lead and Diameter Errors in Tapped Holes

In order to secure accurate fits between screws and tapped holes, it is, of course, necessary to guard against inaccuracy both when tapping the hole and when cutting the external screw thread that is to enter the hole. While this is quite obvious, the relationship between external and internal screw threads is often disregarded, although the direct cause of many thread troubles. When fitting plain cylindrical parts in holes, the manufacturing problem is relatively simple, since the quality of fit usually depends simply upon diameter and finish, but in the case of screw threads, the accuracy and quality of the fit may be decidedly affected either by the lead of the thread or by its shape, in either the screw or the nut, as well as by the respective diameters of the screw and nut. Another feature of the screw thread is that errors are not always apparent at first, as, for example, when a screw seems to fit tightly but has a poor bearing in a nut or tapped hole because of a lead error.

The errors in screw threads produced either by tapping, by means of dies or by some other method, may be due to inaccuracy in the tool or the conditions under which the tool is used. Whatever the method or conditions, it is, of course, impossible to eliminate all error, and especially where the error—as in the case of screw threads—may be in the lead of the thread, the pitch diameter, the sectional shape of the thread, or the difference between the curvature of the thread and a true helix. In order to allow for these errors, which may be very small if considered singly but serious when combined, it is essential to adopt limits or tolerances between the threaded parts. This question of limits is difficult to deal with, particularly in a general discussion of the subject, since a suitable limit for one grade of work might be entirely too large or small for other threaded parts requiring greater or less accuracy. In general, maximum and minimum pitch diameters should be adopted for both taps and screws. The maximum pitch diameters of the screw threads should be slightly less than the minimum pitch diameters of the taps to allow the largest screw to enter the smallest hole, although if the two sizes were exactly the same, there might be no difficulty in assembling, because taps, as a rule, cut a certain amount over size, the amount varying according to the conditions to be referred to later. Tables of limits recommended for interchangeable screw threads and tapped holes were published in MACHINERY, February, 1917, page 480.

In buying taps some manufacturers specify very small limits when the required degree of accuracy in threaded parts

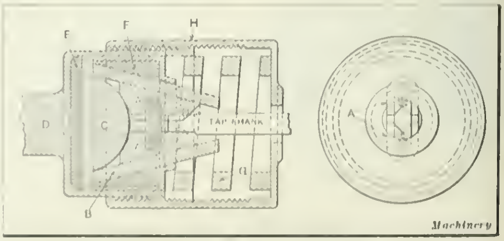

Fig. 14 Woodstock Safety Tapping Chuck

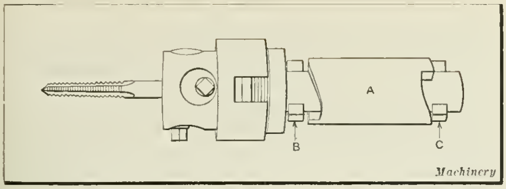

Fig. 15. Errington Friction Tap-holder of Releasing Type

could be obtained with ordinary commercial taps if sufficient care were taken in their use and in making the screws which are to enter the tapped holes. While an accurate fit between threaded parts depends upon both the tap and screw, some users of taps forget that the screw may be at fault. This point is illustrated by the experiences of all tap manufacturers. Taps made for customers who specify very close limits of accuracy are frequently condemned as inaccurate, when the screws inserted in the tapped holes are the cause of the trouble, due, in many cases, to an error in lead. It is evident that little is to be gained by using high-priced taps that are made unusually accurate by employing special methods, if little or no attention is given to the limits of error in the screw; in fact, so far as pitch diameter is concerned, it is usually easier to control the diameters of the screws than the diameters of tapped holes, although with the adjustable taps now available extremely accurate work may be obtained, and holes in duplicate parts may be held to a standard size within small limits.

Many taps, particularly when used in a machine, tend to cut over size. This slight enlargement of the hole may be the fault of the tap or it may be caused by the method of holding it; the size of the hole before tapping is also frequently the cause of inaccurate work. If the threaded part of a solid tap is warped or bent slightly by the hardening operation, this will cause it to cut large, the error increasing as the length or depth of the tapped hole increases, up to the full length of the tap body. When taps are made of steel that is not properly rolled or annealed they may shrink unevenly in hardening or lose their circular form. If the teeth of an evenly fluted tap do not lie in a circular path, the tap will chatter and cut over size. A tapped hole that is too large may also be caused by the crowding of the metal resulting from passing a tap through a hole that is too small. Errors may also be due to excessive clearance or rake on the chamfered part of the tap, uneven chamfering on the different lands, excessive under-cutting in the tap flutes, or too much relief in the thread angle. Lack of alignment between the tap and work is frequently the cause of tapping holes that are too large and tapering. The extent to which errors from lack of alignment may be reduced, if they are not eliminated entirely, by the use of floating tap-holders depends upon the design of the tap-holder and the amount of alignment error. By studying the different causes of error mentioned, tapping troubles that are the direct result of one or a combination of these causes may be greatly reduced or eliminated, and holes may be tapped accurately enough for ordinary commercial requirements without purchasing taps made to order and within specified limits of accuracy which require unusual and unnecessary refinement in their manufacture.

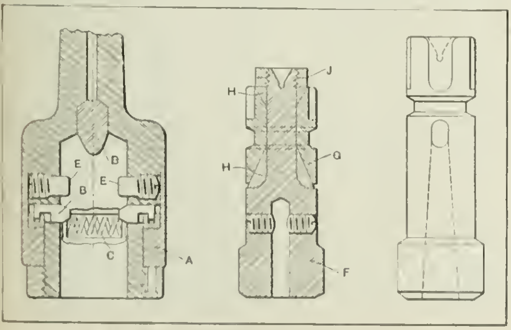

Fig. 16. Horton Quick-change Collet Chuck and Collets

Holding and Driving Taps

The method of holding and driving a tap may vary according to the type of machine used for tapping, the kind of tap, or the class of work. The holder may be designed to hold the tap rigidly or to allow it to slip or stop in case the resistance to tapping becomes excessive. Tap-holders may also be arranged to provide a certain amount of lost motion or floating movement either in a longitudinal or a lateral direction. The object of the longitudinal movement is to allow the tap to advance according to its own lead and independently of the advance movement of the driving spindle or slide to which it may be attached. The lateral floating movement is to compensate for any lack of alignment between the hole being tapped and the tap-driving spindle or holder, although some taps as well as dies that are supposed to have this self-adjusting feature do not line up properly with a hole that is out of line because of the frictional resistance of the driving pins or lugs, which prevents a free floating movement. Tap-holders for solid or non-collapsing taps may be of the releasing or non-releasing type, as described later. Another type of tap-holder is designed especially to permit inserting or removing taps easily and quickly. There are also tap-holding chucks or tapping attachments that are equipped with a mechanism for reversing the rotation of a non-collapsing tap to back it out of a hole. Many tap-holders are designed along the same general lines as die-holders.

Frictional Tapping Chucks

In order to prevent breaking power-driven taps when an unusual resistance is encountered, they are sometimes held in frictional chucks arranged to allow the tool to slip before it is strained to the breaking point. The need for a frictional drive may arise when the tap strikes the bottom of a blind hole, or if the hole before tapping is not large enough, the tap may be subjected to excessive strains. A design of frictional holder that is intended for driving both drills and taps is shown at *A* in Fig. 11. This holder (which is made by the Beaman & Smith Co., Providence, R. I.) has a shank *a*, a friction socket *b* which receives the tap-holder, a cap nut *c*, and a lock-nut *d*. Fiber washers *e* are placed on each side of the friction socket flange and nut *c* is tightened until there is just enough friction between parts *a* and *b* to drive the tap under normal conditions. If the tap should encounter unusual resistance or strike the bottom of a blind hole, it will slip instead of breaking, provided nut *c* is not set up too tight.

With the frictional tapping collet illustrated in Fig. 12, the frictional resistance is obtained by means of a tapered plug *A*, which is drawn into a fiber lined hole of corresponding taper by a differential screw *B*. As the illustration shows, the nut for making the adjustment is threaded internally and externally. These threads vary in pitch so that a sensitive and powerful adjustment is obtained. This frictional collet (which is the product of the McCrosky Reamer Co., Meadville, Pa.) is used in the quick-change collet chuck illustrated in Fig. 17 and described later. By supplying collets for the different taps that may be required in succession on the same job, each size tap may have its own friction properly adjusted, in order to avoid readjusting the friction for different sizes.

The Woodstock safety tapping chuck (made by Peter Bros. Mfg. Co., Algonquin, Ill.) is arranged to hold the tap by the square end of the shank only, between the jaws *A* (see Fig. 14). These jaws are located in a slot in the friction cone *B*, which prevents them from turning except with the cone. A circular projection on part *C* fits into the slot of cone *B* and forces the jaws downward for gripping the square end of the tap shank when the outer shell of the chuck is screwed up or tightened. The tap is prevented from pulling out by a small pin in one of the jaws, which engages a catch or notch formed on the square end of the tap. Between part *C*, which is called the "rocker," and the stem or shank *D*, there is a fiber friction disk *E*. This fiber disk forms part of the frictional surface through which the tap is driven. In addition, there is

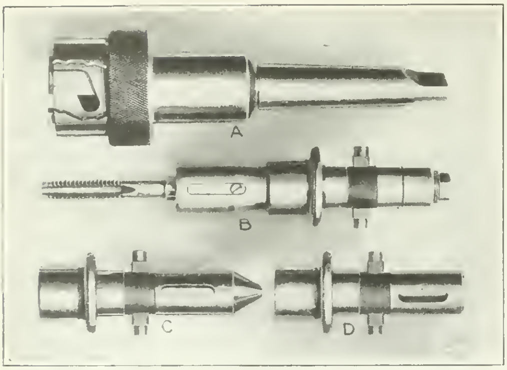

Fig. 17. "Wizard" Quick-change Chuck and Collets

a conical friction surface at *F* formed of fiber contained within a steel case surrounding the cone *B*. This conical cup is prevented from turning with cone *B* when the latter slips, by two pins that engage slots in the inner shell of the chuck body. The cup *F* is held in contact with cone *B* by spring *G*. the tension of which is regulated by screwing the outer shell *H* in one direction or the other. Graduation lines on the body of the chuck serve as a guide in securing the proper amount of frictional resistance. The graduations are for ordinary tapping operations in steel. When tapping exceptionally tough material like nickel steel, it might be necessary to screw the shell, say, half a revolution beyond the graduating line, whereas for tapping cast iron, the shell might not be advanced to the graduating line within half a revolution.

Tap-holders of Releasing and Non-releasing Types

Tap-holders for non-collapsing taps are made in the releasing or non-releasing type the same as die-holders. The non-releasing holder should preferably have enough lengthwise floating movement to allow the tap to follow its own lead, but the tap is at all times prevented from revolving. A simple design of non-releasing holder which is used on many Brown & Sharpe automatic screw machines is shown in Fig. 13. This consists of two main parts *A* and *B*. The outer part *A* is held in the turret, whereas the tap is held in the inner part *B*. The latter is free to move a limited amount in a lengthwise direction against the tension of spring *C*.

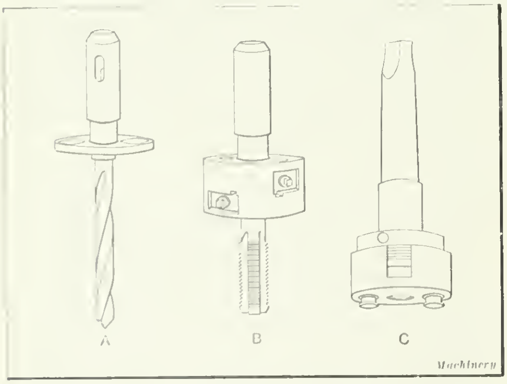

Fig. 18. Errington Drill-holder, Tap-holder and Quick-change Chuck of Frictional Pin-drive Type

With the releasing type of holder the tap is prevented from rotating until the tapping operation is completed, when it is released. One of the Errington releasing holders is illustrated in Fig. 1[illegible]. The shank of the holder passes through a sleeve *A*, having clutch teeth formed on each end. When the tap is entering a hole, the clutch pins at *B* are in engagement with the sleeve and the tap is prevented from rotating. When the forward movement of the turret-slide is arrested by stops previously set, the tap continues to advance until the pins at *B* are disengaged from the clutch sleeve, and then the tap revolves idly with the work. As soon as the work-spindle is reversed and the turret with sleeve *A* is moved in the opposite direction, the clutch pins *C* come into engagement with the sleeve and hold the tap stationary while it is being backed out of the tapped hole. This particular holder is provided with a friction drive, which is adjusted to slip and prevent breaking the tap in case the latter is subjected to excessive stresses or comes against the bottom of a hole. There are various other designs of tap-holders in both non-releasing and releasing types, many of which are similar to die-holders.

In many shops it is the practice to use non-releasing holders on automatic screw machines, and the releasing type on turret lathes or screw machines which may be reversed by hand, especially if a thread is to be cut close to a shoulder. The reason for using a releasing holder on a machine that is reversed by hand is to prevent breaking the tap by allowing it to revolve with the work after being fed in to a predetermined depth. If the holder were non-releasing and the machine were not reversing at exactly the right time, the tap might be broken or the thread damaged.

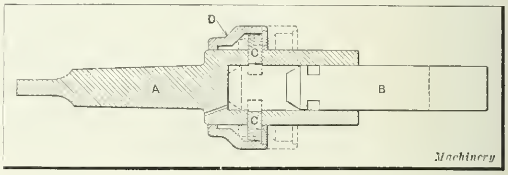

Fig. 19. Sectional View of Quick-action Chuck with Operating Collar in Position for releasing or inserting Collet

Tap-holders Designed for Rapid Insertion or Removal of Taps

When tapping operations are performed on drilling machines in connection with drilling operations, chucks are often used that are arranged for holding either drills, taps or other tools interchangeably, and these chucks or holders are so designed that a drill may be replaced by a tap, or *vice versa*, very quickly. Whether it is advisable to drill all holes to be tapped and then rehandle the work for tapping may depend upon the size of the casting or forging and the relation between the tapping and other operations. When tapping duplicate pieces on a drilling machine that are too heavy to adjust or center themselves with the tap, or when the work is clamped in position, it is common practice to drill, tap, and possibly insert a stud in the tapped hole, in one series of operations, instead of rehandling the parts for tapping. It is for operations of this kind that the quick-change chucks, collets, or holders for drills, taps, etc., are of especial value.

The holder or socket illustrated at *B*, Fig. 11, is used in connection with the Beaman & Smith friction chuck shown at *A*. This holder is splined at *f* on each side, and these splines engage keys *k*. The small spring-pin *m* engages groove *g* on the holder and prevents the latter from falling out of the chuck when there is no upward pressure. The tap *C* is also driven by side keys and is prevented from dropping out by the spring pin *n*. The drill sockets, which are also inserted in this friction chuck, have a standard taper hole for receiving drill shanks.

The quick-change collet chuck illustrated in Fig. 16 is so arranged that either the tap collet or drill collet can be inserted by simply grasping the knurled sleeve of the chuck and holding it back against the rotation of the spindle as the collet is pushed into place. When the sleeve *A* is held against

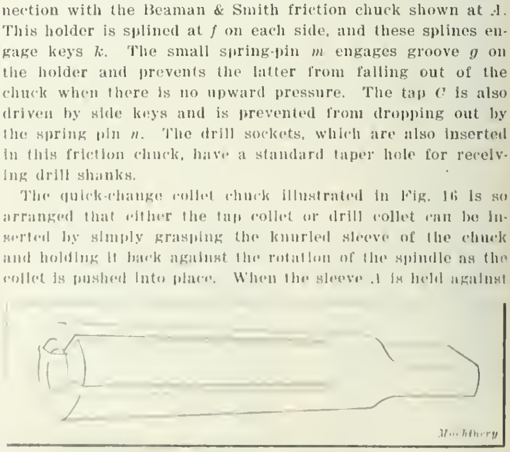

Fig. 20 Scully-Jones Tap Chuck

rotation, the retaining dogs *B* are withdrawn by the action of cam surfaces. As the collet is pushed up into the chuck it is centered by the tool-steel plug *D*. which engages a conical shaped center formed in the end of the collet. The studs *E* come into contact with flat surfaces near the end of the collet and provide a positive drive. As soon as sleeve *A* is released, the retaining dogs *B* are forced inward by the action of spring *C* and engage an annular groove extending around the collet. These dogs or pins *B* prevent the collet from dropping out of the chuck. Both tapping and drill collets are shown in the illustration. The tapping collet is provided with an adjustable friction for safeguarding the tap against breakage. The conical frictions *H*, which are of fiber, are located between the body *F* of the collet and the sleeve *G*. The tension of the friction is adjusted by the nut *J*, so that the tap will slip if the torsional strain becomes excessive. The collet is made 0.015 inch smaller than the bore of the chuck to provide a slight floating movement. This chuck is manufactured by E. Horton & Son Co., Windsor Locks, Conn.

Another chuck designed for rapid insertion or removal of tools is shown at *A* in Fig. 17. Some of the collets used in conjunction with this chuck (manufactured by the McCrosky Reamer Co.) are also shown in the illustration. These collets each have two driving lugs projecting from the side that engage slots in the chuck when in use. The chuck consists principally of a driving body, which is equipped with a Morse taper shank to fit the drill-press spindle, and a slotted collar for holding the collet up into the driving body. This collar is held in position by a headless screw, and it is provided with a coiled spring which keeps it normally in the closed position. A thin sleeve is screwed over the slotted portion of the collar merely to cover up the slots and screw. A slight resistance to the motion of the collar, such as would be caused by grasping it with one hand while the spindle is in motion, opens the slot in the chuck so that a collet may either be inserted or allowed to fall out of the chuck. The spring previously referred to then throws the collar back to the closed position, which serves to lock the collet into place. A friction drive tapping collet for use with this chuck is shown at *B*. The particular collet illustrated is intended for the Beaman & Smith style of tap shank. The collet illustrated at *C* is provided with a Morse taper hole and is intended for holding a tap drill or other tool having a tapered shank. The collet is one solid piece of steel, and it will be noted that the upper end has a conical point. The upper end of the slot in the chuck *A* is angular, and this tends to force the collet upward so that it is accurately centered by the conical end which engages a seat in the chuck. This collet is so made that it bears in the chuck only on the taper end and on that part of the collet between the driving lugs and flange. This flange or collar is convenient when pushing a collet up into the chuck or when catching it when released. The collet shown at *C* is held rigidly in the chuck, whereas the form illustrated at *D* has a floating movement.

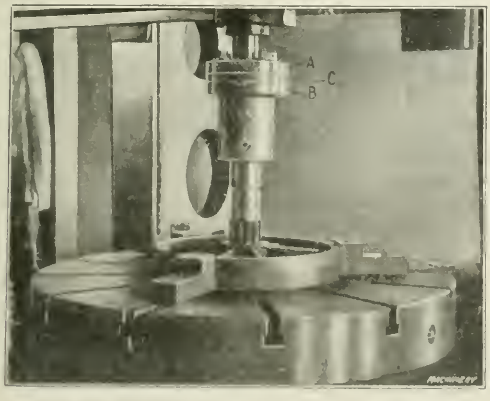

Fig. 22. Tap-holder designed on Principle of Oldham Coupling

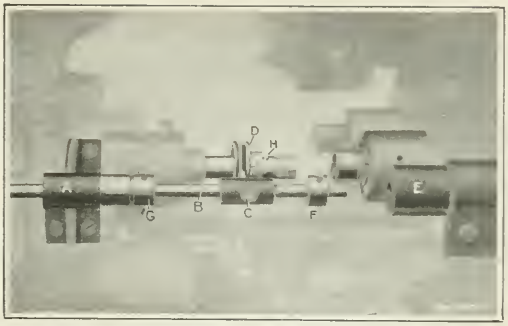

Fig. 23. Tap Resetting Attachment on Acme Multiple-spindle Automatic

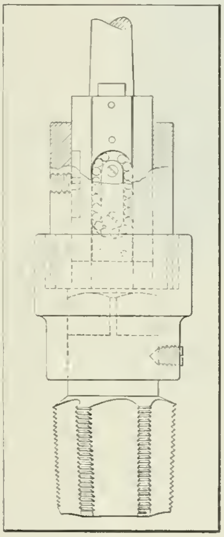

Fig. 21. Cincinnati-Bickford Friction-reducing Tap Chuck

The type of quick-change tool-holders illustrated at *A* and *B*, Fig. 18 (product of the Errington Mechanical Laboratory, 39 Cortlandt St., New York City), is intended for use with a friction "slip-chuck" *C*, or an automatic reverse chuck in case the drilling machine is not equipped with a tapping attachment. The two driving pins seen on the lower face of the chuck have retaining collars or flanges at the end and engage holes in the flange of drill-holder *A*, or holes in the body of the tap-holder *B* when either the drill- or tap-holder is in use. A toolholder can be inserted in the chuck by simply pushing it up into place, or it can be removed from the chuck while the spindle is revolving by depressing a releasing spring. The automatic-reverse chuck referred to is arranged to reverse the motion for backing out the tap. This chuck is arranged to receive the quick-change tool-holders, and may be locked for drilling by pulling out a slide. When tapping, this slide is pushed in, which enables the motion of the tap to be reversed, the same as when using the regular automatic-reverse tapping chuck. The chuck with the pin drive is adapted especially for the heavier classes of tools. For comparatively light weight tools that can safely be dropped out of the socket, a ball-drive chuck is recommended. The shank of this chuck is bored out to receive the tool-holding socket, which has concave crosswise grooves near the upper end which are engaged by the two driving balls. When a sliding sleeve is raised the balls fly outward, thus releasing the tool socket. As soon as another socket is inserted in the chuck, the sleeve is lowered and an inner beveled surface on it forces the balls in to the driving position. Tools may be inserted or removed while the spindle is in motion.

The quick-action chuck shown in section in Fig. 19 is operated by raising or lowering a sliding collar, for inserting or removing a tool-holding collet. The taper shank *A* enters the machine spindle, the collet *B* holds the tap or other tool, the two keys or "pawls" *C* drive the collet by engaging the slots shown, and the sliding collar *D* either holds the pawls *C* in the driving position or allows them to move outward in a radial direction for releasing the collet. The sectional view shows the driving pawls in the outward position to permit inserting or releasing a collet. When the sliding collar is pushed downward, the pawls come into contact with a conical surface and are forced inward to the driving position, as indicated by the dotted lines. This chuck is manufactured by the Quick-Action Chuck Co., Grand Rapids, Mich. The collet with its tap, drill or other tool may be inserted or removed from the chuck while the machine spindle continues to revolve.

Socket or Collet Type of Chuck

The tap-driving chuck shown in Fig. 20 is formed of one piece of steel and is without retaining screws, pins or other separate parts. This chuck is practically a collet or socket having four slots extending in a lengthwise direction to allow enough contraction of the chuck for firmly gripping the tap shank. The chuck is made to a standard Morse taper and is inserted directly in the machine spindle. Any pressure in an axial direction naturally causes the flexible body of the chuck to grip the tap shank, the grip increasing as the pressure increases. This chuck (which is made by Scully-Jones & Co., 647 Railway Exchange Bldg., Chicago, Ill.) holds taps in alignment with the spindle even though the shank may vary somewhat in size.

Friction-reducing Tapping Chuck

Poorly tapped holes may be due to the frictional resistance of the tap-driving spindle to motion in a lengthwise direction. The feather or key that drives the spindle of a drilling machine is subjected to considerable pressure, particularly when tapping rather large holes, and the natural tendency of the tap to advance or screw itself into the drilled hole is partially or entirely resisted in some cases. The result is that the tap cuts a poor thread or fails to start and simply enlarges the end of the hole like a reamer. The tap chuck shown in Fig. 21 (made by the Cincinnati Bickford Tool Co., Cincinnati, Ohio) is so constructed that the tap can advance independently of the driving spindle, and the frictional resistance is reduced to a minimum by means of ball bearings. The central part of the chuck, which engages the machine spindle, connects with an outer sleeve by means of two rectangular shaped keys which are surrounded by ball bearings, as the illustration shows. The lower end of this sliding sleeve is attached to the tap-holder proper. In tapping a hole, the operator exerts a slight pressure on the tap when it first comes into contact with the work. The tap then advances in accordance with the pitch of the thread, the frictional resistance to this movement being reduced to a minimum by the ball bearing driving keys referred to. This friction-reducing feature tends to prevent reaming action or the stripping of the thread, especially when driving comparatively large taps, which without the ball bearing feature would have to advance against considerable frictional resistance.

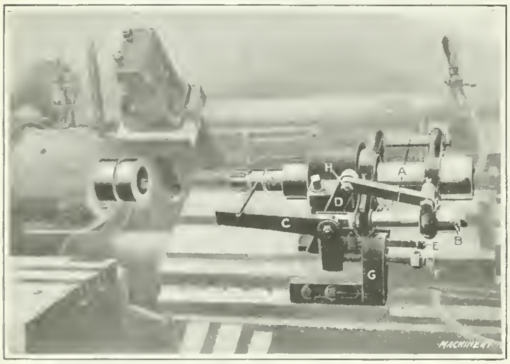

Fig. 24. Tap Resetting Attachment on Gridley Single-spindle Automatic

Tap-holder Designed on Principle of Oldham Coupling

The tap-holder illustrated in Fig. 22 applied to a vertical boring mill is similar in principle to the well-known Oldham coupling. The particular operation shown is that of tapping lathe faceplates. The holder is formed of three sections *A*, *B* and *C*. Part *A* is attached to the tool-slide of the boring mill, part *B* holds the tap, and the central section *C* has a tongue on the upper face engaging a groove in *A*, and a tongue on the lower face engaging a groove in *B*. These tongues are at right angles, so that the tap-holder is free to move laterally in case the tap is not in alignment with the hole. The three sections of the tap-holder are held together by four large cap-screws that are threaded into the lower half of the coupling but pass through enlarged holes in the central section and the upper part that is attached to the tool-slide. Various classes of tapping attachments and tapping machines will be described in the December number.

Resetting Collapsible Taps

The method of resetting collapsing taps varies according to the construction of the tap and may depend in some cases upon the type of machine used for the tapping operations. Collapsing taps of the non-revolving class, which are intended for use in turrets, etc., commonly have a lever projecting from the side which is used for resetting the tap after it has collapsed, as previously explained. This lever may be operated by hand, or the machine, if an automatic type, may be equipped with some form of projecting part arranged to engage the closing lever as the tap and turret-slide are withdrawn after the tapping operation. Some collapsing taps designed to revolve have a sliding flange or collar which engages a suitable collar or stop and serves to reset the tap.

The special tap resetting attachment for a "Namco" tap applied to an Acme multiple-spindle automatic is shown in Fig. 23. The tap, in this case, is arranged to revolve when cutting a thread. The bracket *A*, carrying shaft *B*, is bolted to the main tool-slide of the machine so that shaft *B* is parallel with the tap-spindle. Yoke *C* engages the spool or grooved collar *D*, which is free to slide on the tap proper. Stop *E* is bolted to the cylinder casing of the machine to terminate the travel of the tap. The amount of travel is controlled by the adjustment of collar *F* on rod *B*. When the tap is cutting, the forward travel of the tool-slide carries stop-collar *F* into contact with stop *E*, which is drilled to receive the projecting end of rod *B* and serves as a guide. When the work has been tapped to the required depth, the forward travel of the tool-spindle is stopped and the chasers collapse as described in connection with the "Namco" tap, illustrated in Fig. 2. As the tool-slide recedes from the work to allow the work-spindles of the machine to index for the next operation, a closing attachment operates in the following manner: The backward travel of shaft *B* is accelerated and yoke *C* engaging spool *D* is stopped by contact with collar *G*; as the tap proper continues to recede with the backward movement of the tool-slide, spool *D* remains stationary, causing the resetting pin *H* to travel down the inclined cam surface shown, thus resetting the tap for the next operation.

The resetting attachment for the "Namco" tap, as applied to the Gridley single-spindle automatic, is shown in Fig. 24, and is similar to the mechanism used for self-opening dies. This attachment is bolted to the slide on the turret and consists of guide-rods *A*, a spring at *B* for starting the tap onto the work, a closing lever *C*, a stop-lever *D*, an adjusting screw *E* for the stop-lever, an adjusting screw *F* for the closing lever, and a stationary stop *G* bolted to the side of the turret. The operation is as follows: When the turret is moved forward by the regular cam equipment of the machine and the tap is about to engage the work, the spring at *B*, controlled by stop-lever *D*, causes the tap to start cutting, the bracket shown traveling on guide-rods *A* for the length of the cut. When the tap has entered the hole to the required depth, stop-lever *D* ceases to hinge at fulcrum point *H*, thereby stopping the travel of the tap and causing it to trip or collapse. As the mechanism recedes, the adjusting screws *E* and *F* in bracket *G* cause the closing lever to engage the handle of the tap and reset it for the next operation. When this tap is used on other machines, the mechanism may require more or less modification. When tapping deep holes, special equipment has been applied to allow the tap to cut to any required depth.

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The propelling machinery of the superdreadnought U. S. S. *Tennessee*, now being constructed, will consist of four motors, each driving one propeller shaft, and developing 6700 horsepower at 175 revolutions per minute. The current for the motors will be furnished by two standard Westinghouse steam turbo-driven alternators, each of which is capable of developing a maximum of 13,500 horsepower.

COMMON AND SPECIAL MICROMETER CALIPERS[1]

ILLUSTRATIONS OF USE IN TOOLMAKING AND MANUFACTURING

BY F. SERVER

"WHAT can it do for you?" is perhaps the most pertinent question that can be asked about a well-known tool that is making big strides in its own field in addition to finding many special applications. This tool is the micrometer. It is a precision measuring instrument, an adjustable gage in which the units of measurement are 0.001 inch or 0.01 millimeter. The micrometer caliper is an important factor in interchangeable manufacture which now means more to the nations at war than ever before. We are supplying the armies in Europe with American products measured in inches that will interchange with products made to metric measurements. While the development of micrometers has been interesting, it is their applications to special conditions that will be discussed in this article.

Typical examples are shown in Fig. 1, which illustrates a group of Slocomb micrometers of different designs. Following this in Fig. 2 is shown a group of tools of various construction, running from the one-inch size to the larger sizes. Referring to Fig. 1, the first illustration shows a tube micrometer, and, as its name implies, this micrometer is used for measuring thicknesses of the walls of tubing, rings or any similar class of work. The illustration at the right of this shows a thread micrometer of familiar construction, which is used for comparing or transferring thread measurements from a standard to the work being machined. As a micrometer of this type does not measure points diametrically opposite, care must be taken in its application. The illustration in the center of Fig. 1 shows a micrometer which is adapted for measuring the thickness of a plate at some distance from the edge, this being made possible by the long gap construction. By having the anvil of this micrometer rounded, it can also be used for measuring tubing. The lower view at the left shows a ½-inch micrometer which is used for measuring paper; this is provided with special anvils of large diameter, thereby providing a large contact surface for the paper or cloth. The illustration in the lower right-hand corner shows a ½-inch micrometer with part of the frame cut away and the anvil rounded over. This is used for measuring the walls of tubing and pieces of various other shapes and projections of a similar kind, where the depth is not too great.

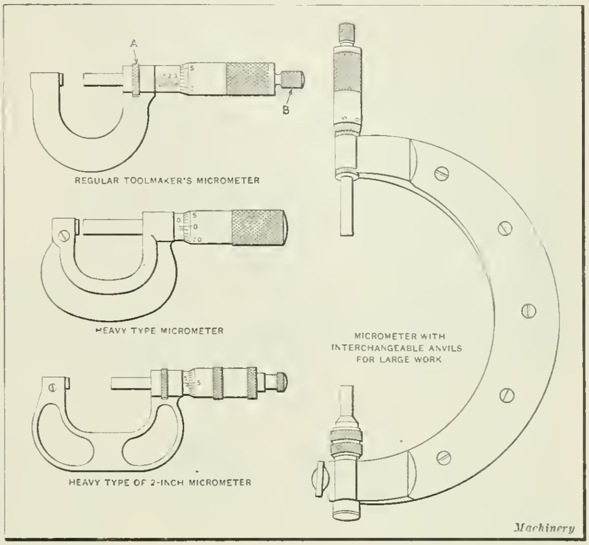
A
B
REGULAR TOOLMAKER'S MICROMETER
HEAVY TYPE MICROMETER
HEAVY TYPE OF 2-INCH MICROMETER
MICROMETER WITH INTERCHANGEABLE ANVILS FOR LARGE WORK
Machinery

Fig. 2. Group of Standard Micrometers of Different Types and Sizes

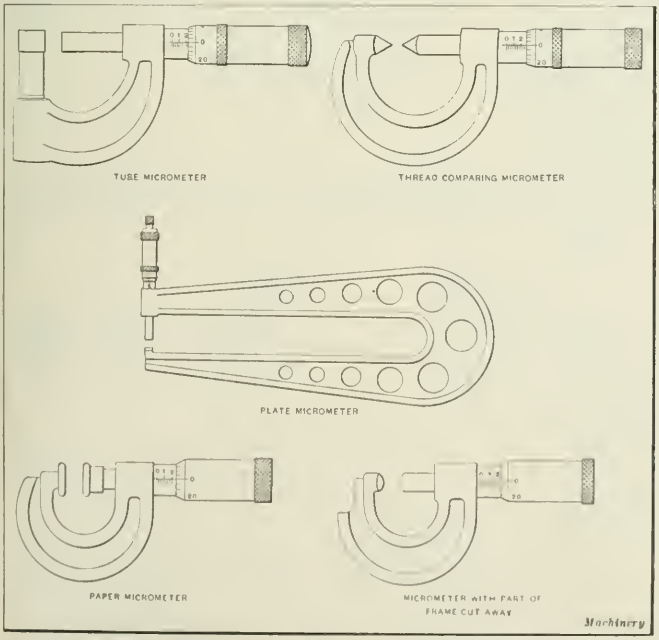
TUBE MICROMETER
THREAD COMPARING MICROMETER
PLATE MICROMETER
PAPER MICROMETER
MICROMETER WITH PART OF FRAME CUT AWAY
Machinery

Fig. 1. Group of Special-purpose Micrometer Calipers of Various Designs

The micrometers illustrated in Fig. 2 are a collection of standard tools, the one in the middle at the left being a heavy type micrometer having a drop-forged frame. The one above this is the familiar toolmaker's micrometer, which has a lock-nut *A* and a ratchet stop *B*. Both of these micrometers have a one-inch range. The micrometer shown in the lower left-hand corner measures from one to two inches; and is a heavy-type tool with a lock-nut and a ratchet stop. The micrometer shown in the right-hand view is adapted for measuring large work, and it is provided with a ratchet stop, rubber grips and interchangeable anvils. By means of the latter feature quite a large range of work may be measured. A micrometer caliper that has a number of patented features enabling it to meet special requirements in tool-room use is illustrated in Fig. 4. This micrometer has a flat surface *A* ground at right angles to the spindle, and there is a hole *B* in the anvil. This tool is put on the market with graduations to 0.0005 inch and also with a double row of figures, one set of which reads in the usual manner, and the other from zero at the open end to 1.000 inch with the anvil and spindle together. The rod shown at *C* is used for measuring depths in the same manner as when using a depth gage.

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[1] See also "How We Came to Have the Micrometer Caliper," in the June, 1915, number of MACHINERY.

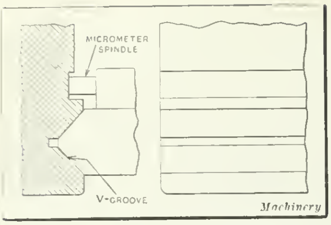


Fig. 3. Use of Micrometer shown at Bottom of Fig. 7

A micrometer of special construction, as applied for measuring a drawn steel part, is shown in Fig. 5. The work is shown in section, and this micrometer measures the thickness from the outside of lug *A* to the inside surface of the wall. This tool is built up with a regular micrometer head *B* and a long anvil *C*, while the frame *D* is forged from machine steel. A micrometer of rather unique construction, but which nevertheless is a practical tool, is shown at the top of Fig. 6. This measures from 0 to 1.000 inch at end *A*, and from 1.000 inch to 2.000 inches at end *B*, thus combining two tools in one. This tool is not as convenient to handle as a micrometer which measures only one range; and, in addition, it costs almost as much to make as two separate micrometers, while two micrometers could be used by two persons and this tool can be used by one only, thereby lessening its value.

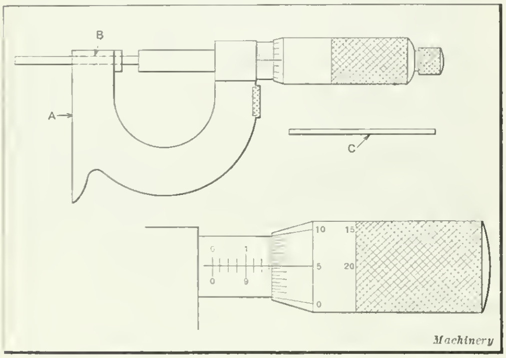


Fig. 4. Micrometer provided with Double Set of Graduations and Depth Plug

In the lower view of Fig. 6 is shown a tool designed on the built-up principle like the Johansson gages. This tool is patented (as are many of the others here shown) and measures from 0 to 6.000 inches, this being accomplished by having a set of end measures or spacers *C*, which are placed against a lug *D* in the spindle frame *E*. These end measures vary in length by inches, and after placing the required lengths between the spindle frame and anvil frame in the tube, other end measures are placed in back of the spindle frame. The whole is then locked by the knurled screw *G* and the micrometer is arranged for measuring a one-inch range in the usual manner, this range being, for example, from 2.000 to 3.000 inches. By rearranging the blocks, any other one-inch range may be had within the capacity of the tool. It will be noticed that on the end of the sliding bar at the knurled end *G* there are two zeros which must coincide in order to indicate the amount of pressure that has been applied in tightening the nut; this also indicates if there is any dirt between the end measures.

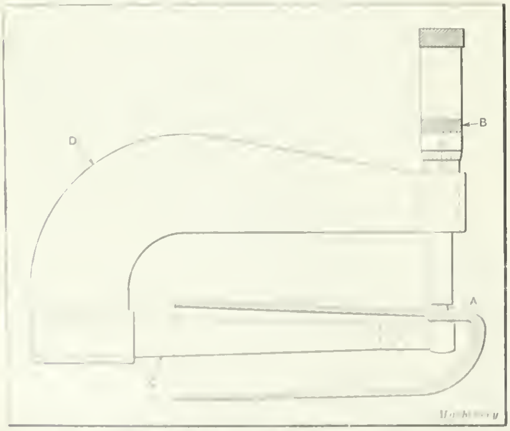


Fig. 5. Micrometer for Measuring Height of Lug A from Inside of Shell

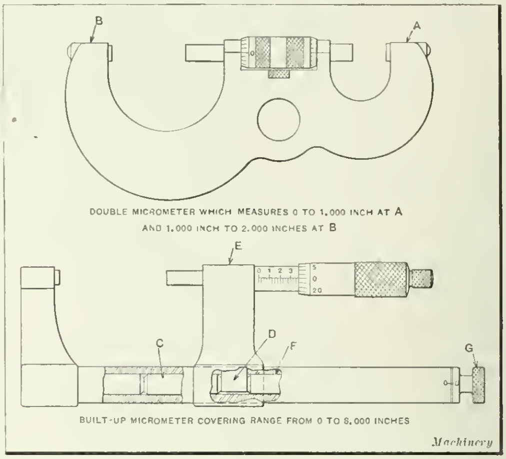

B
A
0
DOUBLE MICROMETER WHICH MEASURES 0 TO 1.000 INCH AT A AND 1.000 INCH TO 2.000 INCHES AT B
E
0 1 2 3
5
0
20
C
D
F
G
0
BUILT-UP MICROMETER COVERING RANGE FROM 0 TO 6.000 INCHES
Machinery

Fig. 6. Two Types of Micrometers covering Large Range of Measurements

Three examples of measuring with micrometers are illustrated in Fig. 7, and each of the tools shown is well adapted to the class of work that is shown being measured. The upper view shows a two-inch micrometer measuring a three-sided piece across the flats. In this tool the spindle *A* is slightly rounded at the measuring end, while the anvil is of a special construction as follows: Pinned to the sides of the caliper frame are two plates *B*, and between these plates a floating anvil *C* is placed, which is free to swivel on pin *D*; thus the work is measured between three points. In using a tool of this type it is a good plan to test it occasionally with a standard, as the rounded points wear fast. This tool is best adapted

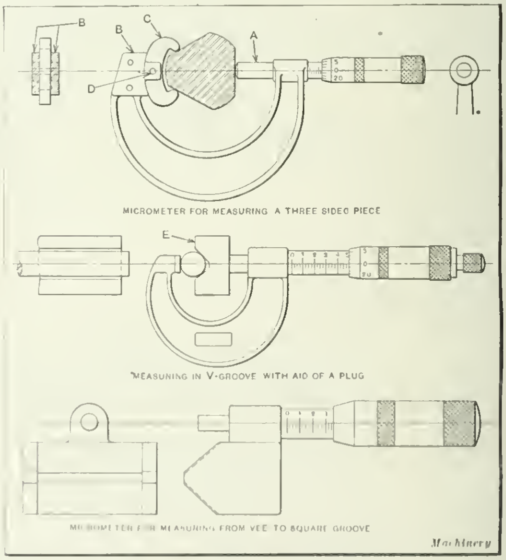

B
C
B
A
D
5
0
20
MICROMETER FOR MEASURING A THREE SIDED PIECE
E
MEASURING IN V-GROOVE WITH AID OF A PLUG
MICROMETER FOR MEASURING FROM VEE TO SQUARE GROOVE
Machinery

Fig. 7. Three Special Applications of Micrometer Calipers

for making comparative measurements.

In the view at the center of Fig. 7 a micrometer used with a standard plug is shown. The measurement being taken is obvious, the object being to machine the V-groove to the correct distance from the bottom of block *E*. In the lower view is shown a tool that must be carefully used, but that, in the hands of a careful man, will give good results. This tool measures from a V-groove to a planed slot at one side of the vee. In using it, the workman holds the formed block portion of the micrometer down snugly into the vee, the weight of the form being so proportioned that it will counteract the weight of the micrometer portion of the tool. This tool takes a relative measurement in the usual manner. Fig. 3 is an enlarged view showing the application of this last tool, this being a cross-sectional view of the spindle and vee portion of the micrometer. Figs. 3 and 7 show some of the advantages of measuring with a micrometer by making simple changes in the tool, and oftentimes the necessity for making expensive gages may be avoided by the application of a special tool in the form of a micrometer caliper.

In referring to the micrometer in this article it is not intended to convey to the reader the idea that this tool is limited to the one- and two-inch sizes found in any toolmaker's kit, as these tools are now made to measure much larger sizes. In Fig. 8 a set of micrometers is shown which measure from 12 to 24 inches; and to the right a large micrometer is shown which has a three-inch range. The latter has interchangeable anvils varying in length by inches, while the head end measures the intermediate range of sizes in the usual manner. In the lower view of Fig. 8, a bench micrometer is shown, having a six-inch range. This tool has large dials so that the reading is very much magnified, and interchangeable dials for coarse or fine measuring may be used. In the illustrations which are to follow a number of different means employed for measuring will be illustrated; these consist of examples taken from practice, and in some cases show the micrometer with slight alterations which are made necessary by various conditions of use.

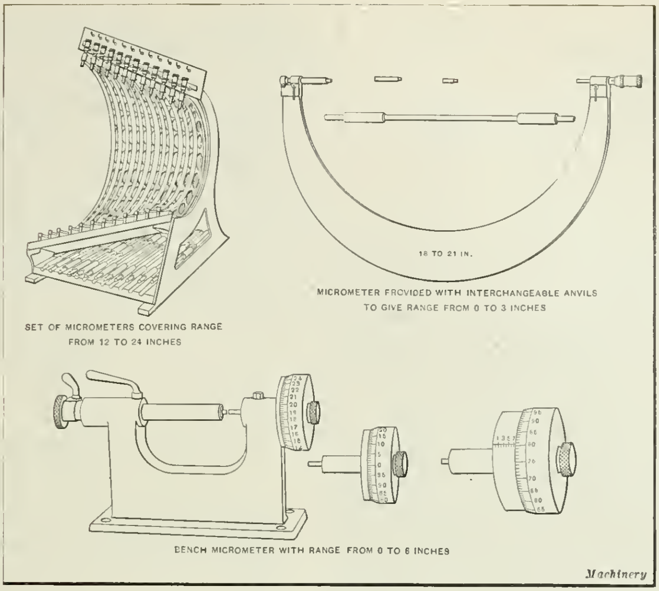

SET OF MICROMETERS COVERING RANGE FROM 12 TO 24 INCHES
18 TO 21 IN.
MICROMETER PROVIDED WITH INTERCHANGEABLE ANVILS TO GIVE RANGE FROM 0 TO 3 INCHES
BENCH MICROMETER WITH RANGE FROM 0 TO 6 INCHES
Machinery

Fig. 8. Three Types of Wide-range Micrometers

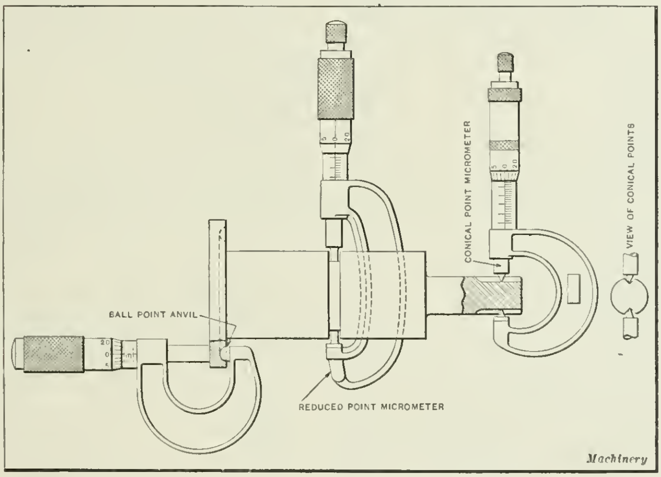


Fig. 9. Three Types of Micrometers with Special Points

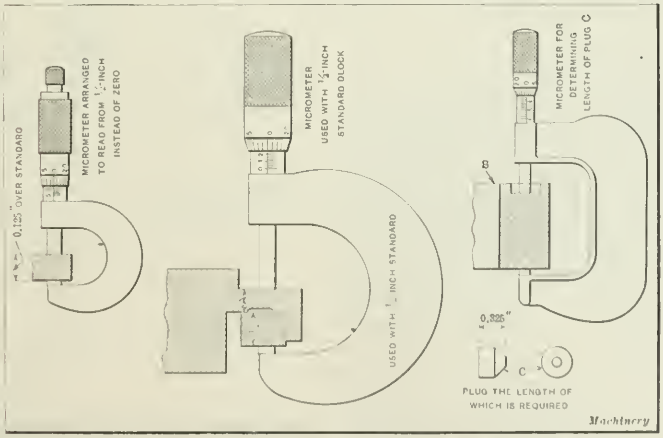

0.125" OVER STANDARD
MICROMETER ARRANGED TO READ FROM ½-INCH INSTEAD OF ZERO
MICROMETER USED WITH 1½-INCH STANDARD BLOCK
A
USED WITH 1½ INCH STANDARD
MICROMETER FOR DETERMINING LENGTH OF PLUG C
B
0.325"
C
PLUG THE LENGTH OF WHICH IS REQUIRED
Machinery

Fig. 10. Micrometers that take Readings from Some Other Point than Zero

Referring to Fig. 9, three micrometers are shown measuring different points on a stud. The first tool with a ball point anvil is shown measuring the depth of a recess in the head; this measurement is being taken from the end of the work, and it will be noticed in this connection that the anvil has been rounded suitably to fit into the groove. The micrometer in the center, known as a "reduced point micrometer," is for measuring at the bottom of narrow grooves, and, as will be noted, the points have been turned down until they are small enough in diameter to allow the tool to be readily slipped through the groove. The tool at the right, known as a "conical point micrometer," has a reduced point and is for measuring the depth of a V-groove.

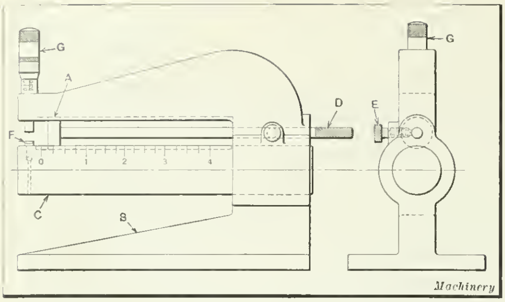
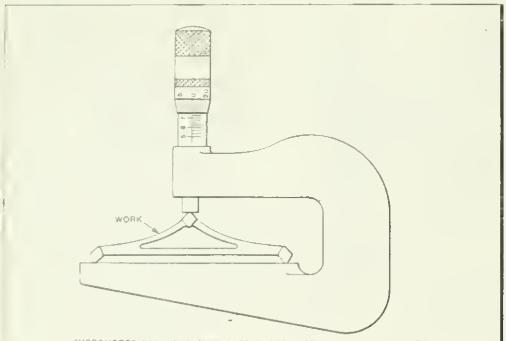
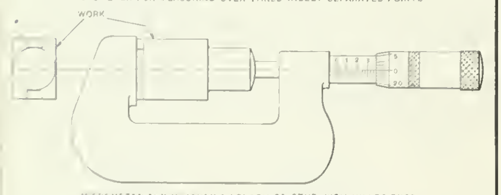


Fig. 11. Micrometer for measuring Thickness of Tubing at Intervals of One Inch

A method of using a micrometer which is not in very general use but which has considerable to commend it is illustrated in Fig. 10. The micrometer reads from some predetermined point and not from zero, as is usually the case. To illustrate this method reference is made to the view at the left. Between the measuring points of the micrometer a block which measures 0.125 inch is shown, and it will be seen that the reading on the tool is 0.625 inch, which indicates that the base of this system (as it might be called) is 0.500 inch. The value of this reading comes from the fact that the piece measuring 0.125 inch is to be used in connection with another piece which measures 0.500 inch. As the two are to be measured independently, it is desired to ignore the other piece which measures 0.500 inch but still get the complete reading, which is the length of a plug that must be made to go in a hole 0.500 inch deep and stand out above this hole 0.125 inch. Referring to the view in the center of this illustration, a working application of this system is shown. In this instance it is desired to measure the thickness through *A*, and to do this it is obviously necessary to use a block that will allow the measurement to be taken in the manner shown. For convenience, this block is called 0.500 inch or ½ inch standard. The micrometer is made to ignore this ½ inch standard in taking the measurements, thus giving the exact reading through the wall *A* without any figuring.



MICROMETER FOR MEASURING OVER THREE WIDELY SEPARATED POINTS



MICROMETER FOR MEASURING LENGTH OF STUD WITH MILLED ENDS

Fig. 12. Micrometers with Wide Anvils to afford Support for Work

In the example shown in the view to the right, it is desired to measure the length of a small plug *C*. The space filled by block *B* plus the plug length is predetermined or standard; thus to find the exact length of the plug, the micrometer is made to read backward from this predetermined figure, automatically giving the length of the plug which it is necessary to make to fill the space. In this instance the space it is desired to fill would be marked zero, and as the measurement being taken on the block is less than zero, the tool reads minus to give the desired length. A special micrometer for measuring lengths and thicknesses of tubing is illustrated in Fig. 11. In using this tool the sliding bar *A* is first placed on an indicating line at zero and the first measurement taken in the usual manner; bar *A* is then moved to the next line and the reading again taken; in like manner, the bar is alternately moved as measurements are taken by the micrometer head, and thus thicknesses at various points from the end of the tube are obtained. This tube micrometer consists merely of the base *B* and anvil *C* over which the tube is slipped, and a long bar *D* which is clamped in the correct position by screw *E*, while the measuring point *F* and micrometer head *G* complete the outfit.

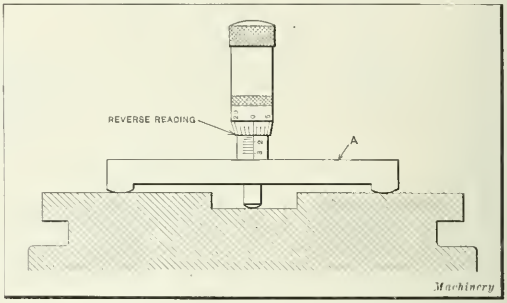
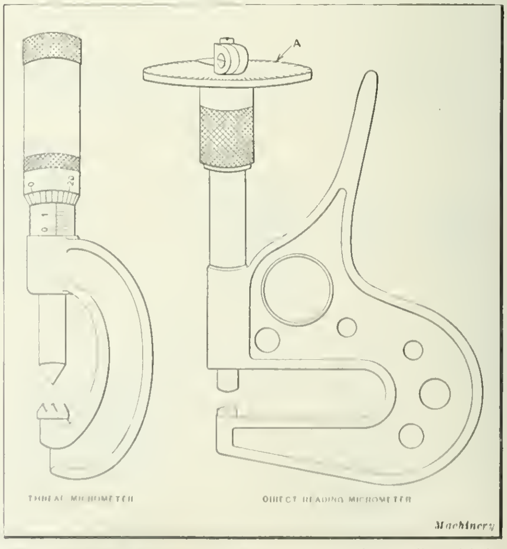


Fig. 13. Micrometer with Reverse-reading Head for measuring Depth of Slot

In the upper view of Fig. 12 is shown a micrometer for measuring over three points; the frame of this tool is of special form with a long anvil ground at right angles to the measuring head. The manner of using this tool is obvious, but one point that might possibly be overlooked requires specific mention. In a number of micrometers on the market, the adjustment for wear of the measuring point is obtained by moving a screw in the anvil, but in the tool here described it becomes evident that this method of adjusting would not do; therefore, care is necessary in the selection of a micrometer head for this purpose, and one should be obtained where the adjustment is made in the head itself. Referring to the lower view, Fig. 12, a micrometer of similar construction to the fore-



THREAD MICROMETER DIRECT READING MICROMETER

Fig. 14. Thread Micrometer and Micrometer with Direct-reading Dial A

going is shown. This tool is for measuring a stud which has the ends milled to shape. The micrometer needs no special description, as it is simply made to straddle the lugs of the work.

At the left in Fig. 14 a thread measuring micrometer is illustrated. This tool is a well-known type, having a V-shaped lower anvil and a conical pointed upper anvil. To the right a direct-reading caliper is shown; this tool has a large disk *A* from which the measurements are read off directly, without reference to lines on the sleeve as in the regular micrometer. This tool is shaped so that it can be held conveniently in one hand. A micrometer that measures the depth of a groove is shown in Fig. 13. It consists of a bar *A* that straddles the groove and bears on the finished surfaces of the work. This bar is held firmly in position by one hand while the micrometer point is brought into contact with the bottom of the groove in the usual manner, when the reading is obtained direct by having the reading reversed as previously described. The remarks on having the adjustment for wear in the head of the tool apply with equal force to a tool of this type. In connection with this tool it might be well to emphasize the fact that if too much pressure is applied while taking measurements of this kind, the bar would be raised clear of the surface from which the measurement is being taken, and in consequence, a false reading would be obtained.

Fig. 15 clearly illustrates the construction of the friction stop as applied to the head of the micrometer. This consists of a coiled spring inside a sleeve, the former being attached to the screw of the micrometer. The large end of the spring is not held in any manner; therefore, in turning to the right, as in taking a measurement, the thimble of the tool will slip over the spring when the screw comes in contact with the part being measured, while in turning the thimble to the left the spring is uncoiled, thereby causing a binding action between the spring and the thimble which causes the screw to be moved with the thimble. In the lower part of this illustration, the outside appearance of the friction head is shown, and a complete micrometer having a friction thimble is also illustrated. This friction thimble is operated in the same manner as a friction stop, the upper portion of the thimble being made to move independently of the lower portion upon which the reading is taken.

A rather interesting example of micrometer measuring is shown in Fig. 16. In this instance the work being measured is placed on a pin *A* and the measurement *B* is taken by having lug *X* come in contact with the anvil *C*; then by taking a measurement with the micrometer head *D* as usual, the desired reading is obtained. From the foregoing it will be evident that the micrometer when applied to measuring special parts has possibilities that are not limited to any particular sphere and can be applied more effectively in many instances than would be possible if using a fixed measuring gage; one advantageous feature of a micrometer is the fact that the screw can be run back to take a reading when making a rough cut, thus enabling the operator to determine the exact amount of stock that has to be removed.

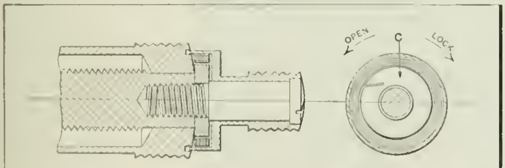


Fig. 15. How Friction Stop is applied to Micrometer Thimble

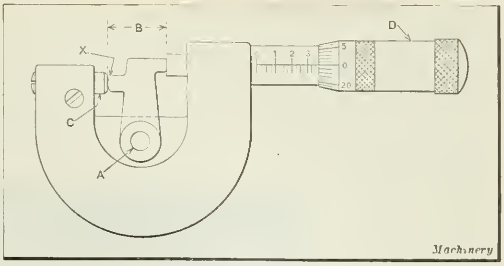


Fig. 16. Micrometer for obtaining Dimension B of Small Lever

* * *

NATIONAL FRENCH TRADEMARK

A member of the Chamber of Commerce in Paris, M. Raynald Legouez, some time ago started a society known as "L'Union Nationale Inter-Syndicale des Marques Collectives," the members of which society are entitled to place on goods and articles produced by them the trademark "Unis—France," the word "Unis" having been formed by the initials of the first four words in the name of the society. The object of the society is to make it practically necessary for every French manufacturer to become a member, so that all products that do not bear the trademark "Unis" will immediately be marked as either imported or manufactured by other than French makers in France. If the manufacture is of purely French origin, there is nothing to prevent anyone from obtaining the right to use the trademark, but goods that are not entirely manufactured in France, and apparently those that are not manufactured by French capital and labor, may not use the trademark. One of the leading French trade papers, *L'Exportateur Francais*, has decided not to accept any advertisements nor open its columns in any form to any manufacturer who does not belong to the trademark society.

There is apparently good reason for this step having been taken in France in order to prevent abuses by German interests after the war. According to an article in *Industritidningen Norden*, Stockholm, German manufacturers realize that after the war their products will not be especially desirable in the world's markets, and the manufacturers of the Central Empires, according to statements published in the Swedish press, have already made efforts to plan arrangements whereby after the war their products can pass in the world's markets under the names of other nations. Thus, for example, some German firms have already installed branches in Sweden, the object of which is to assemble machine parts made in Germany, so that in this way Herr Schultze and Herr Meyer may be able to sell their goods in the world's market as of Swedish origin. No doubt the same methods will be pursued elsewhere. For this reason, the adoption of a trademark similar to the French is now advocated in Sweden. French importers are already extremely suspicious of articles imported from neutral countries, and it is stated that they have every reason to be so, because they have unintentionally been buying products from the Central Empires at times, and as trading with the enemy is not only illegal, but in addition carries with it the risk under present conditions of loss of customers, great care is taken in France to prevent the importation of articles the origin of which is not well known. It is stated that German newspapers, recognizing the danger of national trademarks, have already begun to advocate as one of the conditions of peace that national trademarks should be forbidden. It is not likely, says the Swedish journal from which the above information is obtained, that the rest of the world will be willing to permit the pan-Germans to dictate the conditions of peace, but this particular condition shows clearly what methods they are already planning for the economic war that they expect will follow the present political war.

BROACHING TEETH OF INTERNAL GEARS

The following article describes the work of broaching the teeth of internal gears on one of the No. 3 broaching machines built by the Lapointe Machine Tool Co., of Hudson, Mass. The gears to be broached were 10.666 inches pitch diameter with sixty-four teeth of 6 pitch; and the forgings were made from alloy steel. The teeth to be broached were 1⅛ inch long and the difficulty consisted of designing a fixture to broach these teeth so that when the entire operation had been completed the teeth would mesh perfectly with the pinion and the whole forging would not be distorted. It will be seen from Fig. 1 that the fixture consists of a main casting *A* bolted to the faceplate of the broaching machine. On the inside of this casting there is a cast-iron part *B* which acts as a guide and support for broach *C*. Carried in support *B* is a hardened steel plate *D* which is a loose fit in the holder. This plate is milled on its under side to fit a taper seat in support *B*, and as the broach is drawn through the work, plate *D* is held in its seat and maintains the broach in the proper position to cut teeth of the desired depth. When the return stroke of the broach is started, plate *D* is pushed back in its taper seat and falls out of guide *B*, thus allowing the broach to drop down out of contact with the work.

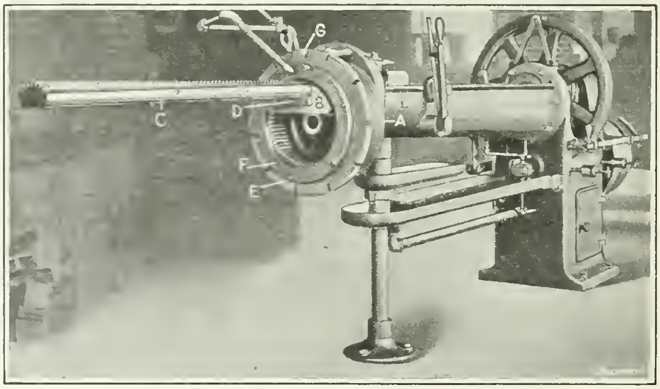


Fig. 1. Lapointe No. 3 Broaching Machine equipped for broaching Teeth of Internal Gears

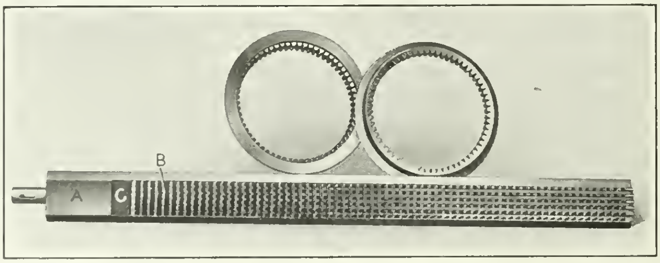


Fig. 2. Close View of Broach and Two Gears broached on Machine

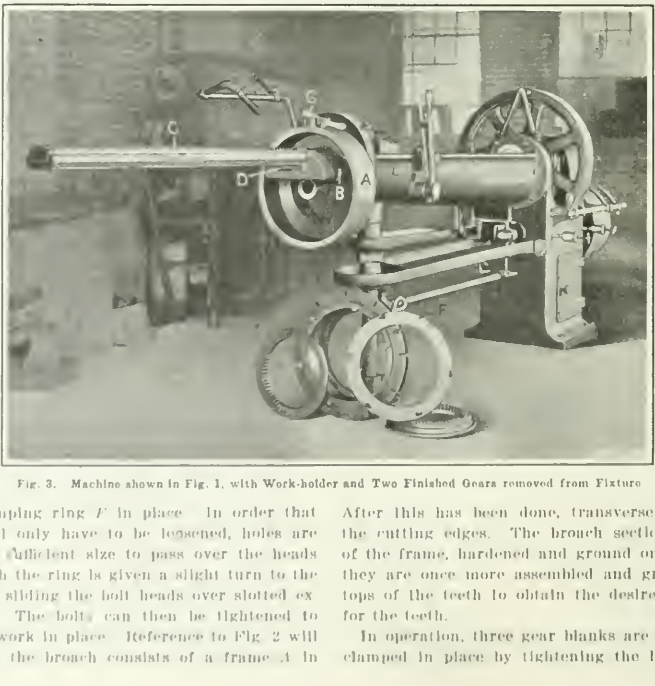


Fig. 3. Machine shown in Fig. 1, with Work-holder and Two Finished Gears removed from Fixture

In broaching internal gear teeth with this equipment, three gear blanks are set up in holder *E* and the blanks are secured in the holder by ring *F*. It will be seen that there are six clamping bolts in holder *E*, which provide for clamping ring *F* in place. In order that the clamping bolts will only have to be loosened, holes are provided in ring *F* of sufficient size to pass over the heads of the bolts, after which the ring is given a slight turn to the right, which results in sliding the bolt heads over slotted extensions of the holes. The bolts can then be tightened to secure ring *F* and the work in place. Reference to Fig. 2 will make it apparent that the broach consists of a frame *A* in which are mounted six broaches *B*. As there are sixty-four teeth in these gears and each passage of the broach through the gear results in cutting six teeth, it will be apparent that eleven passes of the broach are necessary in order to complete cutting the teeth. To provide for indexing the work, it will be seen that holder *E*, Figs. 1 and 3, has eleven slots milled in its periphery, which are tapered on both sides so that latch *G* will index the work accurately when it drops into one of these slots.

In deciding upon the use of a broach of the type shown in Fig. 2, the idea was to provide for the replacement of broken broaches at a minimum expense. Should it happen that a tooth in one section of the broach is broken, this section can be replaced at far less cost than making a complete new broach. These broach sections are first planed to standard dimensions and then drilled in four places so that the entire set of six broaches can be bolted into the frame, which is carefully milled to the right width and depth to receive them. At the left-hand end of the frame in Fig. 2, it will be seen that there is a piece of steel *C* inserted for the broached sections to rest against. These sections are shouldered at the ends so that they fit under piece *C*, provision being made in this way for holding the head ends of the broach sections firmly down in the frame. After the sections have been made, they are put into the frame and bolted in place, so that all sections are drawn firmly together to form the equivalent of a single piece. It is then necessary to turn the outside of the broach sections to the proper radius of curvature and also to cut the teeth. After this has been done, transverse slots are cut to form the cutting edges. The broach sections are then taken out of the frame, hardened and ground on the sides, after which they are once more assembled and ground on the faces and tops of the teeth to obtain the desired height and thickness for the teeth.

In operation, three gear blanks are set up in holder *E* and clamped in place by tightening the bolts over ring *F*. The entire work-holder is then placed in body *A* of the fixture, and latch *G* is inserted in one of the notches in work-holder *E*. Broach *C* is next connected with the draw-head of the machine, and support *D* put in place under the broach. The machine is now started and pulls the broach through the three gear blanks, any standard cutting compound being used as a lubricant. The machine is next reversed and plate *D* is pushed out to allow the broach to drop clear of the work. The work is then indexed by lifting latch *G* and turning work-holder *E* sufficiently to allow the latch to drop into the next notch. Eleven successive operations of this kind complete broaching the teeth, and, of course, three gears are broached simultaneously. The speed of operation naturally depends somewhat upon the skill of the operator in setting up and removing the gears, but a production rate of nine gears per hour has been attained by an unskilled operator. The special fixture required for this job was designed and placed in operation by H. E. Blanchard, works manager of the Lapointe Machine Tool Co. E. K. H.

* * *

COMPENSATION FOR INJURIES OBTAINED IN EMERGENCIES

BY CHESLA C. SHERLOCK[1]

It is well settled that so long as an employe is within the scope of employment he is entitled to compensation in case of injury; but let the workman leave his employment or get outside its scope and he is not entitled to compensation if injury results. This line of demarkation between acts within the scope of employment and those outside is a very fine one, and many nice questions come up every day in industrial centers upon this point. Heretofore, the workmen's compensation acts have been discussed as they apply to cases where the injured workman suffered his injury in the course of his employment. It is equally interesting and serviceable to know under just what circumstances compensation is payable for injuries received when the workman has gone outside the scope of his employment and received an injury.

Even though the rule that an employe is not entitled to compensation for such injuries seems to be grounded firmly in common sense and in good legal reasoning, the courts have allowed compensation in a certain line of cases. They have said that even though the rule is that a workman is not entitled to compensation if he gets outside the scope of his employment, compensation will be allowed him if he was forced to leave the scope of his employment because of an emergency. This does not mean that an ordinary set of circumstances will suffice to throw the mantle of legal protection over the workman's shoulders. It means clearly that the situation which makes cases of this nature compensable must have been one of extraordinary emergency, of unusual peril, or one dictated by humane thought and action.

The Illinois Supreme Court has decided a case that well illustrates the point here made. A workman, engaged in different kinds of work in his employer's plant, was working on some safety devices when an employe working on some steam pipes under the floor, in which an opening had been made but which it was impossible to see because of the escaping vapor and steam, slipped and fell through the opening into the hot water, screaming for help. The first employe dropped his work and ran toward the hole, but owing to the steam obscuring it, fell in and was so badly scalded that he died. The court held that the deceased workman was entitled to compensation for the reason that the emergency justified his act and that, although under ordinary circumstances he would have been outside the course of employment, he was covered in this instance. One of the earliest decisions of the California Commission held that an employe in attempting to escape from a danger incident to his employment is acting in the course thereof and is entitled to compensation.

In a New Jersey case, a workman slipped and fell, sustaining injuries which later resulted in his death, in trying to dodge a blow aimed at him by a fellow workman in a spirit of sport. The court said: "The trial judge found, as a fact, that the decedent did nothing to invite the attack and it is not denied that the decedent was acting, at the time, witnin the scope of his employment. It is a matter of no consequence whether or not the workman, at the time he made the attack, was acting within the scope of his employment. In the case under consideration it appears that the prosecutor employed young men and boys. It is but natural to expect them to deport themselves as young men and boys replete with the activities of life and health. For workmen of that age, or even of maturer years, to indulge in a moment's diversion from work to joke with or play a prank upon a fellow workman is a matter of common knowledge to everyone who employs labor. At any rate, it cannot be said that the attack made upon the decedent was so disconnected from the decedent's employment as to take it out of the class of risks reasonably incident to the employment of labor.

"At common law, the master was not liable for an injury to his servant caused by the negligent act of a fellow servant upon the ground that the servant assumed the risk. Under the workmen's compensation act, the master assumes all risks reasonably incident to the employment. It was a negligent act of the fellow workman to make a pass at the decedent while passing him on the slant of the concrete floor, and for such negligence the master would not have been liable at the common law, not upon the theory that it was not a risk reasonably incident to the employment, but upon the ground that it was a risk which the servant assumed when he entered into his master's employ." The court sustained the award of compensation made by the lower trial court.

In a Californa case, a workman was killed while attempting to rescue fellow workmen who had been imprisoned by a cave-in of dirt. His employers defended on the ground that he was guilty of wilfull misconduct in going back into the tunnel in an attempt to rescue his fellow workmen when he had been warned of the danger. The commission held that the dependents of the deceased were entitled to compensation, saying, "The deceased was the only one of the employes who responded to the call of his fellow workmen for help and he lost his life in the effort to effect a rescue. Such conduct is not misconduct, much less wilfull misconduct. Even though he deliberately exposed himself to the danger of injury and death, his action cannot be said to be wilfull in the sense of being stubborn, perverse, or as evidencing a state of mind opposed to the orders and instructions given him, or as opposed to the action that reasonably should have been taken by him, both as a fellow employe and in his official capacity as an assistant foreman."

In another case decided in the same state, the court held that where an employe is present at the scene of the death by accident of several of his fellow employes while they are working upon the premises of the employer, and where such employe attempts to aid in the rescue, and becomes insane as a result of the mental and emotional shock incident to the excitement, peril and sense of duty to aid in the rescue of his co-workers, such accident is a disability caused by accident. Compensation was allowed on the theory mentioned before, namely, that an act done in an emergency is not outside the course of the workman's employment. In one case, a workman ran to a telephone to summon aid for an injured fellow workman. After reaching the telephone he was seized with an apoplectic shock, which resulted in his own death. Compensation was awarded, the court saying that it was within the duty of a workman to summon aid for a fellow employe, although not specifically mentioned to him or expected in ordinary circumstances.

Employers should bear this point of law in mind, as it will very often take a case out of the non-compensable class and make it compensable. The rule is that if the workman acts in a sudden or extraordinary emergency and is injured, he is entitled to compensation.

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The International Association of Industrial Accident Boards reports that 80 per cent of the injured soldiers and sailors of the Allied Nations are enabled through re-education to take up gainful occupations.

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DAYLIGHT FACILITIES IN INDUSTRIAL PLANTS

FACTORS GOVERNING AMOUNT OF LIGHT TRANSMITTED THROUGH WINDOWS

BY C. E. CLEWELL [1]

ONE of the most fundamental and important problems in the modern industrial plant is that relating to adequate daylight throughout the normal working hours of the day. This is apparent at once from the following considerations: (a) Sufficient daylight for every employe is a primary requisite for the best workmanship; (b) the factory floor space that is well lighted throughout, has a higher value from the manufacturing point of view than the floor that is only partially lighted, and in which certain spaces are too dark to carry on good workmanship; and (c) the plant that is sufficiently provided with natural light during the daylight hours is saved the expense for artificial light during portions of the day. While these phases of the problem are obvious, there are a number of elements in the daylighting problem that are not generally understood and appreciated. One of the chief objects of the present article is to outline some of the more or less fundamental aspects of the case and to follow these up with brief references to modern American practice in window planning. Some typical plants equipped with recent developments in window sash construction are shown in the illustrations.

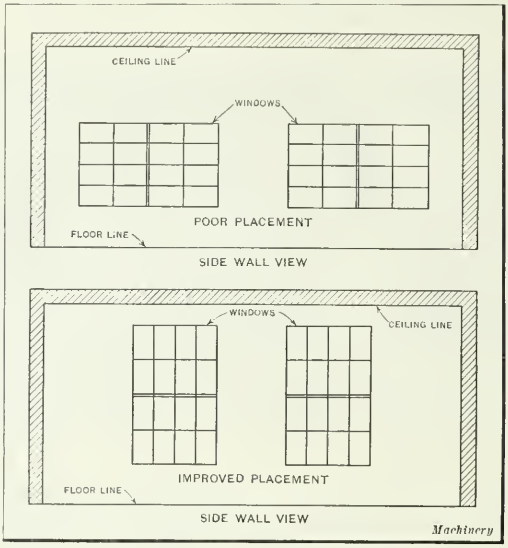

Fig. 1. Illustrating Importance of Arrangement of Window Openings

There is a tendency to look upon large window area as the one requirement to be met in successful window planning. As a matter of fact, the area of the window openings is only one of a number of points that should receive careful consideration in the plans for new factory structures. In other words, a given ratio of window area to floor area, which may be entirely satisfactory in one plant, may not be an adequate arrangement under different conditions. To illustrate this point, two side walls are shown in Fig. 1, in which the window openings have exactly the same area. In the upper part of the diagram, the windows are placed horizontally with a considerable distance between the upper part of the sashes and the ceiling line. In the lower part, the windows are located vertically with the top of the windows near the ceiling line, and it is evident that the latter arrangement is preferable, since the light through the higher windows will reach more remote portions of the floor space in the building. As a first important conclusion, therefore, it follows that the arrangement of the window openings, as well as their area, must be given due weight in factory planning. Fig. 1 merely illustrates the point, the principle being applicable to actual cases found in practice.

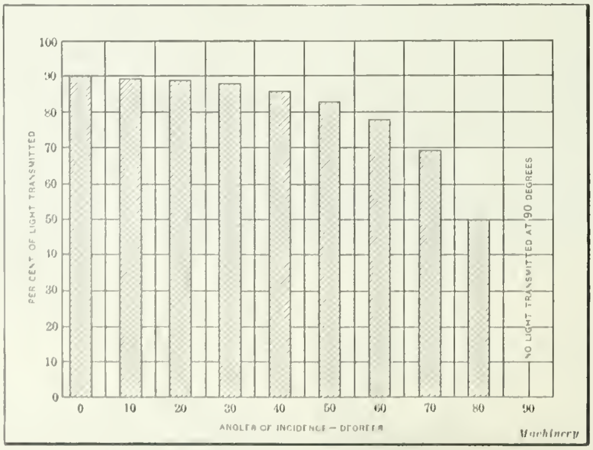

Fig. 2. Chart showing Percentages of Light transmitted into Building for Various Angles of Incidence

Dependence of Transmitted Light upon Angle of Incidence

The most favorable condition for effective lighting is usually that in which each side window receives throughout its entire area the unobstructed light from the sky. Put in a slightly different way, the ideal condition is where an unobstructed view of the sky is obtained from any part of the interior floor space throughout the entire area of each window. Even in such cases, however, much of the light which is incident upon the front surfaces of the windows strikes the glass at rather large angles with a line perpendicular to the glass surface. These angles, as illustrated in Fig. 3, are termed the "angles of incidence." For plain window glass, the maximum amount of light is transmitted into the building when the light strikes the window surface squarely; that is to say, when the angle of incidence is zero. Under this condition, all the incident light save that absorbed by the glass itself is transmitted into the building, this absorption being placed at about 10 per cent by Marks in his lecture before the Illuminating Engineering Society and the Johns Hopkins University in 1910. The same authority shows that for increasing angles of incidence the percentage of light transmitted into the building falls off quite rapidly, particularly after 60 and 70 degrees are reached, as shown in Fig. 2. It will be evident that when the light grazes the surfaces of plain glass at such high angles, much of the light will be reflected away from the glass rather than directed into the interior. For this reason it is often found advantageous to use some special form of roughed, ribbed or prism glass where most of the light reaches the windows at high incident angles, since these special glasses are capable of redirecting a larger proportion of the light into the building than is possible when plain glass is used.

From what has just been stated, it will be apparent that the most favorable condition for the use of plain glass is where the windows face an unobstructed horizon. This very favorable condition, however, is often defeated by the presence of nearby buildings that cut off a large part of the sky. In such a case, two facts should be not-

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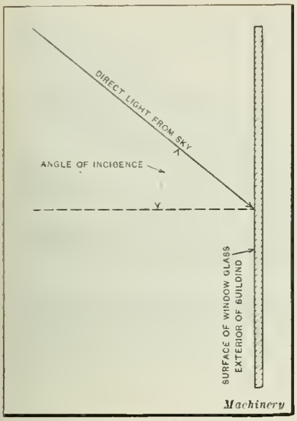


Fig. 3. Exterior Window Surface, showing Angle of Incidence

ed. One is that for most parts of the factory interior, the adjacent building may make it impossible to see the sky through more than a fraction of the window area. The second is that the adjacent building causes most of the light that reaches the windows to come down between the buildings from the sky, and hence involves large angles of incidence, as defined by Fig. 2. In the first case, the reduced visible area of window through which sky is visible causes a direct loss in the effective window area available for lighting, since that part of the window through which sky is not visible from any given point in the factory becomes useless in its lighting effect for the given point, unless the opposite building front is light enough in color to reflect some of the light from the sky across and into these otherwise useless portions of the window areas, in which case the effect is of course less than that due to direct light from the sky. This statement refers primarily to plain window glass. If these relatively uselss window areas are equipped with roughed or prism glass, they may then be utilized in spite of the fact that most of the light is received from overhead sky.

Extreme Variations of Exterior Daylight

It is not always realized that the variations in the intensity of natural light under the open sky are great throughout a given day and for different seasons of the year. Fig. 4 shows graphically typical variations from 5 A. M. to 7 P. M. in June, September and December based on tests in Great Britain by a departmental committee on the lighting in factories and workshops, appointed by Parliament. The intensity values used as ordinates for these curves are expressed in the now commonly accepted unit known as the foot-candle. To understand these curves it is to be noted that the "foot-candle" is the unit of illumination and is defined in the factory lighting code of the Illuminating Engineering Society as the lighting effect produced upon an object by a standard candle at a distance of one foot. At two feet, the effect would be one-fourth instead of one-half foot-candle, since the intensity varies inversely as the square of the distance between the source and the object lighted. Therefore, a sixteen candlepower lamp—one that gives off sixteen candlepower in all directions—will give a uniform illumination of one foot-candle at a distance of four feet in any direction. The actual values of the intensity represented by the curves in Fig. 4 will be better appreciated when it is considered that for rough manufacturing work a satisfactory intensity of artificial illumination usually ranges from about two to four foot-candles. It is apparent, therefore, that the usual intensities of exterior daylight are large in comparison with the intensities that are considered satisfactory for factory interiors when supplied with artificial light, and also in comparison with the actual interior intensities of natural light as explained below. Special attention, furthermore, is directed in these curves to the differences in the intensity at the same hour for typical days in June, September and December. Thus at noon on a June day it may have a value somewhat over 4000 foot-candles, while at the same hour on a typical December day it may be about 750 foot-candles, or less than one-fifth as much. Note also that the values are very low even as late as 8 and 9 A. M. and quite early in the afternoon on December days.

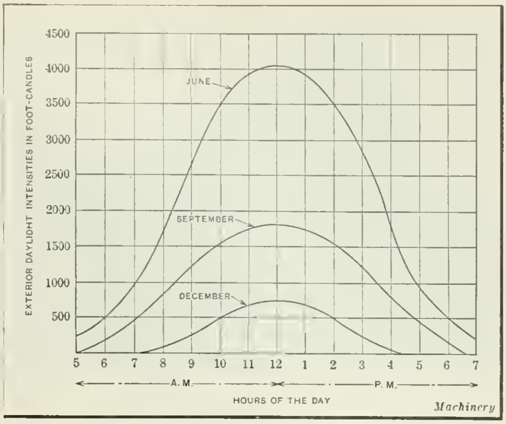


Fig. 4. Curves of Exterior Daylight Intensities

Ratio of Interior to Exterior Illumination

An interesting study may be made of probable interior values of daylight illumination for given exterior conditions, if a fairly definite idea is gained of the relation existing between interior and exterior intensities at any given time of day. The differences between the interior natural light of a factory and the corresponding exterior conditions out under the open sky are likely to be far greater than is ordinarily appreciated, and as such differences depend greatly on the arrangement of the windows and other conditions connected with the daylight problem, we shall now turn briefly to this phase of the subject. It is a fairly simple matter to obtain a numerical value for the ratio between the daylight conditions at a point within a factory and the conditions without under the open sky. Thus if simultaneous measurements are made of these two intensities, we may divide the interior intensity by the exterior value, expressing the result as a percentage, and obtain in this way a numerical measure of the effectiveness

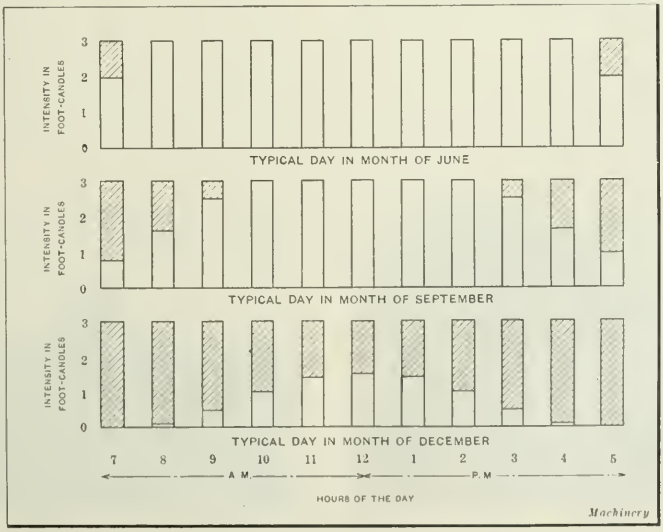


Fig. 5. Chart based on Fig. 4, showing Hours when Daylight Intensities within Buildings will produce Three Foot-candles at Points within Daylight Factor

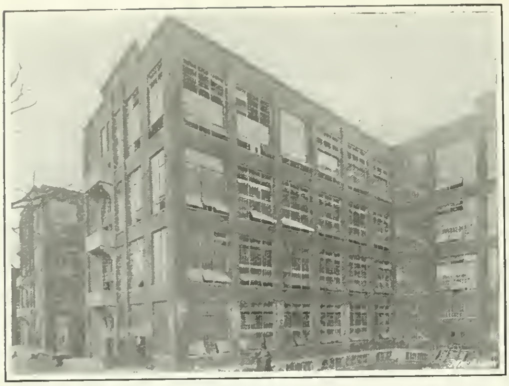


Fig. 6. Exterior View of Plant, showing Top-hung and Centrally Pivoted Steel Sash

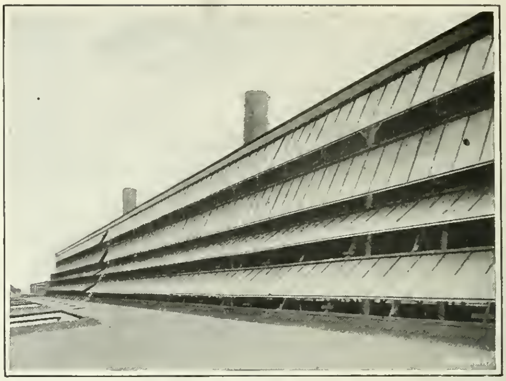


Fig. 7. Exterior View of Factory equipped with Top-hung Continuous Steel Sash

of the windows in lighting the interior. This ratio has been given the name "daylight factor" in the British report referred to. A building with adequate window areas and with no obstructions nearby to cut off the sky, will tend to have a relatively high daylight factor for all points over its floor area; whereas a building with inadequate window area and many surrounding obstructions will ordinarily have a low daylight factor for many if not all of the points throughout its floor space.

The tests in Great Britain to ascertain the value of the daylight factor show that it usually has very low values. In a few cases it reaches 10 per cent, and the mean values for a large number of factories ranged roughly between 0.25 and 2 per cent. It follows, moreover, that for points near the center of a building, which are remote from windows, this factor may be much lower than for points near the windows. In fact, at points near the center of some work-rooms, which depend entirely upon side windows (that is to say, with no roof lighting) this factor has been found to fall below the ranges given above, sometimes being as low as 0.01 per cent, which means that the light reaching such points is only one ten-thousandth of the value existing outside the building.

Application of Daylight Factor

Investigations with reference to this factor in industrial plants have shown that its value is practically constant at all times of the day and at the different seasons of the year. Hence, if its value is known for representative points within a factory, and if the exterior daylight variations are at hand for the geographical location in question in a form similar to the curves of Fig. 4, we may then determine approximately at what hours of the day the daylight will probably fall below any prescribed minimum intensity. To illustrate this point, it has been assumed that the daylight factor at a point in a factory has a value of 0.2 per cent. On a typical June day at 7 A. M. the curves in Fig. 4 show the exterior intensity to be about 1000 foot-candles. For the given daylight factor of 0.2 per cent, the interior intensity at the given point will then have the value 1000 × 0.002 = 2 foot-candles. Let us assume that the minimum value of the illumination for satisfactory work is 3 foot-candles. Then at 7 A. M. on June days, with 2 foot-candles at the work due to daylight, artificial light will be necessary if the prescribed minimum of 3 foot-candles is maintained. In Fig. 5, in the upper left-hand corner, the conditions at 7 A. M. on a June day are shown graphically. The total area represented is 3 foot-candles, of which 2 foot-candles (the unshaded part of the area) are supplied through the windows. At least one additional foot-candle (the shaded part of the area) must be supplied in the form of artificial light to bring up the illumination to the prescribed minimum of 3 foot-candles. At 8 A. M. the curve in Fig. 4 shows the exterior daylight intensity on a June day to be about 1750 foot-candles. This means an interior intensity due to daylight of 3.5 foot-candles for the given daylight factor of 0.2 per cent. Hence the daylight intensity at the given point is greater than the prescribed minimum by 0.5 foot-candle, and the area of 8 A. M. in Fig. 5 is shown unshaded throughout to indicate that no artificial light is required at this hour.

Points Brought Out by Chart

Fig. 5 illustrates in an instructive and interesting manner the changes that occur within a factory with given windows due to the changes of exterior daylight as indicated by the curves in Fig. 4. It must be remembered in a study of Fig. 5, however, that this chart has been prepared on a basis of one given daylight factor and for one set of curves of exterior intensities. Not only may the exterior conditions at various locations be different from those shown by Fig. 4, but the daylight factor may have values which differ materially from the one assumed in the preparation of this chart. Moreover, the different portions of a given factory floor may have

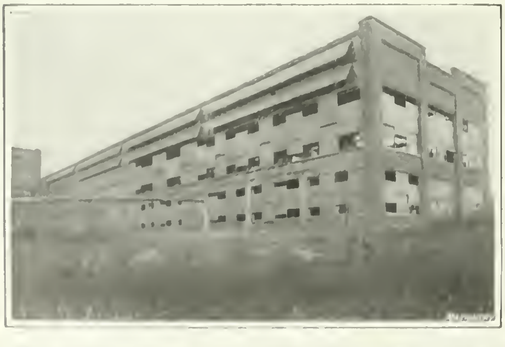


Fig. 8. Exterior View of Foundry, showing Counterbalanced Type Steel Sash

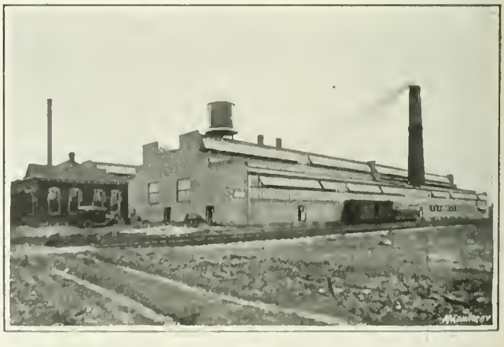


Fig. 9. Exterior View of Building, showing Top-hung Continuous Steel Sash

great variations in the daylight factor, ranging from relatively high values near windows to relatively low values at the center of the building. It should also be kept in mind that the actual changes in intensity throughout a day do not necessarily follow a smooth curve, as in Fig. 4. The passage of clouds of varying density over the sun may cause sudden changes with extreme variations above or below the values indicated by these curves. However, if the daylight factor is determined for the darkest part of a factory interior, and if curves like Fig. 4 are available, it then becomes a fairly simple matter to determine the probable times when artificial light will be required to supplement the natural light during normal working hours of the day and for the worst conditions in the plant. From the standpoint of such a determination, a chart like Fig. 5 becomes of special interest and value, for showing the importance to production of an adequate system of artificial lighting. In Fig. 5 it will be seen that, with the exception of 7 A. M. and 5 P. M., the typical June day has sufficiently large exterior daylight intensities to insure the prescribed minimum intensity at the given point in the factory. In September, the shorter days are evidenced by the need for some artificial light up to 9 A. M. and after 3 P. M. Some artificial light will be necessary under the given conditions throughout the entire day during December, a requirement which is not uncommon for the darker portions of factory floors where the window areas are not adequate.

Ratio of Window Area to Floor Area

As pointed out near the beginning of this article, the area of window openings is only one of the requirements of scientific daylight planning, and the other requirements, some of which have been outlined, should always be given due weight in such plans. It is interesting, however, to note some of the values of the ratio of window area to floor area as found in modern factory practice. Based on the experience of D. Lupton's Sons Co., seven cases have been investigated as representative of typical modern plants. The ratio of window area to floor area ranges in these seven cases from about 19 per cent to about 109 per cent with an average of about 50 per cent. This average value agrees fairly closely with mean values of this ratio for roof-lighted and combined roof- and side-lighted factories based on the extended observations made in Great Britain. Any attempt, however, to arrive at a definite figure for this ratio is limited by the necessity of taking other features aside from area into consideration, and the large ranges in the values of this ratio in current practice indicate that standardization, at least in the present stage of development of the art, is hardly to be expected.

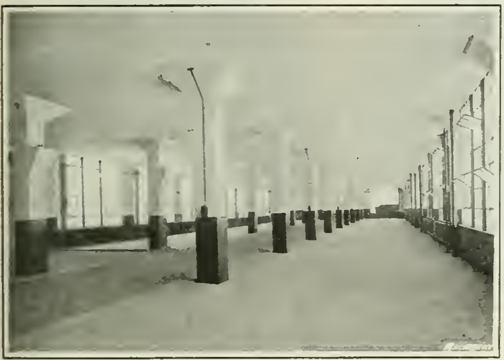


Fig. 10. Interior View of Plant, showing Pivoted Steel Sash

Some idea may be gained of the present tendency to utilize as much of the side wall area as possible for windows, by the experience of the Detroit Steel Products Co., manufacturer of "Fenestra" sash. Figures available from this concern indicate for twenty-two typical cases an average of over 60 per cent for the ratio of side windows to side wall area, the ratio being as high as 90 per cent in some cases. From what has already been said, however, it should be evident that the mere installation of as much window sash as possible is not necessarily a guarantee that the daylighting will be satisfactory unless other factors, which are almost equally important, are given their share of attention when the plans for new buildings are prepared. It is to be hoped that progress in this direction will be such as soon to result in more definite standards for window openings than are now available.

Typical Types of Window Sash Used in Present Practice

To illustrate the practical side of the more or less fundamental principles of the problem just discussed, Figs. 6 to 11 are included. These may be briefly described as follows: Pivoted sash, as it is usually understood, is shown in Figs. 6 and 10. Fig. 6 indicates both the top-hung and the centrally pivoted types, the upper sashes of each window unit being centrally pivoted and the lower line of sash for each unit being top-hung. The use of top-hung sash for the lower sections prevents the sash, when open, from projecting into the building. Fig. 10 is an interior view and gives an excellent idea of the centrally pivoted type with its slight projections into the building, when open. This may be an objection when it is desirable to locate work close to the side walls.

An interesting development is shown in Fig. 8, where the counterbalanced type of Lupton sash is used. When the lower sash is raised for ventilation purposes, the upper sash is lowered a corresponding amount automatically, thus increasing the ventilation and at the same time avoiding any projections into the building as with the centrally pivoted type. The close relationship between the daylighting and ventilation problem has received an unusual degree of attention by certain manufacturers. Perhaps the foremost case of this kind is illustrated by Figs. 7, 9, and 11, which indicate the use of the Pond patented continuous sash (top-hung) as employed with the Pond truss. Fig. 7 is a close view of the continuous sash, showing the long lines of sash used as a unit, the opening and closing of which is accomplished by a special operating device. Fig. 9 gives an idea of the applications of the continuous sash to a finished structure; and the end view of the roof in Fig. 11 shows the effect on the general shape of a partially completed shop through the use of this form of truss, which is designed to improve ventilation as well as lighting.

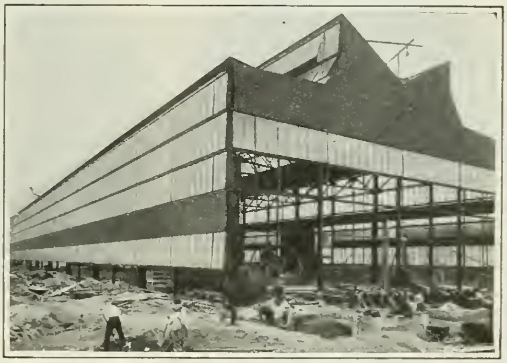


Fig. 11. Exterior View of Building, showing Continuous Sash and Truss

These illustrations will convey the idea of the radical departures which have been made in sash design and construction in comparison with older shop window practice. There can be little doubt as to the many advantages which these improvements in window planning will have on factory methods and production, but at the same time a word of caution is in place that, with the acceptance of these improvements, the other extreme of excessive light and undue glare be carefully avoided. There is the danger that, in the desire to possess the best daylight facilities, undue emphasis may be placed on quantity rather than quality of light, and that other fundamental aspects of the problem may be overlooked. Too much light is as harmful as too little. The illumination of the old gloomy factory is certainly a step in the right direction, and this article does not in any sense discourage these commendable advances. It merely suggests the importance of a realization of some of these other factors.

FILE RENEWING

At this time, when the conservation of materials and the prevention of waste is highly important, the various methods for file renewing, whereby dull files may be restored to their original usefulness, rather than being thrown onto the scrap heap, are of importance. A number of different processes have been developed from time to time for the renewing or resharpening of worn files. One company has put out a machine known as a "file-sharpening machine," which is, in effect, a sandblast. The objection to the sandblast for file renewing is that, while it sharpens the teeth, it does not deepen the groove between the teeth, and hence does not restore the file to its original condition. Another method is the acid dip, consisting of mixtures containing hydrochloric, nitric and sulphuric acids. This will deepen the space between the teeth, but inasmuch as it eats away the tops of the teeth as well as the metal in the groove, it does not restore the file to its original condition, nor does it sharpen it appreciably. The same may be said of the electrolytic method, in which the file to be sharpened is made the anode in an electrolytic bath. A fourth method, which is really only a cleaning method and which does not in any way restore the file, is the wire-brush method, which has been used to a limited extent for file renewing. None of these methods can be said to have been successful in restoring files to a condition equal to new.

The American File Renewing Co., Providence, R. I., is using a method for renewing files which consists more or less of a combination of some of the other methods, whereby not only the grooves between the teeth of the file are deepened, but a sharp edge is also produced on the top. This method was originated in 1902 by August Beran, and is used exclusively by this company and by no one else. The process employed is briefly as follows: The worn-out files, as received from the customers, are first listed; that is, they are provided with some identifying mark on the tang, making it possible to distinguish the files belonging to each customer after they have received the required treatment. They are then graded according to their condition, as files that are badly worn or rusted must be treated differently from those that are less worn and in a reasonably good condition. After the grading, the files go to the cleaning bath into which they are dipped to clean out the dirt that adheres to them. Where chips are wedged firmly between the teeth, these must be afterward removed by picking, which simply consists in using the end of a wire for picking out the material between the teeth. The file is now clean and ready to receive the renewal treatment. A resist which will prevent the acid dip from attacking the tops of the teeth is first lightly applied, so that the tops are covered, but the spaces between the teeth are left uncovered. The files are then dipped into crocks containing solutions that will eat away enough metal in the grooves to produce teeth of the original depth. The length of time that the files remain in the acid dip depends upon their condition, and it is at this time that the proper grading of the files becomes important. When the groove has been made of sufficient depth, the sand blast is used, when required, to produce a sufficiently sharp tooth, and after this the files are covered with a solution or varnish to prevent them from rusting and give them a good appearance.

The advantages of this process are that the cuts are uniformly deepened, so that the teeth are restored to their original length. A good file can be renewed by this process from four to six times; after this, it will be too thin for service. By treating the files by the methods described, a sharp point is produced. In fact, it is claimed that the point is even sharper than in a new file, on account of the absence of the burr that is present when the file is cut with a chisel. The methods of file renewing as practiced by the company mentioned also have the advantage over the recutting methods of not drawing the temper, as the file is not submitted at any time to a heat higher than that of boiling water. In the recutting methods, where the file is annealed and recut, the resharpened file is softened and the metal is not as good as in a new file.

In the accompanying illustrations, Fig. 1 shows an enlarged photograph of a file in the state in which it is received for file renewal; Fig. 2 shows a file that has been cleaned and is ready for the renewal process; while Fig. 3 shows the condition of a file after it has been properly treated. While it is difficult to reproduce in a photograph the exact condition of the file, it may be noticed that the depth between the teeth has been increased and that, instead of the flat or rounded tops of the teeth in Figs. 1 and 2, there is a distinct sharp edge on the teeth shown in Fig. 3.

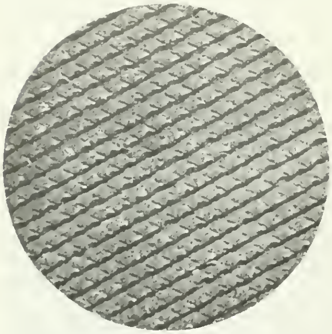


Fig. 1. Worn Condition in which File is received for Renewal

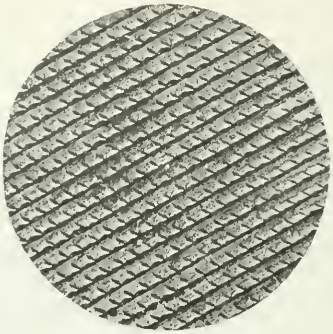


Fig. 2. Worn File Ready for Renewal Process

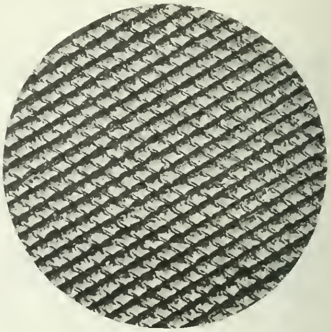


Fig. 3. File after having passed through Renewal Process

The cost of file renewing is enough less than the cost of new files to warrant the use of this process, and at this particular time it is especially important because of the saving of time and material in the production of new files. The American file Renewing Co. makes a practice of charging for the renewal of files in accordance with the original cost of the file. The saving over a new file is over 33 1/3 per cent on American pattern files and up to 50 per cent on toolmakers' files, the charge being made by giving a discount on the list price of new files, so that the cost of renewal is always a definite proportion of the cost of the new file, and in no case more than 66 2/3 per cent.

In the file industry, a peculiar method of discounts is in vogue, which causes considerable confusion and sometimes misunderstanding as to the actual price paid by a customer. For example, one manufacturer may give a discount of 70-10-10-50 and 25, which, while it looks like a very heavy discount, is practically the same as that of 90 and 10. This is something that buyers of files and those who contract for file renewal should take into consideration, so as to determine exactly the cost of new files as compared with file renewal, and also so as to be able to compare the prices charged by various companies engaged in file renewal. E. O.

* * *

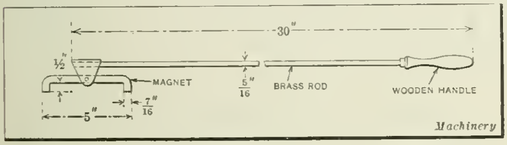
According to a British consul, the production of platinum in Russia last year was only one-third the normal output. This reduced output was due to the scarcity of labor and the difficulty of securing mechanical parts for the dredges.

LETTERS ON PRACTICAL SUBJECTS

WE PAY ONLY FOR ARTICLES PUBLISHED EXCLUSIVELY IN MACHINERY

MAGNETIC TEMPERING DEVICE

As I have seen several magnetic tempering devices advertised at $10 and upward, it has occurred to me that others may be interested in a tempering magnet that I have used for a number of years. The illustration shows the construction, which is very simple, so that the entire device can be made for $2 or $3, including the toolmaker's time. The handle is a 5/16-inch brass rod, 30 inches long; the yoke is of 16 or 18 gage sheet brass, riveted to the handle. The magnet is 7/16 inch square and about 5 inches long over all after being bent, and the two legs are about 1/2 inch long. The hole in the yoke is for a 3/32-inch cotter-pin, and is drilled about 1/4 inch off center. A cotter-pin is used so that the magnet can be easily removed for recharging. The magnet is mounted with the long end toward the handle, and is free to tip up or down about 3/8 inch. The steel companies manufacture a special magnet steel, but the best one that I have had was made from "Novo" high-speed steel. It must be hard and drawn very little. In order to charge, draw the magnet over the pole of a strong electromagnet using direct current, being careful to draw only in one direction. I have used the field of a direct-current motor or dynamo.



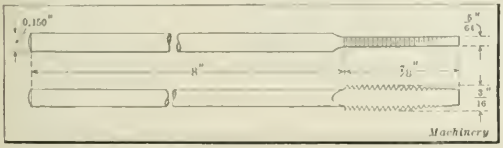
Magnetic Tempering Device

When using the magnet, the front leg is placed on the steel as it approaches the proper heat, and if it has not reached the correct temperature, the magnetic pull will lift the rear end up against the handle when the whole thing is raised, but when the correct temperature is reached there will be no attraction, and the magnet will withdraw without tipping. The various parts of the steel may be tested, and if it is not uniformly heated, this will be shown definitely. As high temperature destroys magnetism, the magnet should be kept cool by frequently dipping in water, and should not be held in the furnace long at one time. I believe that anyone who uses this tool will not want to go back to judging temperatures by the eye. In drawing, I use half and half wire solder instead of judging by color. Carbon steel drawn until it will just melt the solder is right for most die and tool work.

Plymouth, Mich. **W. B. Greenleaf**

FLAT TAPS

In tapping a 3/16-inch, thirty-six-thread hole in steel 3/4 inch thick, we had considerable trouble with taps breaking when tapping with a short tap, running it in and backing it out of each piece. We therefore made up a flat tap with a shank about 8 inches long. As the flat tap allows plenty of chip room and the long shank acts as a sort of torsion spring, taking up sudden shocks, the taps last several times as long. As a consequence, we are now making all our taps that way, up to 1/2 inch diameter. There is a saving of time, as well, for the tap is run clear through the piece and is left on the shank until it is full, instead of backing the tap out each time. When the shank is full, it is taken out of the chuck and emptied like a regular nut tap.



Proportions of a Small Flat Tap

Boston, Mass. **J. A. Shand**

A MOUSE-TRAP CONVEYOR

The writer has seen an arrangement in a manufacturing concern whose specialty is the making of mouse-traps that is very interesting. The body of each trap is a piece of beechwood that comes to a staple machine as shown at *A*, Fig. 1. Because of market conditions, the blocks are often held up after this operation, and it was formerly the practice to let them fall out in back of the machine into boxes on trucks, in which they were stored until desired. The building in which the work is done has a roof supported on deep trusses, and it was decided to store the blocks in that space in hopper-bottomed bins with chutes leading down to the place where they would be used next, as illustrated in Fig. 2. The machine is tended by a girl who keeps the hopper filled with blocks *B*.

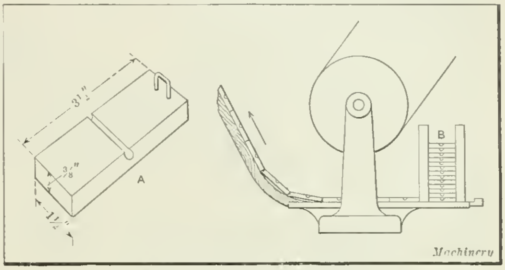


Fig. 1. Mouse-trap Block Hopper filled with Blocks

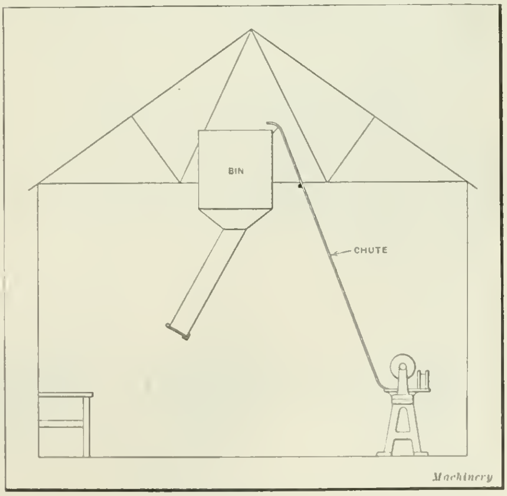


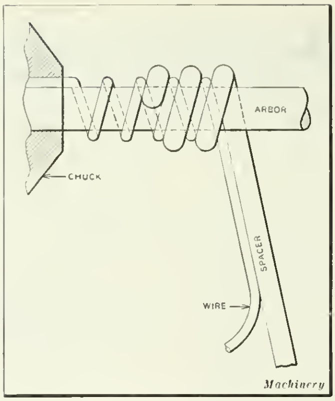
Fig. 2. Diagram of Mouse-trap Conveyor

A pusher shoves the bottom block out at the rate of forty a minute, and it is pushed up the incline into the bins. The blocks are light, and the pusher moves the entire load successfully. The runway is made of wood and takes up less floor space than the boxes formerly did. The curved portion was steamed to shape.

Middletown, N. Y. **Donald A. Hampson**

SIMPLE SPRING-WINDING METHOD

In the July number of MACHINERY, there is described an easy method of winding a spring; but the method shown in the accompanying illustration is quicker and simpler and is available for any size and pitch. For instance, suppose that a spring of No. 16 wire and a ¼-inch space is to be made. First, a piece of ¼-inch cold-rolled steel, or whatever may be on hand, is wound around a piece of the same diameter as the arbor so that it will have a left-hand lead (that is, if an ordinary lathe is used) of about two and one-half coils with a space between the coils about 0.003 inch wider than the diameter of the wire used for the spring. Then the arbor is placed in the chuck, the spacer is slipped on over the arbor near the chuck, and the wire is fastened in the chuck. After the arbor is given a half turn, so that the spacer can be easily engaged with the wire, the machine is started and let run until the desired length is wound. Springs from ⅛ to 1 inch in diameter have been wound in this way with good results.



Quick Spring-winding Method

Newark, N. J. GEORGE WERNER, JR.

USING THE SHOP CLOCK IN PLACE OF THE PYROMETER

The other day it was necessary to harden a high-speed cutter when the pyrometer was out of order. But, fortunately, we had put a mark on the gas valve and had found that it required 1½ hour to raise the temperature of the furnace to 1700 degrees F. and that the temperature was then raised about 100 degrees each hour. So the furnace was started at one o'clock and at half-past two the cutter, packed in compound, was placed in it. At half-past three, the temperature of the furnace was 1800 degrees; at half-past four, 1900 degrees; and at half-past five, 2000 degrees. The cutter was then taken out and plunged in oil. After it was cold, the temper was drawn down to 500 degrees. The cutter was then given a severe test, cutting heavy steel gears. As it was 10 inches in diameter by 2 inches thick, its cost, including stock and labor, was nearly $100.

Worcester, Mass. E. M. PETERSON

SHRAPNEL-SHELL HOLDER

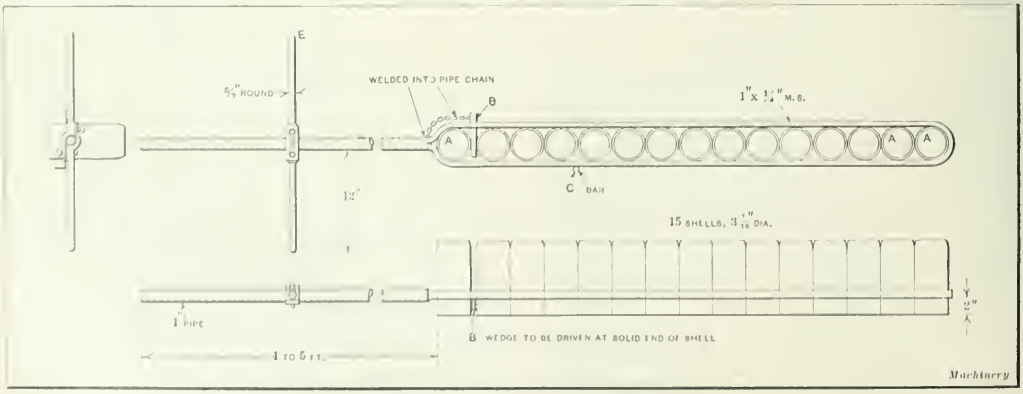
The shell-holder here shown was designed and used by the writer with excellent results in one of the prominent munitions factories. The method commonly used when heat-treating shrapnel cases is to place the shells in the furnace one at a time; in this factory, as forty-five shells were heated at one time, it took about eight minutes to load the furnace. As the furnace doors were open during this period, the pyrometer dropped about 300 degrees, and the operator absorbed most of the heat.

The holder shown can be built by a smith in two hours and will more than pay for itself in one day. The writer used three holders, which were kept on a bench about two feet high, three feet long, and two feet wide, placed conveniently near the furnace opening. While one load of shells is being heated, the cold shells (fifteen in each holder) are placed in the openings *A* and secured in place by a wedge *B*. When the furnace is ready, helpers place a porter bar *C* under the holder and the operator holds the handles *E*. After the shells are lifted to the edge of the furnace and pushed in by the operator, he turns them into the upright position, when the wedge drops from between them. The helpers again place the porter bar under the holder and, lifting it clear of the shells, pull it out of the furnace. Using this holder, the furnace can be charged in less than one and a half minute. When loading the furnace one at a time forty-five shells were heat-treated in thirty-five minutes; when the holder was used, the same number of shells were heat-treated in twenty-five minutes. This was an increase of over 25 per cent in production; besides, a considerable amount of fuel was saved.

Charlestown, N. H. JOHN FITZGERALD, JR.

HANDLING LARGE MACHINES

During the last three years, a great number of machines have been sent from the United States to Europe. These have been shipped in cases that generally bore on their tops the legend "This side up," and the condition of the machine on reaching its destination has depended on the care with which it was packed. But it is generally after the cases have been removed that the trouble begins. The machines are usually required in some other part of the factory, maybe up one or two stories, so the question arises as to where to take hold of it. If a crane is to be used for lifting the machine onto the truck, it must be decided where the ropes or slings are to be placed. If they are put in one place, the machine will not balance; if placed in another, a bar is bent or a bracket is twisted. Without doubt, the makers have been blamed for poor packing when the machine erector was to blame or the maker was to blame for not sending with the machine a blueprint giving the information. Motors and dynamos are nearly always provided with a hook or an eye to sling them with, but lathes, milling machines, etc., never have any provision for handling. Therefore the writer would suggest that the



Device for loading Shrapnel Shells into Heat-treating Ovens makers enclose with each machine a blueprint that will show how the machine can best be handled so that slings will not injure it. If necessary, some holes should be left in the casting, so that one or more bars may be passed through when the machine is moved.

York, England **John Scott**

PROBLEM IN TRIGONOMETRY

Some readers may be interested in a problem in trigonometry which occurred in our shops some time ago. It was desired to drive three pinions by one gear, and the accompanying illustration shows the dimensions given, and the dimension X required. We made the following trigonometrical computations to solve the problem:

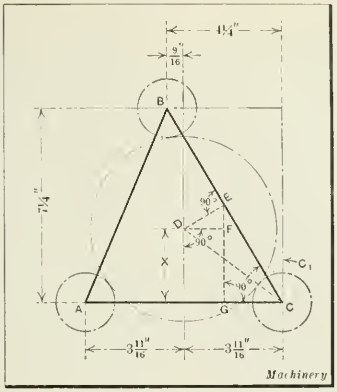


Diagram illustrating Solution of Problem in Trigonometry

$$BC = \sqrt{4.25^2 + 7.25^2} = 8.4038 \text{ inches}$$

$$\text{Tan}^{-1}\, C_1 = \frac{4.25}{7.25} = 0.586 = 30 \text{ degrees, } 22 \text{ minutes, } 46 \text{ seconds}$$

ACB = 90 degrees — 30 degrees, 22 minutes, 46 seconds = 59 degrees, 37 minutes, 14 seconds. CEG = 30 degrees, 22 minutes, 46 seconds

$$EC = \frac{BC}{2} = 4.202 \text{ inches}$$

EG = 4.202 cos 30 degrees, 22 minutes, 46 seconds = 3.626 inches

GC = 4.202 sin 30 degrees, 22 minutes, 46 seconds = 2.125 inches

$$DF = 3.688 - 2.125 = 1.563 \text{ inch}$$

EF = 1.563 tan 30 degrees, 22 minutes, 46 seconds = 0.916 inch

$$X = EG - EF = 3.626 - 0.916 = 2.710 \text{ inches}$$

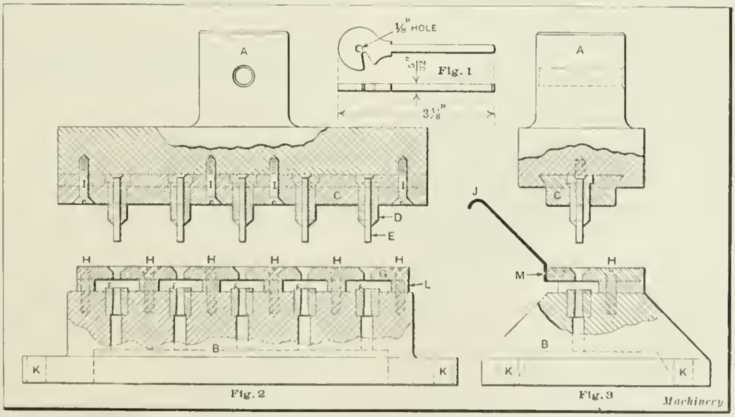
To find the center distance of gear to pinion solve for DC.

$$DC = \sqrt{2.710^2 + 3.688^2} = 4.576 \text{ inches}$$

C. O. H.

ECONOMICAL PERFORATING DIE

In Fig. 1 is shown a small stamping that must be produced in large quantities each day, but as the shape permits this part to be made from the waste from other jobs, it has been found more economical to make the part in two operations. As the thickness of the metal exceeds the punch diameter, a great strain is placed on the perforating punch, which, coupled with occasional breakage and the necessity of punching a clean hole, made it necessary to replace or grind the punch a number of times a day, thereby holding up production, as well as increasing the cost of grinding and replacing the punch. In order to keep the press operating more steadily, getting more production and a better quality of work, and reducing the cost of repairs to a minimum, a punch and die with five perforating punches and centering gages has been designed. This arrangement is superior to the single die, because the operator is able to shift from one punch to another if the punch he is using should give any trouble at all. The punch and die have been simplified in order that the necessary repairs may be easily and quickly made.



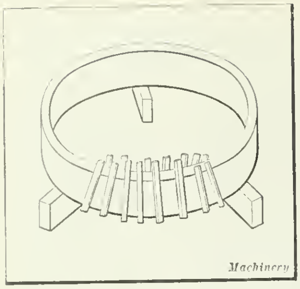
Figs. 1 to 3. An Economical Perforating Die

Fig. 2 shows the front and Fig. 3 the end elevation. The punch A is made of cast iron and has a hole through the shank, in which a pin is inserted to prevent the die from being drawn out or otherwise shifted while in operation. The steel plate C is hardened and ground and held in a dovetailed slot by flat-head screws I. Plate C, in turn, seats the hardened and ground tool-steel bushings D that hold the perforating punches E. The punches E are made from standard drill rod and their heads are upset. They are hardened and drawn to a light straw. The die B is made of cast iron and the bushings F are made from tool steel and are hardened and drawn to a light straw. Bushings F must have plenty of clearance so that the slugs will discharge freely; otherwise too great a tension may be put on the already overburdened perforating punch by reason of too many slugs being in bushing F at one time. The stripper G is held in position by flat-head screws H; it is made of machinery steel and is carburized. The tool-steel gage L is hardened and ground and is held in position by the stripper G and screws H. A guard J, Fig. 3, prevents the operator from getting his fingers caught between the punch and the stripper. This guard is made of ordinary sheet steel and is attached to the stripper G by small flat-head screws M. Holes K are provided for fastening the die to the bolster plate.

Highland Park, Mich. **Ernest A. Walters**

SHRINKING ON BANDS WITHOUT TOOLS

A power plant had three tandem compound engines of a well-known make, all of 500 horsepower rating and less than ten years old. One day the crank disk of one of the engines burst, fortunately injuring no one, which led to an examination of the other two disks. One of these had two cracks extending radially from the hole, but the builders decided that it would be perfectly safe if a band were shrunk around the outside. This was accordingly done by men sent from the factory, and in the five years since the cracks have not opened up. Not long ago, however, it was found that the disk on the third engine was cracked, so the power-plant people asked a local machinist to shrink on a band. There are many machinists who have never done a shrinking job, and while they have a general idea of the process, they think it has to be done with gas and much special equipment and is beyond an untrained man if it has to be done in the field. This particular band, however, was shrunk on by the lathe hand who bored it out, the first job of the kind he had done; but working under instructions he and his helper went to the power plant four miles away, shrunk on the band, and returned to the shop in three and a half hours, using no tools whatever but two large monkey wrenches



Method of heating Band

to carry the hot band. The finished size of the ring was 1½ inch thick and 4 inches wide; the hole was made 0.04 inch smaller than the disk, which was 36 inches in diameter. The linear expansion of a piece equal to the circumference of the ring would be 0.848 inch if heated to a dull red, which gives a clearance of 0.23 inch over the diameter of the disk. It will be noted that this makes ample allowance for loss of heat in handling and also allows for a lower heat if a red was not fully reached.

Heating the ring, or band, was the simplest thing in the world. It was supported on three large firebricks out in the yard and a wood fire built all around it, as shown in the accompanying illustration. There was plenty of pine waste to be had and the helper piled it on. A rod the size of the expanded diameter served as a gage, and when it entered, the fire was immediately pulled, the ring turned up on edge, and carried to the engine room. The monkey-wrenches, with long pipe handles, make a pair of convenient handles for carrying and for placing the ring over the disk.

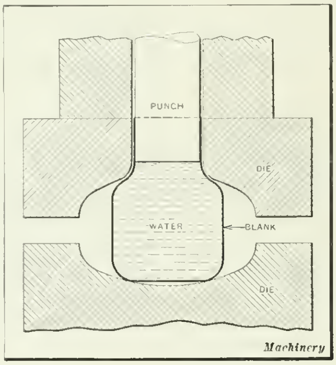
There always seems to be a little uncertainty as to how much larger the ring will be when heated than the piece it goes on. For work of this kind, the increase in internal diameter is roughly 0.002 times the mean length of the ring, assuming that it is heated to a red—but it must be remembered that a red appears in a dark room sooner than in sunlight.

Donald A. Hampson
Middletown, N. Y.

MAKING A ONE-PIECE BRASS DOOR KNOB

In the article in the June number of Machinery describing the process of making one-piece brass door knobs, one important step was omitted. When the blank *F*, Fig. 1, is to be drawn to the form shown at *G*, it is placed in a die that is split horizontally, as shown in the accompanying illustration, which shortens and bulges it so that it will enter the die shown in Fig. 2 of that article.

Robert Morris



Split Die used in making Brass Door Knob

A POINT IN DRILLING MACHINE DESIGN

On sensitive drilling machines, binding of the sliding head and lower sliding member is accomplished by simply tightening two levers, but I wonder how many of Machinery's readers have noticed on which side of the machine these levers are placed. On most sensitive drilling machines, both binding levers are located at the left-hand side. It will be noticed that the lower binding lever on the sensitive drilling machine is not located in the same position as the table binding lever on the average upright drilling machine. On the latter it will almost invariably be found that the binding lever for the sliding head is located at the left-hand side, just as it is on the sensitive drilling machines; but the clamping lever for the circular table and the crank for raising and lowering this table are located on the right-hand side, i. e., in the position directly opposite that in which these levers are placed on most sensitive drilling machines.

If the larger drilling machine is more conveniently manipulated with the table binding lever and elevating crank located at the right-hand side, why is this not true of sensitive drilling machines? As the lower support will go on the machine just as well with the binding lever to the left or right, I have reversed it on its slide and have noticed that the sensitive drilling machine altered in this way is much more convenient to operate. In centering lengths of steel, one end of the bar is set in the cup center, and the natural position is to hold the bar with the left hand and adjust the center with the right hand. Of course, one must get used to the fact that with the binding lever of a sensitive drilling machine table reversed in this way, tightening is done by turning the lever in the opposite direction to that used in tightening an upright drilling machine, because both levers turn screws with right-hand threads. I was interested to see if sensitive drilling machines are really assembled with the levers at the left-hand side, as I have mentioned. Upon referring to the advertising pages of Machinery and to manufacturer's catalogues, I found that in nearly every case both binding levers are located at the left-hand side, while on upright drilling machines the table binding lever and elevating crank are at the right-hand side. What is the reason for this difference of design of two machines that are operated in essentially the same way?

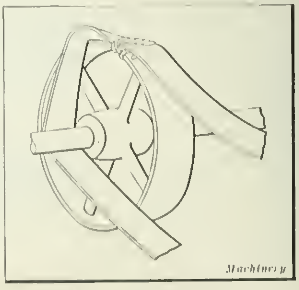
Worcester, Mass. Clarence Anderson

It is scarcely safe to say that the principles of drilling machine design to which reference has been made are followed in the construction of all sensitive and vertical machines. On sensitive drilling machines, the binding levers for both the head and table are generally placed on the left-hand side, because both the head and table are adjusted by hand and it is more convenient to use the right hand for this purpose and to tighten the binding lever with the left hand. A further reason for placing the head binding lever on the left-hand side is that in some cases it would interfere with the feed-lever if placed at the right-hand side of the machine. On vertical drilling machines where a screw and crank are provided to adjust the position of the table, the natural method is to locate this crank on the right-hand side of the machine because most men are right-handed. Where such means are used for adjusting the table, the position of the binding lever is a matter of little importance. On all machines where an elevating screw is not provided, it is probably better practice to locate the binding lever at the left-hand side.—Editor

PLACING TIGHT BELTS ON PULLEYS

Considerable difficulty is often encountered in putting tight belts over pulleys; and since the pulleys are usually located at some height, the proposition is troublesome and dangerous as well, even though hooks and other devices are available for the purpose. The writer recently saw a belt put over a pulley by means of a piece of rope, which seems a simple and effective method, free from danger. The belt is first pulled up to the pulling side of the driving pulley and a rope is wound around the pulley rim and over the belt where it comes in contact with the pulley face. The ends of the short piece of rope are then placed underneath the belt, that is, between the belt and the pulley face, as shown in the accompanying illustration. When the power is turned on, the ends of the rope are clamped between the pulley face and belt so the rope is held tight and pulls the belt around with it on the pulley face. After making a half revolution, the grip of the pulley on the rope relaxes, so the rope releases the belt and falls away, leaving the belt on the pulley. If just enough rope is used to encircle the belt and catch itself between the belt and pulley, there will be no trouble, as the rope does not release itself.

W. A. Lailer
Philadelphia, Pa.



Using Rope for planing Tight Belt on Pulley

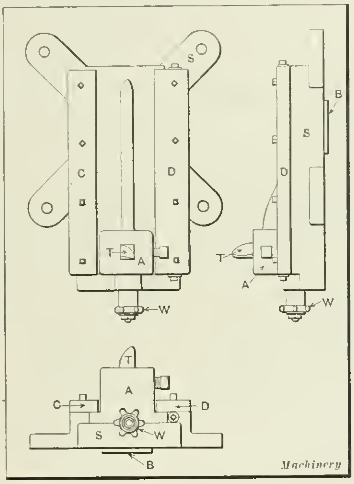
FINDING FACE AND CUTTING ANGLES FOR STUB-TOOTH BEVEL GEARS

In Machinery's Handbook, tables are given for face and cutting angles for the ordinary bevel gear, but for a stub-tooth gear it is necessary to calculate the addendum angle, and subtract it from the pitch cone angle of its mating gear, to find the face angle. In our drawing-room we have discovered that the difference between the addendum angle of a regular tooth gear and a stub-tooth gear is proportional to the diametral pitch; that is to say, in gears having the same number of teeth, the addendum angle of a 10/12 pitch gear would be 10/12 the addendum angle of a 12 pitch gear. To use the tables in Machinery's Handbook, find the difference between the face angle and the pitch cone angle of its mating gear, and make this in proportion to the pitch. This is not theoretically correct, but as it is inaccurate only 0.6 minute, in what is apparently the most severe test, it should be sufficiently accurate for all practical purposes. C. O. H.

FIXTURE FOR FACING WORK CARRIED ON A LATHE CARRIAGE

The fixture shown in the accompanying illustration was designed to face the ends of some heavy castings of square section that were too large and too heavy to swing on centers in the largest lathe available for the job. The fixture made a satisfactory record in removing the stock—from ½ inch to 2 inches—from the various castings, and is used quite frequently on other jobs.

The spider *S* is bolted to the lathe faceplate, the boss *B* fitting into the hole in the center. A slide *A* carries the cutting tool *T*, which is fastened by the set-screw shown. The wear of the slide is taken up by a gib by means of a collar-head screw at each end and is held to the spider by the plates *C* and *D*. A nut that engages with the feed-screw is attached to the under side of the slide by two cap-screws. This feed-screw, in turn, is operated by the star-wheel *W*, which is actuated automatically by a tripping finger clamped to the bed of the lathe. The screw may be turned by hand, when it is necessary to move the slide for some distance, by means of a small crank that fits over the star-wheel. The castings are firmly clamped to a cast-iron saddle bolted to each end of the carriage ways. A cut 3/8 inch deep, with a feed of one tooth of the star-wheel, or 1/36 inch, is used.

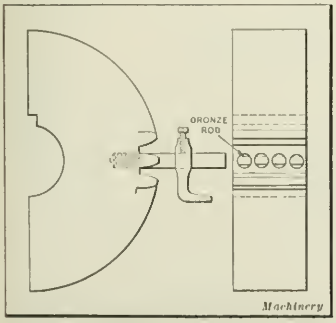


Fixture for facing Work carried on a Lathe Carriage

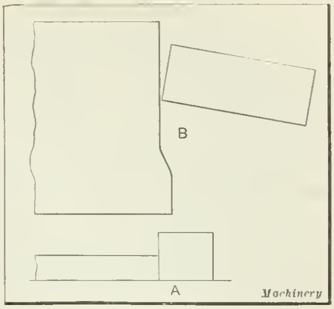
Watervliet, N. Y. Martin H. Ball

REPAIRING RAWHIDE PINION

One day, when the cupola was shut down, it was found that several of the teeth of a rawhide pinion on the blower were giving way. This pinion was 12 inches in diameter, 1¼-inch circular pitch, and had a 3¾-inch face. As it was necessary to run the heat the next day, it was decided to effect a temporary repair until a pinion could be shipped from the makers. So the worn teeth of the rawhide were chipped off and filed smooth; then the spaces were laid out for four plugs, as shown in the accompanying illustration, and holes made with a ratchet drill for a ¾-inch tap. Bronze plugs 13/16 inch in diameter and about 4 inches long, threaded on one end, were screwed tightly into place by a carrier attached to the bronze rod, as shown, and were then cut to the proper length. A templet showing the shape of the teeth was made and the teeth were rasped down and finish-filed to the templet. Bronze was used because it could be quickly worked into shape. The rawhide pinion repaired in the manner described was entirely satisfactory and it held out for the two weeks that elapsed before the new pinion was received from the factory. C. H. M.



Repairing Tooth in a Rawhide Pinion



Handy Surface-plate Block

HANDY SURFACE-PLATE BLOCK

The plain block shown above is made of tool steel, hardened and ground as square as possible. When working the surfaces of small parts to form by hand, particularly when working a form gage, this block aids in making the surfaces square with the face. Resting upon the surface plate with the work, and with one of the sides coated with Prussian blue, the block, if applied as at *A*, will mark the points of the gage that must be removed in order to bring the side square with the face. If the amount to be removed is very small, the gage may be scraped with the corner of the block as at *B*.

Newark, N. J. Gustave A. Remacle

WASHING CONCRETE AGGREGATES

The statement on page 1108 of the August number of Machinery, that washing the aggregate increases the strength of hand-mixed concrete 30 to 40 per cent, and of machine-mixed concrete, 15 to 20 per cent, is misleading, because often it is quite the reverse. The result of washing depends on the cement, as the various kinds are differently susceptible to dirt. Some kinds of dirt are exactly what some kinds of cement need to attain their full strength.

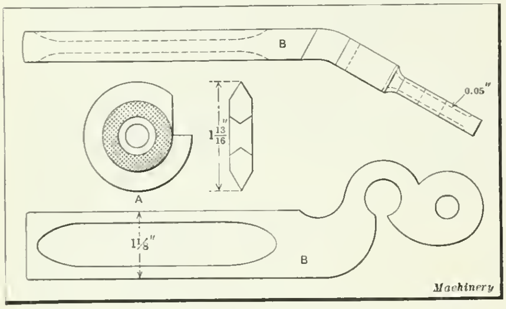
The writer had considerable experience in Germany with this material, as the Bavarian State works, for which he acted as consultant, made eighty tons a day of slag cement (not a Portland cement mixed with slag, but one made from blast-furnace slag), which acted very different from most of the cements on the market. Passow, the greatest German authority on cement, says: "There are cements which mixed with clayey sand show much higher strength than when mixed with normal sand; while others, similarly tested, are markedly reduced in strength. In all cases where sand with considerable dirt is to be used, it is essential that the sand be thoroughly tested with the cement to be used, in order to establish the influence of the impurities. This rule is often neglected."

Another point, not generally known, is that while the setting of real Portland cement is retarded by the admixture of a small proportion of so-called plaster-of-paris, the same addition hastens the setting of the slag cement above mentioned, which is called in Germany "montanzement."

New York City Robert Grimshaw

SPRING THREADING TOOL

A tool that has proved useful when cutting V-threads on tool-steel screws is shown at *A* in the accompanying illustration. The holder *B* is made from ½ inch by ⅛ inch spring steel, which was 6 inches long before bending. The gooseneck shape allows it to spring and eliminates chattering to a large extent during a finishing cut. However, when a roughing cut is being taken and a stiffer tool is required to prevent digging into the work, a ground disk is slipped into the recess, making the tool quite solid. The cutting tool is a circular disk of high-speed steel fastened by a bolt to the holder, which fits in the toolpost of the lathe. The hole through the center of the cutter is ⅜ inch in diameter and is recessed at an angle of about 80 degrees on each side; the cutter is checkered on both sides, which allows a firm grip on the face of the tool-holder and prevents slipping.



Useful Threading Tool and Tool-holder

The tool can be used on either side of the tool-holder, which enables a thread to be cut up to a shoulder, either on the right or left side of the work in the lathe. This tool can be taken off the holder, reground, and replaced without altering the position of the holder, which is a great help when cutting a good thread. Two bolts and nuts were made to secure the cutter to the holder, one having a left-hand thread for right-hand cutting, and the other having a right-hand thread for left-hand cutting. The heads of these bolts have an angle of 80 degrees on the under side, which coincides with the angle in the hole of the cutter, by which means a greater bearing surface is obtainable. As standardization is rapidly gaining ground in the mechanical field, we will sooner or later standardize lathe cutting tools, and a round-nose tool of this type may become adopted with considerable advantage for the turning of all parts in lathes that have less than a twelve-inch swing.

New Haven, Conn. Eric Lee

MILLING AUTOMOBILE THROTTLE HAND-LEVER WORMS

Recently we had a lot of automobile throttle hand-lever worms to make; a glance at Fig. 1 will make apparent the difficulties experienced because of the size of the worm and the amount of metal to be removed. The worm has a double right-hand thread with a 41-degree, 40-minute helix angle, a 29-degree tooth angle, and a 1.5625-inch lead. The thread is 0.128 inch thick at the root.

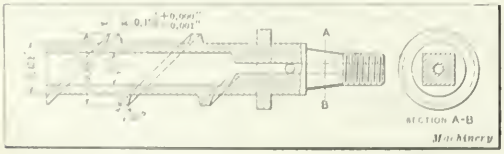


Fig. 1. Automobile Throttle Hand-lever Worm

The first step was to develop the cutter shown at *A*, Fig. 2. For this kind of work, the face of the cutter must be a curve, as shown, and not straight, as might be supposed. The curve of the cutter must correspond to the curve formed by cutting the cylinder, at the root diameter of the worm, at an angle of 41 degrees, 40 minutes. But owing to the width of the cutter, there was considerable trouble due to chatter, distortion and interference, with the resulting undercutting. So, after repeated trials, this cutter had to be abandoned. Two similar cutters, fastened side by side on the spindle, as shown at *B*, are now used to form the tooth by straddle-milling it. The curved-face cutter is then used to trim the space between the teeth, the angular sides of the cutter having been ground so that they will not touch the tooth already formed. This cutter now works without any trouble, as the straight cutters remove more than half the stock.

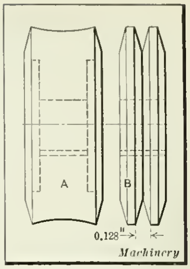


Fig. 2. Cutters used for milling Throttle Hand-lever Worm

As two operations were necessary to complete a worm, it was desirable to provide some means for cutting a number with the straddle cutters and then changing to the curved-face cutter and finishing, rather than changing cutters for every worm; therefore, a uniform setting and indexing in the thread miller was essential. Fortunately, there is a tapering square on the end of the worm, which solved the problem with the aid of the holder shown in Fig. 3. This holder fits over the live center of the machine, a square being filed in the bottom to receive the squared end of the worm. Also, a keyway cut to correspond with the key fitted in the live center allows the holder to slide but not turn. A spring pressing between the center and the bottom of the holder insures perfect contact between the squares. As shown in Fig. 1, a small hole is drilled in a fixed relation to the square in the worm, so the operator is instructed, when changing work, to see that this hole is in line with the set-screw in the holder, so as to cut all worms the same, also securing the same setting for the second operation.

Of course, it is necessary to put a small chamfer on the end of the worm while drilling the 5/16-inch hole, so as to use the tailstock center. As these worms are double threaded, an index plate with twenty-four holes is used. For the first operation, holes 1 and 13 are used; but after changing cutters, the plate is advanced a quarter turn, either from 1 to 7 or from 13 to 19, as the case may be.

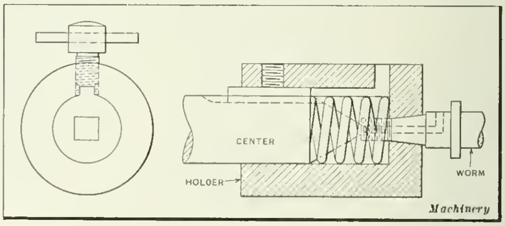


Fig. 3. Holder used in milling Throttle Hand-lever Worm

Springfield, Mass. P. J. Visco

WHAT IS THE MATTER WITH THE DRAFTSMAN ?

The draftsman is often found fault with. Some writers point out his weaknesses and give him advice, while others expose his faults. The demand is that the draftsman consider his work from the standpoint of the workingman and deliver a clear, complete "message" to the shop; one that will give no opportunity for confusion whatsoever. But where will the draftsman get his knowledge? He must often start the work without sufficient information, being favored instead by his supervisor saying, "If anything is not clear, ask about it," and because of this lack of information he fails to grasp the situation in general. The sketch he is furnished with in many cases is one that only a superman could comprehend. Often, after getting the necessary information by tireless hunting here and there, many good draftsmen ask themselves, "How could the situation ever be clear, even to the best man in the world, by the facts presented at the start?" This state of affairs is the most favorable for the making of mistakes and confusion. Give the draftsman a square deal; don't make him guess the impossible.

Turtle Creek, Pa. B. A. Wach

KINK FOR CROSS-SECTIONING DRAWINGS

Uniformly spaced cross-section lines can easily be drawn if this suggestion is followed. As shown in Fig. 1, score two lines on the 45-degree triangle, making *B* 1/16 inch from edge *A* and *C* 1/8 inch; then fill in these scored lines with ink so as to make them heavier and clearer. To cross-section, place the triangle against the T-square and draw a line along the edge *A* of the triangle. Then move the triangle until line *B* or *C*, depending on the spacing desired, is over the line drawn, and draw a second line along edge *A*. Again place line *B* or *C* over the line drawn and draw the third line.

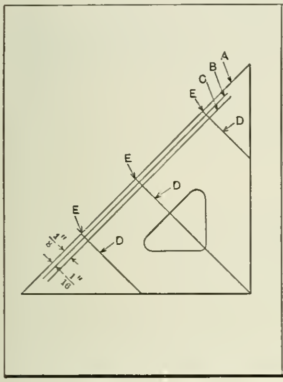


Fig. 1. Triangle marked for Cross-sectioning

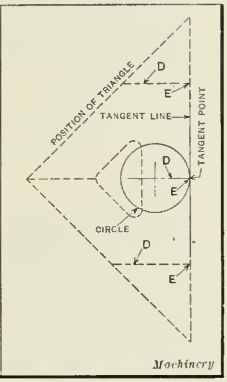


Fig. 2. Using Triangle to draw Tangents

Tangents to curves and circles may be easily drawn, as shown in Fig. 2, if lines *D* are drawn at right angles to edge *A*. Place the tangent point *E* of any line *D* at the point in the curve or circle where the tangent is to be drawn, letting the line *D* pass through the center of the circle or curve; then draw the tangent along the edge of the triangle. The writer has used these lines on his triangles for the past three years and has found them exceedingly useful.

Pittsburg, Pa. M. J. Stack

MILLING CUTTERS WITH REMOVABLE HUBS

In Fig. 1 is shown an inserted-tooth milling cutter that differs from the ordinary cutters of this type only in that the hubs *A* are removable. These cutters were designed to operate in a Briggs milling machine having a solid arch, through which the arbor and cutters are passed, as shown in Fig. 2. The capacity of the machine was limited to 8-inch cutters, but the work required cutters of 14 inches diameter. Split cutters were considered, but the removable-hub cutters were adopted; the latter were more easily removed, as the space necessary for side fastening was lacking.

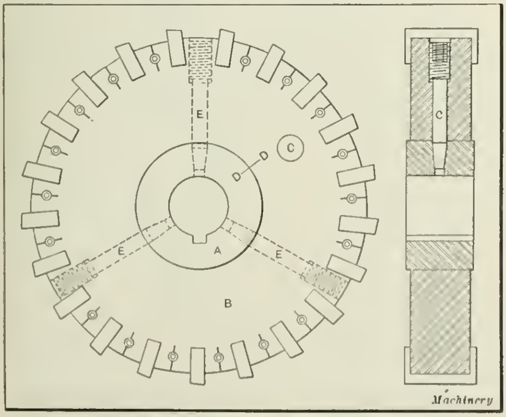


Fig. 1. Milling Cutter with Removable Hub

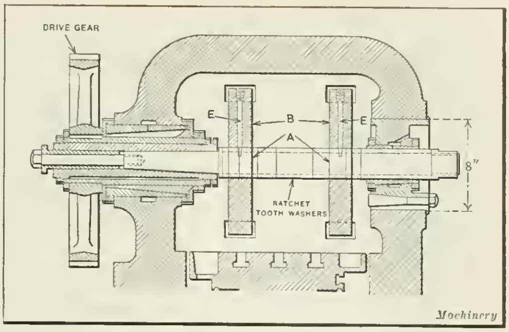


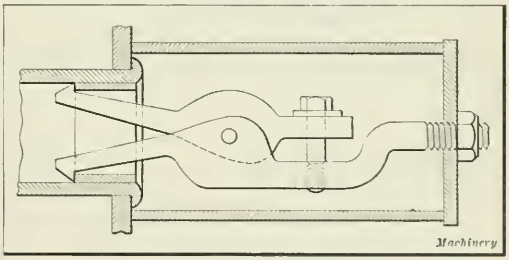
Fig. 2. Briggs Milling Machine, showing Cutter in Place

The arbor was set up with the necessary spacing collars and the hubs *A* in place. The cutter disk *B* was suspended from the arch by means of a rod passed through the hole *C*, Fig. 1, and the assembled arbor was passed through the cutter disk and adjusted until the indicator marks *D* registered. Bolts *E* were then inserted and set down tight, the slightly tapering ends locating the hub centrally with the cutter body. The bolts *E* are solid throughout, threaded on one end, and countersunk to receive a hexagon wrench, as with set-screws. The work finished proved that these cutters were worth the investment. These cutters are run in pairs for straddle-milling.

Elmhurst, Ill. H. F. McKnight

BUSHING EXTRACTOR

The illustration shows a useful device for extracting ferrules from tube ends. It is adjustable for many sizes of tubes, and may also be used for extracting small bushings, valve seats, etc. It should be made from high-grade steel to give strength and long service. The illustration is self-explanatory, and needs no extra explanation.

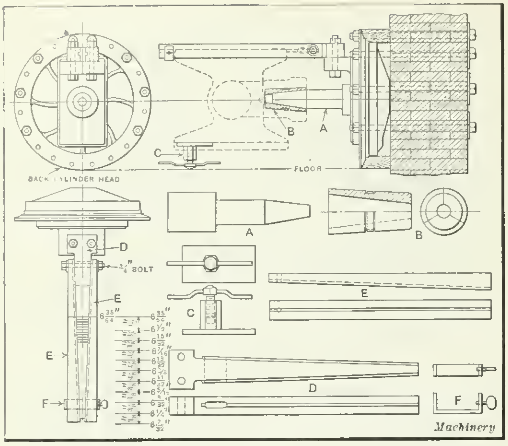


Bushing Extractor

Concord, N. H. C. H. Willey

BABBITTING SOLID CROSS-HEADS

For the benefit of fellow employes in railroad shops, I wish to describe a method of babbitting the guide bearings of solid cross-heads that has been the means of reducing labor and increasing the quality of workmanship. A back cylinder head is bolted to the wall of the shop and held away at the proper distance by means of wooden blocks. The large end of plug *A* is next put into the hole in the cylinder head, which is counterbored to receive packing and accessories. After this an adjustable bushing *B*, which is made in three parts and held together by a spring band, is put into the piston-rod end



Fixture for Use in babbitting Guide Bearings of Solid Cross-heads

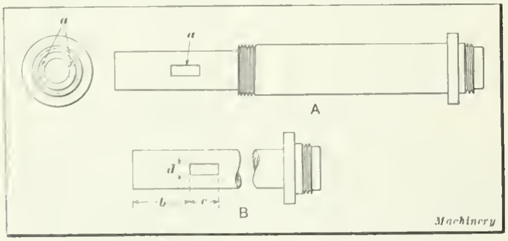
of the cross-head. The cross-head is then lifted so that bushing *B* can be slipped over the tapered end of plug *A*. A jack *C* provides for accurately adjusting the height of the cross-head so that it is supported in a perfectly level position.

After the work of setting up has proceeded to this point, pieces *D* and *E*, which are adjustable for width, are put in place and set to the proper width to suit the guides of the locomotive on which the cross-head is used. It will be seen that the side pieces *E* are held to center piece *D* by means of a ¾-inch bolt. This bolt passes through a slot in center piece *D*, so that side pieces *E* can move the bolt in order to make proper adjustment for the width of the guides on the locomotive. As indicated by the scale, this adjustment covers a range of from 6 7/32 to 6 35/64 inches. The pieces *D* and *E* are held in place at the outer end of the cross-head by means of clamp *F*. When the work has been set up in this way, babbitt is poured into the guide bearing, and after one bearing has been babbitted, it is a simple matter to turn the cross-head over and set the fixture up for babbitting the second bearing.

M. K.

WHO BLUNDERED—THE DRAFTSMAN OR THE MACHINIST?

Some time ago we had to redesign the spindles of a number of screw machines to adapt them for draw-in collets in place of the push forward type with which these machines were provided. The only change required on the spindles was cutting two slots through one end for clearance through which the ends of the fingers that operated the draw-rod could project. These clearance holes *a* are plainly shown in the view at *A*, which also shows a complete view of the spindle. As no other machine work was required on the spindle, the drafting room made a drawing like that shown at *B*, the only figures on it being those that show the actual dimensions of the slots and their location. The thread and the difference in diameter of the spindle were neither shown nor indicated by dimensions, as these were thought to be entirely unnecessary. The spindles, when taken from the machines, were sent out to a job shop to have the alterations made. Instead of going by dimensions only, they assumed, after having completed the work actually shown by the drawing, that we also wanted the spindles turned down to the size of the small end, and this they did, completely ruining ten spindles, as, of course, they turned off the thread and the bearing surfaces. Why they did not continue and break the spindles in two is a wonder. The whole job reminds me of the man who hired out in a railroad blacksmith shop and claimed to be able to read blueprints. When they gave him a drawing of a long connecting-rod which had been shown broken for convenience in getting it on a standard sheet, he inquired whether he was expected to make the teeth on the ends. Who should be held responsible in a case of this kind, the shop or the drafting-room?

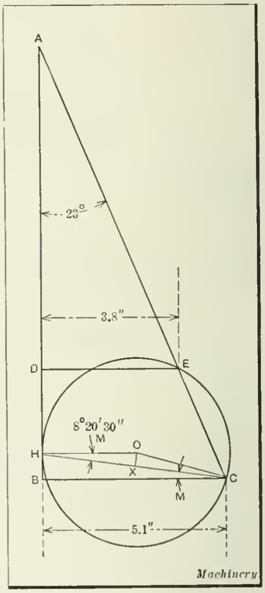


(A) Drawing of Spindle. (B) Sketch sent to Machinist

New York City **Donald A. Baker**

FINDING RADIUS OF CIRCLE

The following is a simpler method of finding the radius of a circle than that given in the May number of MACHINERY: $AE = \frac{DE}{\sin 23 \text{ deg.}} = \frac{3.8}{0.39073} = 9.7253$ and $AC = \frac{BC}{\sin 23 \text{ deg.}} = \frac{5.1}{0.39073} = 13.0522$. By geometry, $AC \times AE = (AH)^2$, so $AH = \sqrt{9.7253 \times 13.0522} = 11.267$. $AB = BC \times$ cot 23 degrees $= 5.1 \times 2.3558 = 12.0148$. $HB = AB - AH = 0.7478$. Tan $M = \frac{HB}{BC} = \frac{0.7478}{5.1} = 0.14644$; $M = 8$ degrees, 20 minutes, 30 seconds. $HC = \frac{BC}{\cos 8 \text{ deg., } 20 \text{ min., } 30 \text{ sec.}} = \frac{5.1}{0.98942} = 5.1546$. $HO = \frac{0.5HC}{\cos 8 \text{ deg., } 20 \text{ min., } 30 \text{ sec.}} = \frac{2.5773}{0.98942} = 2.6049$, which is the radius desired.

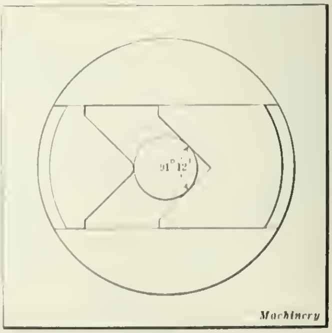


Method of finding Radius of Circle

Toronto, Canada **Oscar M. Woelfe**

MOVEMENT OF V-REST

Referring to the V-rest problem answered by F. Webster Brady in the September number of MACHINERY, I would like to make a slight addition to the practical side of the problem. The illustration shows a device that I have used once or twice; I have found it of advantage to make one thread five per inch and the other seven per inch. In this case the included angle should be 91 degrees, 12 minutes, as any mathematical shark can readily show.



Jaws of Reid Drill Chuck

This is much easier than to monkey with fractional threads. So far as I know, this form of mechanism was first used in the Reid drill chuck, at least thirty-five years ago.

Eau Claire, Wis. C. M. Conradson

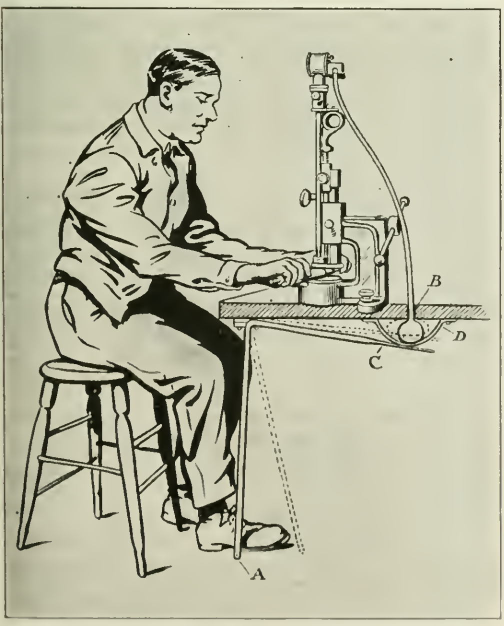
BALL BEARINGS FOR HAND-POWER DETAILS

Ball bearings, of both the journal and the thrust types, are an acknowledged success in the elimination of friction and consequent saving of fuel when applied to power-driven details. On that point all engineers are agreed. But why not carry their application a step farther and apply these bearings to journals of hand-power details? This matter is especially important now, when there is need for the greatest possible output, and every means should be used to keep the wheels of the factory turning. Could there be any better way to conserve energy than to apply ball bearings to all hand apparatus, such as winches, trucks, and other appliances used in transporting goods in a factory or outside erection? These bearings may even be applied to devices used to lift the shells for the big guns on the battlefield. At the present time, it is imperative that not an ounce of power, either manual or motive be wasted, and to provide the most efficient means of hand transporting of goods is certainly a matter demanding the closest attention.

Liverpool, England Mark Meredith

RAPID METHOD OF OPERATING SCLEROSCOPE BULB

The accompanying illustration shows a method of operating the bulb of a scleroscope which has been found to save a lot of time. This saving is chiefly due to the fact that operating the bulb with a foot-pedal *A* leaves both the inspector's hands free. It will be seen that a hole is drilled in the inspector's bench, through which passes a tube *B* connecting the bulb with the instrument. This bulb is held close to the under side of the bench and a piece of thin leather *D* is tacked over it to prevent the iron from wearing it out. A steel rod *C*, flattened at the end, is pivoted in such a way that when the pedal is pushed forward this rod will be swung up against the bottom of the bench and will compress the bulb. The inspector sits at the bench with his foot resting on the pedal as shown, and when he desires to operate the scleroscope the pedal is pushed forward.



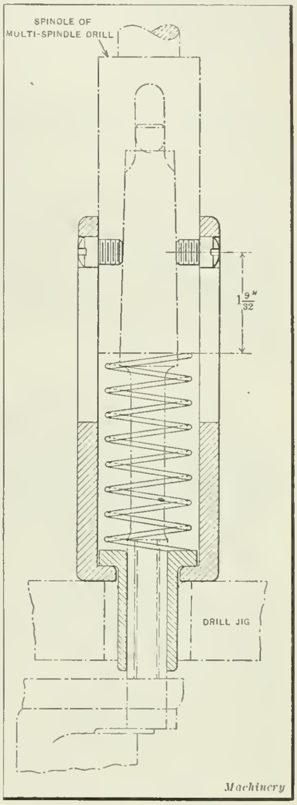
Bench arranged with Foot Pedal for operating Scleroscope Bulb

Flint, Mich. C. C. Spreen

PUMP-SPRING BUSHING-HOLDER GUIDE

In the July number of Machinery appeared an article entitled "Multi-Machining in Production Quantities," which showed a stationary pilot for multi-drilling and reaming tools. The pump-spring bushing-holder guide here shown has the advantage of allowing the bushing to rotate with the drill or reamer when the bushing is not engaged with the permanent bushing in the drilling jig. This feature does away with wear of the drill in the bushing, which is a point to be considered, especially in reaming. This device has been used for the past nine months, and is working satisfactorily in every way. While it was designed for use on a Baush multiple-spindle drilling machine, it is also used in a horizontal position for cross-boring, as the position does not affect its operation. It was intended for use instead of the large, heavy, costly pump-spring bushing plate that was required when there were only a few holes but with large center distances. These devices cost $18.60 each.

Earl S. Hutton
Detroit, Mich.



Bushing-holder Guide with Pump Spring for Use with Drill Jig

LAYING OUT INACCESSIBLE PARTS

Recently the writer had to repair a large cone pulley that had raised binder lugs, which had been torn off. A plate was substituted for the broken lugs and was fitted over the arms with a bearing on the sides. But it was found that it was impossible to lay out the arms on the plate, as the under side of the plate could not be reached. The following plan was finally hit upon: A torch was made by wrapping some oily cotton waste around a piece of wire, and, after lighting, it was passed into the cone through the opening around the edge of the plate. By holding the torch under each arm until it was well smoked the outline of the arm was left upon the plate, for there was no soot on those parts of the plate that were protected by the arms. When the plate was removed, it was easy to prick-punch the outline of the arms and mill the necessary slots. F. J. D

CHEAP PARTITIONS

Paneled partitions can be made out of regular stock doors placed edge to edge, with strips top and bottom to give the line, more cheaply than by cutting lumber; and the doors have higher salable value when the partitions are no longer needed. Telephone booths may be made cheaply of these doors and a board top.

New York City Robert Grimshaw

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

PRIZE FOR PERPETUAL MOTION

C. C. S.—Do you know of any prize offered for a working model of a perpetual motion apparatus?

A.—No official prize for a perpetual motion machine has ever been offered, so far as we know, and probably none ever will be offered. It is agreed by all who understand the principle of energy conservation that a perpetual motion machine is an impossibility.

CHANGE-GEARS FOR CUTTING WORM

C. G. M.—What should be the compound change-gears used in a milling machine for cutting a worm with a lead of 1.5781 inch?

A.—If the worm is to be cut on a standard milling machine, the ratio of the change-gears will be 1.5781 to 10. The selecting of these gears will be comparatively easy if the tables in an article, "Simplified Change-gear Calculations," published in MACHINERY, May, 1917, are used. By placing a 29-tooth gear on the worm-gear stud, meshing with a 73-tooth gear on the intermediate stud, and placing another 29-tooth gear on the same intermediate stud, which is also driven by a 73-tooth gear on the feed-screw, you will mill a worm with a lead of 1.5781 inch.

STRAIGHTENING THIN-WALL TUBING

H. E. G.—I wish to obtain some information on straightening thin-wall tubing. Our tubing is made of brass and comes in lengths of 10 feet. The wall thickness is 0.010 inch. Some of the tubing is cylindrical, having an outside diameter of 0.125 inch, and some of it is bean-shaped in cross-section.

A.—The cylindrical tubing may be straightened with a pair of rolls set with their axes out of parallel and with their peripheries apart a distance equal to the thickness of the tubing. The rolls are belted to run in the same direction. The tubing is fed between them from one end and is shot out of the other in a straightened condition. Ordinary wire straighteners of the revolving frame and roller type can be used successfully on tubing for taking out kinks if of not too short radius. The bean-shaped or elliptical cross-section tubing may be drawn through a die to straighten it. Readers who have had experience with this work are requested to contribute whatever they can on the subject.

DUTIES OF MASTER MECHANIC

G. A. V.—What constitutes the duties of a master mechanic? How does the position of master mechanic compare in rank with that of chief engineer?

A.—The duties of a master mechanic differ widely. In some places he is an important official, while in others his duties are minor. The master mechanic of a mill should be in charge of the repair and maintenance of machinery, the erection of all machines, motors, belts, pipes, electric wires, compressed air equipment, etc. The moving of machines from one department to another should be part of his duty, and the oiling of lineshafts, countershafts, and other bearings not in the immediate charge of any mechanic or workman. The chief engineer should be in charge of the design and layout of plant and machinery. He is not an executive officer in the larger sense, but one who plans work for others to execute. However, the chief engineer may also be an executive and in immediate charge of those who carry out his plans. Ordinarily the chief engineer ranks higher than a master mechanic, but they may be coordinate. The master mechanic may be in charge of the machinists, mechanics, electricians, and laborers required outside the machine shop for the care and maintenance of machinery and equipment in his charge, while the chief engineer may have charge of the drafting department and be the superior of the foremen of the machine shop, pattern-shop and foundry.

QUARTER-TWIST BELTS

B. C. S.—I should like a good rule for quarter-twist belts, one that can be used for any case when the shafts are not parallel.

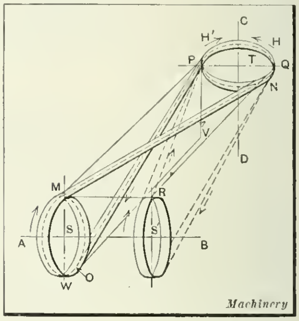


Illustration of Quarter-twist Belt

A.—Referring to the illustration, S and T are two pulleys, the axes of which are represented by AB and CD, respectively. In the present case, the axes are at right angles to each other, thus giving a quarter twist to the belt, but the rule given will apply to any angle that the axes may make with each other. Let $PQRM$ represent the middle plane of the pulley T, which intersects the pulley in the circle PQN (shown by the dotted line), and let $MPVW$ represent the middle plane of the pulley S, which intersects the pulley in the circle MWO (shown by the dotted line). Now if S is the driving pulley, and it turns in the direction indicated by the arrow, the belt must be placed as shown in order to turn the other pulley T in the direction of the arrow H. The belt can come off the pulley at almost any angle without running off, but it must go on the pulley in such a manner that the center line of the belt will lie in the middle plane of the pulley receiving the belt. Note that the center line PO lies in the middle plane $MPVW$, O being the point where the center line of the belt goes on the pulley S; that the center line MN lies in the middle plane $PQRM$, N being the point where the center line of the belt goes on the pulley T; that the line MP is the line of intersection of the two middle planes; and that M and P are the points where the belt leaves the pulleys. M is a point of tangency of the middle plane of T with pulley S, and P is a point of tangency of the middle plane of S with pulley T. Hence, if the shafts are not parallel, the pulleys must be so arranged that the middle plane of either pulley is tangent to the other pulley. If it were desired to have the pulley T turn in the direction of the arrow H', pulley S continuing to turn in the same direction, pulley S must be shifted on its shaft an amount equal to the diameter of the pulley T, and the belt arranged as indicated by the dotted lines. It is necessary always to remember that the center line of the belt must lie in the middle plane of the pulley on which the belt goes. J. J.

CAPACITY OF CYLINDRICAL TANK AT DIFFERENT LEVELS

W. A. F.—We have a cylindrical tank that is 90 inches in diameter and 18 feet long, so placed that its axis is horizontal. Please show how to calculate the contents in gallons for each six inches of depth. The ends of the tank are flat.

A.—Referring to the illustration, the horizontal lines represent the various levels, 6 inches apart. For any particular level, as AB, the contents in gallons is equal to the area of the segment ACB in square inches multiplied by the length of the tank in inches, and the product divided by 231. Let A = area of any segment; h = height of segment; r = radius;

and V = central angle. Then, $A = \frac{1}{2} r^2(V - \sin V)$. V is measured in radians, and is found as follows: For any level, as AB, $\cos \frac{V}{2} = \frac{r - h}{r} = \frac{45 - 6}{45}$. With the aid of a table of sines and cosines, find $\frac{V}{2}$; the result multiplied by 2 gives V. If a table giving angles in radians is not available, express V in degrees and decimal of a degree; then, $V = 0.0174533V$ in degrees. The area of the segment is then readily computed. By repeated applications of this process, the area of the segment that corresponds to each level is found. When the level FG is reached, the areas above it may be obtained by adding to the area last found the corresponding area below HI. Thus area $FGML$ = area $HIJK$, and area $HIJK$ = segment HCI — segment KCJ, both of which areas have been previously calculated. Since 18 feet = 216 inches, the capacity at any level is $C = \frac{216A}{231} = 0.935065A$. Using a five-place table of logarithms and natural trigonometric functions, the writer obtained the results given in the table.

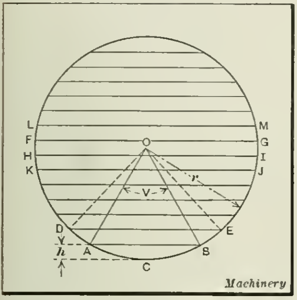


Diagram illustrating Method of finding Contents of Tank

Depth	Area of Segment	Gallons	Depth	Area of Segment	Gallons
6	182.1	170	54	3985.4	3727
12	504.3	472	60	4505.4	4213
18	905.8	847	66	4999.8	4675
24	1361.9	1273	72	5455.9	5102
30	1856.3	1736	78	5857.4	5477
36	2376.3	2222	84	6179.5	5778
42	2911.6	2723	90	6361.7	5948
48	3450.1	3226			

J. J.

STRESSES IN A CRANE

F. P. T.—I enclose a sketch of a crane. With the dimensions given, what will be the stress in the tie-rod BA and in the strut BC when the load is 5000 pounds? Also, what will be the bending moment at A?

A.—For practical purposes, sufficiently accurate results can be obtained by drawing the stress diagram to some convenient scale, and then determining the various stresses by measuring the lines of the diagram. Thus, draw A_1C_1 vertical and of such length as to represent 5000 pounds. If the scale is 1 inch = 1000 pounds, A_1C_1 will be 5 inches long. The line A_1C_1 then represents to scale the pressure at the foot of the mast DC due to the load of 5000 pounds. Then draw A_1B_1 parallel to AB, and C_1B_1 parallel to CB; they intersect at B_1. Measuring A_1B_1 and C_1B_1 to the same scale as A_1C_1, A_1B_1 = 4800 pounds, the stress in AB, and B_1C_1 = 6400 pounds, the stress in BC. To find the bending moment at A, it is necessary to find the horizontal stress at A. Hence, resolve the stress A_1B_1 into the horizontal component A_1H and the vertical component HB_1. Measuring A_1H, it is found to equal 4750 pounds. The reaction at D equals $4750 \times \frac{18.75}{22} = 4048$ pounds. Therefore, the bending moment at A is $4048 \times (22 - 18\frac{3}{4}) \times 12 = 157{,}872$ inch-pounds. If it is desired to calculate the stresses and the bending moment, consider the triangle $A_1B_1C_1$. The lengths of the sides will be proportional to the lengths of the sides in the triangle ABC; hence, suppose $A_1C_1 = 18\frac{3}{4}$, $A_1B_1 = 18$, and $B_1C_1 = 24$. The angles are then calculated, obtaining $A_1B_1C_1$ = 50 degrees, 35 minutes, 50 seconds; $B_1C_1A_1$ = 47 degrees, 53 minutes, 5 seconds; and $B_1A_1C_1$ = 81 degrees, 31 minutes, 5 seconds. Now, taking A_1C_1 as 5000, $A_1B_1 = \frac{\sin A_1C_1B_1}{\sin A_1B_1C_1} \times 5000 = 4800$ pounds; $B_1C_1 = \frac{\sin B_1A_1C_1}{\sin A_1B_1C_1} \times 5000 = 6400$ pounds. Angle HA_1B_1 = 90 degrees — 81 degrees, 31 minutes, 5 seconds = 8 degrees, 28 minutes, 55 seconds; and A_1H = 4800 × cos 8 degrees, 28 minutes, 55 seconds = 4747.6 pounds. The reaction at $D = 4747.6 \times \frac{18.75}{22} = 4046.2$ pounds, and the bending moment at $A = 4046.2 \times 3\frac{1}{4} \times 12 = 157{,}802$ inch-pounds. It will be noticed that the graphical method is sufficiently accurate for all practical purposes. Note that the horizontal pressure at C is $GC_1 = HA_1$, the two forces being equal, but in opposite directions, thus forming a couple that tends to overturn the crane. Here GC_1 is the horizontal component of the stress in the strut BC.

J. J.

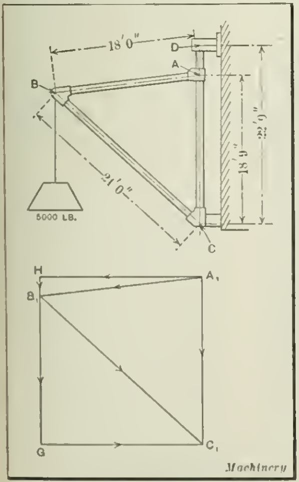


Diagram illustrating Stresses in Crane

PRESSURE ON BEARINGS DUE TO BELT PULL

F. H. L.—In the drive indicated by Fig. 1, the speed is 2000 revolutions per minute and the width of belt is 3 inches. Can you advise me what is the loading of the bearings due to belt pull, both for single- and double-ply belts? Also, what load per inch of width should be allowed for different thicknesses of belting?

Answered by John S. Myers, Philadelphia, Pa.

As neither the power it is desired to develop nor other conditions of service are stated, it will be assumed that this is a leather belt driving a machine readily accessible for retightening and under the care of a belt-fixer following scientific methods. Using a paper read by Carl G. Barth before the American Society of Mechanical Engineers, in January, 1909, as a basis, the curves of which are reproduced in Figs. 3 and 4, we have the following: (The lower-case letters represent pounds per square inch of belt section and the capital letters the total pulls in the given belt.)

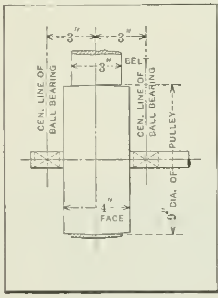


Fig. 1. Belt Drive

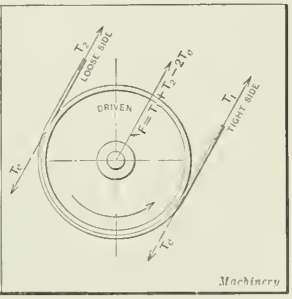


Fig. 2. Forces acting on Pulley

t_0 and T_0 = initial tension;
t_1 and T_1 = tension in tight side;
t_2 and T_2 = tension in slack side;
t_c and T_c = centrifugal tension;
p and P = effective pull for driving;
f and F = pull against bearings;
V = velocity of belt, in feet per minute.

Assume the arc of contact to be 180 degrees and take the coefficient of friction as a variable represented by the equation

$$\phi = 0.5A - \frac{140}{500 + V} \qquad (1)$$

For the conditions of service assumed, in order to avoid too frequent retightening or too rapid deterioration of the belt, the minimum initial tension t_0 of the belt is made such that when the belt is doing the maximum amount of work required of it

$$t_1 + \tfrac{1}{2}t_2 = 240 \text{ pounds per square inch} \qquad (2)$$

The pulley being 0.75 foot in diameter and the speed 2000 revolutions per minute, the belt velocity is:

$$V = 0.75 \times 3.1416 \times 2000 = 4712 \text{ feet per minute}$$

This is figuring on the net size of the pulley instead of to the center line of the belt to make some allowance for slip. The curves shown in Fig. 3 give, for this velocity, the approximate values: $t_0 = 142$, $t_1 = 190$, $t_2 = 100$, $t_c = 78$, $p = t_1 - t_2 = 90$. Then:

$$f = t_1 + t_2 - 2t_c \qquad (3)$$

Substituting the given values in this equation, $f = 190 + 100 - 2 \times 78 = 134$ pounds per square inch.

The cross-section of a single-ply belt 3/16 inch thick is $3/16 \times 3 = 0.5625$, say 0.56 square inch. The total pulls are then approximately: $T_0 = 142 \times 0.56 = 79.5$; $T_1 = 190 \times 0.56 = 106.4$; $T_2 = 100 \times 0.56 = 56.0$; $T_c = 78 \times 0.56 = 43.7$; $P = 90 \times 0.56 = 50.4$; $F = 134 \times 0.56 = 75$. The last value, $F = 75$ pounds, is the load acting upon the bearings, 37.5 pounds upon each, when the belt is developing its full capacity. The horsepower in this case is:

$$\text{H.P.} = \frac{PV}{33{,}000} = \frac{50.4 \times 4712}{33{,}000} = 7.2$$

When at rest, the tensions in both sides of the belt are equal; hence $T_1 = T_2 = T_0$, and, since $V = 0$ and $T_c = 0$, $F = 2T_0 = 2 \times 79.5 = 159$ pounds. For a double belt 3/8 inch thick, the various loads and power developed are twice those given for a single belt.

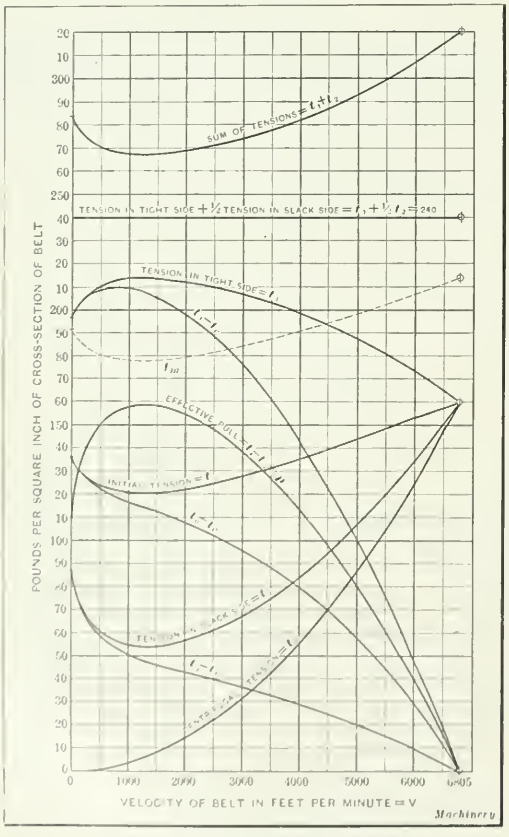


Fig. 3. Relations of Pulling Power to Tensions at All Speeds for a Belt of One Square Inch Section

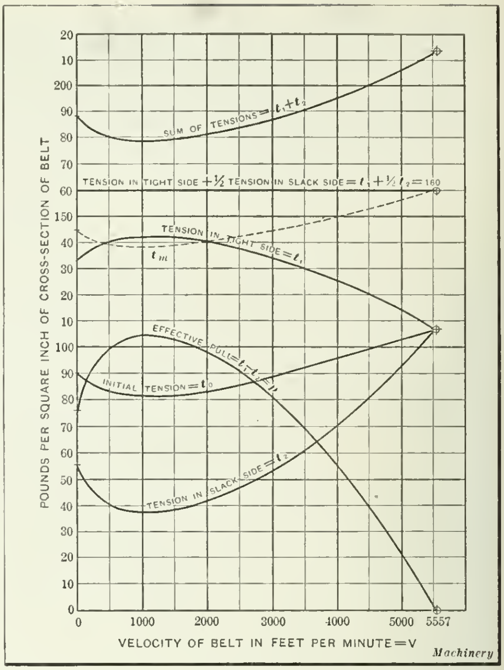


Fig. 4. Relations of Pulling Power to Tensions when Pulley is on Countershaft

In the case of a countershaft belt, or a belt so located that it is not easily retightened, lower initial tensions are allowed, for which Mr. Barth adopted the values:

$$t_1 + \tfrac{1}{2}t_2 = 160 \qquad (4)$$

For such conditions, the curves shown in Fig. 4 are applicable.

* * *

STRAIGHTENING HARDENED TOOLS

One of the perplexing problems of manufacture that is practically unsolved, as regards the substitution of machinery for the human hand and eye, is the straightening of twist drills, sewing machine needles and smaller steel parts that are warped in hardening. The general practice in straightening twist drills is to provide the workmen with light hammers and surface plates, the latter being mounted on a level with the workman's eyes so that he can see daylight between the defective drill and the plate. He strikes the drill with the hammer at the point that experience determines to be the place where a blow is required, and rolls the drill on the plate to test it. Automatic machines for doing this work have been developed, but they were practically commercial failures on account of slowness, unreliability and the need of expert attendance.

Practically the same condition exists in the sewing machine needle industry, it being necessary to straighten defective needles by hand also. The operation of straightening needles is about as follows: A hard steel plate, about 8 inches square by 1¾ inch thick, is provided with a vee in the center about 7/16 inch wide. This plate is set in front of a window at an angle of 15 degrees, inclined toward the operator. The needles are rolled with the fingers on this plate and the operator is governed by the shadow that the needle throws upon the plate. If the needle is crooked, it will show by this shadow the amount of its eccentricity, magnified as the error is multiplied in the shadow, owing to the angle of the plate. The operator uses a small copper hammer to straighten the needle, placing the needle over the vee and striking a blow in the right place by a force that experience and judgment dictate.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

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CONE FOUR-SPINDLE AUTOMATIC

Three features of this machine that will attract attention are: the use of a double-bed construction with the cam-shaft carried by the upper bed, and the machine spindles and tool-slides by the lower bed; the fact that all movements are obtained by flat cams bent to fit cam drums; the arrangement of all operating levers within easy reach of the man in charge of the machine.

IN working out the design of a four-spindle automatic screw machine which has recently been placed on the market by the Cone Automatic Machine Co., Windsor, Vt., the designers have departed from established practice in the design of machines of this type. The Cone "automatic" is styled a "double-bed" machine, and the reason for adopting this name will be apparent from the accompanying illustrations. It will be seen that two beds are provided; the upper bed supports a cam-shaft with cam drums and cams that actuate all parts of the mechanism; and in the lower bed there are provided bearings for the machine spindles, and ways for the slides on which the different types of tools are carried. The best idea of the general arrangement of the mechanism of this machine will be obtained from Fig. 1, but in referring to this illustration the readers' attention is particularly called to the fact that all guards have been removed in order to show the arrangement of cams, gearing, spindles, etc.; Figs. 2 and 4 show the complete way in which all moving parts are covered to provide for the safety of the operator, although in Fig. 2 the hinged gear cover is swung back in order to show the gearing.

Before entering upon a detailed description of the design of the Cone automatic, it will be of interest to present a summary of the features of this machine. It has already been mentioned that all cams are carried on a single cam-shaft at the top of the machine, and in this connection it is important to note that all cams are of the flat type, milled to the desired form and bent to fit on cam drums. This standardization of the form of cams greatly simplifies the setting up of the machine for handling different classes of work. Another important feature is that all the operating levers and wheels are situated at the front of the machine and at such a level from the floor that they may be conveniently reached by the operator. Viewed from the standpoint of accuracy in the product of this machine, prospective users will be interested in the care that has been taken to provide a rigid support for the cross-slides. These are supported by bearings at both the top and bottom, so that deflection caused by pressure of the cut is practically impossible. The top bearings which support the cross-slides against the pressure of the cut are furnished with gibs to provide for compensating for wear, so that it is possible always to have the bearings in perfect adjustment.

All heavy turning and forming operations are performed in the two lower positions, so that chips may drop into the pan below the machine without any tendency for them to accumulate on the work, tools and spindle noses; furthermore, these turning and forming tools can be more rigidly supported in the two lower positions, so that it is desirable to have the tools in these positions perform the heavier cutting operations. A patented deflector guides the finished work into a separate receptacle from the chips, and the chip pan is not only of ample proportions, but special arrangements have been made for removing chips from the end of this pan, so that the laborer who performs this work does not interfere with the operator who has charge of the machine.

To provide the desired degree of durability, the Cone automatic is equipped with hardened steel spindles running in phosphor-bronze bearings which may be easily adjusted to compensate for wear. The stock is fed through the upper front spindle, and in this position it is possible to perform drilling, counterboring, reaming or threading operations in addition to cutting off the finished piece. It is claimed that this arrangement brings the finished piece of work into a position where it may be easily inspected

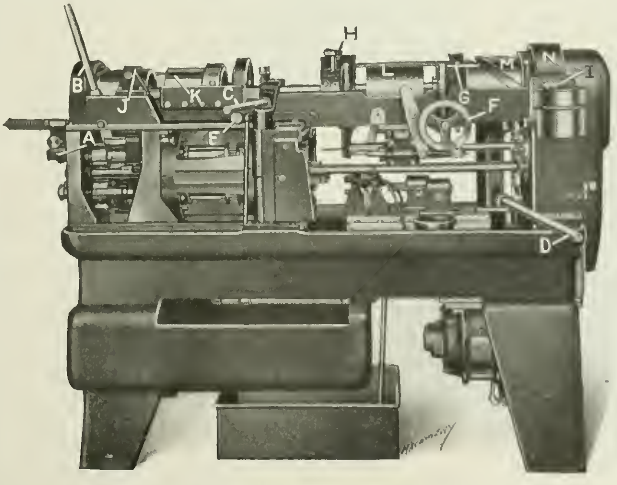


Fig. 1. Cone Four-spindle Automatic with Covers removed to show Arrangement of Cams, Gearing, Spindles, etc.

by an operator who is looking after a battery of machines, making it possible for him to ascertain readily that the stock is being fed right up to the stop to produce pieces of full length. In both the third and fourth positions, which are the two upper spindles on the machine, it is the practice to divide up those operations which have just been mentioned; then, my performing turning, forming and similar operations in the first and second positions, *i. e.*, the two lower positions, advantage is taken of adequate tool support and a better arrangement for chip clearance, to which reference has already been made. The tool-slides are heavily built, with plenty of room for a wide range of tool lay-outs, and there is no overhang at the front.

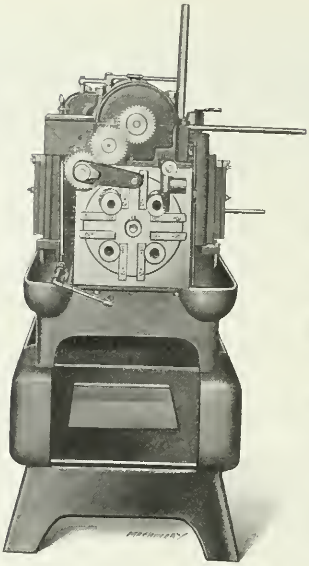


Fig. 3. View of Cone Automatic from Spindle End

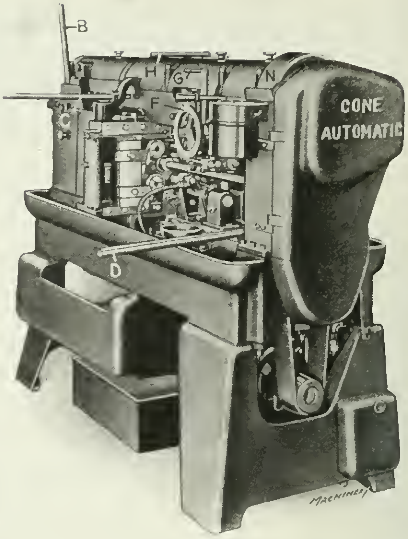


Fig. 4. Arrangement of Spindles, Cross-slides, etc., on Cone Automatic

Arrangement of Operating Levers and Handwheels

Referring to the front views of the machine shown in Figs. 1 and 4, the following outlines the purpose of each of the operating levers and handwheels that are shown. Block *A* is carried on a pivotal support and may be lifted up to disengage the stock feed mechanism. Lever *B* provides for opening or closing the chuck by hand. In setting up the machine, it is often desirable to have means of operating the cross-feed by hand in order to ascertain if the tools are located in the proper positions in the cross-slides. For this purpose lever *C* is provided. When it is desired to operate the cross-feed with this lever, the cam-shaft is rotated backward so that the rollers that run in engagement with the cross-feed cams are no longer in contact with these cams. With the cam-shaft in this position, lever *C* may be pushed back and forth to manipulate the cross-feed at will. Lever *D* provides similar hand adjustment for the tools carried on the slides that run parallel to the machine spindles. Handwheel *F* is carried at the end of a shaft on which there is mounted a worm meshing with a worm-wheel on the cam-shaft. By turning handwheel *F*, provision is made for backward rotation of the cam-shaft so that the cams are moved out of engagement with the rollers in the manner to which reference has been made. Before making this hand adjustment of the position of the cam-shaft, lever *G* is turned; this results in sliding the shaft on which handwheel *F* is carried through the splined worm so that the bevel gear at the opposite end of this shaft is thrown out of mesh with its driving gear, thus disconnecting the power feed. Lever *H* provides for engaging either the fast or slow movement. Lever *C* is a sliding fit in a socket, from which it may be withdrawn and pushed into socket *E* to provide for pulling the turret locking pin when it is desired to adjust the position of the turret by hand. Electrical control on the machine is manipulated by lever *I*. It will be apparent that all these levers are located within easy reach of the operator, so that he is not required to stoop over to reach any of them.

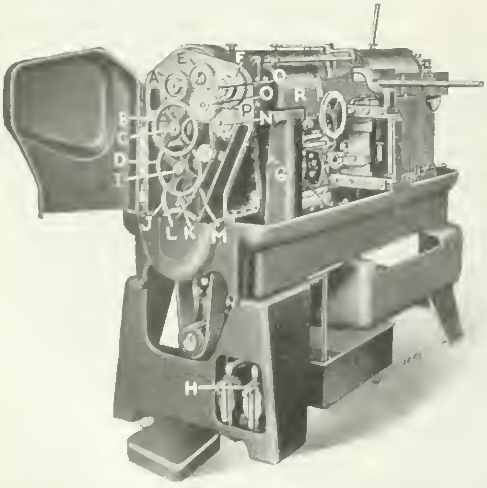


Fig. 2. Cover swung back from Gear-case to show Arrangement of Gears

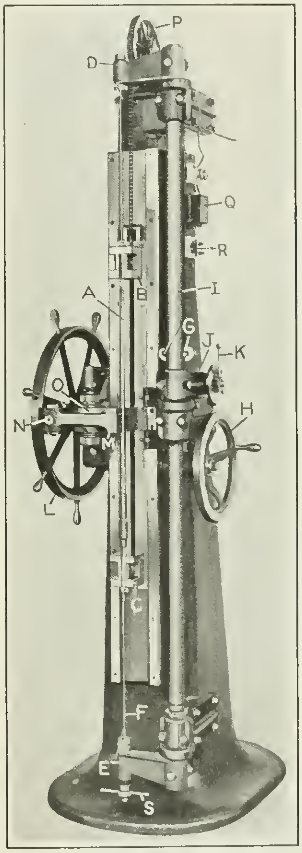
The Cone automatic screw machine is arranged for single belt drive, the design being worked out in such a way that with a machine of standard design provision may be made for driving from an individual electric motor or from a pulley on the lineshaft. The only difference is that where individual motor drive is employed the electric motor is bolted under the machine and a belt is carried up to the driving pulley shown at *N* in Fig. 1, while a belt is carried down to this pulley from the lineshaft where it is desired to take power from the general transmission system provided in the machine shop. Where individual motor drive is employed, the motor bracket may be raised or lowered as much as two inches by means of a handwheel, which provides for adjusting the belt tension to the desired point. It will be seen that the belt is entirely enclosed except at the top; and that the motor is placed directly beneath the machine and not on the floor; in this way, it is adequately supported and does not take up any additional space in the shop. The main driving shaft is hardened and ground and carried in Hyatt roller bearings.

Power is transmitted from the main driving shaft to the spindle driving shaft by means of compound gearing which provides for obtaining a wide range of spindle speeds. The speed gears are shown at *A*, *B*, *C* and *D* in Fig. 2, and these gears may be changed to obtain the required degree of compounding for any spindle speed which may be required on the work which is performed on the machine. Drive for the pump is taken through gears *E* and *F* and then transmitted through a sprocket chain *G* to the pumps, which are shown in a case *H*, the cover of which has been removed. From the speed gears power is transmitted through reduction gears *I*, *J*, *K* and *L*, and thence through a sprocket chain *M* to the feed gears *N*, *O*, *P* and *Q*. The double reduction gears *I*, *J*, *K* and *L* have a ratio of 16 to 1, and the feed gears *N*, *O*, *P* and *Q* may be compounded to give the desired feed changes. These feed gears are used during the time that the cutting tools are in operation. During the idle movement, *i. e.*, while the tools are being backed away from the work, drive to the feed mechanism is through gears *E* and *F* and thence through a quill, on the opposite end of which there is a friction clutch carried in case *R*. This clutch transmits power to the feed mechanism. Attention is called to the fact that all the gears for obtaining speed and feed changes and for driving the pumps are contained in a single case, which affords a design that is practically as compact as it could be made.

Arrangement of Cams on Cam-shaft

Referring to Fig. 1, it will be seen that there is a pair of cam drums at *J*, and the cams on one of these provide for operating the spindle chuck, while the cams on the other feed the stock through the spindle until it reaches the distance stop. At *K* there is a second pair of cam drums, on which there are carried cams that control the operation of the cross-feeds at the front and back of the machine, respectively. A small cam at the right of this pair of cam drums controls the operation of the turret locking pin. A third pair of cam drums at *L* operates the third and fourth position tools, which are opposed to the spindles in the two upper positions. At *M* there is a single cam drum which carries cams that govern the movement of the forming and turning tool-slide on the lower bed of the machine. In conclusion, attention is called to the fact that all oil-pipes for delivering cutting compound to the tools and lubricating oil to the machine bearings are located beneath the bed of the machine, the only exception being flexible tube connections that transmit lubricant from the supply pipes to the cutting tools.

SPONSEL GUN BARREL CALIBRATING AND STRAIGHTENING MACHINE



Sponsel Barrel Calibrating and Straightening Machine

In order for a gun or rifle to shoot accurately, it is obvious that its barrel must be perfectly straight. After the barrel has been drilled or turned off, it is necessary for it to be straightened several times, and the men who do this work are often given credit for possessing knowledge of certain secret methods. As a matter of fact, it is far more likely that the results they obtain are due to exceptional skill and judgment acquired through years of practice. However, the work of the most proficient barrel straightener is far less accurate than that done by men employed in many other departments of gun shops, as shown by the fact that manufacturers have not been able to accept specifications calling for the bore of a barrel to be straight within less than 0.002 inch for its entire length. While this figure has been regarded as the limit of accuracy in straightening barrels, it is by no means a close limit on many of the classes of machine work involved in the manufacture of guns. Obviously, it would be desirable to have a means of straightening barrels that would enable the work to come within the same limits of accuracy attained in machining gun parts, and such means have been provided in a calibrating and straightening machine which has recently been placed on the market by the Sponsel Co., Inc., 647 Main St., Hartford, Conn. The machine was designed and developed by Charles W. Sponsel, who is known as a designer of machines used for drilling and rifling gun barrels. It consists of a sensitive electrical apparatus for detecting any slight deviation from straightness in the bore, and means of applying pressure to the gun barrel at the point of error so that a permanent "set" will be imparted to the metal at this point to bring the barrel into the desired alignment. Referring to the accompanying illustration of the Sponsel barrel calibrating and straightening machine, it will be seen that a rifle barrel is shown in position at *A*, this barrel being held by plugs which are carried by two adjustable brackets *B* and *C*, which, fastened to a slide, move on ways planed on the machine column. Stretched between arms *D* and *E* there is a wire *F* that runs through the bore in the gun barrel to be tested. A V-shaped platinum "feeler" is carried on this wire, and when this feeler comes into contact with the gun barrel one of the electric lights *G* which are connected in series goes out while the other continues to burn at full voltage; when the feeler is free from contact with the gun barrel both lights burn at half voltage in the usual way. By turning handwheel *H*, movement is imparted to the sliding brackets *B* and *C* so that the gun barrel to be tested is traversed past the feeler carried by wire *F*.

It will be seen that the two arms *D* and *E* are carried at the ends of a vertical shaft *I*, and that there is a third arm *J* near the center of the shaft. Shaft *I* is supported in three annular ball bearings, and there is a thrust ball bearing at the bottom, in order that the movement of this shaft may be quite sensitive. The desired oscillatory movement of the arms carried by shaft *I* is secured by a screw that is turned by lever *K*; this screw runs through a nut at the end of arm *J* and bears against the column of the machine, so that by turning the screw, arm *J* is either swung toward or away from the machine, thus imparting movement in the opposite direction to arms *D* and *E*. The length of arms *D* and *E* from the center of wire *F* to the axis of shaft *I* is exactly the same as the length of arm *J* from the axis of shaft *I* to the center of the screw turned by lever *K*. The platinum feeler carried by wire *F* is located so that its knife edge always points directly toward the column of the machine, and when the oscillatory movement is imparted to shaft *I* it results in either moving the feeler toward the wall of the gun barrel or away from it. As previously stated, when this feeler comes into contact with the barrel, one of the lights *G* goes out.

In straightening a barrel the idea is to bring the feeler up almost into contact with the barrel so that both lights are burning; then handwheel *H* is turned so that brackets *B* and *C* are traversed up the column of the machine, which causes the entire length of the barrel to traverse past the feeler. If this traverse is made without extinguishing one of the electric lights *G*, *i. e.*, without the feelers touching the barrel, the feeler is brought closer to the barrel by turning lever *K*, the distance of the feeler from the barrel being indicated by a micrometer dial carried on the screw which is turned by lever *K*. This screw has twenty threads per inch, and the dial is divided into fifty spaces, each of which corresponds to 0.001 inch. At each side of the zero point, two spaces are graduated to 0.00025 inch. Successive traverses of the gun barrel past the feeler are made—and each time the feeler is brought nearer to the barrel—until a point is finally reached where one of the lights is extinguished, indicating contact between the barrel and the feeler. It then becomes necessary to start straightening the barrel to remove the "highest spot" which has been found; but this part of the work will be described later. To be sure of securing accurate results, it is necessary to repeat this sequence of tests, rotating the gun barrel on its centers through the series of tests. In this way it will eventually be found that the feeler can be set within 0.00025 inch of the barrel in any position and the entire length of the barrel traversed past it without coming into contact. Such a degree of accuracy in straightening would be utterly impossible to obtain, even if the most highly trained barrel straighteners were employed, by the "hammer and eye" methods which are now in quite general use.

In explaining the method of straightening a barrel on this machine, we shall assume a condition where one of the electric lights *G* has just been extinguished, indicating contact between the feeler and the inside of the gun barrel. This indicates a "high point" in the barrel, and to overcome such inaccuracy the operator of the machine simply turns handwheel *L*, leaving the barrel in exactly the same position that it occupies while testing it for straightness. This results in forcing hammer *M* down onto the front of the barrel, this hammer being located opposite an anvil with two supporting points on which the gun barrel is held from the back. In this connection it is important to note that the feeler is always located exactly midway between the two supporting points of the anvil, so that the hammer will descend upon the high point of the barrel, which is detected by the feeler. Pressure applied in this way results in imparting a permanent "set" in the steel, which should be just enough to remove the high spot; but the machine operator can easily make sure that such is the case by subsequent testing with the electrical calibrating apparatus on the machine. In straightening a barrel it is likely to be found that there are a number of high spots—some greater than others—and the machine operator must carefully remove all these high spots as they are found, the highest first, in order to get the bore perfectly straight or at least straight within the limit of accuracy that can be attained with this machine. By this method a barrel can be straightened so that the correctness of the work can be proved mathematically. Furthermore, an unskilled operator can be trained in a few days to do work which it is claimed would be superior to that done by a barrel straightening expert who had spent years in learning the details of his trade.

From the shaft on which handwheel *L* is carried, motion is transmitted to the hammer and anvil through a pair of bevel gears and a shaft *N*, which is threaded right- and left-hand, respectively, in the ends of the hammer and anvil. The hammer is carried on a pivot at *O* and the anvil on a similar pivot, so that when the left- and right-hand threads on shaft *N* are turned in the nuts at the end of the hammer and anvil, these members swing about their pivots so that the barrel is gripped between three points, allowing the hammer to bend the barrel between the two-point anvil to remove the high spot. A compensating mechanism is provided so that in case either the hammer or anvil engages the barrel too soon, pressure will not be applied until the two supporting points of the anvil and the hammer are in contact with the gun barrel. During the operation of straightening, both ends of the barrel naturally move outward away from the column, and to accommodate this movement the plugs supporting the barrel are secured in hinged members, which normally are held in an aligned position by a spring.

Obviously it is of the greatest importance to have the machine set up so that the plug centers carried by sliding brackets *B* and *C* are in accurate alignment with each other, and also in alignment with the ways on the column of the machine in two planes. This result is obtained by substituting a test bar in place of the rifle barrel *A*. The bar is drilled and carefully reamed to correspond to the bore of the rifle barrel to be tested, and then accurately ground on the outside so that it is true with the bore. This bar is set up on the plug centers, after which a dial test indicator is mounted on a bracket bolted to the column of the machine. The bar is traversed past this indicator with the latter in contact with first the front and then the side of the bar. Adjustments are made until the test may be conducted without deviation of the indicator. This shows that the bar is parallel with the ways on the column of the machine in two planes, and hence that the plug centers on which the bar is supported are in accurate alignment with each other and with the machine ways.

In conclusion, the reader's attention is called to several interesting details of design on this machine. Sliding brackets *B* and *C*, on which the gun barrel is supported, are connected by a cast-iron slide, and the entire weight of these members and the gun barrel is counterbalanced by a weight hung on sprocket chain *P*. This chain extends down behind the slide that connects brackets *B* and *C*, forming a rack that meshes with a sprocket wheel carried on the same shaft with handwheel *H* that provides for traversing the sliding brackets. This is a simple and inexpensive way of making a rack. Ordinarily the current used for electric lights *G* is taken from an ordinary illuminating circuit and passed through transformer *Q* so that the E.M.F. is reduced to six volts. The reason for this reduction in voltage is to avoid the danger of an operator receiving an electric shock while working on the machine. As there is always a possibility of interruption in electric service from a central power station, a battery of four dry cells is carried on a shelf inside the machine column, and these batteries may be connected to the electric lights *G* by reversing the position of double-throw switch *R*. In one respect the machine shown in the accompanying illustration has been modified. Originally a hand-screw *S* was employed to put the necessary tension on the wire *F* after it had been threaded through the gun barrel and secured in the chuck carried by arm *E*. This tension is necessary in order to keep the wire taut and also to be sure that the edge of the feeler is pointed constantly in the same direction. An improvement in the arrangement for applying tension to wire *F* has been provided by substituting a quick-acting cam mechanism for hand-screw *S*. This cam stretches the wire ½ inch and applies a tension of approximately 300 pounds in the wire, so that accuracy is insured.

MASTER ENGINE LATHES

The Master Machine Tool Co., 110-112 W. 40th St., New York City, has added to its line the two lathes illustrated and described herewith. It will be apparent that the design of these machines is essentially the same except that the lathe illustrated in Fig. 1 is provided with a geared head, while the machine shown in Fig. 2 has a cone head; also, the geared-head machine is furnished with an oil-pan and cabinet legs. With the exception of the features to which particular reference has been made, the following description will apply to both machines.

These lathes are intended for use in tool-rooms and on manufacturing work where accurate ma-

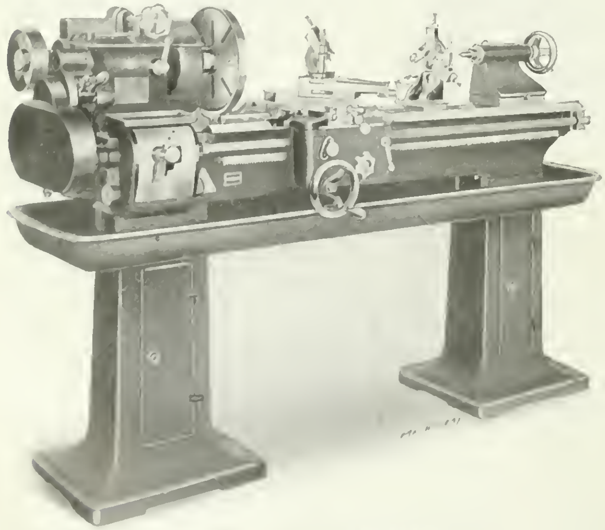


Fig. 1. Geared-head Lathe built by the Master Machine Tool Co.

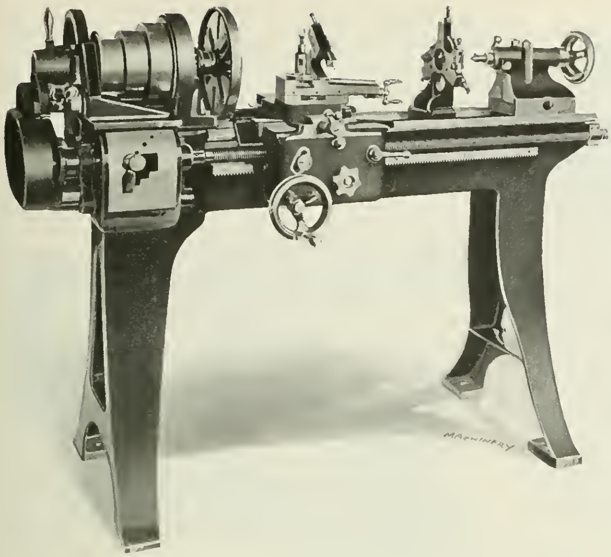


Fig. 2. Lathe with Cone Pulley and Back-geared Drive built by Master Machine Tool Co

chining is required. The bed is designed with two wide-spread vees and two flat bearing surfaces, and is supported by cross-braces to reduce vibration to a minimum. The splined lead-screw is set immediately below the guides to obtain a steady motion for the carriage. The spindle is made of special carbon steel, accurately ground to size, and it has a hole through the entire length of ample size to take draw-in attachments and collets. The spindle runs in phosphor-bronze bearings, the large end being threaded to receive chucks and faceplates. There are two adjusting collars for taking up wear. Special means are provided for carrying the end thrust, so that smooth operation is insured under heavy cuts.

The apron is simply designed, with a detachable back-plate that allows the removal of all parts for repair or inspection. The lead-screw is splined for driving the worm which operates the automatic longitudinal- and cross-feeds through a friction clutch. It is impossible for both feeds to be in operation at the same time, as a safety lever prevents engaging the split nut while either feed is in use, thus making the lathe practically fool-proof. The accurately milled thread of the lead-screw is only used for screw-cutting operations, so that the life of the screw is prolonged. The four-change feed-box has steel gears and provides for instantaneously obtaining the usual changes of feed, as, for instance, where it is desired to change from roughing to finishing. Threads are cut through the feed-box as indicated on the gear plate. Regular equipment furnished with the machines consists of a countershaft, large and small faceplates, follow-rests and fixed steady-rests, change-gears, and the necessary wrenches for making all adjustments.

On the geared-head lathe shown in Fig. 1 the headstock is equipped with all steel gears, which provide six changes of spindle speed ranging from 28 to 418 revolutions per minute. Drive is through a positive clutch. The headstock is secured to the bed by two ¾-inch bolts. Changes of spindle speed may be easily and rapidly obtained by means of a lever and a hand-wheel conveniently located on the headstock. The changes are so arranged that no two speeds can be engaged at the same time. All gears are completely enclosed and run in oil. On the cone-driven lathe illustrated in Fig. 2, the headstock is secured to the bed by three staybolts. This headstock is of the back-geared type, and the three-step cone pulley carries a belt two inches in width.

"RED-E" TOOLS

The Ready Tool Co., Bridgeport, Conn., has added to its line what are known as Types X4 and X5 tool-holders. These are the regular "Red-E" chrome-nickel tools made in large sizes to meet the demand for such tool-holders. The Type X4 holder takes a ½-inch square tool bit, and the Type X5 holder takes a ⅝-inch square bit. The inserted half-round section of tool steel electrically welded in place, which is a well-known feature of "Red-E" tools, is provided in these tool-holders, thus preventing wear at a vital point. The set-screws are made of carefully selected steel and are not likely to break. A special process of heat-treatment makes the holder hard on the outside and tough on the inside, so that it will not "mash" down on the top. The tool-holder is a chrome-nickel steel drop-forging.

"AMTEW" ENGINE LATHE

The American Machine Tool Engineering Works, 4854-4858 W. Kinzie St., Chicago, Ill., are now building the "Amtew" 14-inch high-power engine lathe illustrated and described herewith. One of the important features of this lathe is that in the apron there are four changes of cross- and longitudinal-feed, any of which can be obtained by simply moving the feed-change lever to one of four positions, which constitutes a quick and efficient means of making changes of feed. A back-gear shifting lever makes it possible to change the speed of the machine from the lowest range to the intermediate range of speeds without loss of time. The feed-rod is driven direct from within the headstock by a train of gears and an overload friction, no feed belt being employed. Overloading the feed by accident simply causes the friction to slip, thus preventing damage to the mechanism.

The headstock is of the bowl type, and the spindle is made of 60-point carbon crucible steel. The front spindle bearing is 2 7/16 inches in diameter by 4 inches long, and the spindle is bored to hold a bushing bored for No. 3 Morse taper. The spindle bearings are lined with bronze and accurately scraped to fit the spindle. All gears subjected to severe service are made of steel and the idlers are bushed with bronze. The tailstock spindle is made of exceptional length, which gives ample rigidity as well as provision for drilling unusually deep holes with a twist drill without having to move the tailstock. The tailstock spindle is 1¾ inch in diameter and has a maximum

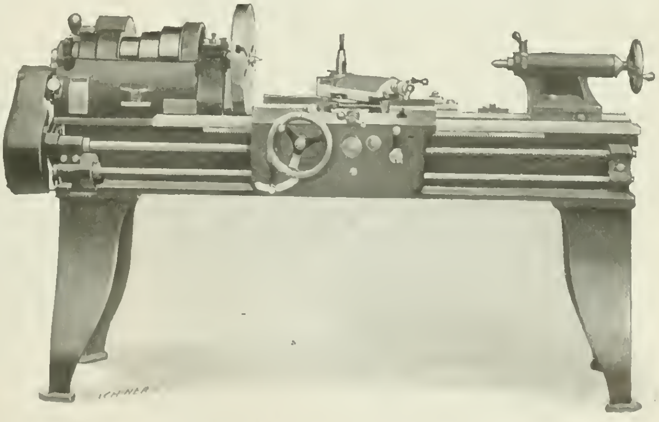


Fig. 1. "Amtew" 14-inch High-power Engine Lathe built by American Machine Tool Engineering Works

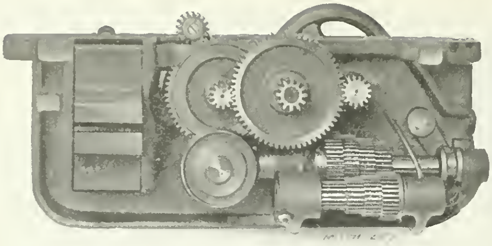


Fig. 2. Rear View of Apron, showing Arrangement of Feed Change-gears

travel of over 8 inches. The carriage has a bearing 23 inches long on the ways, and the carriage bridge is 7¼ inches wide. The apron, including its bearings, is cast in one piece, and a safety device makes it impossible to throw in the half-nuts when either feed is connected. Mention has already been made of the fact that the feed change is located in the apron. The principal dimensions of this lathe are as follows: swing over ways, 14 5/8 inches; swing over carriage, 7 inches; distance between centers for six-foot bed, 36 inches; taper of centers, No. 3 Morse; diameter of hole through spindle, 1 5/16 inch; range for thread cutting, 1 to 48 threads per inch; cone pulley diameters, 5 1/2, 6 1/4 and 8 inches; width of belt, 2 1/2 inches; ratio of double back-gears, 3 to 1 and 8 to 1; number of spindle speeds, 18; range of spindle speeds, 30 to 655 R.P.M.; and weight of machine with six-foot bed, 1600 pounds.

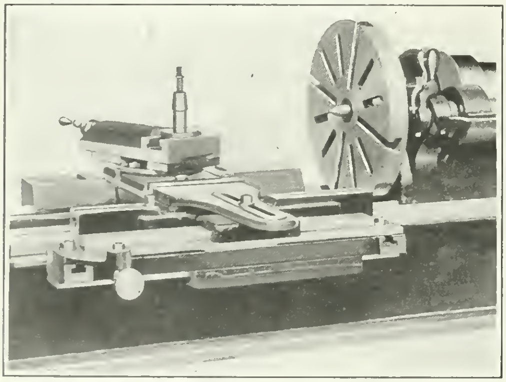
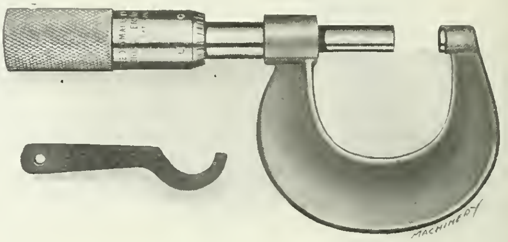


Fig. 3. View of Taper Attachment and Carriage from Back of Lathe

REED MICROMETER CALIPER

Micrometer calipers manufactured by the Reed Small Tool Works, Cherry and Vine Sts., Worcester, Mass., are provided with means of adjustment for any wear that may develop on the ends of the anvil and spindle by having the thimble made in two separate parts. The sleeve and knurled section are held together by friction in such a way that the sleeve may be rotated in either direction by the use of the small spanner wrench shown beside the micrometer. This constitutes a simple method of adjusting, by which it is an easy matter to bring the zero mark on the sleeve and the horizontal division line on the barrel of the micrometer into coincidence when the spindle and the anvil surfaces are together, or when a standard testing block is placed between the spindle and the anvil. The same spanner wrench is used for taking up the tension nut at the end of the threaded barrel to compensate for spindle wear. This wrench is cut to two arcs of circles, one of which is the outside diameter of the spindle and the other the diameter of the nut. A rigid joint is insured between the thimble and spindle, the spindle being threaded and locked into the knurled thimble.

This micrometer has the frame made of drop-forged steel and is provided with a dull nickel finish. It is so designed that it "hangs" well for the machinist, who will appreciate the deep throat, allowing plenty of finger room, and the concaved frame, which affords a natural finger grip. By making the anvil stationary, it has been found possible to reduce the width of the frame at this point, thus adapting the micrometer for working in close places. The tool is compact, and the design has been worked out so that the number of parts has been reduced as far as possible. These micrometers are graduated to 0.001 inch and are made in six sizes, ranging from one to six inches; each size of micrometer has a range of one inch. Micrometers of corresponding sizes are also furnished for making metric measurements, and a lock-nut can be furnished with either type.

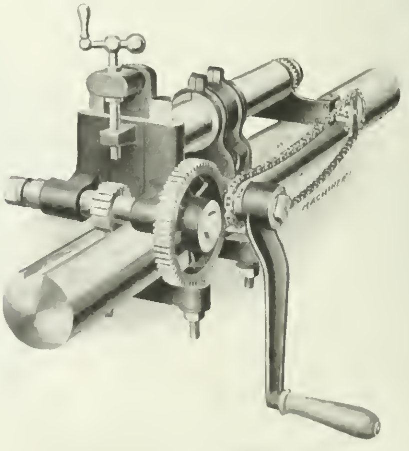


Micrometer Caliper made by Reed Small Tool Works

BUCHER-SMITH PORTABLE KEYSEATER

In the accompanying illustration is shown a portable keyseater which is a recent product of the Bucher-Smith & Co., Ravine St., East Liverpool, Ohio. This machine is so designed that it may be driven by a hand crank, or this crank may be removed and the machine driven by a one-fourth-horsepower electric motor. Five milling cutters are furnished with the machine, which may be ganged in various combinations to provide for cutting keyseats from ¼ to 1¼ inch in width. Keyseats may be cut in shafts from 1¼ to 5 inches in diameter, and the capacity of the machine is for cutting keyways up to 12 inches in length without requiring the machine to be reset.

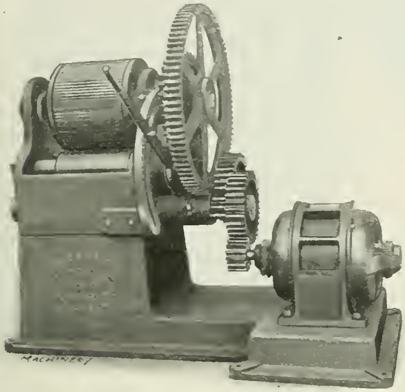
This machine has been designed to meet the requirements of mechanics, millwrights and repair men in mills, mines, factories, etc. The feed-screw is located inside the spindle, which brings the pull very close to the shaft. Provision is made for disengaging the feed mechanism by a sliding clutch at the rear of the spindle. The use of a portable machine of this type, which may be taken to the work and used without requiring much disassembling, is often the means of saving a substantial part of repair costs.



Portable Keyseater built by Bucher-Smith & Co.

KANE & ROACH TUNNEL PLATE BENDER

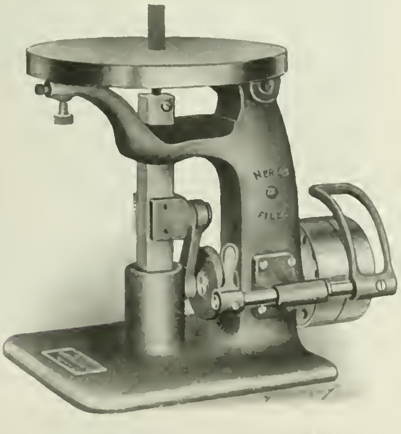
One of the recent additions to the line of machines built by Kane & Roach, Niagara and Shonnard Sts., Syracuse, N. Y., is the No. 35 tunnel plate bender illustrated and described herewith. This machine is adapted for bending special work, such as wide channels made from light sheets, *i. e.*, sheets with flanges turned up at each side. It is especially suitable for use where plates are to be bent with the flanges on the inside of the circle. After the tunnel plates have been produced on the machine in this way, they are bolted together by the flanges to form sections of the desired length.



Tunnel Plate Bending Machine built by Kane & Roach

NEWARK FILING MACHINE

The Newark Engineering & Refrigerating Co., 476 18th Ave., Newark, N. J., is now building the "Nerco" filing machine, which forms the subject of the following description. It will be apparent from the illustration that this machine is of simple but rigid construction. The machine is provided with a square shaft, which runs in two babbitted bearings that fit closely, so that side motion is practically eliminated. This does away with tendency to under-cut when working to finish lines. A table is provided which is of ample size to handle a great variety of work, and the adjusting and locking screws enable the table to be set accurately to the desired angle. The principal dimensions of the machine are as follows: diameter of table, 8 inches; height of table from bench, 10 inches; total width of machine, 8 inches; total length of machine, 12 inches; diameter of tight and loose pulleys, 3½ inches; width of driving belt, 1 inch; and net weight of machine, 22 pounds.



"Nerco" Filing Machine built by Newark Engineering & Refrigerating Co.

Fig. 1. Type of Inserted-cutter Tool made by Lovejoy Tool Co.

LOVEJOY INSERTED-CUTTER TOOLS

In working out the design of its line of inserted-cutter tools, the purpose of the Lovejoy Tool Co., Inc., Springfield, Vt., has not been to develop universal holders having adjustments to cover all positions that might be required for toolmaking, and which are only occasionally used, but rather to design production tools that closely approach solid forged tools as regards rigidity and freedom from unnecessary overhang and objectionable projections. The cutters are made of high-speed steel and are carefully heat-treated by a method that insures satisfactory results. All cutters are made to gage measurements so that they are interchangeable in their respective holders. As a result, it is possible to order cutters and be sure that they will be ready to begin work when received, because they are sure to fit properly in the holders and they are heat-treated ready for service.

The turning, facing and planing tools included in this line are of a positively locked type, the tool thrust being taken on the locking key, which, in turn, takes its seat on the solid metal of the holder. The vertical locking wedge only serves to bind the cutter in position, making it virtually a part of the holder. It is claimed to be impossible for the cutter to slip while taking heavy intermittent cuts. Height adjustment is provided for the cutters as they become worn, so that the maximum amount of service is obtained. The toolholders are carefully heat-treated and capable of withstanding the heaviest strain imposed by high speeds and feeds.

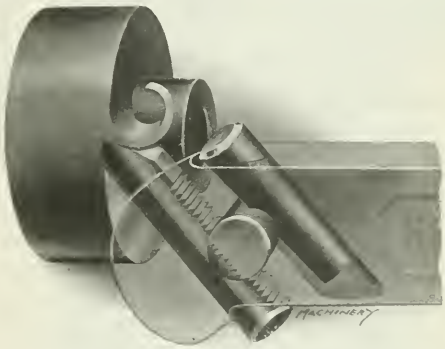


Fig. 2. Phantom View of Head of Lovejoy Inserted-cutter Tool

It is claimed by the manufacturers of these tools that a tool taking the cutting thrust approximately in the direction of its length is more serviceable from the standpoint of durability under heavy cuts than a tool of equal size taking the strain at right angles to its length. This, of course, assumes that the tool is securely held in the holder. By reducing the strain in the cutters, it has been found possible to harden them to a high degree of cutting efficiency. Although the nature of boring operations does not make it possible to work under the superior conditions obtained in the performance of turning and facing operations—in so far as the relation of the cutters to the work is concerned—the cutters are placed in such a position in boring-tool holders that they receive as nearly as possible an end thrust and natural top rake. Grinding is done entirely on the end and the tools are locked in their holders with a total absence of protruding set-screw heads, thereby giving unobstructed chip clearance from the holes when they are only slightly larger than the boring-tool holders.

SWIND COLD SAW

The Swind Machinery Co., Widener Bldg., Philadelphia, Pa., is now building a cold saw that has a cutting capacity for work up to 3¼ inches in diameter. This machine is of compact design, so that it takes up a relatively small amount of room, which is an important factor in shops where floor space is at such a high premium that it is desirable to utilize out-of-the-way corners for cold saws and similar equipments. It will be apparent that the chief point of interest in connection with the design of this machine is the means which have been provided for feeding the saw to the work. The shaft on which the saw is carried is eccentrically mounted in a cylindrical frame which is furnished with means for giving it an oscillatory movement, as a result of which the saw is fed through the work to be cut off. The saw is automatically fed into the work.

The way in which the feed mechanism operates will be best understood by reference to Fig. 2. Here it will be seen that there is a bellcrank carrying two pawls that engage a ratchet wheel. These pawls and the bellcrank on which they are carried are actuated by means of a link, adjustment of the number of teeth picked at each stroke, and consequently of the rate at which the saw is fed into the work, being regulated by changing the position of the crankpin in the slotted disk provided for that purpose. At the opposite end of the shaft on which the ratchet wheel is carried, there is a pinion that meshes with an arcuate rack secured to the frame of the machine. As the pinion rotates in mesh with this rack, it will be apparent that the cylindrical frame carrying the saw is rotated, thus causing the saw to be fed into the work. It will be seen that there is a short arm carried by the cylindrical frame that carries the saw. This arm may be set so as to trip a clutch on the driving shaft when the saw has completed its cut.

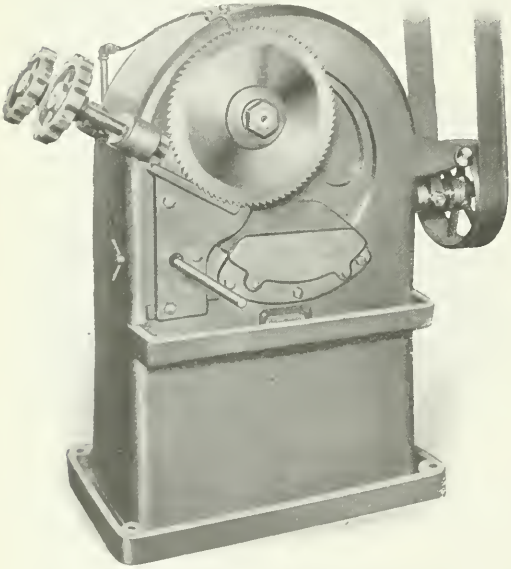


Fig. 1. Cold Saw built by Swind Machinery Co. for Work up to 3¼ Inches

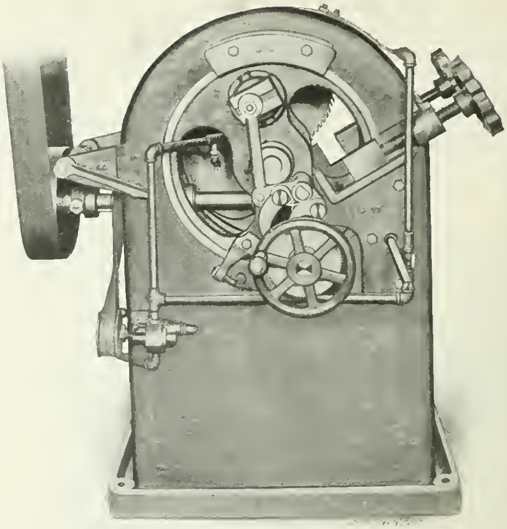
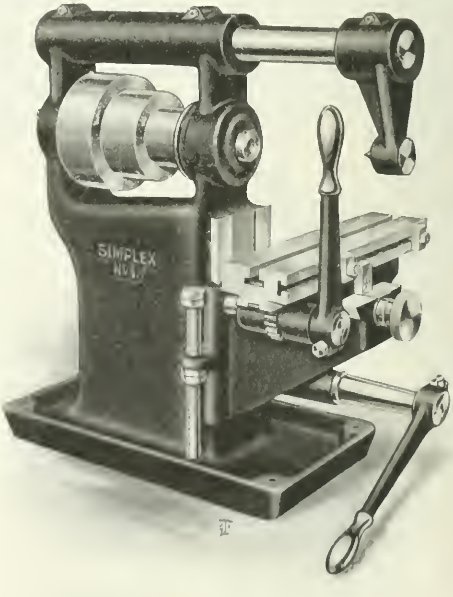


Fig. 2. Opposite Side of Machine, showing Feed Mechanism and Automatic Trip

Since taking the photographs from which illustrations were made for use in connection with this article, some minor changes have been made in the design of the machine. The pump is placed on the inside of the column, which has improved the arrangement of the pipe connections considerably, making it possible for the pipe to be connected so that it extends up from the pump to the top of the machine without requiring the angle and T-connections which are shown. The reservoir has been considerably enlarged and a hand-hole has been provided at the front of the machine, making it possible to clean out the oil retainer thoroughly. The use of an oil channel around the base has also been discarded.

WRIGHT HAND MILLING MACHINE

In the accompanying illustration is shown a machine known as the "Simplex" hand miller, which is a recent product of David A. Wright, 568 Washington Blvd., Chicago, Ill. This machine is adapted for milling small parts, such as those that are machined in factories manufacturing typewriters, guns, sewing machines, etc. The overhanging arm is two inches in diameter and can be adjusted horizontally to accommodate different lengths of arbors, or it can be swung out of the way when desired. All sliding bearings are provided with gibs to afford means of compensating for wear. The cross-feed knob



"Simplex" Hand Milling Machine built by David A. Wright is graduated to 0.001 inch and adjustable stops are furnished for both the table and knee. As shown, this machine is arranged to be set up on a bench, but to meet the requirements of shops that desire to use it as a floor type machine, a pedestal base is furnished to which the bench machine may be bolted.

The principal dimensions are as follows: size of working surface of table, 3½ by 13 inches; maximum table cross-feed in line with spindle, 3¼ inches; maximum table longitudinal feed, 6½ inches; maximum vertical adjustment of knee, 5¼ inches; distance from arm to center of spindle, 5½ inches; maximum distance from center of spindle to table, 5¼ inches; width of T-slot, ½ inch; taper of spindle, B. & S. No. 8; diameter of hole through spindle, 11/16 inch; available spindle speeds, from 100 to 1200 R.P.M.; speeds of two-speed countershaft, 200 and 600 R.P.M.; size of countershaft pulleys, 2¼ by 6 inches; weight of bench miller, 250 pounds; and weight of bench miller on column, 400 pounds.

DETROIT SENSITIVE DRILLING MACHINES

To provide for drilling holes up to ⅜ inch in diameter on production work, the Detroit Tool Co., 1487 St. Antoine St., Detroit, Mich., is now manufacturing Model L-1 high-speed sensitive drilling machines which are shown in the accompanying illustrations. These machines are made in both floor and bench types, a front view of the floor type machine being shown in Fig. 1 and a rear view of the bench machine in Fig. 2. Except for the fact that one machine is furnished with a pedestal base, both are of essentially the same design, so that the following description applies to both types. Power is transmitted from the tight pulley through rawhide and steel bevel gears to a straight vertical shaft, at the top of which there is an aluminum pulley. From this pulley a straight belt with an idler pulley to maintain the desired tension, transmits power to a two-step aluminum pulley on the spindle.

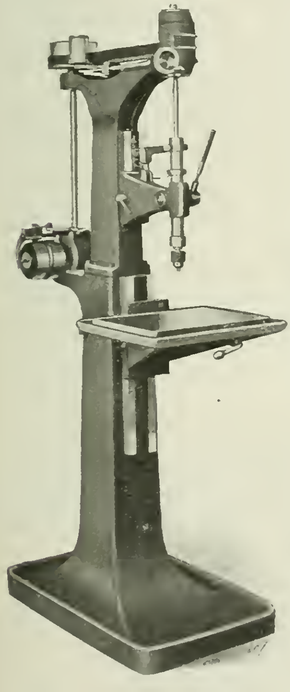


Fig. 1. Front View of Detroit Floor Type Sensitive Drilling Machine

The straight driving pulley permits of making quick changes from one to another of the steps on the spindle cone pulley, the difference in belt length for these two steps being taken up by the idler pulley operated by a handwheel, screw and idler lever. With this arrangement more belt contact surface is obtained on the cone pulley when running on slow speed. The belt shifter is located on the same side of the machine as the handlever. If it is necessary to shift the belt from the large to the small cone, the operator merely lets go of the lever and raises his hand about a foot to reach the belt shifter, with which he shifts the belt onto the small step on the cone. The spindle is then free to back up and rise out of a troublesome burr, etc.; then by pulling down the belt shifter the spindle is immediately in motion again. The whole operation only takes a second and the operator is not required to touch the belt. His left hand is on the work or jig all the time. The driving belt is 1¼ inch in width and is made of woven fabric. The machine is adapted for speeds up to 8000 revolutions per minute.

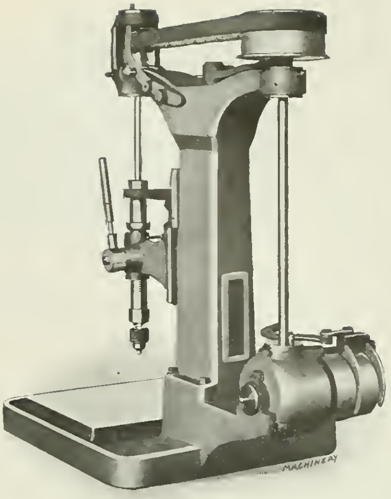


Fig. 2. Rear View of Detroit Bench Type Sensitive Drilling Machine

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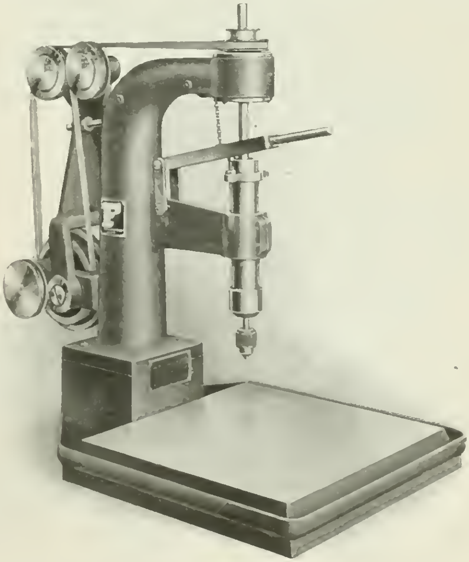
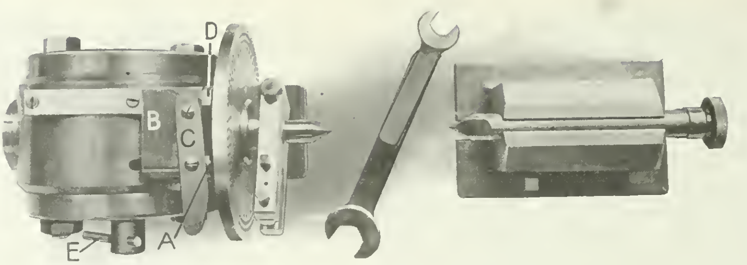
FENN HIGH-SPEED DRILLING MACHINE

In the high-speed sensitive drilling machine that has recently been developed by the Fenn Mfg. Co., 385-405 Broad St., Hartford, Conn., a departure has been made from the usual method of feeding the spindle through a rack and pinion. On this machine it will be seen that the feed movement is obtained with a lever direct connected to the spindle sleeve. The weight of the lever, sleeve, spindle and chuck is counterbalanced, thus permitting the operator to know just what pressure he applies to the point of the drill. This drilling machine is adapted for a maximum speed of 15,000 revolutions per minute, and it is fitted throughout with SKF ball bearings. The principal dimensions are as follows: distance from chuck to table, 5¼ inches; distance from upright to center


High-speed Drilling Machine built by Fenn Mfg. Co.

of spindle, 6½ inches; size of table inside oil-groove, 13½ by 13½ inches; maximum feed movement, 3 inches; available spindle speeds for a countershaft speed of 965 R.P.M., 7735, 9285, 12,500 and 15,000 R.P.M.; diameter of tight and loose pulleys, 4¼ inches; and weight of bench machine without countershaft, 140 pounds.



Plain Index Head made by Secor Mfg. Co.

SECOR PLAIN INDEX HEAD

The index head illustrated is a recent development of the Secor Mfg. Co., Derby, Conn. Its construction is essentially simple and it is for use on milling machines or other machines on which any indexing is required except that which combines spiral work. The complete index head comprises the headstock, tailstock and wrenches as shown. The tailstock is of rigid construction, the base being made of cast iron, while the moving parts are made of hardened steel. The tail-center is turned eccentrically, and, in addition, is slightly flattened on top, making it possible to mill very close to the center of the work.

The index head itself is regularly furnished with one dial containing three rows of holes of 80, 72 and 42, respectively. This combination gives a great deal of leeway and can be divided into any ordinary number of spacings. Great accuracy is employed in making these plates and each hole is lapped, causing the index-pin to fit nicely. The index-pin *A* slides freely in the swiveling block *B*, and is operated by the hand-lever *C*. By loosening the nut *D*, the block is free to swing through a sufficient arc to cause the index-pin *A* to engage in any one of the three circles of holes, where it is rigidly clamped. In addition to the use of the index-pin in preventing rotation, a binding handle *E* is provided, which securely binds the spindle and relieves the thrust of the working tool from the index-pin.

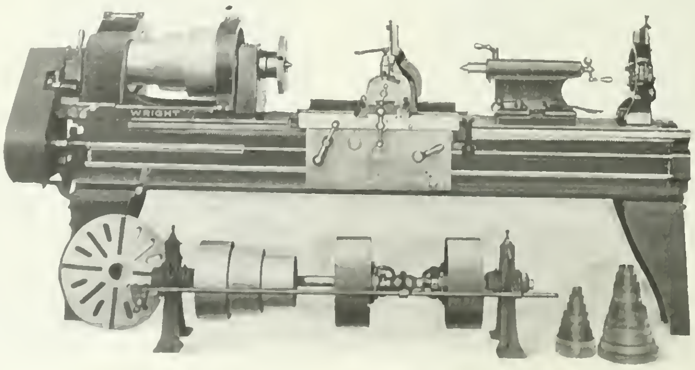
The center, instead of fitting directly into a taper in the spindle, fits a hardened steel collar, which, in turn, fits into the spindle. On this collar is carried the dog driver, which fits the collar snugly but is split and equipped with a binding screw, so that fractional spacings may be secured, such as when a partially finished piece of work is being returned to the centers. Instead of the dog on the work being bound to the driver by a simple screw, a block is furnished that is rounded on its edge so that a line contact is secured between it and the dog. This is desirable in ordinary work, but is especially desirable when the head is set for tapered work.

The dividing head is of the tilting type, accurately graduated in degrees in a position on the body where the readings are plainly visible. When the head is tilted, it is rigidly clamped by the two generously proportioned bolts shown. This part of the head is constructed of three iron castings, the base, the two side plates and the tilting body. The remaining parts are chiefly made of hardened steel; and the spindles, etc., are accurately ground. The head is equipped with double-end wrenches, fitting all the nuts and screws in use on the head. The construction is plain and durable, with no unnecessary finish.

WRIGHT ENGINE LATHES

In the accompanying illustration there is shown a back-geared engine lathe which is built in 18- and 20-inch sizes by David A. Wright, 568 Washington Blvd., Chicago, Ill. This machine is of the independent change-gear type and is built single or double back-geared. The bed has three vees and one flat way, which assures adequate support for the carriage. The headstock has a three-step cone pulley that carries a 5-inch belt. This cone pulley and spur gear can be instantly connected or disconnected by an improved locking device which does not require the use of a wrench, and permits of rapid engagement or release of the back-gears. All exposed gears on the machine are covered by removable guards. The spindle has a hole 1⅝ inch in diameter through its entire length and is furnished with special means of lubrication, which consist of oil reservoirs placed under both spindle boxes with chains to carry oil up to the bearings. This insures constant lubrication at all times when the lathe is in operation. Oil pockets are provided in the cone pulley which provide lubrication when the pulley is revolving around the spindle Phosphor-bronze bushings are provided for the spindle bearings, and anti-friction thrust bearings are furnished with an adjusting nut and steel thrust washers which reduce friction to a minimum. The tailstock is designed with a curved front, which allows the compound-rest to be used at right angles to the cross-feed.

On this lathe the carriage is securely gibbed at the front, center and back. Power longitudinal- and power cross-feeds are provided. There is a micrometer adjustment on the cross-feed screw, and when the cross-feed is used the carriage can be quickly clamped to the bed by a conveniently located lever. A chasing dial is provided. The compound-rest is fitted with taper gibs which require only one screw for their adjustment, and means are provided for removing the handle of the compound-rest so that it does not interfere with the cross-feed handle. Both the longitudinal- and cross-feeds are reversible from the apron, with the mechanism so designed that it is impossible for the lead-screw and feed-rod to be engaged at the same time. Feed reverse is controlled by a lever placed near the bottom of the apron at the right-hand side, this device being used for the control of turning feeds but not for screw cutting. The reverse for screw cutting is obtained by shifting a lever which is conveniently located at the end of the head-



Engine Lathe built in 18- and 20-inch Sizes by David A. Wright stock. Great care is taken in cutting the lead-screw, and the lead-screw nut is of the usual split pattern and lined with babbitt metal. The feed-box is placed directly beneath the headstock and so arranged that by shifting a lever four changes may be easily obtained. When not required, this device may be disconnected by shifting a small lever at the bottom of the headstock. The gear-box is so designed that changing the gear on the shaft coming directly from the box enables any desired speed to be obtained. A double friction countershaft is furnished as part of the regular equipment, this countershaft having large pulleys which run on self-oiling bushings. Included in the regular equipment there are also a compound rest, steadyrest, follow-rest, large and small face-plates, change-gears, and the necessary wrenches for making all adjustments.

VAN NORMAN AUTOMATIC BORE GRINDER

For the rapid and accurate grinding of short, straight or taper holes the Van Norman Machine Tool Co., Springfield, Mass., has added to its line a No. 34 automatic bore grinder which is illustrated and described herewith. A feature of this machine is economy of floor space, which is made possible through the provision of special means for withdrawing the work from alignment with the grinding spindle for gaging. This is done by means of a cross-slide, which enables the work-head to be pulled forward after the grinding spindle has been withdrawn from the work. In this way a plug gage may be used without having to back the work-head a considerable distance away from the wheel.

Fig. 1 shows the work-head drawn back from the wheel for gaging the work, while in Fig. 2 the wheel is shown in the operating position. Withdrawal or return of the wheel from the work and the work-head from alignment with the wheel-spindle, is effected by means of the two hand-levers shown. Both levers are provided with locking devices, that on the wheel-slide serving to secure it to a subslide which is in constant connection with the operating mechanism. Gripping the wheel-slide lever with the right hand disconnects the operating mechanism, and movement of this lever withdraws the wheel from the work. This lever is manipulated with the right hand, and with the left hand the operator swings over the lever that draws the work-head out of alignment with the wheel-spindle. Gripping of this lever is also responsible for first withdrawing the locking device, while further movement causes the work-head to be drawn forward. It is not necessary to disconnect the cross-feed while making these adjustments.

This grinder was especially designed to meet the requirements of ball bearing manufacturers for a machine adapted for grinding short straight or taper holes of various diameters. It is provided with a cross-feed mechanism of the same refinement as that employed in the Van Norman oscillating or radius grinders. The automatic cross-feed for the wheel-spindle is equipped with a fine graduated dial and adjustable cut-out latch device. Hand feed for the wheel-spindle is operated with a handle when the automatic mechanism is disconnected from the dial. Automatic table traverse gives any variation in the length of stroke from ⅛ to 1⅝ inch, and there is also hand table feed operated by a lever that actuates a rack and pinion and gives a traverse movement of the table up to 4½ inches. The work-head cross-slide is operated by a hand-lever that carries the head crosswise from the center of the wheel-spindle in the manner previously described. The maximum movement available is 4½ inches. Owing to the convenience of operation and the accuracy of the feed mechanism, several machines may be looked after by a single operator. Machines of this type are furnished either with or without water equipment.

The principal dimensions are as follows: capacity for handling work from the smallest up to 4 or 5 inches internal diameter; distance from floor to center of wheel-spindle, 44 inches; number of table traverse speed changes, 4; number of wheel-spindle speed changes, 4; number of work-head speed changes, 4; and weight of machine, approximately 1850 pounds. A countershaft and the necessary wrenches for making all adjustments are furnished as part of the regular equipment.

SIMMONS DRILLING AND TAPPING MACHINE

In the July, 1917, number of MACHINERY a description was published of a bench type automatic tapping and drilling machine that had just been placed on the market at that time by W. H. Simmons & Co., 208-212 Lawrence St., Cincinnati, Ohio. Recently, this firm has brought out two floor type machines of essentially the same design, except that they are furnished with a pedestal base. One of these is equipped for belt drive from a countershaft and the other for individual electric motor drive. The clutch and reversing mechanism can be set to run the tap to any desired depth, reverse auto-

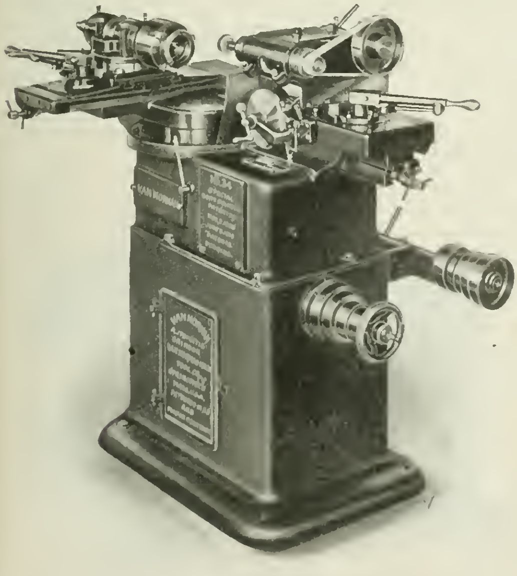


Fig. 1. Van Norman Automatic Bore Grinder with Work-head drawn back from Wheel for Gaging

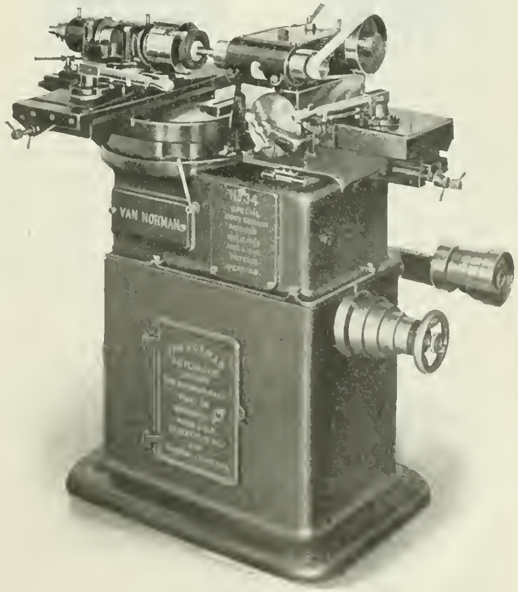


Fig. 2. Van Norman Automatic Bore Grinder with Grinding Wheel in Operation

matically and then stop the spindle automatically. The clutch is of the jaw type, made of steel and hardened. To secure a sensitive drive for light tapping or tapping soft metal, provision is made to adjust the belts to any desired tension. This is accomplished by the lower pulleys being mounted on an eccentric shaft which is revolved by means of a knob on the right-hand side of the column.

The column of this machine is of tubular section, and the bearings are bronze bushed and provided with felt oilers. The lower cone pulley and the tight and loose pulleys run on bronze bearings with oil reservoirs to afford continuous lubrication. The clutch and trip mechanism are made of steel, and all contact points are hardened. The spindle is made of carbon steel and is counterbalanced by an adjustable counterweight. Each machine is furnished with four spindle lead attachments to tap 16, 18, 20 and 24 threads per inch. Extra leads of any desired pitch, including metric pitches, can be furnished as special equipment.

The principal dimensions of this machine are as follows: capacity for drilling to the center of a 12-inch circle; maximum distance from spindle to table, 25 inches; maximum vertical adjustment of spindle, 3¼ inches; maximum vertical adjustment of table, 5 inches; diameter of spindle in sleeve, 13/16 inch; diameter of table, 10 inches; diameter of cone pulley steps, 3½ to 7 inches; width of driving belt, 1½ inch; diameter of tight and loose pulleys, 7 inches; face width of tight and loose pulleys, 1¾ inch; tapping capacity in cast iron, ⅝ inch; drilling capacity in cast iron, ½ inch; and available spindle speeds, 150, 250, 390 and 600 R. P. M.

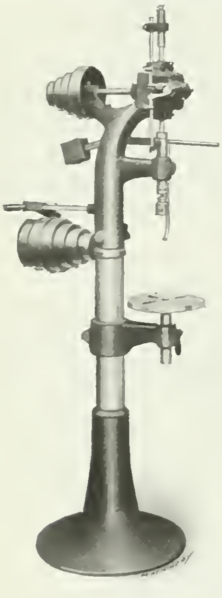


Fig. 1. Simmons Drilling and Tapping Machine with Belt Drive

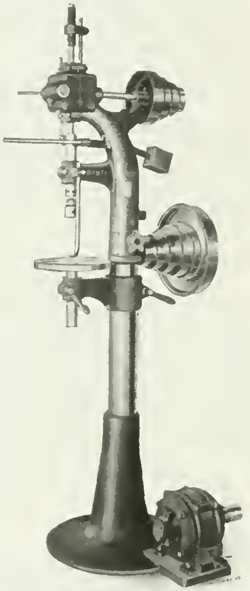
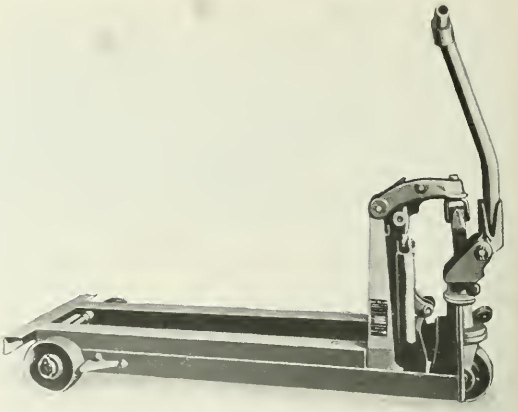


Fig. 2. Simmons Drilling and Tapping Machine with Motor Drive

LEWIS-SHEPARD ELEVATING TRUCK

In the May, 1916, number of MACHINERY a description was published of an elevating truck built in capacities for handling loads from 2500 to 5500 pounds. Trucks comprising this line were heavily constructed to meet the requirements of severe classes of service. Recently, the Lewis-Shepard Co., 48 Binford St., Boston, Mass., has added to its line a Type L "Jacklift" master truck, which is really a lighter model of the trucks previously described in MACHINERY. Their carrying capacity is 2500 pounds, and as they are intended for less severe service, these trucks are more lightly constructed. All the operating features of the heavy-duty type are retained in the Type L trucks. These include obtaining a high lift by moderate pressure on a free-lifting handle, which permits the load to be elevated with the handle of the truck turned to one side, thus enabling elevation to be effected in narrow aisles or other cramped places.


Lewis-Shepard Type L "Jacklift" Elevating Truck

Attention is called to the fact that the only cast or gray iron used in the construction of these trucks is in the wheels; all other parts are made of either malleable iron or crucible steel. Type L trucks are made in six models, three of which have 6-inch wheels and three 10-inch wheels. The lifting ratio is 40 to 1, which permits women and boys to operate the trucks when handling heavy loads. As trucking is one of the departments of labor in which women and boys may be employed to take the place of men who have been drafted for National service, these may properly be called "wartime" trucks.

THE COSTIMETER

The "Costimeter," made by the Costimeter Co., 130 Montcalm E., Detroit, Mich., is an elapsed-time recording device, which stamps directly on a card the elapsed time from one job to another and when used with the "Costimeter" wage chart gives the corresponding wage value. The accurate keeping of time by an operator or workman is reduced to its simplest form, as he has only to place his daily card in the slot on the machine and press the lever upon the completion

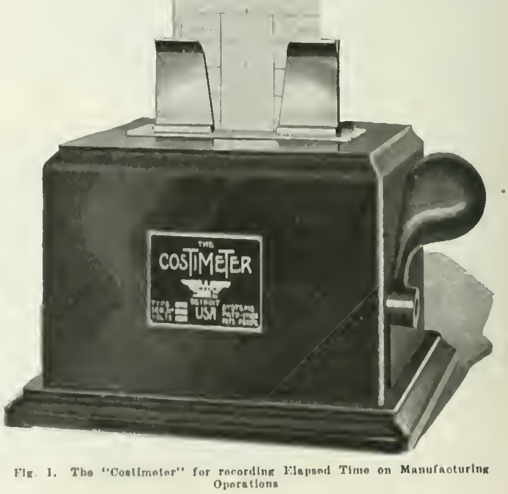


Fig. 1. The "Costimeter" for recording Elapsed Time on Manufacturing Operations

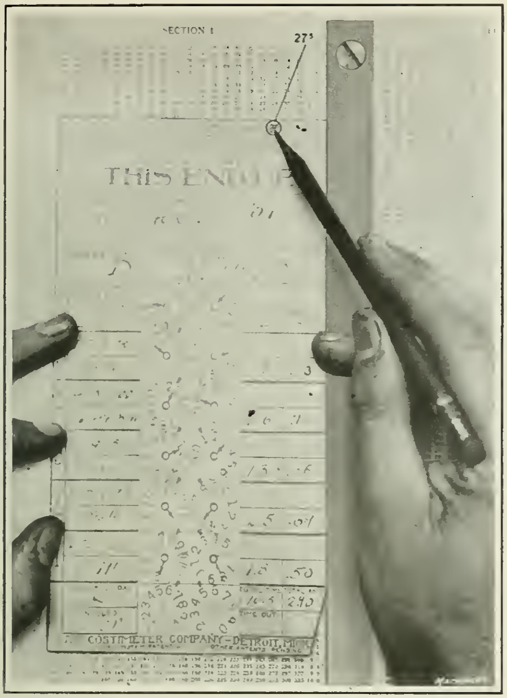


Fig. 2. Use of Record Card from "Costimeter" in calculating Money Equivalent of Elapsed Time

of each job. The lower right-hand corner of the card is cut off at an angle, which operates the safety lever, making it possible to enter the card only in the correct way, face outward and right side up. Upon arriving at the factory in the morning the workman inserts his daily card and presses the lever. Thereafter during the day he inserts the card again after the completion of each job. It is assumed that the foreman or planning department has filled his card out for the various jobs that he is to do throughout the day. His card then is his guide as to which is the next job.

The card and the "Costimeter" wage chart are special for different concerns. At the top of the card is printed the maximum and minimum rate per hour at which the various men in the factory are being paid. The time clerk is enabled to read the time consumed by each job directly off the card, and its equivalent in money is arrived at with little mental effort by placing the card on the "Costimeter" wage chart and reading it directly as illustrated. In Fig. 2 the card of N. P. Hall, No. 31, working in Department D, is shown fully stamped; this indicates that he worked on six different jobs during the day. The dials stamped in the lowest space on the card gives the time in the morning when he started. The next pair above indicates the elapsed time to be one and eight-tenth hours to do the drilling on part DT 39. This is repeated through each of the operations that he completes.

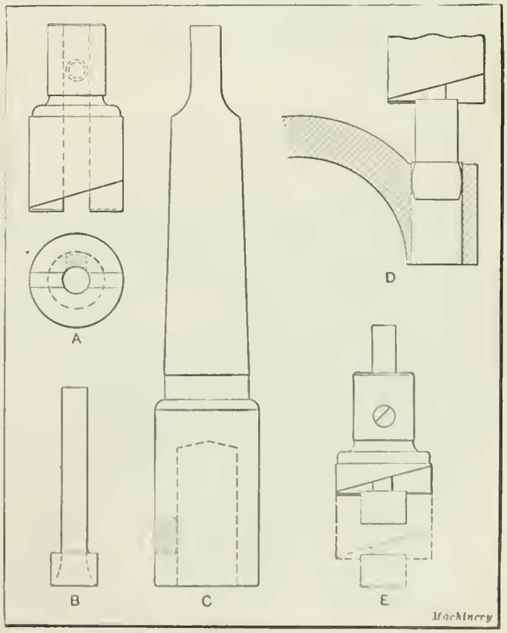
The time clerk places the card on the "Costimeter" wage chart, guiding it by the strip at the right, then glancing at the uppermost stamped dials, he reads "one and two-tenth hours," and enters it in the column marked "Time" on the card. He then slides the card down the chart until the time 1.2 in the list of figures adjacent to the guide strip, is exposed, and then directly above the rate per hour, of this particular man, 22½ cents, he reads "33 cents" and enters it on the card in the right-hand column marked "Amount." Thus we have clearly indicated the elapsed time for any job, and with very little mental effort, its equivalent in money is arrived at with the chart. The operation is repeated by the time clerk in the same way for all the operations and the time is then totaled, amounting to 10½ hours and the money to $2.90.

The operation of the "Costimeter" is simple and consists in placing the card in the slot and pressing one lever. It is furnished as an entirely self-contained device with an eight-day clock or with electrical control. The timing device may be arranged for intervals of any desired frequency, from one minute up, but the customary length of interval is one-tenth hour or six minutes. That is the interval at which the clock was set for making the record card shown in Fig. 2. The machine is constructed along sturdy lines, having a heavy cast-iron frame and base. A device of this kind is likely to be abused by workmen, and it is designed to withstand rough usage.

PRODUCTION SPOT-FACER

Spot-facing operations are often performed where it is desired to secure a local finish on castings, forgings, and similar parts without removing the strong outer skin from other portions of the work. Spot-facing operations are inexpensive to perform, except for the fact that the life of the tools is often quite short. With the view of overcoming trouble of this kind the Production Tool Co. of America, 24 John R. St., Detroit, Mich., has developed a spot-facer that is made with two lips instead of four or six. With this tool it is claimed that the hard surfaces of cast iron, malleable iron, forgings, etc., may be immediately penetrated, and that the tendency of the tool to break has been considerably reduced by the large amount of backing behind each lip. Because of the full buttress form of the lips, head radiates quickly, thus allowing tools of this type to run at relatively higher speeds than could be employed with tools having a greater number of teeth.

Pilots are made up standard with heads ⅜ inch in length. These are well suited for ordinary spot-facing operations, but on many kinds of castings where there are shoulders to cut away before getting down to the base, longer pilots are required to guide the cutter. These are made up in various designs to suit the work on which they are to be used. Pilots used on all heavy work are slotted to fit over the lips of the cutter and thereby release the strain from the shanks. In the accompanying illustration, one of the spot-facing cutters is shown at *A;* a pilot is illustrated at *B;* the holder is shown at *C;* at *D* is shown a spot-facing tool provided with one of the special pilots to which reference has been made; and at *E*



Parts of Two-lipped Spot-facer made by Production Tool Co. of America is shown a spot-facing tool and pilot assembled. This last illustration shows the original position of the pilot and cutting edges of the tool by dotted lines, while the full lines show how far the tool can be ground away before its period of usefulness is terminated.

NEW MACHINERY AND TOOLS NOTES

Industrial Truck: C. W. Hunt Co., Inc., West New Brighton, N. Y. A Type DF-60 truck which has a 1¼-horsepower motor in each of the front driving wheels. The storage batteries are contained in a separate compartment at the front of the truck and the load is carried on a low platform at the rear.

Cutting-off Machine: Etna Machine Co., Toledo, Ohio. A 3-inch cutting-off machine of the heavy-duty type, which is driven by a two-step cone pulley from a friction countershaft. This pulley has steps 10 and 12 inches in diameter and carries a 5-inch belt so that ample power is provided for handling heavy work.

Portable Lubricant Tank: Gilbert & Barker Mfg. Co., Springfield, Mass. A portable tank outfit for handling cutting oils or lubricants. It has a capacity for 50 gallons of lubricant and is furnished with a quick-acting pump that may be utilized either for delivering clean oil to the machine or collecting the used lubricant and conveying it to the filter.

Disk Grinding Machine: Carter & Bucholz Co., Inc., Syracuse, N. Y. A 15-inch disk grinder which is particularly adapted for use in wood-working shops such as those engaged in pattern-making, cabinet-making and other classes of fine wood working. The machine is suitable for use in making joints, fitting bevels, grinding the draft on patterns and for similar classes of work.

Milling Machine: Standard Engineering Works, Pawtucket, R. I. A hand milling machine equipped with power longitudinal feed and an oil-pump equipment. The power longitudinal feed of the table is secured through a rack and pinion movement that permits a quick return of the table by hand. Four power feeds are provided by means of two two-step feed cone pulleys which are interchangeable.

Airplane Propeller Lathe: Defiance Machine Works, Defiance, Ohio. A No. 613 airplane propeller turning lathe which may also be used for turning other irregular-shaped pieces up to 12 inches in diameter by 10 feet, 4 inches in length. Either right- or left-hand work may be produced from the same model. By a simple adjustment of the tailstock either end of the work or the entire piece can be made larger or smaller than the model.

Worm-hobbing Machine: Moline Tool Co., Moline, Ill. A machine provided with adjustments that enable it to handle work up to 56 inches in length by 13 inches in diameter. A straight hob is employed that is automatically fed into the worm and hobbing of the worm is completed at a single revolution. With this machine worms up to eight pitch may be handled without difficulty. The machine is practically automatic in operation.

Gate Shear: Long & Allstatter Co., Hamilton, Ohio. A large gate shear which has a capacity of 146 inches between the housings and a throat depth of 30 inches. An automatic hold-down is provided for clamping and holding the work while it is being cut, pressure on the hold-down being applied by heavy coil springs. This machine is designed to cut off 12-foot sheets and plates, and is capable of handling work up to 1 inch in thickness.

Portable Crane: Canton Foundry & Machine Co., Canton, Ohio. A portable crane which has a capacity for handling loads up to 4000 pounds. The base of the crane is a steel casting, while the uprights are made of semi-steel and reinforced. The chain is of hand-forged steel and is tested to determine its ability to handle loads exceeding the rated capacity of the crane. Roller bearings are used in the wheel and axle to make the crane easy to operate.

Sensitive Drilling Machine: Waukegan Machine Tool Co., Waukegan, Ill. A 14-inch sensitive drilling machine of the floor type which is adapted for drilling holes up to 9/16 inch in diameter. This machine is provided with two tables, one of which is square and may be swung around the column or tilted to any desired angle; the other table is round, and this table may be removed from the machine in order that a cup-center may be substituted.

Sheet and Plate Cutter: W. J. Savage Co., Inc., Knoxville, Tenn. A machine known as the "Gray No. 3" universal sheet and plate cutter. This machine is especially adapted for cutting shapes instead of handling the work with a hammer and cold-chisel, by drilling or with the use of an oxy-acetylene torch. It is claimed for this machine that cutting is accomplished without springing or buckling the metal and that all edges are left square and true.

Lubricator: Madison Kipp Lubricator Co., Madison, Wis. An automatic lubricator which stops and starts with the machine on which it is used so that a supply of oil is only delivered while the machine is actually in operation. The hand-crank makes it possible to deliver a supply of oil at the start, or in case the machine has been idle for a considerable length of time. With this outfit there is only one oil-tank to be filled on the whole machine.

Lubricant Pump: C. F. Roper & Co., Hopedale, Mass. A pump for circulating lubricants and cutting compounds, which is claimed to be constructed in such a way that priming is unnecessary. It is also said that this pump will deliver a large volume of lubricant at low pressure or at a pressure of from 20 to 60 pounds per square inch. This pump is made in four sizes, with capacities when running at 100 revolutions per minute, of 1, 1.6, 3 and 8 quarts, respectively.

Universal Tool Grinder: Dauber-Kratsch Co., Oshkosh, Wis. A universal grinder adapted for tool, cutter, cylindrical, internal and surface grinding operations. The machine is furnished with a cabinet base with a door at the back to provide for storing tools and fixtures. A shelf is cast at the front of the machine to hold tools used on the machine while in operation. E. L. Essley Machinery Co., 551-557 Washington Blvd., Chicago, Ill., is sales agent for this machine.

Drilling Machine: Moline Machinery Co., Moline, Ill. A 20-inch drilling machine especially adapted for the performance of manufacturing operations. This machine is built with either power or lever feed as desired. The spindle is driven by a worm and gear to insure smoothness and quietness of operation. This drilling machine is equipped with the usual type of swing table which allows work to be fastened on either the table or on the base of the machine.

Drilling and Boring Machine: Pawling & Harnischfeger Co., Milwaukee, Wis. A horizontal drilling and boring machine of somewhat similar design to the No. 12 machine built by this company. There are four mechanical changes of spindle speed and the spindle is made of a high carbon steel forging and bored for No. 6 Morse taper. Spindle thrust due to feeding is carried on a dust-proof ball bearing, the spindle itself running in bronze bearings. Four changes of feed are provided.

Multiple Drill Head: Covington Multiple Drill Co., 2449 W. McMicken Ave., Cincinnati, Ohio. A six-spindle auxiliary drill head in which any number of spindles from two to six may be employed. The spindle units are readily attached or removed to meet the requirements of the work; and each spindle is individually adjustable. When located in the desired position each spindle is rigidly held. Adjustments may be made very quickly, as only one lock-nut is used for securing each spindle in place.

Drilling and Tapping Machine: Barnes Drill Co., 814 Chestnut St., Rockford, Ill. An all-geared 26-inch sliding-head drilling and tapping machine. This machine represents an improvement of a preceding design of the same type built by this company. The present machine is equipped with a new style of self-oiling reverse gear and with an outboard bearing support for the driving pulley. The friction clutches and drive-shaft bearings are continually lubricated by means of a geared pump which delivers lubricant from the reservoir.

Gear-hobbing Machine: Barber-Colman Co., Rockford, Ill. A No. 3 gear-hobbing machine on which the bed and upright are of box section reinforced by ribs which are cast integral. The sub-base is also of box section and contains a tank for the oil or cutting lubricant delivered to the tool. The work-spindle is horizontal. Either a right- or a left-hand hob swivel may be provided, the former accommodating a range of spiral settings from 60 degrees right hand to 90 degrees left hand, while the latter accommodates a range of spiral settings from 60 degrees left hand to 90 degrees right hand.

* * *

The first merchant ship built on the interchangeable plan, or, as it is generally termed, the first "standardized" merchant ship, was put into commission in Great Britain a few months ago. This ship is of 8000 tons dead-weight carrying capacity, and was completed in slightly less than five months. She is the forerunner of a great fleet of sister ships which are now being built. In addition, other standard ships of 7000, 5000 and 3000 tons dead-weight capacity are being built. The waste connected with shipbuilding as it has been carried on in the past, where every ship, as well as the engines and auxiliary machinery used in connection with it, was individually designed, is apparent. It is evident that ships may be built to the same designs just as well as locomotives or automobiles. The war has taught many important lessons in the economics possible in trade and engineering, but few which will prove of greater importance than that in connection with the building of ships in great numbers on the interchangeable plan. The only wonder is that it has not been done before.

MARTELL ALIGNING REAMERS

SYSTEM WHICH COMPENSATES FOR DISTORTION OF CRANK-CASE

BY EDWARD K. HAMMOND[1]

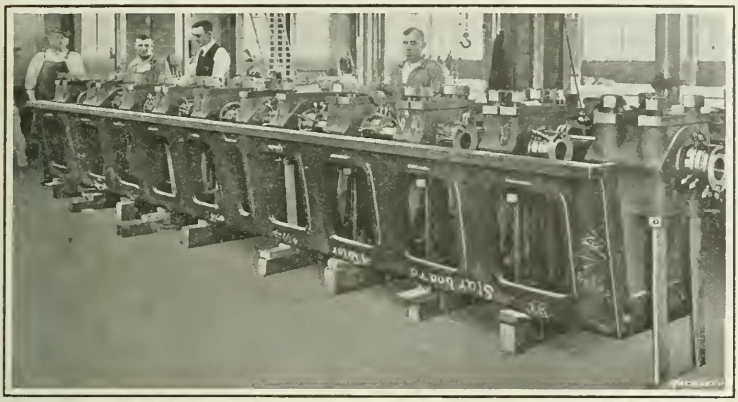


Fig. 1. Crank-case of Diesel Type Engine having Bearings reamed with Martell Aligning Reamer

IN the April, 1914, number of MACHINERY a description was published of the Martell aligning reamer which had just been placed on the market at that time for use in reaming the bearings of automobile crank-cases. Recently the manufacture of these reamers has been taken over by the Taft-Peirce Mfg. Co., Woonsocket, R. I., and tools of the same general type have been developed for handling work far beyond the range of the original Martell reamers. In order to get a clear idea of these tools and their work, the reader must grasp the fact that Martell reamers, as they are now built, are really more than tools adapted for a specific class of machining operations; possibly the term "Martell system of reaming" would be more suitable because when a manufacturer buys Martell reamers he adopts the use of an entirely distinctive system of reaming bearings to insure accurate alignment.

A good idea of the range of work that may be handled with Martell reamers will be obtained from the accompanying illustrations which show reamers engaged in line-reaming the bearings in automobile crank-cases, and in the crank-case of a Diesel engine at the plant of the Winton Engine Works in Cleveland, Ohio, the total length of the latter case being 23 feet.

In the previous article to which reference has been made, attention was called to the fact that with the Martell method of line-reaming, the reamer-bar is supported by a series of adjustable eccentric bushings which are, in turn, supported by the bearings in the work. The reason for adopting this construction is to provide means of offsetting the effect of distortion caused by clamping the crank-case in fixtures used in the preceding operations. If the crank-case bearings are reamed without making allowance for such distortion, accurate results will not be obtained. In preparing for a reaming operation, the reamer-bar with the eccentric bushings in place is set up in the crank-case. Then the eccentric bushings are adjusted so that the reamer-bar is in accurate alignment. (Before starting to ream the bearings in the crank-case, the bar is withdrawn from the end bushings alternately, and if it can be pushed back without interference, it shows that all the bushings are in accurate alignment.) Otherwise the eccentric bushings must be adjusted until this test can be made with satisfactory results. Experience gained with the Martell reamer has shown that it not only produces more accurate alignment in the bearings, but that it is also the means of considerably reducing the time required for performing hand operations, and in some instances entirely eliminates them.

Referring to Fig. 1, it will be seen that the crank-case illustrated has eleven bearings which receive the crankshaft shown in Fig. 2, that has journals 8 inches in diameter. The total length of this case is 23 feet and to avoid the obvious disadvantages of making a reamer-bar the entire length of the case, a bar 10 feet long is used, the idea being that if the alignment of four bearings were accurately secured, the fifth bearing could easily be located from the original four; and if the fifth could be located accurately, the sixth and all succeeding bearings could be treated in the same manner. This supposition was borne out in practice, and it was found on the first attempt that the alignment was materially better and that a great saving in time had been secured.

Fig. 5 shows the construction of the centering bushing. The cone *A* is made of pack-hardened machinery steel, and is provided with a fine-pitch thread on the tapered surfaces, which allows it to be screwed securely into the soft metal of the bearings to be reamed. At *B* and *C* are shown, respectively, the inner and outer eccentric bushings. The inner eccentric *B* is bored and ground to a neat running fit for the reamer-bar. Outer eccentric *C* is bored and ground to a like fit on the eccentric portion of bushing *B*. As the eccentricity of these two bushings is the same, it is at once seen that there will be a certain point at which the hole in the inner bushing is exactly concentric with the outer diameter of the outer bushing. In other words, the rotation of the inner bushing in relation to the outer bushing determines the amount of eccentricity or distance off center that the bore of the inner bushing shall assume in relation to the outer diameter of the other bushing. The rotation of the two bushings within the conical sleeve determines at what point or in what direction the center line of the bar shall lie. Lock-screws are provided on all these members to permanently maintain the alignment.

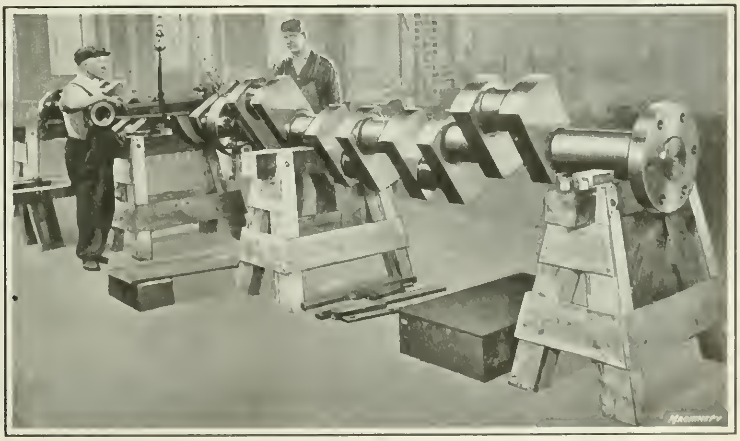


Fig. 2. Partial View of Crankshaft that goes in Case shown in Fig. 1

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[1] Associate Editor of MACHINERY

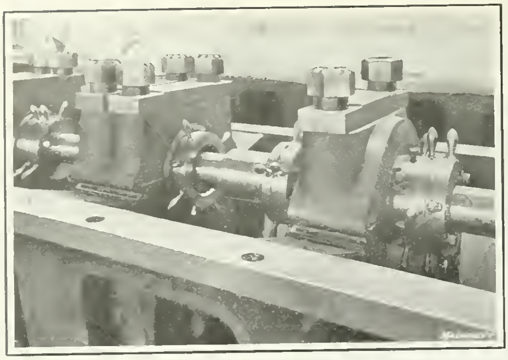

Fig. 3. Close View of Reamer-bar supported in its Centering Bearings

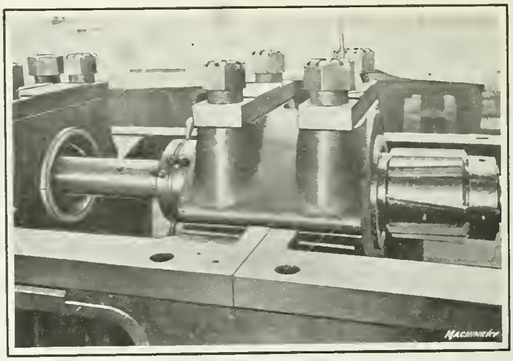

Fig. 4. Close View of Centering Bearing and Reamer Ready for Operation

At the top of Fig. 5 is shown the construction of the reamer, which is of the shell type and has eight adjustable blades As will be noticed these blades are set in at a slight angle to the axis of the reamer-head—six of them having a left-hand angle and two a right-hand angle. Adjustment is secured by means of the adjusting nuts *D* and *E* at each end, which are ground on the surfaces adjacent to the blades to the same angle as the ends of the blades. The expanding members consist of pack-hardened and ground wedges which are held in the bottom of the slots by means of bosses, formed integral with the wedge. It is claimed that very close variations in size can be secured by means of this type of adjustment. The reamer-head is driven by means of screw pins on opposite sides of the body which engage the recesses spaced at intervals in the reamer-bar. Provision was made on this bar for power drive as well as by hand. It was found, however, that it was an easy matter to ream the bearings without the use of power. In view of the great quantity of engines of this type and of various sizes now under construction it would seem that there is a wide field of usefulness for this tool in marine work.

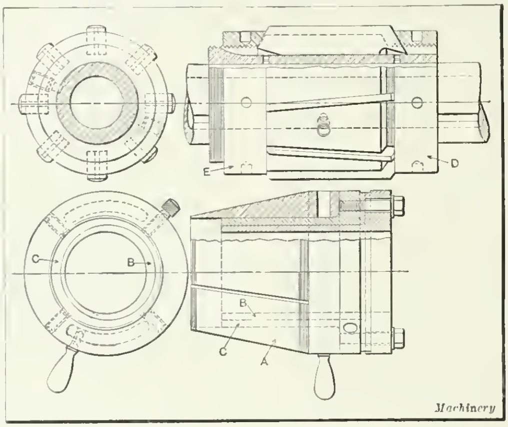

Fig. 5. Top View—Type of Reamer used; Bottom View—Adjustable Bearing for Reamer-bar that provides Compensation for Distortion of Work

Compensating Line-reaming Fixture

A careful study of existing practice in line-reaming the bearings of automobile crank-cases disclosed these facts: The average manufacturer of motors is very particular about the balance of crankshafts; practically all of them are using the Norton static balancing machine, and more recently many are also using the Akimoff dynamic balancing system. This great care is exercised in an effort to reduce, in so far as possible, the phenomenon known as the "whip" of a crankshaft. The whip of the crankshaft makes its presence felt by a decided vibration of the motor, which in most cases is recurrent with some particular speed or multiple of that speed; for instance, one vibrating period will occur at 650 R.P.M., another at 1300 R.P.M., and still another at 2600 R.P.M. Many efforts have been made to overcome this trouble, and at present the most approved method is to counterbalance the crankshaft webs individually. This has been carried to such an extent in one popular motor that the crankshaft and flywheel weigh about 360 pounds. The performances credited to this motor indicate that this method is effective.

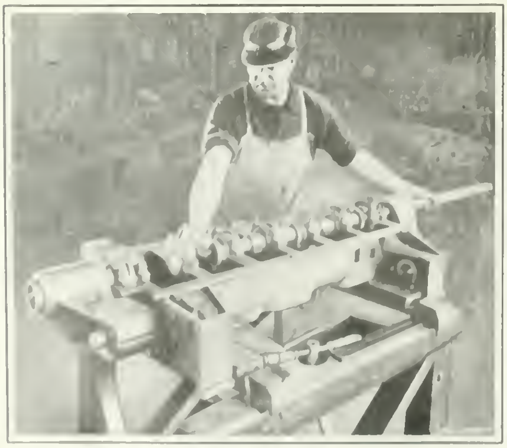

Fig. 6. Setting up Centering Bearings in an Automobile Engine Crank-case

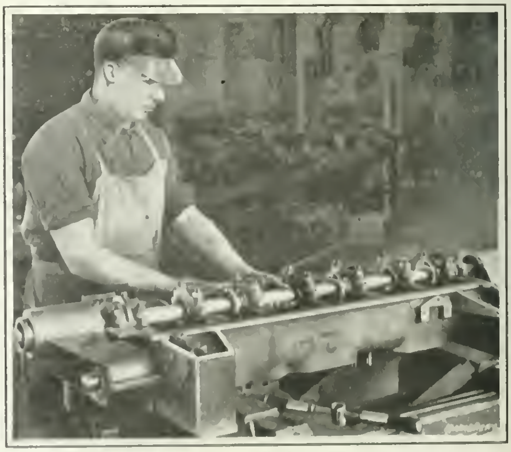

Fig. 7. Adjusting Eccentric Bushings in Bearings to secure Alignment

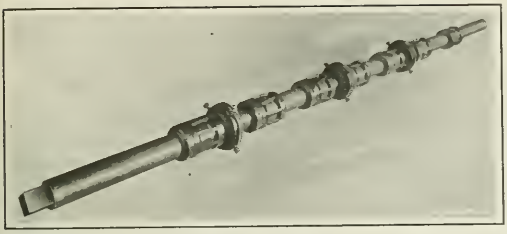

Fig. 8. Small Reamer-bar used in Automobile Crank-cases, shown completely assembled

It is fairly safe to assume that the art of balancing crankshafts is developed to a point of great accuracy. Let us now look at the bearings that carry this finely balanced shaft and see if the methods of alignment are fine enough to form a true path in which this shaft is to revolve. Assume that the Martell line-reamer is used to ream the bearings in an absolutely straight line. The practice in all motor factories, when reaming bearings, is to turn the crank-case upside down, for the sake of accessibility, and support it in what is known as a "motor jack." A motor jack is simply a frame of wood or metal, and in most cases the crank-case rests on it either on the milled surface that receives the cylinders or on the motor supporting arms. Having reamed the bearings in the crank-case to an accurate size and finish, the crank-shaft is assembled and the connecting-rods and pistons are attached; the motor is then turned right side up, and the cylinders, starting motor, carburetor, generator, transmission and other parts are attached. It is an accepted fact that weight applied to a beam will deflect that beam, no matter how light the weight nor how heavy the beam. So in this case, the crank-case is usually made of an aluminum alloy and strongly webbed, but the addition of the very considerable weight embodied in the parts that are attached after the reaming operation has been performed, cannot help but deflect the case, and therefore cause disalignment of the carefully reamed bearings.

In an effort to get something tangible with which to work, a test was made on a six-cylinder motor crank-case. The large case used in this test has seven bearings and the cylinders are cast in pairs. In conducting this test the crank-case was turned bottom side up as usual; the Martell reamer-bar was supported by the locating fixtures, and three Martell supporting bushings were attached in the usual manner. After the bar was correctly lined up, two of the supporting bushings were removed, leaving the bar supported by the locating fixture at each end and one bushing in the middle bearing. By carefully measuring the distance from the reamer-bar to the bore of the cap, using a small pair of inside calipers and a micrometer, the position of the bar when truly aligned was determined. The eccentric bushings were carefully marked as to position and then removed, and the distance from the reamer-bar to the bore of the cap was once more calipered. The difference between these distances proved to be 0.001 inch and showed the amount of natural sag in the bar. Replacing the eccentric bushings in their original positions, the crank-case was reversed and placed on a running-in jack, on which it was supported by the lugs that are used as supports when the motor is assembled in the chassis. The cylinders were next bolted on, all electrical apparatus was attached, the crankshaft, connecting-rods and pistons were placed on top of the cylinders in approximately their normal positions relative to the horizontal plane, and the flywheel was suspended opposite its normal position. A careful measurement of the distance between the reamer-bar and the bearing cap at the point used in making the former measurement showed that the deflection was 0.007 inch direct reading, and adding to this figure the deflection of the bar of 0.001 inch gives a total deflection of 0.008 inch. This same test was applied to another crank-case which showed a deflection of 0.0025 to 0.003 inch. This case was shorter and deeper, the oil-pan was very stiff and ribbed on the outside in a fore and aft direction, and the cylinders were cast *en bloc* and there are two blocks.

Fig. 9. Performance of Line-reaming Operation on Automobile Engine Crank-case

To thoroughly understand the method of making up for the differences due to the reversal and loading of the crank-case after reaming, it must be understood that the crank-case is left bottom side up as before, while reaming; but the same load is artificially imposed on the case, and in the same direction that it normally sustains when mounted in the chassis. Fig. 10 shows what for lack of a better term is called a "compensating reaming fixture." Supported in this fixture is shown a V-type crank-case. Straps *A* are provided at each end of the fixture, which come in contact with the lugs of the crank-case and resist the upward pressure exerted by the weight through action on lever *B* that swings on fulcrum *C* and exerts pressure through equalizers *D* and *E*. These equalizing bars are provided with various holes to allow for any needed adjustment to secure the proper alignment. The pressure is applied to the crank-case through yoke *F* and pads *G*.

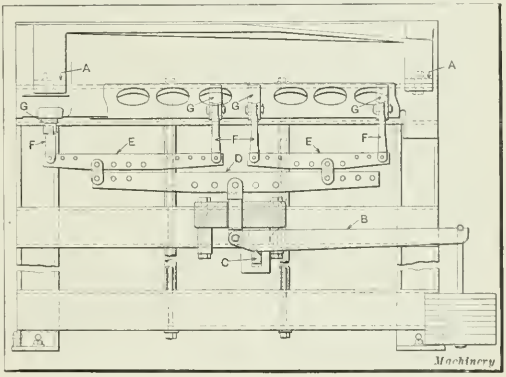

Fig. 10. Compensating Fixture used to enable Reaming Operation to be performed under Same Load that Crank-case carries in Assembled Motor

This fixture must be calibrated for each type of motor that is reamed, and the calibration is determined as follows: The crank-case fully loaded with all equipment, but with the crankshaft bearings open, is placed in a chassis. The Martell reamer-bar is then carefully lined up in the crankshaft bearings, using several supporting bushings and making sure that the bar will slide both ways and enter either end bushing without touching the sides of the holes. Remove all parts from the crank-case and place it in the reaming fixture, and then shift the weights and equalizing bar centers until the bar slides back and forth as before. Having calibrated the fixture in this way for one type or model of crank-case, all other crank-cases of the same model can be reamed in the fixture without changing the weights or equalizers, as any differences in crank-cases due to molding would be automatically cared for. Data are not available to show that the use of this device will eliminate all crankshaft whip, but it seems reasonable to believe that a variation of several thousandths inch in the alignment of the bearings, with a speed of 1000, 2000 or 3000 R.P.M. would cause trouble, and if it is possible to straighten the path of the crankshaft, some advantage will be gained.

THE INSPECTION OF GEARS[1][2]

TESTING SPUR, BEVEL, HELICAL AND WORM GEARS—HARDNESS TESTS

The inspection of gears requires as much attention as the making. If the requirements are not severe, the inspection need not be; but if the gears must work at high speeds and under severe stresses with quietness an essential factor, the inspection must be strict. In other words, the more exacting the gear requirements, the more exacting must be the inspection, not only the final examination, but also the tests between the various operations, to make sure that the gear is not spoiled, and that other operations will not be performed on a gear that will not pass the final inspection. These inspections are also necessary to insure that one department does not do poor work, with the expectation that some other department will correct the error. The methods given here apply principally to gears of the smaller sizes and are those used by the Brown & Sharpe Mfg. Co.

It is the practice of this company in the case of all gears made to a customer's specifications to first inspect the gear blank. Then after cutting the teeth, the gear is inspected for the running or rolling qualities of the teeth on a hand testing machine, unless the specifications state that the gear must run quietly at some given speed. In this case, the gear is mounted on a power-testing or speeding machine, and run as nearly as possible at the speed at which it will run in practice. When the gears are to be used in the company's machine tools, some of the intermediate inspections, such as the blank inspection, are not necessary. It has been found that any error in the blank that will affect the running of the machine will be discovered at some time before the final inspection of the machine, which is always made under the belt.

It is also the practice of the Brown & Sharpe Mfg. Co. to mark the drawings of gears that will have a speed of over 400 feet per minute with a note to that effect, the note stating simply "Speed 600 feet," or whatever the speed may be. This shows the man responsible for the cutting that he must take the necessary precautions to cut quiet gears and also shows the inspector that he should inspect the gears carefully. It has been found that this practice eliminates misunderstandings as how carefully the gears should be cut and inspected, and has considerable influence on the time consumed in the cutting operation and the inspection.

Testing Spur Gears

The method of testing the average spur gears used by the Brown & Sharpe Mfg. Co. is the usual one of mounting the gears on studs at the correct center distance. The most satisfactory way, in most cases, is to have adjustable studs where one fixture or machine will take care of a wide range of center distances; there are several such machines on the market. Where gears are too large for such a machine, a gear-tooth caliper set to chordal figures is a satisfactory way to get the pitch diameter correct. This test consists of calipering the teeth for size and variation; although very large gears may be cut to the correct depth, as the center distance is usually adjustable. In testing the gears used on the company's variable spindle speed and variable feed cases, stud plates are used, where the various gears can be tested at the correct center distance and with each gear it may have to run with. But for general work, standard spur gear testing machines are used with what is called a spur gear indicating attachment, which has been found useful for testing the run-out and also the rolling qualities of the gears. In using this attachment, the gears are pressed together by springs while a dial indicator presses against a square stud in the slide, so that any tendency of the gears or slide to move away from the mating gear, due either to run-out or poorly shaped teeth is shown on the dial. It has been found that when the indicator pointer vibrates from tooth to tooth not over 0.001 inch, the gears are usually satisfactory; and when no vibration is shown, the shape of the gear teeth is perfect. Even in the case of spur gears that are hardened and then ground in the hole, it is good policy to see that they are cut true, for then the inspectors need not make allowances for run-out in testing; besides, this practice keeps up the quality, or tone, of the gear-cutting in general.

Transmissions are run off in a test stand of some kind and tested with a light load or without any load. Usually, if a pair of gears or a transmission running dry does not rattle, the gears will run quietly under load.

Testing the Run-out

A test used in connection with the grinding of the holes in spur gears for the so-called "run-out" in gears is that known as the ball test. The apparatus consists of a pair of centers under a spring-plunger block. A ball on the end of the plunger fits between the teeth of the gears at about the pitch line, and the point of a dial indicator rests on the top of the plunger. The plunger block, which is fitted with quite a stiff spring, is used between the indicator and the work to rotate the gear into position while the indicator shows the "run-out," or variation in the pitch line. The final run-out in the gear is tested with this apparatus. The number of spaces the plunger is set into depends on the requirements of the gear.

A gear with a run-out sound, usually causes trouble, no matter how nicely the teeth may be cut or shaped. There can be, and often is, cause for a difference of opinion as to the degree of quietness of a pair of gears, but there is not much chance of this in the case of a run-out, for anyone can detect a run-out sound, and for this reason it is very objectionable.

In the case of cones built up of a number of gears keyed and pressed on a shaft, the inspection for run-out should be made after assembling. Index change-gears and lead change-gears must be cut true, as they are usually meshed closely, and a bad run-out in an index gear might prevent the machine indexing properly.

Inspection of Bevel Gears

The bevel gears that require the closest inspection are probably the driving bevel gear and pinion for automobiles. It is necessary to hold these closely to figures in the blank, and an effort is made to cut them dead true. It is not good practice to let gears of this type with run-out in the teeth go to the fire, expecting that the grinding department will overcome it. An out-of-round sound is usually fatal to these gears.

After the teeth are cut in driving bevel gears, the soft gears are tested in the hand testing machine with a hardened master gear, to determine the bearing between the teeth and the feel of the gears. They are then tested on a speeding machine with the same master gear and under some load. After they have been hardened and the holes and webs have been ground for the final inspection, they are tested in pairs as they will be shipped, but not in the particular order in which they will be used on the axle. The procedure is as follows: A gear is mounted and several (four or five) pinions are run with it; then the gear is removed and four or five gears are run with these pinions, so that every gear and pinion sent out has been run or tested with one or more pinions or gears. In this way the gears are kept interchangeable as nearly as possible. It can be seen that if the final product were tested with the master gears only, should an error appear in the cutting, the master gears might lend themselves very slowly perhaps to this error and fail to show it; but when the product is run together, an error that might not show with the master gears will appear, and it may be such that the gears are not usable. The customer is never interested in how well the gears furnished run with the master gears, but how well they run together and at the same time interchange with the gears previously sent him. The company has also adopted this method on gears for its machine tools, and repairs can be made quickly and surely, because the inspectors have tested the gears just as they will run together, previous to their going into stock.

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[1] Paper by Benjamin F. Waterman, read before the American Gear Manufacturers' Association convention in Chicago, Ill., September 14.

[2] See also "Gaging and Inspecting Gears," in MACHINERY, April, 1917.

In testing driving bevel gears for the amount of run-out, the ball-testing fixture is used. This fixture makes it possible to clamp the gears down to a rigid spindle and, with the spring-plunger block, to bring the space of the gear centrally under the plunger; the dial indicator will then indicate the run-out. The bevel pinion can be tested in this way for run-out by adjusting the plunger block to the suitable angle and setting the pinion on a stud. These run-out tests are not made in the final inspection unless the gears have shown a run-out in the running test. In this case, an effort is made to find the exact amount of the run-out and the possible remedy.

The average bevel gears are tested by hand on a bevel-gear testing machine. Care is taken to have a full length bearing along the teeth; if the bearing falls short of being full, as it may do owing to the need of some working limit, it is expected that it will bear heaviest on the inside or small end, as the bearing will pull in or extend full length with the least wear and the spring of the bearings or shafts.

Testing Spiral Gears, Helical Gears, and Worm-gears

In testing spiral gears that run at right angles, about the only thing that can be done is to see that the center distance is correct, with some backlash for oil space, and that the surfaces of the teeth are as smooth as possible. Any test of spiral gears other than under actual working conditions is rather unsatisfactory, for they are unreliable to use except where the pressures are light.

This is also true of helical spur gears, as they are made only for high speed, although it may be possible to develop a running test at some speed that will serve to show the defects in the gears, if there are any. The Brown & Sharpe Mfg. Co. has decided that there is no test that can be satisfactorily used in testing helical timing gears by anyone else but the user, and for this reason it has hesitated to cut these gears, as it feels that the user or motor manufacturer should assume the responsibility of cutting them.

Worm-gears, as they are being used today, require closer inspection than ever before, as more is expected of them. It was only a short time ago that the worm-gear had a poor reputation for serviceability, but since the advent of the worm-driven motor truck this gear has taken a new lease of life So, now that more is expected of the worm-gear, greater care must be taken in the inspection.

With the difficulties that arise with the average worm-gear cutting equipment, it is not enough to know that the hob is marked correctly or that the centers of the spindles of the hobbing machine are the correct distance apart when the gear is finish-cut. The worm and wheel should be mounted at the correct center distance and in proper alignment to be sure that the bearing between the worm threads and the wheel teeth is correct, a point that increases in importance as the service to which the gears are to be put increases in severity. On large gears, where a testing machine would be out of the question, the worm can be laid in the wheel and measurements taken from a straightedge (laid across the rim of the wheel) to a bar in the hole in the worm or to the worm-shaft. If the measurements taken on one side or end of the worm differ from those taken on the other, it is evident that the shafts are not at right angles with each other. If these gears are mounted in a gear-case in which the shaft bearings have been bored square, the bearing between the teeth will be a cross-corner one, and the amount of this bearing will depend on what the wheels have to do. When the pressures carried by the teeth of worm-gears are taken into consideration, it is evident that the bearing should be as full, or broad, as possible.

When testing the average small worm-gear, this company uses its bevel-gear testing machine, which is also a worm- and spiral-gear testing machine. But for automobile-truck driving gears, it has fitted up a special machine, where the gears can be run under some pressure. This machine is fitted with a scale and a vernier for reading the center distance

Hardening Inspection

Probably no inspection operation depends more for its success on the very operation it professes to inspect than the hardening inspection. When inspecting the machine operations performed on a gear, the mechanical errors can be determined with the measuring tools, and it is possible to feel and hear how smoothly and quietly the gears run. It is therefore possible to pass judgment on them without considering what equipment or methods were used in producing the results obtained. When it comes to testing the gear for the quality of its hardness, however, we find we cannot do more than give it a superficial test, which may mean a great deal if we are sure the hardening was done properly, but which means very little if the hardening was done improperly.

Assuming that the proper treatment for a given gear is known, it is essential that the men in charge of the hardening operation should supervise it closely so that no deviation from the best treatments is made, for the slightest lack of attention produces unsatisfactory or weakened gears which cannot be discovered until they break in service. This satisfactory treatment must be determined by measured breaking tests of gears and an examination of the fracture, to determine not only the depth of case but the condition of the grain of both the core and the case. From a gear having undergone this test, the desired scleroscope and Brinell readings may be found.

This breaking test cannot be carried on indiscriminately, of course, owing to the expense of making test gears, but it is so good a check on the work that it should be done as often as possible or as often as the job will warrant. If gears that have been spoiled are hardened with the good gears and then the teeth are broken, either under a drop or with a hammer, and the fracture is examined, the quality of the hardening may be checked under the best conditions with the least expense.

As a rule, the Brown & Sharpe Mfg. Co. also tests every hardened gear with a ball-peen hammer for depth of case and with a file for hardness. The scleroscope and Brinell machines are used as auxiliaries, except where a customer may demand a given reading from either machine when it becomes the decisive test.

Besides these tests for hardness, on driving bevel gears, this company tests for flatness on a surface plate and for any disturbance of the web in the direction of the axis of the gear. This test is a hardening-room test, for if it is found that gears are becoming distorted in hardening, it is necessary to change the hardening fixtures.

At times, after all these tests have been made, and probably after any other possible test, there is always the question as to whether the gears will run satisfactorily under actual service conditions. As a result, it is sometimes advisable to have gears tested under these conditions before proceeding at full speed to manufacture. When the gears are satisfactory, it is a good plan to have a pair or set that has been tested out in actual service to hold as master gears, with which the future product can be compared. In closing, it should be said that the amount or severity of the inspection of any gear depends entirely on the purpose for which it is used, although at all times that quality which represents your product should be maintained.

* * *

The following note was published in a contemporary in the year of our Lord 1916, although it reads as if clipped from a journal of 1876:

> It largely facilitates the execution of work if the actual worker has a scale drawing to refer to, on which the dimensions are clearly marked. Such drawings may very well be tracings on paper, done in waterproof ink, the finished tracings being fastened to a board with Stickphast paste, Gloy, or other cheap and efficient and hard-drying mountant, as usually rough usage has to be provided for. Tracings can be produced at a cheap rate, where only essential outlines are given, and neither shading nor color is used, the outlines only being necessary in the workshop. Blueprints may be mounted in the same way, where they are fixed sufficiently to bear light exposure, and possibly some amount of dampness, but these too often "run," and, as a rule, do not stand well.

TOOL SYSTEM THAT PREVENTS TOOL SHORTAGES

BY D. M. PERRILL [1]

One effect of the increasing difficulty experienced in securing tools, tool steel, or toolmakers has been a greater interest in the tool-crib. The development of the system of which this article treats is not a war-time measure, but present conditions make it a most timely subject. Realizing the vital need of ascertaining their tool needs well in advance so that proper time might be given to secure or make the tools, the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, has developed a new tool record system. Until recently this company used the check system, each man having a supply of brass checks or tags, for each of which he deposited five cents. This amount was returned to him when he turned in the checks, either on leaving or when he was transferred to some work that did not require them. Hooks were placed on the tool-crib shelves immediately beneath each tool position. When a man obtained a tool, he turned in one of the brass checks, which was hung on this hook until he returned the tool. The check was then given back to him. The faults encountered in this system were:

1. There was no record kept of the purpose for which the tools were used, and it was impossible to tell what tools had been used in producing a given piece. It was therefore impossible to check the tools called for by the routing department with those actually used in manufacture. These differences might be due to some particular hobby of the workman which it would be well to correct, or they might represent an omission of the routing department, which the workman took care of on his own initiative without referring the matter to the proper parties. In the latter case, if the tools used for some run were checked up from the routing department's information, the necessary tool might be missing without being noticed. Then again, all of the type of machines called for by the routing department might have been busy and the foreman might have done the work on some other machine without any record being made of it.

2. Since no record was kept of the purpose for which the tool was used, there was no way to tell where excessive breakage or wear occurred in the tool during the manufacture of some particular part, unless the workman or his foreman reported it. This made it difficult to find what tools needed strengthening or redesigning.

3. There was no way of telling just what tools a man had except by looking through the entire tool-room and noting the checks on every hook, and then nothing could be told of how or for what he was using them. For this reason, too, in looking through the tool-crib for tools soon to be needed, no estimate could be made concerning the possibility of using tools that were checked out of the tool-crib, since it was impossible to ascertain for how long these would be used.

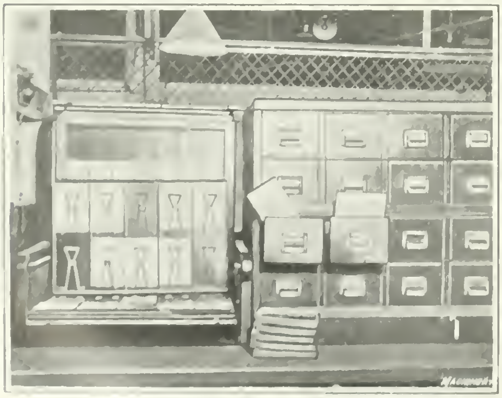
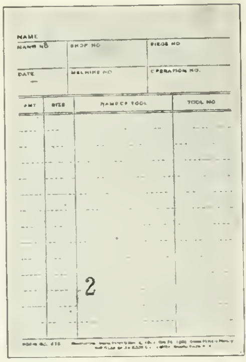


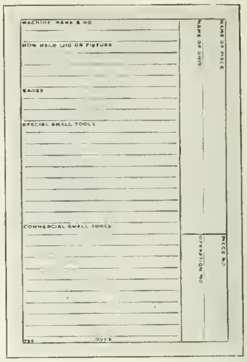
Fig. 1. Files used in keeping Temporary Record of Tools while out of Tool-crib and Permanent Record of how Tools are used



NAME
MAN'S NO
SHOP NO
PIECE NO
DATE
MACHINE NO
OPERATION NO

AMT	SIZE	NAME OF TOOL	TOOL NO

Fig. 2. Form used for both Temporary and Permanent Tool Records



MACHINE NAME & NO
HOW HELD (JIG OR FIXTURE)
GAGES
SPECIAL SMALL TOOLS
COMMERCIAL SMALL TOOLS
NAME OF UNIT
NAME OF PIECE
OPERATION NO
PIECE NO
OVER

Fig. 3. Operation Card, giving Details of Each Step in machining Work

4. This also made it practically impossible to check up the tools at the workman's bench to see if they corresponded to the ones called for by his checks. This was necessary whenever a man was leaving, and the increasing labor turn-over made this point of steadily greater importance.

5. The men could secure tools, such as micrometers worth several dollars, by turning in a brass check having a value of five cents. On leaving, a man could hold out the tool and lose only five cents, since there was no positive record to prove that the check had not been misplaced on the micrometer hook when the workman received some other tool.

A triplicate form system was installed to do away with these troubles. It gives a complete record of the tools required for the manufacture of any given piece, so that it is possible to tell exactly what tools will be required for a given set of machines as soon as the pieces required are known. Three records are used; the original (pink sheet), the first carbon (yellow sheet), and the record card made as the second carbon (Manila board). All three use the form shown in Fig. 2; one is given to the man securing the tool, the other two are filed. One of the files is temporary and is only used to show the tools that are outside the tool-crib, who has them, and what they are being used for. The file used for this record is one that has been especially developed for use in keeping accounts in groceries and retail stores, and is admirably adapted for keeping tool accounts.

The file will be seen to the left in Fig. 1. Steel clips hold the slips in place. On each of these clips is a number under which the slip is filed. An index, a part of which can be seen above the boards holding the clips, gives the men's names and their numbers. The other record is filed permanently in a standard metal card file, shown to the right in Fig. 1. Some of the triplicate record books can be seen in front of the files. When a tool is requested, these forms are filled out and may be used in either of two ways, depending on the conditions. When there are several duplicates of the kind of tool asked for, or when there is no possibility of the tool being needed by another workman, the original copy (pink) is given to the man to whom the tool is issued, the first carbon copy (yellow) is put in the register, and the record carbon copy (Manila card) is put on the permanent files for setting up and checking up the operation card, Fig. 3.

When there are only a few of the tools on hand and there is a possibility of the supply being exhausted, the original copy is given to the workman as before, the first carbon copy is put in the tool crib in the space where the tool was, and the record card is put in the register. The object of this is to make it easy to check up the tools that are out in case there is a shortage. In this way it is easy to call in the tools that are not in actual use, or to ascertain whether the workman will be finished with them by the time they are required.

When the tool is returned the workman brings back the original copy with it; this and the first carbon copy are destroyed. If there has been no possibility of tool shortage and the record carbon copy is in the permanent files, it is simply left there. However, if the record carbon copy was placed in the register while the first carbon copy was retained in the tool's place in the tool-crib pending the return of the tool, the first carbon is destroyed as previously and the record carbon copy is now transferred to the permanent files. In order that the record carbon copies may be of maximum use in checking up and setting up the operation cards, care is taken to fill the spaces calling for the man's number, piece number, date, machine number, and operation number as carefully as possible.

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[1] Address: 316 Probasco Ave., Cincinnati, Ohio

To see if the tools are lost or broken, the register is gone through once each week, and all slips two weeks or older are checked up. The broken tools are noted on the carbon record copy so that the fact can be seen in checking up the operation card. Every two weeks the tools that the men have are checked against the slips. In this way it is possible to gather up all the tools that are on the various benches and to find those for which the men have no slips. The slips used in making this check are the originals which were given to the workman when he obtained his tools, and which he is required to keep and return with them. This matter of checking up the tools on the benches is of particular value in shops operating both a day and a night shift, as in this particular instance. By consulting the record of the man who is off, it avoids any chance of a tool being left on one man's bench under the impression that the other man is using it.

The greatest value of this system is the prevention of tool shortages. In the Lodge & Shipley plant all machines are built in lots to secure the greatest accuracy and the maximum production. The product is assembled from interchangeable units. The number of units required are laid out and divided into the various assemblies, sub-assemblies, and finally the individual pieces. In this shop, this takes place about three months before the machines are required. At this time the tool-room foreman and the tool clerk go over the pieces required, checking them against both the actual record of the tools previously required and the operation card. Any shortages are noted and taken care of immediately, so that the tools are in stock long before they are actually required for use in manufacturing.

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SHADOW ON DR. DIESEL'S DEATH REMOVED

In justice to Dr. Diesel, the engineer who invented and so remarkably developed the engine that bears his name, and whose untimely death in October, 1913, while crossing from Antwerp to Harwich, England, on the steamer *Dresden*, was at the time explained as suicide due to despondency over the condition of his business, it should be mentioned that later information indicates that there could have been no such cause for his suicide. Articles now published in America by Axel Bjornsen, a Scandinavian who served for many years in the German submarine and torpedo boat service, indicate that Dr. Diesel's death was due not to suicide but to murder. A peculiar coincidence may be mentioned in this connection. If it is true that Dr. Diesel met his death in the manner indicated by Mr. Bjornsen, he is the second of the great inventors in the internal combustion engine field who has thus met his death. The Frenchman Philippe Lebon, one of the earliest workers on engines of this kind, was murdered in 1804 in a similar manner, the murderer never having been apprehended. It is believed that if Lebon had lived to develop his invention further, the internal combustion engine might have been developed to a commercial stage earlier than the steam engine, and there might have been a complete reversal in the development of steam and internal combustion engines in the first half of the nineteenth century.

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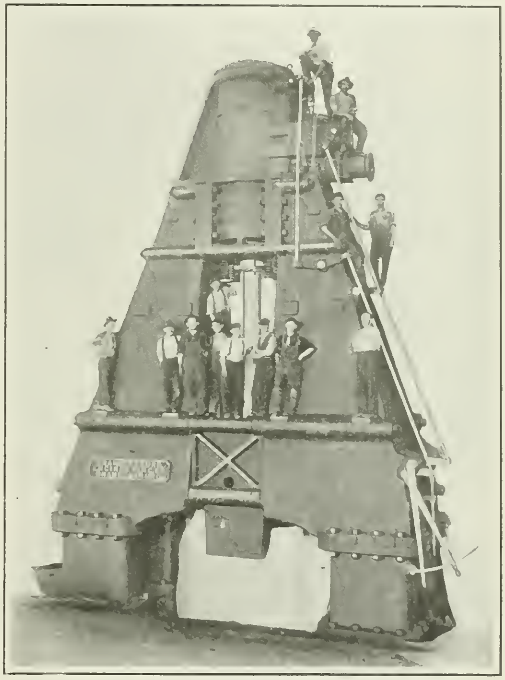
CORRECTION

In the article "Strength of Condenser Tube Plate," on page 65 of the September number of MACHINERY, the line just above Fig. 2 should read: $A_n = A_g - A_o = 0.524 - 0.221 = 0.303$ square inch. This was merely a typographical error and does not affect the rest of the problem.

HUGE CHAMBERSBURG DOUBLE-ACTING STEAM FORGING HAMMER

The illustration shows a forty-ton, double-frame, double-acting steam forging hammer recently built by the Chambersburg Engineering Co., Chambersburg, Pa., and shipped to the Washington Steel & Ordnance Co., Washington, D. C. It is said to be the largest double-acting steam forging hammer ever produced in the United States. It required fourteen railroad cars to ship the hammer in sections.

The cylinder is 40 inches diameter and 96 inches stroke. The main steam pipe is 10 inches in diameter, the exhaust pipe 14 inches, and the diameter of the piston-rod is 15 inches. The ram proper is 51 inches wide, 66 inches thick from front to back, and 72 inches high. It is dovetailed to hold a steel die 72 inches long, front to back, 41 inches wide, and 28 inches high. The approximate weight of the die is 10 tons, and the total weight of the falling parts is approximately 80,000 pounds. The main cylinder is lined with cast-iron bushings of special mixture, and the cylinder proper is mounted between the two main frames in machined fits and is securely bolted with body bound bolts, the frames being shrunk together with four large rods or bolts, making the upper works of the hammer one rigid piece. The superstructure is mounted on four massive pedestals and is fitted to them with large steel body bound bolts. Underneath the four pedestals and securely fastened to them are the two heavy base-plates, which are spaced apart with cast-iron distance pieces and shrunk together with two heavy steel tie-bars.



Chambersburg Forty-ton Double-acting Steam Forging Hammer

The hammer was built for use with steam pressure of from 100 to 150 pounds per square inch, and with full steam pressure is capable of delivering a blow of 8000 tons. The anvil, steel anvil cap and steel die weigh 350 tons. The total weight of the hammer is 600 tons. The hammer was built to drawings; jigs and fixtures and all parts were machined accurately and independent of assembly. It was erected in the plant, taken down, and re-erected in the plant of the Washington Steel & Ordnance Co., and put in operation within one week.

* * *

A machine gun in operation uses up a bale of cotton in three minutes.

PRACTICAL WARTIME SHELL MAKING[1]

So many foolish statements have been made in regard to the manufacture of munitions and the possibility of automobile factories, implement works or other equally ill-adapted shops being turned, upon very short notice, into shell factories that it seems well to consider of how little value for the manufacture of munitions is the equipment of the average shop. Outside of the already existing munitions plants, the equipment that manufacturers brought to the business of shell making consisted mostly of their money and credit and the nucleus of an organization. The machinery and tools were more than 90 per cent new, and the greatest success has been made by those companies that were not even owners of machine shops of any kind. All the equipment, enumeration and listing that has been going on may be of some use and the so-called "educational" orders may do some good, but the only thing we are sure of is that very little of tradition, precedent or theory is observed in the conduct of a great war.

The suggestions made here for emergency factory construction are to be understood as applicable strictly to emergency conditions, to meet a demand for an unusual amount of ammunition with the least possible delay and in no way as suggestions for permanent private or government arsenal construction. In the construction of the plant, the first point to be considered is the locality with reference to labor supply and transportation. Within easy reach of all our large centers of population may be found level, unoccupied, naturally well-drained acreage that is suitable for the purpose and is gridironed by railroads; these are the sole requirements for such a plan. Final inspection, cleaning, painting, toolmaking, etc., will be provided for in fully enclosed one-story buildings at the delivery end of the plant; but the large part of the work will be performed with the lightest kind of shelter over machines, operators and transfer track, and circumstances probably will not always justify even this shelter.

The dimensions of the plant should be determined by the size of shell to be manufactured. Units of a given hourly capacity should be located between and perpendicular to two lines of railroad siding at the ends of the plant; one track will be a receiving track and the other a shipping track. The distance between the tracks will represent the proper length of each unit to avoid congestion and afford the simplest movement and transfer of product. Each unit, commencing at the rear of the plant, will start with an unloading platform and will extend in a double row of opposed machines for the different operations toward the finishing end, where the machinery installation will be replaced by hand operations and inspection, to the packing and shipping track. All machine tools will be horizontally belted, but since space is not considered, the convenience of having all transmission machinery within easy reach is a consideration.

In the construction of the plant, lines of concrete piers will carry the lineshafting; storm-water drains will be placed parallel to these; concrete foundation walls for the machine tools will come next; and transfer tracks will be between the machine foundations. A cutting-compound drain will extend the length of each machine-foundation wall to a sump and pump at the end of the line or at intermediate locations. From each concrete pan under or at the machines, there will extend a chip channel, having a slightly raised bottom, connecting with covered chip tanks sunken in the ground, but readily removable by the cranes. Between each two rows of machines there will be an industrial railway upon which platform cars will be operated, at each machine, car-floor height platforms will be placed. Such a plant can be erected and operated to capacity within sixty days from the time authority is given to build it.

A complete series of machines for all shell making operations can be designed along lines that will permit of their construction in immense quantities within thirty days from the time when the necessity for them arises, and at a rate of output that will supply any conceivable demand within the following sixty days. The practicability of such performance has been definitely proved in the last two years; one company accepted orders for hundreds of machines on the guaranteed deliveries of "Commence in thirty days and ship 5 per cent of any sized order every working day thereafter."

The United States government can easily be prepared to deliver such machines in the desired daily quantities within thirty days by the following method: In each selected industrial center establish a government plant in which will be stored the necessary patterns, jigs and equipment to make such machines; and in which will also be kept a list of the plants in the territory equipped to make the required parts. Upon order from Washington, the patterns will be shipped to the designated foundries, and, beginning with the third day, castings should be received at the rate of one casting a day per pattern. It will probably require about three weeks to manufacture the various working parts of the machine, but within thirty days at the outside completed machines will be ready to run in the munitions plants. The number of machines added to the equipment daily will be the same as the number of patterns from which castings are made. This record can be bettered by stocking in the warehouse the various machine parts, aside from the large bed castings, sufficient to make up machines of a desired daily output during the period found necessary. If this is done, completed machines can be delivered to the munition plants within a week of authorization by the government. The total cost to the government for the patterns, jigs and equipment necessary for such a plan of preparedness will be approximately but $1,000,000.

Retrospection on the days of 1915, when manufacturers were begging for standard machine tools with which to make shells and were given deliveries of eight to eighteen months, shows the necessity for an entirely different provision of emergency machines. To depend at all on current stocks or to hope to utilize to any extent the working equipment of existing shops is equally ill-advised. To cut from new cloth in such an emergency as wartime conditions is the only method that promises success, and there is promise of nothing but disappointment in the attempt to adapt existing shops and machinery.

* * *

THE CASUALTY LIST OF PEACE

In calling attention to the great waste of human life in our industries, Secretary Redfield touched upon a subject which is still very much alive, in spite of all the efforts that have been made to safeguard the workers in the industries. The enormous loss due to industrial accidents can perhaps be grasped in no better way than by comparing it with the losses on the battlefield. We read that during the month of August 20,000 British soldiers were killed at the front. This is an appalling number for a month when no great battle took place, and yet the number of men killed in the peaceful industries in the United States during a year is estimated to exceed this number by 50 per cent. During the same month, over 100,000 British soldiers were wounded, but the monthly average in the industries in the United States is 250,000, or two and one-half times that of the whole British army at the front.

We are prone to give our attention to the spectacular and to forget that which does not force itself upon our attention. In a few months, we shall probably be greatly concerned over the casualties at the front, but we shall forget the much greater casualties that constantly, from year to year, take place in our factories and industries at home, a large percentage of which are preventable. It should not be forgotten that the men and women behind the lathes and looms are just as necessary to the prosecution of the war as the men behind the guns, and while every effort is being made to prosecute the war at the battle front properly, the efforts to safeguard the workers at home should be doubled. In spite of all that has been done in the last few years, there are still too many dangers to which industrial workers are exposed that could be eliminated, providing the indifference and ignorance of both those in charge and of the workers themselves could be successfully combated.

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[1] Abstract of a paper read before the American Society of Mechanical Engineers at Cincinnati, May, 1917, by [illegible] Yeomans, of Chicago, Ill.

PRODUCTION OF ALCOHOL FROM SAWDUST

Arthur D. Little stated before the Canadian Manufacturers' Association, in discussing the production of alcohol from wood waste, that in 1819 Braconnot boiled up some cellulose in the form of an old shirt with sulphuric acid and found that the cellulose was converted into a sort of sugar, some of which he subsequently fermented into alcohol. He exhibited his results to the French Academy to the amazement of its members. A hundred years of industrial research has at last transformed that laboratory method into a commercially operative process, by which thousands of gallons of high-grade ethyl alcohol are made from yellow pine sawdust. This is not wood alcohol, but is identical in every particular with that commonly made from grain. The industrial importance of this achievement can hardly be overestimated. A cord of sawdust costing fifty cents yields ten gallons of 95 per cent alcohol, whereas a bushel of corn costing over eighty cents yields only two and one-fourth gallons, and a gallon of molasses worth at least fifteen cents gives only half a gallon of alcohol. By this process any vegetable waste that can be collected cheaply and in quantity becomes a raw material for alcohol and releases for their proper use as a food the corn and molasses now diverted to alcohol production. Incidentally it removes substantially all menace of a possible failure of the gasoline supply, since alcohol is equally available as a motor fuel.

The Forest Service of the U. S. Department of Agriculture has issued a bulletin declaring that there is no reason for discriminating against ethyl alcohol made from wood in favor of that from grain or molasses. The amount of impurities in commercial ethyl alcohol is very small, and they are probably less objectionable when wood is used as a base than when grain or molasses is used. The prejudice against the use for some purposes of ethyl alcohol made from wood is probably accounted for, the experts say, by a confusion with methyl or "wood" alcohol, which is poisonous. Both products are derived from wood, but are radically different. The ethyl, or grain alcohol, is made by reducing the wood to sawdust, treating the sawdust with an acid to produce chemical sugars, and converting the fermentable sugars into alcohol by fermentation, as in the case of grain or molasses. Wood alcohol, however, is obtained by condensing certain gases which are liberated when the wood is heated in air-tight retorts, so that it decomposes without burning. Ethyl alcohol has been commercially manufactured from wood in this country for several years. It is suitable for any use to which ethyl alcohol from any other base is put. Improvements on the processes that have been developed at the Forest Products Laboratory have made it possible to decrease the former cost of production.

* * *

GAS AND FLAME SERVICE

The Thirtieth Engineers, headquarters Camp American University, D. C., is in need of expert mechanics and chemical workers for the Gas and Flame Service Regiment. The regiment is being recruited now from men volunteering for the service and will be ready to go to France by Thanksgiving. It is a regiment for skilled, practical men and the service offers a real chance for red-blooded Americans to get in where their efforts will give definite results. Those who can qualify are analytical, research and manufacturing chemists, chemical workers, powdermen, men experienced in gas manufacture, machinists, automobile repair men, gas and steam engine repair men, pipe fitters, electricians, designers, carpenters, blacksmiths, plumbers, boiler-makers, chauffeurs, and interpreters. Men with long experience in their trades are especially desired to fill the master engineer grades. American citizens with the above qualifications between the ages of eighteen and forty years, who have not actually been called by a local board in the draft, are eligible for enlistment. Colonel A. A. Fries, Engineers, N. A., is the commanding officer, and Major E. J Atkisson, Corps of Engineers, is organizing the first battalion at Camp American University, D. C. Those who enlist may go to the nearest recruiting station or United States district engineering office and state their qualifications and wish to enlist in the Thirtieth Regiment of Engineers, Gas and Flame Service.

JOSEPH T. RYERSON & SON CELEBRATE SEVENTY-FIFTH ANNIVERSARY

The firm of Joseph T. Ryerson & Son, Chicago, Ill., celebrated its seventy-fifth anniversary November 1. The Ryerson family has been associated with the iron industry for a much longer period than seventy-five years, however. In the early years of the eighteenth century George Ryerson and associates purchased 6000 acres in New Jersey in which there were deposits of iron ore. These deposits were mined from 1750 to 1770, and the ore was used in the crude processes of iron manufacture then in vogue. Thomas Ryerson became a wholesale dealer in finished iron and steel products in Philadelphia in 1790, and his son, Joseph T. Ryerson, went to Chicago in 1842, where he established the present firm. At that time Chicago was a city of only 6000 inhabitants, having but a few brick buildings, the remainder being rough frame structures. Mr. Ryerson's venture was successful and he erected additional buildings as more and more space was required. After his death, the firm was incorporated, and his son, Edward L. Ryerson, became the president. Three of his grandsons are vice-presidents of the concern. Large plants have been erected at Chicago, New York and St. Louis, and another plant was opened in Detroit on the seventy-fifth anniversary.

* * *

GREAT SHIPBUILDING PLANT AT FORE RIVER

The United States Government has appropriated $80,000,000 for the construction by the Fore River Shipbuilding Corporation, Quincy, Mass., of a $9,000,000 plant and a minimum of forty-six destroyers. The destroyers will cost approximately $1,500,000 each. The construction work on the plant will be done by the Aberthaw Construction Co. of Boston. The buildings to be erected will afford an aggregate floor space of more than 2,000,000 square feet. A tremendous amount of steel will be required for the construction of the reinforced concrete buildings and the destroyers, but the material will not be lacking, since the Priority Board has given the destroyer building preference over all other requirements of concerns working for the government, even over shipbuilders constructing the merchant fleet. The construction of the plant will require more than 4000 men, and for the construction of the destroyers the Fore River Shipbuilding Corporation will need from 8000 to 10,000 men at Quincy, about 3500 at Buffalo, and 1000 at Providence.

* * *

NEW AIRPLANE RECORD IN AMERICA

A new American airplane record was made on October 22, when a Caproni biplane carried nine persons 330 miles in four hours and twenty-five minutes. A Pomilio scout biplane, which left at the same time and carried two persons, made the trip in two hours and fifty-five minutes. Both airplanes are machines the Italian government has sent here to show their capabilities and are in charge of Italian officers; in the flight from the Langley field, near Norfolk, Va., to Mineola, L. I., each carried representatives of the Italian and American armies. The Caproni biplane has a wing spread of 72 feet and is equipped with three Isotta 150-horsepower engines. It made an average of seventy-three miles an hour and flew at about 5000 feet, so as to follow the coast line; part of the trip, however, was made at an altitude of 11,500 feet. The Pomilio biplane is equipped with a 350-horsepower engine, a machine-gun platform, and places for six 65-pound bombs. It flew at a height of 12,000 feet and averaged 112 miles an hour, though sometimes a speed of 140 miles was reached.

* * *

A training school for women oxy-acetylene welders has been established at Notting Hill Gate in England, the expenses in connection with which are paid by the British Government. About two hundred skilled women welders have been trained in this school and at least twenty women are constantly in training. The trained women are successfully carrying out welding work in airplane factories, and the demand for them is so great that so far all the welders have been engaged by the various factories two or three weeks ahead of the completion of their course of instruction.

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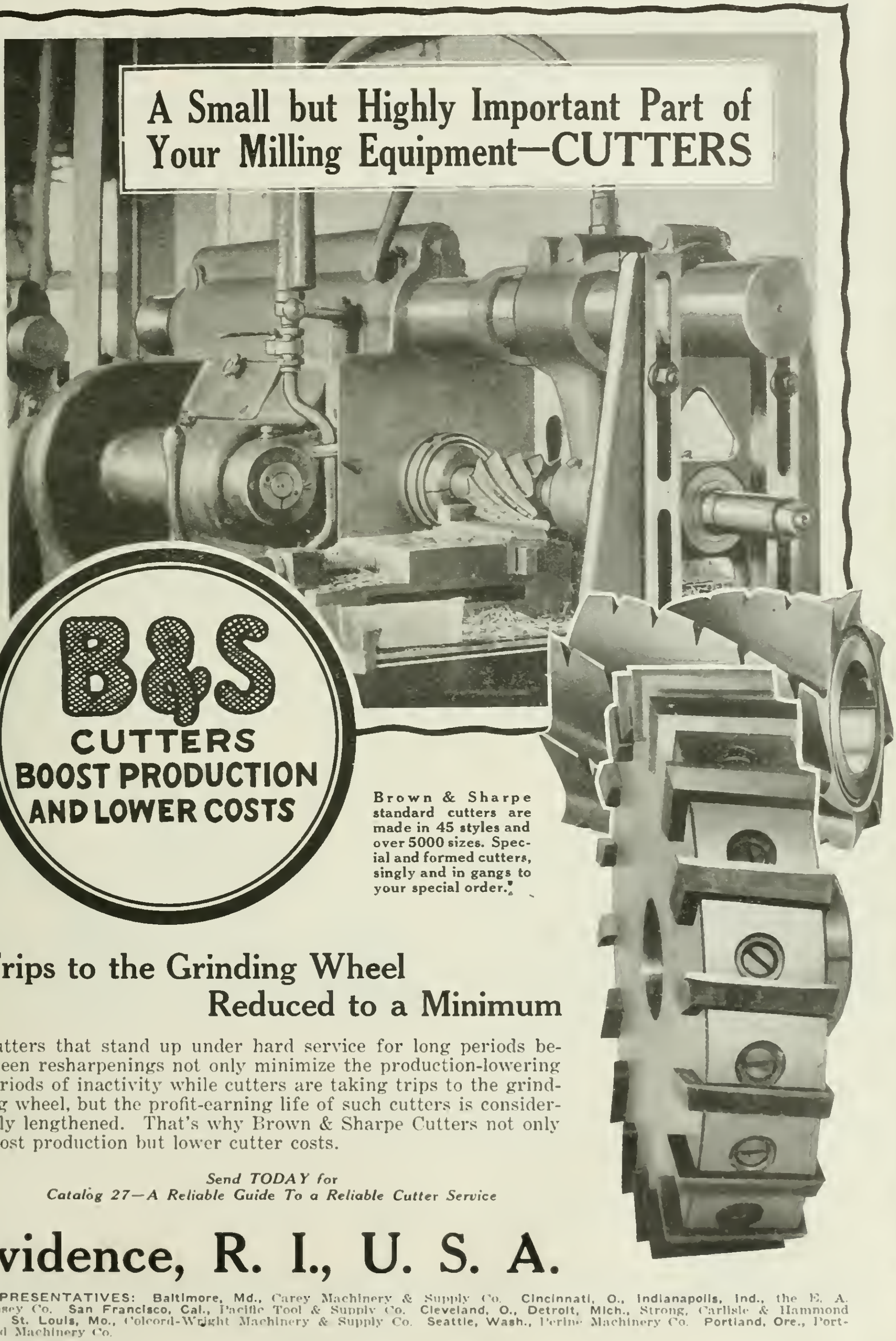

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TRADING WITH THE ENEMY ACT

Secretary William C. Redfield of the Department of Commerce and Labor, Washington, D. C., addressed about two hundred editors at the editorial conference held at the Automobile Club of America in New York City, October 16, on the subject "Trading with the Enemy Act." He spoke, in part, as follows:

The ways of commerce are commonly the ways of peace, but now commerce is used as a war weapon in two ways: first, to provide the nations associated with us in the war with the means of warfare; second, to see that our enemies do not, by direction or indirection, obtain anything that comes from our shores that we can prevent. A third element is conservation, or the saving of that which is not plentiful for use that must be made of it in the war, and the using, on the other hand, of that which is abundant in its place. We are not certain that we are going to have enough for ourselves, our associates and the neutrals to whom it seems to be safe to sell any goods in these days. Consequently, the principle that lies behind the restriction of exports is the principle of conservation.

The restriction of the act will exist whether there is any act or not. It has long been the law of nations that in time of war all communication with the enemy is prohibited. The prohibitions of the act are clearly stated and made plain by the language of the law—but they existed before. There is in the bill, however, an original clause; that is, the creation of the alien property custodian, to whom all debts, interest, dividends, etc., belonging to enemies or enemy allies can be paid, and a full discharge thereby had of the debt.

An American citizen, also, may obtain, providing Germany will reciprocate, patents in an enemy country during the war, and our enemies may obtain patents in this country. Any American manufacturer or industry may apply to the War Trades Bureau for a license to use, during the war, any patent belonging to an enemy or an ally of the enemy existing and valid in this country. He may use the patent if he secures a license for a small fee, but he must pay to the alien patent custodian 5 per cent of the value of the articles that he makes under that patent. At the end of the war, the foreign owner may sue in our courts, within a year, for a royalty for the use of that patent, and if he recovers, this 5 per cent fund, so far as it goes, will be used to pay the judgment; if he does not recover, or if during the year he does not bring suit, the 5 per cent will be refunded to the American user.

* * *

MECHANICS WANTED FOR ORDNANCE CORPS

The Enlisted Ordnance Corps, National Army, into which the Ordnance Enlisted Reserve Corps has been merged, is charged with the supply, maintenance and repair of all cannon and artillery vehicles and equipment; all machines for the service and maneuver of artillery; all small arms, ammunition, harness, motor trucks, motorcycles, tractors and railroad cars. In fact, it is the army behind the army, commonly known as the "Service of the Rear."

There is a place in the Enlisted Ordnance Corps for practically every sound man between the ages specified, who knows a trade. Machinists, mechanics, plumbers, painters, carpenters, canvas workers, motor car repair men, saddlers, blacksmiths and wheelwrights are especially needed at this time. Applicants must be between eighteen and forty years, citizens or declarents, and be able to speak, read and write the English language. They should have no absolute dependents and must be able to pass a physical examination conforming to that prescribed for the regular army.

In view of the importance of their work, a large number of men will serve as non-commissioned officers. Original enlistment is required as private, but later courses of training or special qualifications quickly lead to higher grades. Pay ranges from $30 to $97.20 a month, depending upon the demonstrated ability and place of service. Men registered under the Selective Service Law may voluntarily enlist prior to the posting of their names by the local boards. Application blanks may be obtained by writing to the Chief of Ordnance, Enlisted Personnel Division, Washington, D. C.

PERSONALS

Robert T. Turner has joined the Shepard Electric Crane & Hoist Co. as sales engineer at 30 Church St., New York City.

P. J. Kroll has resigned as representative of the International Oxygen Co., 115 Broadway, New York City, for Pittsburg and the middle western territory.

Murray Shipley and Henry M. Wood, formerly with the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, have joined The Sechler & Co., Cincinnati, Ohio.

C. W. Johnson, general superintendent of the East Pittsburg Works of the Westinghouse Electric & Mfg. Co., has been elected vice-president of the American Institute of Metals.

C. F. Goodrich, assistant manager of the Buffalo Forge Co.'s Boston office, has left for active duty as first lieutenant in the Ordnance Department, and is stationed at the Watervliet Arsenal.

Hans Karlsrud, representing A/S. National Industri in the United States, has returned to Norway, and the interests of the company will be in charge of Bjarne Holm-Hansen, 309 Broadway, New York City.

Charles C. Cheyney, manager of the Chicago office and store of the Buffalo Forge Co., has a commission in the Naval Aeronautic Corps, and is beach engineer at Pensacola, Fla., in charge of aeroplane engines.

B. D. Fuller, superintendent of foundries of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., was elected president of the American Foundrymen's Association at the recent annual convention in Boston.

Edmund Barany, machine designer of the Singer Mfg. Co., Elizabeth, N. J., has assumed the duties of mechanical engineer and assistant to the general superintendent of the Cleveland Twist Drill Co., Cleveland, Ohio.

Don R. Marsh, production manager with the Buffalo Forge Co.'s Buffalo office, has given up his work to assume similar duties at Washington in the production of ammunition. Mr. Marsh received a captain's commission.

H. F. Bardwell, well known to buyers of tool steel in the East, has been appointed New York district manager for the Vanadium-Alloys Steel Co. of Pittsburg and Latrobe, Pa. Mr. Bardwell's offices will be at 30 Church St., New York City.

N. C. Walpole, southern sales manager of the Niles-Bement-Pond Co. and the Pratt & Whitney Co., with office in Birmingham, Ala., has been granted leave of absence for the duration of the war. He has been commissioned major in the Ordnance Department.

Edmund B. Moore, for the last six years demonstrator with the Jones & Lamson Machine Co., has been commissioned as first lieutenant in the United States Army, Ordnance Section. Mr. Moore is a graduate of the Massachusetts Institute of Technology in the class of 1912.

Charles O. Rowe has joined the sales force of the Hess Steel Corporation, Baltimore, Md. Mr. Rowe was formerly associated with the Union Drawn Steel Co. in the sales department. He will act as representative for the Philadelphia district for the Hess Steel Corporation.

Frederic Meron, a mechanical and electrical engineer who has given much attention to efficiency methods of production, has opened an office at 2 Rector St., New York City, where he will give attention to lay-outs, location of machinery and equipment, the handling of materials, working methods, industrial accounting and other problems in industrial engineering.

H. F. Brandes, who for the past four years has been works manager of the Putnam Machine Co., Fitchburg, Mass., has resigned. He directed the erection and equipment of the new plant of the Putnam Machine Co., which is considered one of the most modern in the country. Mr. Brandes has returned to Bridgeport for the present to give his attention to his interests in the Springfield Mfg. Co.

J. F. Sallows, Lansing, Mich., a heat-treatment expert and occasional contributor to MACHINERY, has worked out a method for hardening carbon steel gears and other parts whereby they hold their size and shape in every way. There is no warping, shrinking, swelling or scale; the holes in gears do not require grinding after hardening, and may be broached to exact size before hardening.

William A. Batley, who has been connected with the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., as Eastern sales manager and sales director since its start in this field, has resigned; his resignation is to take effect December 1. He will retain his interest in the company and continue as a director. W. C. Briggs, who for the past ten years has been associated with Mr. Batley in the company's New York office as sales engineer, will become district manager.

Cincinnati Gauging and Inspection Methods

Interchangeability of machine parts is a very flexible term. Even the parts of agricultural machinery are interchangeable, which shows that this word may mean much or little. In machinery construction it must be used in connection with stated or known accuracy limits. The limits to which parts of Cincinnati Millers are made vary from .001″ on some parts to .00025″ on others, and in many cases no tolerance is allowed. When such parts are made interchangeable, the gauging and inspection methods must be rigid.

Gauging Unit Mechanisms—Our unit system of construction demands different gauging methods from those usually employed. Figure 1 shows a set of gauges for testing the alignment of the splined shafts in milling machine knees. This is tested by two indicators, one reading on the top and the other on the side of a master shaft, inserted in the knee. Before making the test, these indicators are set to the master gauges, shown on top of case. This gives us a permanently accurate method of testing, which shows us more closely than any fixed or snap gauge can do whether a shaft is parallel and in its proper position, or in wind and out of position.

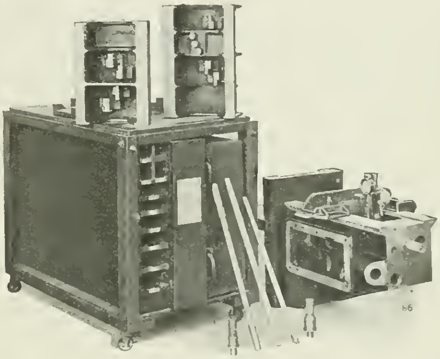

Fig. 1

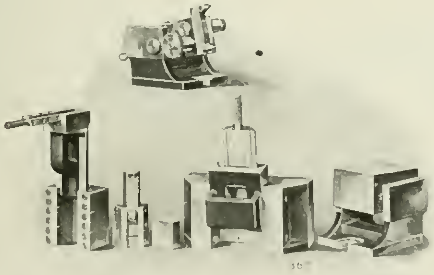

Fig. 2

The Testing Gauges for Our Dividing Head Tailstocks—These tailstocks consist of four parts, all of which slide into each other accurately. These parts are manufactured in lots of fifty. They are absolutely interchangeable in the machining stage, and can be pushed together without any hand work. The final scraping, which merely removes the loose iron, serves to give them a snug sliding fit.

These are only two examples out of manyhundreds which we use. You are welcome to inspect these things in our factory at any time.

Let us send you our catalog showing the full line of Millers made by these methods.

THE CINCINNATI MILLING MACHINE CO.
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COMING EVENTS

November 29—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

December 4-7—Annual meeting of the American Society of Mechanical Engineers in New York City; Engineering Societies Bldg., 29 W. 39th St., headquarters. Calvin W. Rice, secretary.

NEW BOOKS AND PAMPHLETS

The Effect of Mouthpieces on the Flow of Water through a Submerged Short Pipe. By Fred B. Seely. 49 pages, 6 by 9 inches; 14 illustrations and diagrams. Published by the University of Illinois, Urbana, Ill., as Bulletin No. 96 of the Engineering Experiment Station. Price, 25 cents.

Merchants' Association of New York Year Book 1917. 272 pages, 7 by 10 inches. Published by the Merchants' Association of New York, Woolworth Bldg., New York City.

The year book covers the activities of the association for the period from May 1, 1916, to April 30, 1917, and contains the reports of the president, the secretary and the managers of the various bureaus. It also has alphabetical and classified lists of the members, which should be found especially helpful.

The Secret of Typewriting Speed. By Margaret B. Owen. 157 pages, 5 by 7½ inches. Published by Forbes & Co., Chicago, Ill. Price, $1.

This book, by the world's champion typist, belongs with the literature on scientific management, as it embodies the principles of efficiency of action and the elimination of lost effort in typewriting. The marvelous speed capacity of the typewriter when operated by one who has studied the science of key action is indicated by the fact that Miss Owen has written 137 words a minute for one hour.

Graphics. By H. W. Spangler. 95 pages, 6 by 9 inches. Published by John Wiley & Sons, Inc., 432 Fourth Ave., New York City. Price, $1.25.

The work comprises the substance of lectures on graphics given to students in mechanical, electrical and chemical engineering at the University of Pennsylvania, and is intended to cover only fundamental principles. It includes a brief treatment of trusses, and sufficient of the graphics of machines to clearly set forth the effective friction on the line of action of force to be determined, taking for one example the friction of gear teeth. Application to the stresses in crankshafts is also included.

American Stationary Engineering. By W. E. Crane. 311 pages, 5 by 7½ inches; 131 illustrations. Published by Norman W. Henley Publishing Co., 132 Nassau St., New York City. Price, $2.

This is the second edition of a book first published in 1910 which begins at the boiler room and takes in the whole power plant. The author emphasizes the practical side of stationary engineering and exhibits some scorn of the professed expert, although he has not hesitated to avail himself of much that has been developed by specialists in their various capacities. The book is one that should be found helpful by firemen and young engineers ambitious to better their conditions.

Learning to Fly in the U. S. Army. By E. N. Fales. 180 pages, 5 by 7¼ inches; 40 illustrations. Published by McGraw-Hill Book Co., Inc., 239 W. 39th St., New York City. Price, $1.50, net.

This book is a manual of aviation practice, and is well suited for the aeronautic instruction of the large number of men that have joined the flying corps since the declaration of war. Many of these men have been called from non-technical occupations, and the book brings forth to the non-technical student the gist of aviation in such a manner that accuracy is not sacrificed to brevity. It contains a review of the history of aviation, the types of military airplanes, and fully explains all that is necessary to know in order to successfully fly and care for a machine, but it does not treat the subject of airplane motors.

Mechanical Drawing Problems. By Charles William Weick. 153 pages, 6 by 9 inches; 48 illustrations, 112 plates and 12 tables. Published by McGraw-Hill Book Co., Inc., 239 W. 39th St., New York City. Price, $1.25, net.

This is a satisfactory book for either school or self instruction. It provides typical drawings for elementary and advanced work, the data of which the student is required to obtain by the use of formulas and tables, thus developing a knowledge of drawing principles and designing ability and tending to make him more careful in reading directions and the lay-out of his sheets. It contains problems on geometrical constructions, projections, developments and intersections, isometric drawing, machine details, and tables that are useful to draftsmen which the student is required to use when making the various drawings.

Everyman's Chemistry. By Ellwood Hendrick. [illegible] pages, 5 by 8 inches. Published by Harper Brothers, 3-5 Pearl St., New York City. Price $2.

While this book does not profess to be a complete treatise and is in no sense a laboratory guide, it contains so much information that even a casual reader will obtain some knowledge of the subject. The first part, which contains 56 pages, emphasizes the importance of a knowledge of chemistry and deals with the elements of the subject. The second part, which contains 176 pages, is confined to a discussion of inorganic chemistry. Here the various elements are described and their uses, alone and in their more usual combinations, are given. The third part is devoted entirely to organic chemistry. Among the subjects treated are coal-tar intermediates and finished products; aromatic compounds; cellulose and nitrogen compounds; and fats, oils, and their products.

The Essentials of Descriptive Geometry. By F. G. Higbee. 218 pages, 6 by 9 inches. Published by John Wiley & Sons, Inc., 432 Fourth Ave., New York City. Price, $1.80.

This work as published in 1915 has passed into the second edition. It deals with orthographic projection, profile plane, assumption of points and lines, planes, location of points, lines and planes, revolution of points, problems on the line, problems on the plane, problems on angles, problems on points, lines and planes, surfaces, plane surfaces, cylindrical surfaces, conical surfaces, intersection of surfaces, surfaces of revolution, warped surfaces, tangent planes and lines, and model making. Each chapter concludes with problems involving the principles enunciated therein. The section on warped surfaces is illustrated with easily constructed models which can be duplicated by the student, thus providing visual means for fixing their position in space.

Elements of Machine Design. By O. A. Leutwiler. 607 pages, 6 by 9 inches; 339 illustrations; 107 tables. Published by McGraw-Hill Book Co., Inc., 239 W. 39th St., New York City. Price, $4, net.

This book is a discussion of the fundamental principles involved in the design and operation of machinery. It contains a chapter on the strength of materials and mechanics of machinery, and a chapter discussing the properties of materials used in machine construction. The remaining chapters treat the various elements of machine design, including rope transmission; chains and sprockets; gearing; couplings; cone and multiple disk friction clutches; shafting; and bearings. A special feature is a chapter on brakes. The standard works on this subject, the various engineering societies and the technical press were freely consulted in the preparation of the book. The work is one heartily recommended to all needing a modern work on the elements of machine design.

Saws: Their Care and Treatment. By Harry W. Durham. 272 pages, 4¾ by 7¼ inches; 155 illustrations. Published by D. Van Nostrand Co., New York City. Price, $2.50, net.

This work is on saws for wood-working machines and was written by one who has given the subject careful investigation for twenty-five years, during which time he visited a large number of saw mills and investigated the methods followed in their saw sharpening shops. It opens with general introductory notes on saws, following which are particulars of reciprocating saws and circular saws; notes on sharpening saws by hand filing; saw sharpening machines; setting the teeth of saws; hammering and tensioning circular and reciprocating saws; sharpening large band-saws: the saw sharpening room: small and narrow band-saws; wide band-saws; tensioning, leveling and hammering band-saws; doctoring band-saws, saw packing and saw guides; power required to drive sawing machines; and miscellaneous matters.

Some Unusual Features in the Microstructure of Wrought Iron. By Henry S. Rawdon. 25 pages, 7 by 10 inches; 12 illustrations. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards, No. 97. Price, 5 cents.

Wrought iron is usually described as being of a very simple structure as revealed by the microscope, as compared with many of the alloys in commercial use. A study of the microstructure of a series of commercial wrought irons carried out at the Bureau of Standards, however, has shown the occurrence of some very peculiar and unusual variations in structure in such material. Many of the ferrite crystals, when properly prepared and etched for microscopic examination, show a decidedly banded structure instead of the homogeneous appearance usually described. This unusual structure is to be attributed to a relatively high phosphorus content in such portions and to a non-uniform distribution of this element. Although most specimens showing these unusual features of structure are of a rather poor grade, they are not characteristic of low-grade iron in general. The probable relation between such microstructural features and "fatigue" failure of such material is suggested.

Hendricks' Commercial Register of the United States for Buyers and Sellers. 2378 pages, 7½ by 10 inches. Published by the S. E. Hendricks Co., Inc., 2 W. 13th St., New York City. Price, $10.

The twenty-sixth annual edition of this well known trade directory contains 2209 pages of text matter, and the index to trade classification covers 151 pages, listing over 50,000 trade references. The section devoted to trade names, brands, titles of identification, etc., is printed on pink paper to differentiate it from the remainder of the book. It covers 212 pages, and furnishes ready reference to distinctive products manufactured by all concerns whose names appear in the work. An alphabetical list of manufacturers is included for the first time. It contains the name, trade description and address of every concern appearing in the work. The scope of this commercial register is broad, being devoted to the interests of the architectural, contracting, electrical, engineering, hardware, iron, mechanical, mill, mining, quarrying, railroad, steel and kindred industries. Full lists are included of producers, manufacturers, dealers and consumers, covering all products from the raw material to the finished article, together with the names of concerns manufacturing these products from the producer to the consumer. The directory is indispensable to concerns who would compile their own mailing lists for the distribution of catalogues and other advertising literature.

NEW CATALOGUES AND CIRCULARS

Standard Optical Co., Geneva, N. Y. Circular of the "Stoco" protection goggles.

General Electric Co., Schenectady, N. Y. Bulletin 41021 on RF adjustable speed motors.

Burt Mfg. Co., Akron, Ohio. Catalogue of oil-filters, exhaust heads and ventilators.

Alloy Die Casting Co., 80 Fort St., E., Detroit, Mich. Pamphlet treating of alloy bronze bearings.

Newark Engineering & Refrigerating Co., 476 18th Ave., Newark, N. J. Circular of the "Nerco" filing machine.

Worthington Pump & Machinery Corporation, 115 Broadway, New York City. Bulletin S-112 of Snow oil pumps.

Gits Bros. Mfg. Co., 553 W. Monroe St., Chicago, Ill. Circular of Gits self-closing spring-lid oil-cups, giving dimensions, prices, etc.

Reed Small Tool Works, Worcester, Mass. Leaflet giving list prices of Reed micrometer calipers from one to six inches, inclusive.

Neilsen-Barton Chuck Co., 106 S. Jefferson St., Chicago, Ill. Circular containing price list of the "Eclipse" roller-bearing drill chuck.

Nagle Corliss Engine Works, Erie, Pa. Bulletin 29, illustrating and describing Class A-E and A-E2 air compressors with short-belt drive.

General Electric Co., Schenectady, N. Y. Bulletin 401801 on motor-driven exhaust fan outfits, driven by direct- and alternating-current motors.

David A. Wright, 568 Washington Blvd., Chicago, Ill. Circular of the Wright "Simplex" bench milling machine with or without overhanging arm.

American Chemical Paint Co., 1118-1126 S. 11th St., Philadelphia, Pa. Circular of the "Deoxidine" process of cleaning steel preparatory to painting.

Worthington Pump & Machinery Corporation, 115 Broadway, New York City. Bulletin W-500 of pot valve pressure pumps, giving sizes and capacities.

Metalwood Mfg. Co., Detroit, Mich. Circular B-32 of Metalwood horizontal forcing presses with hand-operated pump, giving specifications for the 20- and 50-ton sizes.

Remington Arms Union Metallic Cartridge Co., Inc., Bridgeport, Conn. Pamphlet describing the apprentice courses given by the Remington Armory at Bridgeport.

Charles M. Terry, Inc., 23-25 Beaver St., New York City. Catalogue describing and illustrating the Dunbar variable-speed pulley, which entirely eliminates gearing.

Fenn Mfg. Co., 385-405 Broad St., Hartford, Conn. Circular of the Fenn high-speed sensitive drilling machine which gives a maximum spindle speed of 15,000 revolutions per minute.

Peerless Machine Co., Racine, Wis. Circular descriptive of the Peerless high-speed metal saw made in three sizes, having capacities of 6 by 6 inches, 9 by 9 inches, and 13 by 16 inches.

David A. Wright, 568 Washington Blvd., Chicago, Ill. Circular of the Wright 18-inch and 20-inch cone-head engine lathe with independent change-gear and single or double back-gears.

Master Machine Tool Co., 110-112 W. 40th St., New York City. Circulars of the Master 13-inch lathe built with three-step cone pulley and single pulley for constant-speed belt drive.

Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. Bulletin 860 descriptive of the Leeds & Northrup optical pyrometer, a portable instrument for works temperature measurements.

H. G. Doran & Co., Peoples Gas Bldg., Chicago, Ill. Circular of the R. & D. portable electric drill with pistol grip. The pistol grip with trigger control saves drills and facilitates drilling.

Locke Steel Chain Co., Bridgeport, Conn. Circular entitled "From Planting Time to Harvest," showing uses of Locke steel chain for transmitting power in agricultural machinery.

R. G. Haskins, 511 W. Washington Blvd., Chicago, Ill. Catalogue of portable universal motor drills, motor-driven grinders, "Strand" flexible shaft machines, toolpost equipment, grinders and burnishers.

Bilton Machine Tool Co., Bridgeport, Conn. Circular of the No. 10 Bilton gear-hobber, having a capacity for cutting gears of 10 diametral pitch, 10 inches outside diameter and 10 inches width of face.

Hammel Oil Burning Equipment Co., Inc., 409 Pine St., Providence, R. I. Catalogue of Hammel oil burners and oil burning systems, containing a detailed description illustrated by line engravings and halftones.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Catalogue of the Shepard Technical Night School, containing announcement of courses for 1917-1918. The school is conducted for employes of the company only.

H. G. Doran & Co., Peoples Gas Bldg., Chicago, Ill. Circular of the "Pull U Out" portable crane, having a lifting capacity of one ton and weighing only 250 pounds. The crane is portable, being mounted on three wheels.

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LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF **CLEVELAND, O., U.S.A.**

Oliver Machinery Co., Grand Rapids, Mich. Bulletins descriptive of Oliver 23-A patternmaker's wood-turning face lathe, and Oliver 60 universal saw bench with tilting table that can be adjusted to any angle up to 45 degrees.

Gisholt Machine Co., 1211 E. Washington Ave., Madison, Wis., has issued a brief pictorial history of aircraft development up to the modern airplanes; it also shows how the Gisholt turret lathes are used in manufacturing some of the important mechanical parts.

Worthington Pump & Machinery Corporation, 115 Broadway, New York City. Bulletin W-400, illustrating and describing Worthington outside-packed plunger pattern pumps for general service. Catalogue W-308, treating of Worthington duplex piston pattern pumps.

Wirt Co., Germantown, Philadelphia, Pa. Bulletin of "Di-el-ite" resistance units especially adapted for signaling systems, telephone and telegraph work, electrical testing, motor regulations, and other service where durable and rugged resistors are needed.

Boston Scale & Machine Co., 381 Congress St., Boston, Mass. Circular descriptive of a universal angle-plate that can be adjusted quickly to any angle without disturbing the work bolted to it. It has a motion through 360 degrees horizontally and 90 degrees vertically.

Link-Belt Co., Chicago, Ill. Folder 340, descriptive of the machinery designed and built by the Link-Belt Co. for the sand and gravel washery of the Raritan Ridge Clay Co., at Metuchen, N. J. Book 343, descriptive of Link-Belt rope tramway system of the Watson type.

Diamond Machine Co., Providence, R. I. Catalogue entitled "The Diamond on the Job." containing a number of excellent illustrations showing the Diamond heavy face grinding machine in operation on various jobs, and giving briefly the essential facts concerning its performance.

Springfield Machine Tool Co., 631 Southern Ave., Springfield, Ohio. Catalogue of standard engine lathes, 14- to 42-inch swing; brass working lathes; axle boring lathes; crank shapers, 12- to 20-inch stroke; back-geared pillar shapers, 16-, 20- and 25-inch stroke; and bench straightening presses.

American Steel Export Co., Woolworth Bldg., New York City., has issued a 24-page pamphlet giving the groups of countries and lists of materials affected by the president's proclamation and subsequent orders, together with facsimiles of forms prescribed and explanation of their use.

Walter A. Zelnicker Supply Co., 325 Locust St., St. Louis, Mo. Bulletin 220, containing lists of new and second-hand girder rails, locomotives, railway cars, trucks, steam shovels, air compressors, steam engines, electric light outfits, machine tools, steel piling, pressure tanks and other equipment.

Armstrong Cork & Insulation Co., Pittsburg, Pa. Folder describing a test made to determine how much fuel could be saved by the use of an effective heat-insulating material in boiler settings, and the results obtained by the use of "Nonpareil" insulating brick. Copies will be sent free upon request.

Elgin Tool Works, Elgin, Ill. Catalogue 5 of precision bench lathes, slide-rests, milling attachments, screw-cutting attachments, dividing and indexing attachments, planing and slotting attachments, vises, chucks, lathe collets and light bench machinery. A number of new tools are included in this catalogue.

E. C. Atkins & Co., Indianapolis, Ind., manufacturers of "silver steel" saws, are issuing a folder entitled "The Straight Road" to the members of the Atkins Silver Steel Saw Club. The club is composed of several thousand retail hardware salesmen, and folders containing sales talks are sent out to the members about every sixty days.

Vulcan Iron Works, 327 N. Irving Ave., Station D, Chicago, Ill. Circular 44 of portable hydraulic presses for machine shops, railway and contractors' shops. The No. 2 press has a capacity of 60 tons, and the No. 3 press of 100 tons. The No. 2 size is ordinarily used for machine shop work. This size weighs 1600 pounds and sells for $200.

American Steel Export Co., Woolworth Bldg., New York City, has issued a new pamphlet entitled "Utility Letters of Credit in the Export Trade—A Plea for Standard Forms," by J. P. Beal, secretary and assistant treasurer of the company. The pamphlet makes recommendations for standard forms that should receive the attention of American bankers and exporters.

Diamond Machine Co., Providence, R. I. Catalogue of disk grinding machines of various types and sizes. These machines are made with right- and left-hand plain tables, with right- and left-hand swinging tables, and with single tables either right or left hand. The grinding disks are 18, 20, 26 and 30 inches in diameter, and the chucks are made in 14- and 22-inch sizes.

Simonds Mfg. Co., Fitchburg, Mass., has just issued a little booklet illustrating and describing various styles of solid and inserted-tooth metal saws entitled "Methods of Cutting Metal." The booklet contains sixty-four pages of information on metal cutting, covering the use of each saw and the sizes furnished, the teeth, speed and feed, and details which should be given when ordering them.

Prest-O-Lite Co., Inc., 837 Speedway, Indianapolis, Ind. Bulletin entitled "Turning Waste into Profit," showing many examples of broken machinery parts that were successfully welded by the Prest-O-Lite oxy-acetylene apparatus. The bulletin is of interest to all users of machinery and valuable to oxy-acetylene welding operators, as it shows a variety of work done and methods of preparing for welding. It contains eighty-two illustrations representative of reclamation welding work in practically every field of the industrial world. In the face of present high prices and scarcity of metal equipment, the subject of welding is receiving more than usual consideration, as it enables plant owners to hold down the scrap heap.

TRADE NOTES

Warren F. Fraser Co. has moved its plant from Boston to Westboro, Mass.

Reynolds Machine Mfg. Co., Massillon, Ohio, has changed its name to Reynolds Machine Co.

Laughlin-Barney Machinery Co., Pittsburg, Pa., has removed its offices to 481 Union Arcade.

Victor Saw Works is the new name of the Massachusetts Saw Works of Springfield, Mass., manufacturers of "Victor" hacksaw blades.

M. Mett Engineering Co., New York City, has moved from Hotel Vanderbilt to 1 Madison Ave. J. M. Wimpie is the American representative.

Worthington Pump & Machinery Corporation, 115 Broadway, New York City, has opened a new branch sales office in the American Trust & Savings Bank Building, Birmingham, Ala., to take care of part of the territory hitherto controlled by the Atlanta office. Edward Stauverman, formerly with the Atlanta office, will be in charge.

Macleod Co., Cincinnati, Ohio, which has been established for over twenty years in the manufacture of sandblast equipment and metallurgical furnaces, has recently enlarged its plant and increased its capital to $100,000. The larger facilities and increased capital were required to take care of the company's rapidly expanding business.

Onondaga Steel Co., Syracuse, N. Y., has nearly completed a new plant in East Syracuse which provides floor space and new equipment that will increase the capacity ten-fold. The company is engaged exclusively in converting high-speed steel scrap into merchantable steel bars by the Onondaga process.

Davis-Bournonville Co., Jersey City, N. J., has opened a sales office in the Colorado Bldg., Washington, D. C., with Henry R. Swartley, Jr., resident manager. The Washington office will facilitate the company's business with the government, which is a large user of oxy-acetylene welding and cutting apparatus in both army and navy.

Parker Mfg. Co., Inc., manufacturer of drill chucks, has moved from Detroit, Mich., to Ann Arbor, Mich. The company is incorporated with $75,000 capital, and has purchased the plant formerly owned by the Star Motor Co. on East Summit St. It is expected that over one hundred men will be employed when the plant is in full operation.

Herman A. Holz, 1 Madison Ave., New York City, was not awarded the Edward Longstreth Medal of Merit by the Franklin Institute, for his portable Brinell meter, as stated in the October number. The medal was awarded for the invention of a portable Brinell meter to Frank H. Schoenfuss and Albert Ringland, of Philadelphia, who are the joint inventors of the instrument.

Porter-Cable Machine Co., Syracuse, N. Y., has purchased a five-story brick building at N. Salina and Wolf Sts., 60 by 200 feet, and affording 60,000 square feet floor space. The entire building will be devoted to the manufacture of the Porter-Cable manufacturing lathe. Extensive alterations will be made in the building and the plant will be ready for occupancy about December 1.

Brown Instrument Co., Philadelphia, Pa., has purchased a large plot of land located on the south side of its factory to provide for extensions to the plant made necessary by the unusual demand for Brown pyrometers and other scientific instruments manufactured. The property of the company now extends along Wayne Ave. from Windrim Ave. on the north to Roberts Ave. on the south.

Long & Allstatter Co., Hamilton, Ohio, manufacturer of shearing and punching machinery, has purchased the shearing business, patterns, etc., of Thomas Carlin's Sons, Pittsburg, Pa. The equipment will be merged with that in the works at Hamilton, Ohio. Thomas Carlin's Sons was one of the oldest concerns engaged in this line of manufacture, the business having been established in 1854.

Cleveland Planer Works, 3150-3152 Superior Ave., Cleveland, Ohio, manufacturers of "Cleveland" open-side planers, have been incorporated as the Cleveland Planer Co., with a capital of $300,000. George W. Ford, partner with James G. Dornbirer, has sold his interest, and a corporation has been formed. The officers are Frank S. Shields, president; J. A. Camm, vice-president, J. L. Whitelaw, treasurer; and James Sarrell, secretary. James G. Dornbirer is manager.

E. P. Reichhelm & Co., Inc., 24 John St., New York City, representative of the American Gas Furnace Co. and the American Swiss File & Tool Co., has purchased the six-story marble-front building at 26 John St., using Liberty bonds in payment. The building is on a plot 25 by 70 feet. The officers of the company are E. P. Reichhelm, president, P. F. Reichhelm, vice-president; E. H. Brownell, treasurer; and Charles A. Leibman, secretary and assistant treasurer.

National Bank of Commerce, 31 Nassau St., New York City, has issued a pamphlet containing the complete official text of the war tax law, together with the income tax law in its amended form, the title being "War Revenue and Federal Income Tax Laws." The provisions of the law are arranged in such a manner that they may be readily referred to by busy men. The pamphlet is one of a series of official laws that have been issued from time to time by the National Bank of Commerce.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., announces another wage increase for shop employes aggregating nearly $2,000,000 a year, which became effective October 16. All employes observing shop hours, except munition workers, will receive an additional bonus of 10 per cent if they are on a salary or time-rate basis, and of 7 per cent if they are on a piece, premium or task basis. This will affect about 20,000 employes of the company. Since the outbreak of the war these employes have received increases amounting to about 60 per cent of the former average compensation.

Buffalo City Line Realty Co., Buffalo, N. Y., a subsidiary of J. H. Williams & Co. of Brooklyn, N. Y., manufacturers of drop-forgings, has sold to the United States government a plot of between 12 and 20 acres, having a depth of 1320 feet and a frontage of 400 to 600 feet on Vulcan St. at the city line in Buffalo, as a site for the government-owned manufacturing plant which is being erected for the building of steam turbines. The turbines are for the torpedo boat destroyers provided for in the Urgency Deficiency Bill. The plant will employ between 2000 and 3500 men and will be operated by the Fore River Ship Building Corporation.

Fairmount Tool & Forging Co., 10585-10611 Quincy Ave., Cleveland, Ohio, is a new concern recently organized to manufacture hand- and drop-forged tools for motor cars, motor trucks, tractors, airplanes, etc. The officers are J. Wentworth Smith, president; B. G. Gilmore, vice-president and sales manager; Charles W. Yarham, secretary and treasurer. The management of the company has been associated with the tool manufacturing business for the last ten years, particularly the tool equipment supplied by the motor car manufacturers for their cars. A factory affording 16,000 square feet of floor space with ample room for expansion has been provided.

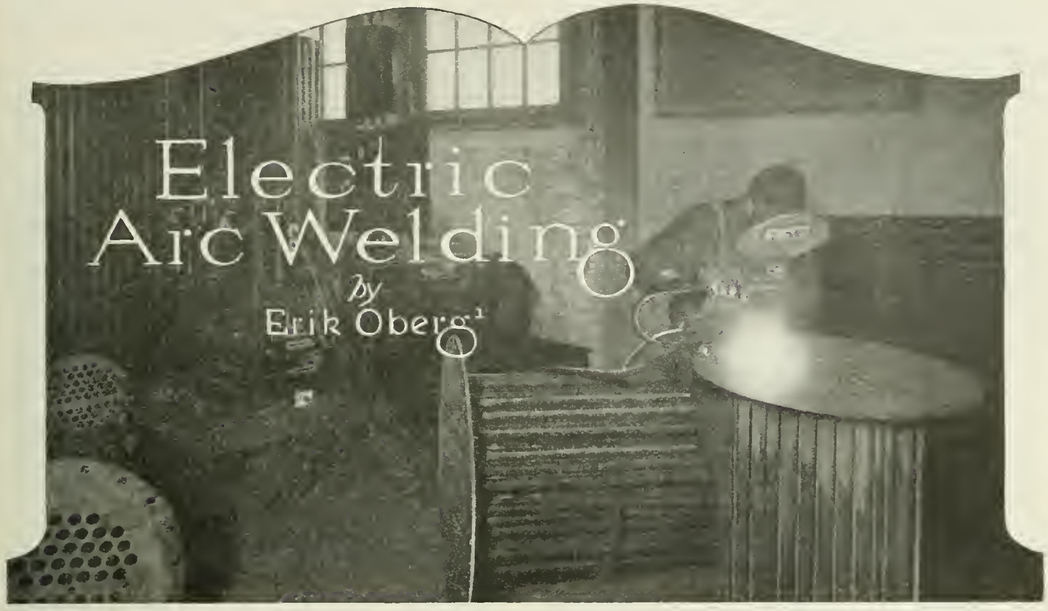
Vulcan Steel Products Co., 120 Broadway, New York City, has opened an office in Havana, to take care of its rapidly growing business in Cuba. The company's branches or agencies are now established over the principal trade centers of the world. Branch offices are maintained at Paris, Hongkong, Shanghai, Yokohama, Milan, Barcelona, Melbourne, Sydney, San Juan, Singapore, and Havana. The company is also represented by well-known business houses in London, Brazil, Portugal, Argentine, Uruguay, Paraguay, Peru, Chile, Bolivia, and Venezuela. Within a year from its incorporation in September, 1916, the company built up an export business in steel and iron, machinery and similar lines, which in August alone amounted to $8,000,000.

New Remington Rifle Co., Bridgeport, Conn., was organized under the laws of the state of Connecticut early in September. Under the terms of its charter it can manufacture, buy, sell and deal in firearms of every description. It is expected that the company will continue the manufacture of Russian rifles which work was heretofore carried on by the Remington Arms Union Metallic Cartridge Co., and the manufacture will be carried on in the plant established by the Remington Arms Union Metallic Co. in Bridgeport. The directors of the new company are Samuel McRoberts, Henry S. Kimball, William E. Griswold, P. A. Morosoff, R. Poliakoff, and F. W. Abbot. The officers are Henry S. Kimball, president; James T. Anyon, treasurer; and John P. Murray, secretary.

New Departure Mfg. Co., Bristol, Conn., held a barbecue and field day for its employes September 21, which was attended by three thousand people. At four o'clock in the morning the chefs built their fires and began preparing for the dinner. At noon there was a parade, led by an employes' band, in which all the different departments of the company were represented. The parade marched through the center of the city and ended at a grove, where there was served an excellent dinner of barbecued lamb, roasted and browned for eight hours, and all the fixings that go with it. While the dinner was in progress, an entertainment consisting of vocal solos and a concert by the band was provided. Afterward there were athletic contests, prizes being given to the winners, and ball games between the various plants of the concern. Moving pictures were taken of the event, which will be shown in a local theater.

Davis-Bournonville Co., Jersey City, N. J., has taken over the plant and factory of the Davis Acetylene Co., Elkart, Ind. The Davis Acetylene Co. has been dissolved and the manufacture of acetylene lighting generators and accessories discontinued. The plant will hereafter be operated under management from Jersey City for the manufacture of acetylene pressure generators for the oxy-acetylene process, and for special products. The Canadian factory at Niagara Falls, Ontario, which has been jointly occupied by the two companies, has also been taken over and will be operated exclusively for the manufacture of oxy-acetylene apparatus for the Canadian trade. The Davis-Bournonville Co. has also purchased the H. G. Kotten Co. factory and land adjacent to its Jersey City property. This factory will be used for manufacturing electrolytic oxygen apparatus and accessories. A four-story warehouse, 60 by 100 feet, of brick and mill construction, will be immediately erected on the Kotten property, and a five-story factory, 60 by 150 feet, corresponding to the company's No. 3 factory recently completed, will be erected during the coming year.

DECEMBER MACHINERY 1917



Electric Arc Welding

by Erik Oberg[1]

Electric arc welding is one of several processes of joining metals that have been developed during comparatively recent years. The process has been found to be of great importance on account of its cheapness and the rapidity with which welds can be made, and is now used to a large extent in both repair and manufacturing work. For many classes of work it has taken the place of oxy-acetylene welding because it is cheaper. However, there is a distinct field for both these processes, and it is the purpose of this article to outline the principles of the arc-welding process, and the field for which it is best suited.

THE principle of electric welding is simple; the parts that are to be welded together are heated to a welding temperature by means of an electric current. There are two ways in which the electric current can be utilized for heating to a welding temperature, and according to the methods used, two main processes or systems of electric welding may be distinguished—the electric resistance-welding process and the electric arc-welding process. In the former—the resistance-welding process—the parts to be welded are brought to a welding heat by passing through them an electric current of such voltage and amperage that the resistance to the flow of the current produces sufficient heat so that, when the parts are brought together by a slight pressure, they will be joined by the fusing of the metal—that is, by welding. In the latter system—the arc-welding method—an electric arc is drawn between two electrodes, or between the work and one electrode. This arc is brought into such a position relative to the work that the heat from the arc melts the metal to be welded and enables the parts to be united. There are various modifications of the latter process, but the principle is as described.

The resistance process of electric welding, in turn, may be divided into two specific processes, differing from each other in some important details. The process generally known as the "resistance" or "incandescent" welding process was developed by Elihu Thomson in 1886, and is, therefore, also generally known by the name of the inventor as the Thomson process. The percussion electric welding process, which was developed by L. W. Chubb of the Westinghouse Electric & Mfg. Co., is also in principle a resistance-welding process. The principles and the practice of the resistance-welding process have been covered completely by the articles published in MACHINERY March, 1915; April, 1915; June, 1915; August, 1916; September, 1916; January, 1917; and May, 1917. The present article will deal with the general principles and application of the arc-welding process, describing different methods and equipment.

Arc-welding Processes

There are at least four distinct methods of electric arc welding. These are named after the men who are generally credited with their development, and are known, respectively, as the Zerener process, the Bernardos process, the Slavianoff process, and the Strohmenger-Slaughter process. Another method, known as the "voltex" process, may be considered as a development and improvement on the Zerener process. The Slavianoff process is sometimes considered not a distinct method, but merely a development of the Bernardos process.

There is still another method frequently classified as an electric welding process—the La Grange-Hoho method—also known as the "water-pail forge." This differs from the regular resistance or arc-welding processes in that it is simply a method of heating replacing the blacksmith's forge, the welding itself being accomplished by hammering on an anvil, as in ordinary forge welding.

The principle involved in electric arc welding consists chiefly in heating the work to be welded to a welding heat by means of an electric arc produced or struck (1) between the work itself and a carbon electrode, as in the Bernardos process; (2) between the work itself and a metallic electrode, as in the Slavianoff process; or (3) between two carbon electrodes, as in the Zerener process. When carbon electrodes are used, a metal rod is nearly always employed for feeding additional material into the joint to be welded. When a metallic electrode is used, it is made from a metal that is suitable for feeding into the joint to form the material required to complete the weld. It is generally conceded that, where applicable, the arc-welding process is cheaper than the oxy-acetylene or oxy-hydrogen welding processes.

Zerener Arc-welding Process

In the Zerener process, two carbon electrodes, so arranged in a holder as to form a vee, are employed. An arc is drawn between the carbon electrodes, and is caused to impinge upon the metal surfaces to be welded by being so located in relation to a powerful electromagnet that the arc is forced toward the work. This causes the arc to act in a manner similar to the flame of an oxy-acetylene torch. This welding system, also commonly known as the "electric blow-pipe" method, on account of the peculiarity of the impinging arc, was invented by Dr. Zerener, of Berlin, Germany, some twenty years ago. In this case, no current passes through the work. The Zerener system, as well as all the other arc-welding systems, is based upon the fact that when two rods of carbon or other electrodes connected to the poles of a generator so that current flows through them are brought into contact, a flame will play between them, this flame being known as an "electric arc." The size of the flame or arc may be varied by increasing the gap or distance between the ends of the carbon electrodes, by increasing or decreasing the amount of current passing through the electrodes, or by placing varying resistance in the circuit. The Zerener method is used to a limited extent for comparatively small work on steel and brass and for welding small corners in tubes and tanks. The process, however, is inefficient and complicated, and requires great skill to apply properly. Hence it is not used as extensively as the Bernardos and the Slavianoff arc-welding methods.

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[1] Associate Editor of MACHINERY

In a development of the Zerener arc-welding process known as the "voltex" process, the carbon electrodes contain a small percentage of metallic oxide which is converted into metallic form and then vaporized. The metallic oxide used is frequently oxide of iron. The metallic vapor created by this arrangement increases the size of the arc and minimizes or prevents the carburization of the work by the carbon of the electrodes at the welding point, which is one of the difficulties met with in the regular Zerener arc-welding process.

Bernardos Arc welding Process

The Bernardos electric arc welding process, until recently, was the method most extensively used. It is especially adapted to large and heavy work. In this process, the arc is drawn between the metal of the work to be welded and a single carbon or graphite electrode. The process is, therefore, commonly known as the "carbon electrode welding process." It is evident that the metal to be welded forms one electrode and the carbon the other electrode for the circuit. The arc is drawn by touching the electrode to the work and withdrawing it to the proper distance in a manner similar to that in which an arc lamp is lighted. The temperature of the arc is approximately 3500 degrees C. (6300 degrees F.), and the heat is confined to a comparatively small space directly in contact with the arc. The use of a small electrode with low amperage permits comparatively light material to be welded, but the process is generally used with large electrodes and heavy currents for heavy work.

In the early development of this process, it was first attempted to use the carbon electrode as the positive terminal and the work as the negative terminal. These attempts, however, were unsuccessful, because part of the carbon from the electrode was carried into the work, making it very hard and difficult to machine subsequently. It is, therefore, considered advisable always to connect the work to the positive side of the circuit and the carbon electrode to the negative. By this method, also, the greater portion of the heat of the arc is concentrated at the work, which is the positive terminal. The rod of carbon, which forms the negative electrode, varies generally from 3/16 to 1 1/2 inch in diameter, according to the size of the work to be welded. It is held in an insulated holder, which the workman holds in his hand, striking the arc by placing the carbon in contact with the work and quickly withdrawing it a few inches from the metal. The operator then manipulates the arc so as to spread it, and heats the work at or near the point to be welded with what is called a "soaking" heat. The pieces of metal to be welded are melted on their faces together with a small iron rod which acts as a solder and flows in between the two surfaces to be joined. The work is often hammered after the weld has been made. Screens with colored glass windows must be used to protect the eyes of the workmen from the effects of the violet rays of the arc, and gloves are also frequently required, especially when heavy welding is done, for protecting the skin.

The Bernardos system, when properly adapted to the work to be done, is practical, simple and efficient. Direct current is used. The quantity of current, depending upon the thickness to be welded, generally ranges from 200 to 500 amperes.

Slavianoff Arc-welding Process

The Slavianoff electric arc welding process is also commonly known as the "metallic arc welding process," because, in this case, a metal electrode is used instead of the carbon electrode.

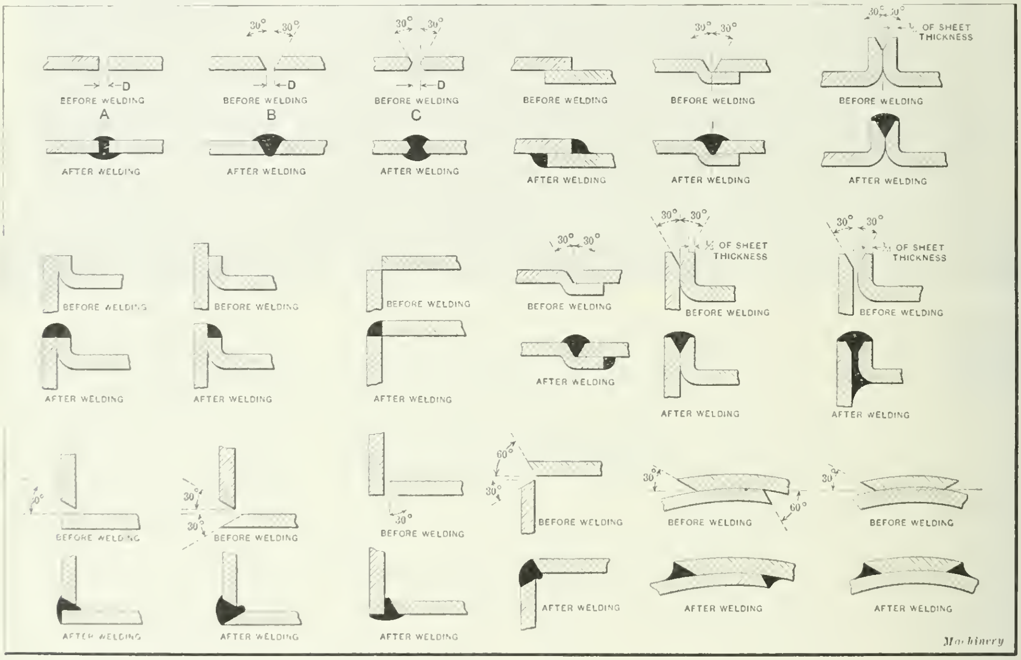


Fig. 1. Methods of preparing Sheet-metal Work for Welding

The objects of using a metal electrode are to prevent the introduction of carbon in the weld, to obtain a stronger weld, and to make vertical and overhead welding possible. The arc is drawn by touching the work with the metal electrode and drawing it away in the same manner as in the Bernardos process. No metal rod to act as a solder is required, however, as the metal electrode itself accomplishes this purpose by gradually melting away and entering the weld. The Slavianoff process produces a softer weld than the Bernardos process, because of the freedom from extraneous carbon in the weld. The arc is smaller than in the Bernardos process and, for that reason, the process is slower, but this is of less importance on smaller work. As the arc itself will carry the metal from the electrode to the work, it is possible to use this method for welding on a vertical wall or overhead, and hence the process is largely used in overhead repair work, in fireboxes, for welding flues in locomotive boilers, and, in general, when repairs must be made in place. It is also largely used for welding steel plate in the manufacture of tanks, etc.

Strohmenger-Slaughter Arc-welding Process

In the Strohmenger-Slaughter electric arc-welding process, the parts to be welded together are placed in the required position, and an electrode, consisting of a soft iron rod covered all over except at the extreme ends with a flux suitable for the metal to be welded, and which also serves as an insulator, is laid along the welding line. The work acts as one electrode, the same as in the Bernardos process. The work and one end of the electrode are brought into contact and an arc is thereby struck. This causes the electrode to melt, the weld being coated with the flux at the same time, thus preventing oxidation. The process is claimed to be successful in the welding of rails and for filling up worn places, but it is not so generally used as the other systems. In this process, either direct or alternating current may be used, but alternating current is preferred. Successful welding has been carried out with 85 volts direct current and 220 volts alternating current.

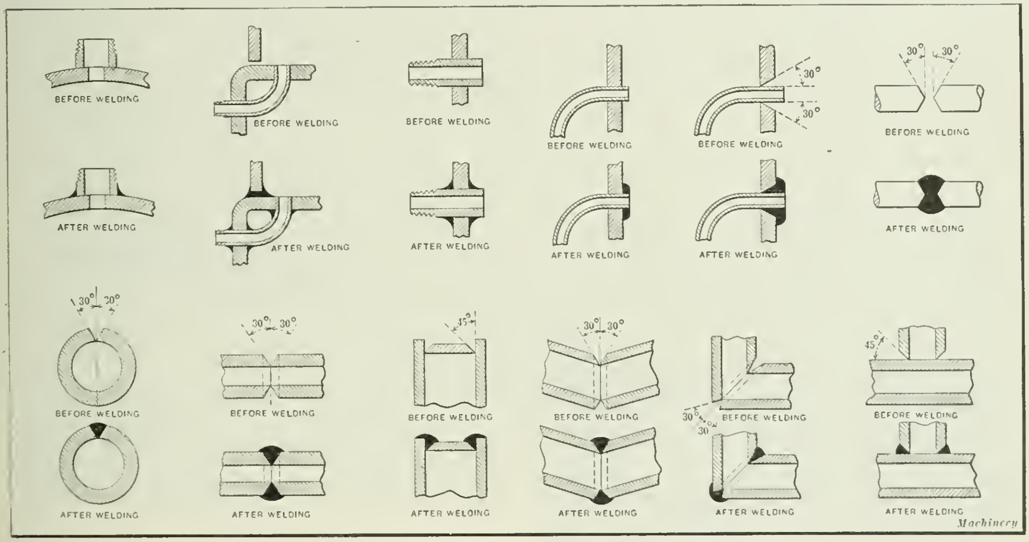


Fig. 2. Methods of preparing Piping and Tubular Work for Welding

La Grange-Hoho Electric Heating Process

The La Grange-Hoho electric welding process, strictly speaking, is not an electric welding process at all, but merely an electric method of heating the metal to a welding temperature. The method, sometimes referred to as the "water-pail forge," makes use of a wooden tank filled with a suitable fluid in which the positive electrode of the electric circuit is placed. A negative electrode is connected to the metal to be heated, and this metal is then immersed in the fluid until it reaches a welding temperature. It is then removed and the actual forging or welding is carried out under a hammer or at the anvil in the usual manner.

Earliest Use of Arc Welding

Arc welding appears to have been first used in 1881 by de Meritens for welding together parts of storage-battery plates. In this case, the work was connected to the positive pole of the current supply and a carbon electrode was used. The heat generated by the arc fused the lead of the storage-battery plate, the various parts of which were thus united or welded.

The Electric Arc

An electric arc is formed when a current of electricity passes from one conductor to another through a gas or vapor which has been brought to incandescence by the discharge of electricity. The conductor from which the current passes into the incandescent gas or vapor is known as the "positive" electrode, while the conductor to which the current passes is called the "negative" electrode. It is estimated that approximately 75 per cent of the resistance offered to the passage of a current of electricity from the positive to the negative electrode takes place at the positive electrode. The remaining 25 per cent of the resistance takes place in the medium between the electrodes and in the negative electrode. It is generally believed that the negative electrode offers more resistance to the flow of current than does the gas or vapor between the electrodes in the short arcs that are used in the arc-welding process. As the amount of heat in the arc or electrodes is proportional to the amount of resistance offered to the passage of the electric current, it is evident that the visible arc or flame produces a comparatively small percentage of the total heat of the arc; by far the largest part of the heat is produced on the positive electrode at the point where the arc impinges.

The Carbon Arc

The system of electric welding that makes use of the carbon (or graphite) electrode is often known in the shop as "carbon arc welding." The electrode is a rod of carbon or graphite between which and the work the electric arc is drawn until the work is heated to the point of fusion. This method is used for three principal purposes: Its first and most important use is for burning metal off iron or steel parts, which is the simplest application of the electric arc. It is frequently used for reducing scrap material to sizes capable of being easily handled, and for cutting risers and fins from large castings in foundries. Some manufacturers of electric welding apparatus, however, do not recommend it for general use for "cutting"

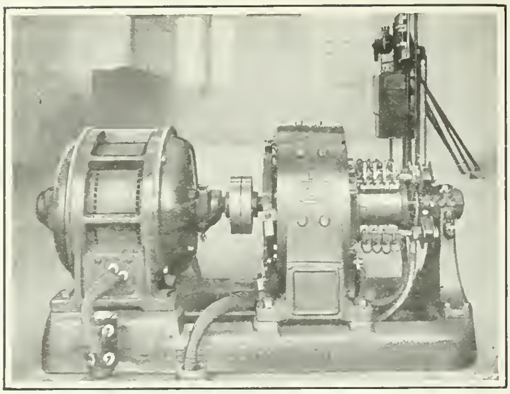


Fig. 3. General Electric 500-ampere Electric Arc-welding Motor-generator Set

structural steel, as cutting of such material, where there are no blow-holes, can be more neatly and cheaply done by oxy-acetylene or oxy-hydrogen torches; but when a small amount of cutting is to be done and an arc-welding outfit is on hand, it provides a convenient means for doing this kind of work, and the method is especially applicable in cutting off pieces to prepare repair work for welding. The second application of the carbon arc is for the welding of very heavy work by the use of heavy currents and large electrodes, and its third application, which is very limited, is in the welding of brass. In each of the two latter cases, a rod of suitable metal must be introduced into the arc, so that the weld can be built up by adding welding material. The metal supplied may be either a rod held in the operator's hand or may consist of small pieces of scrap material which are fused so that they will unite with the part of the work that is already raised to a molten state by the arc, thus forming a solid mass of even structure upon cooling.

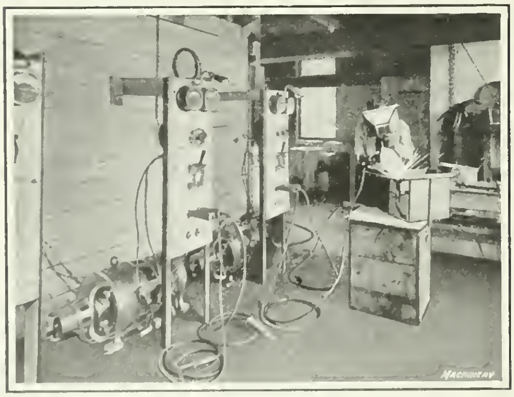


Fig. 4. Lincoln Electric Co. Equipment for Arc Welding

The principal field for the carbon arc for welding is in foundries and steel mills for the repair of imperfect or broken castings of large size. The loss from imperfect castings of large size is always high, but can be reduced to a small percentage by the use of the arc-welding processes, as castings containing blow-holes, cracks, etc., can be readily repaired at small expenditure for material and labor. For all work in which the carbon arc is used, comparatively heavy currents are required, ranging from 200 to 1000 amperes. With these heavy currents, the heat can be applied quickly and can be concentrated at the required point until an intense heat is reached and the process of cutting or welding becomes very rapid. However, the carbon arc is not used anywhere nearly as extensively as the metallic arc, for reasons that will be explained in the following paragraphs.

Polarity for Carbon Arc Welding

As already mentioned, the work is made the positive electrode and the carbon the negative electrode: Two advantages are gained in this manner: (1) Particles of carbon from the electrode are not carried into the weld, and (2) the greater portion of the heat of the arc, being concentrated at the positive terminal, heats the metal to be welded more rapidly.

The Metallic Arc

In the Slavianoff process, commonly known as the "metallic" or "metallic arc" welding process, the metallic electrode—usually made from a soft grade of iron or steel of some special composition, or from bronze for the welding of bronze objects—is brought into a fused state by the heat of the arc, and metal from it is gradually deposited at the point of the weld, where the work is raised to a state of incandescence, so that the metal from the electrode unites intimately with it. This method of welding is very rapid, as the softening or melting of the electrode is continuous after the arc is started, and thus the weld is quickly filled with the filling material. The method is extensively used in all classes of repair and reclamation work, as, for instance, in the filling of cracks and blow-holes in castings, in the building up of worn parts of rolls, rails and locomotive wheel tires, in the repairing of cracks in boilers and locomotive fireboxes, in marine repair and construction work, and in many other industries where it is used as a manufacturing method for increasing the speed or convenience with which the finished product may be brought out. Examples of manufacturing work in which the arc-

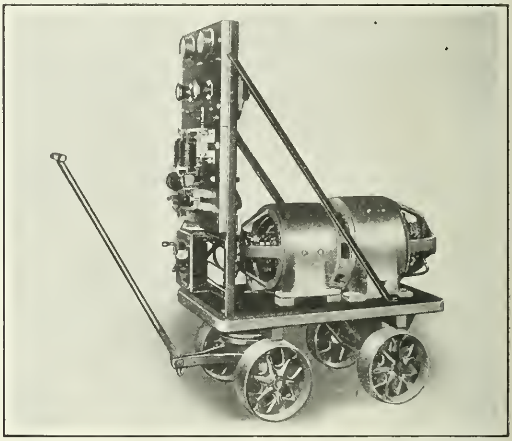


Fig. 5. C & C Electric & Mfg. Co. Portable 150-ampere Constant-current Welding Outfit

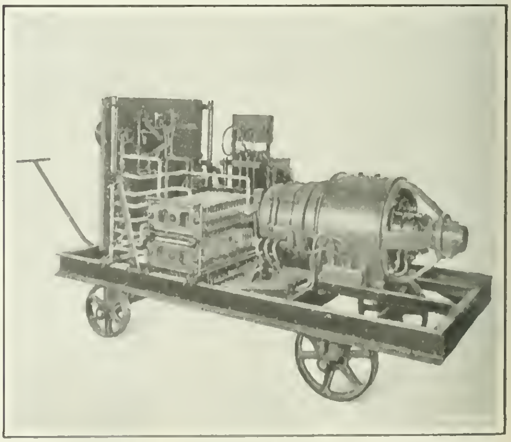


Fig. 6. General Electric Portable 200-ampere Arc-welding Outfit

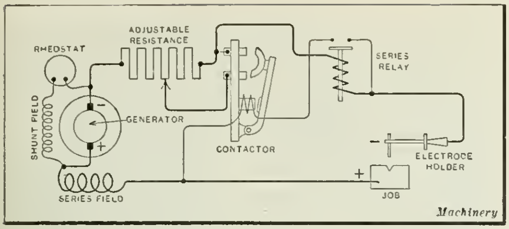


Fig. 7. Diagram of Connections for C & C Electric & Mfg. Co. Arc-welding Equipment

welding process is applied are found in the welding of heads and branches to tanks, in the joining of the seams of tanks and boilers, in the welding of fireboxes, flue sheets, boiler tubes, in the manufacture of steel cars, and in the welding of automobile bodies, rear axle housings, universal joints and other automobile parts, as well as in all classes of pipe and sheet metal work. About 90 per cent of all electric welding is done by the use of metallic electrodes.

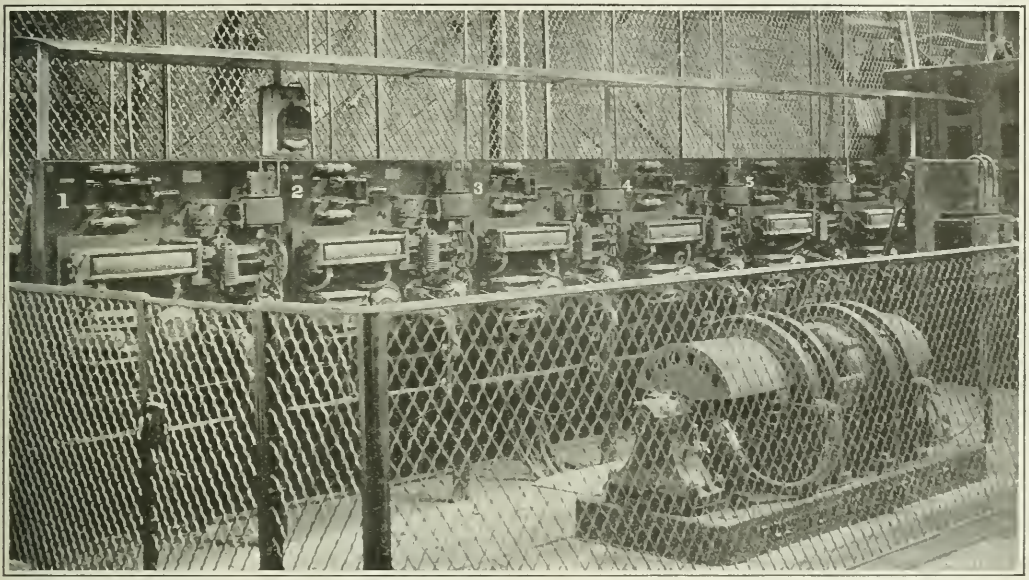


Fig. 8. Wilson Welder & Metals Co. Equipment for Electric Arc Welding—Six-panel Installation at American Locomotive Co., Dunkirk, N. Y.

The metallic electrode process does not require as heavy a current as the carbon arc. The maximum current required is about 200 amperes. For this reason, it is slower than the carbon electrode process, and the metal is deposited less rapidly. It is deposited more uniformly, however, and a weld made by a metallic electrode is stronger and has a smoother and more regular appearance than a weld made by the carbon electrode; hence metallic electrode welding is employed when the strength of the weld as well as its appearance are of importance.

Polarity for Metallic Arc Welding

On account of the fact that the heat of the positive electrode is greater than that of the negative electrode, the work is made the positive electrode, while the metallic electrode is made the negative terminal. In this way, the piece to be welded, which usually has a much larger mass than the welding electrode or wire, and which consequently loses more heat by conduction, is still enabled to heat rapidly. In a few cases, as in the welding of very thin sheet metal, the welding wire is made the positive electrode in order to reduce the tendency of the arc to burn through the sheet metal. It is only when welding thin sheets by the metallic arc that it is desirable to use the metal electrode as the positive pole. In carbon arc welding, the carbon electrode is always the negative pole, as otherwise the carbon is carried over from the electrode into the weld, causing hard spots, brittleness and unsatisfactory results.

Combination of Metallic and Carbon Arcs

In some cases, especially in repair work, it is necessary to remove some parts of the metal to be welded at the place where the weld is to be made. It may be necessary, for example, to cut out part of a burnt, broken or worn spot in order to insert new material, or to widen a crack in order that the metal from the electrode may be properly deposited in it. As the cutting operation must be performed by means of the carbon arc, the combined use of the carbon and metallic arcs is often desirable, the carbon arc being used for cutting, and the metallic arc for the subsequent welding. Preheating of large castings may also be done in this way, as a large section of the work may be raised to a high temperature by using the carbon arc, after which the actual welding is performed by the metallic arc. The strains in the welded parts are more evenly distributed on account of the preheating, and welds of greater strength are thus obtained.

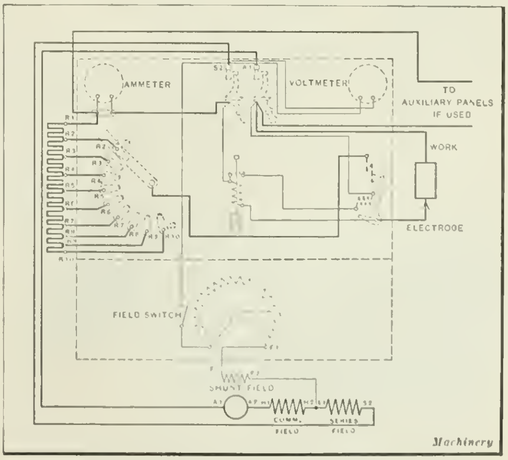


Fig. 9. Diagram of Connections for General Electric Co. Arc-welding Control Panel for controlling Generator and One Welding Circuit

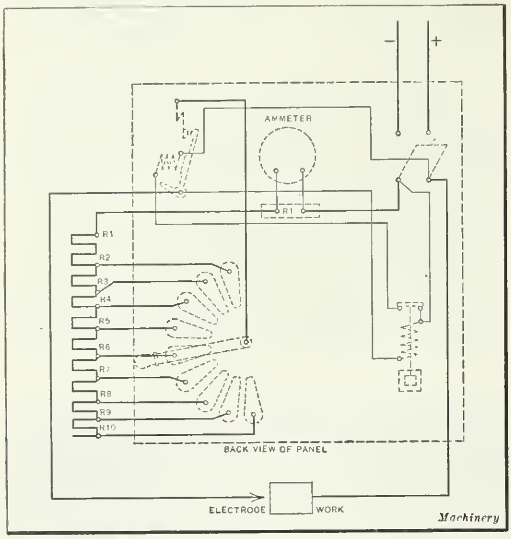


Fig. 10. Connections for General Electric Co. Arc-welding Auxiliary Control Panel for One Welding Circuit

Carbon Electrodes

The carbon electrodes may be made either from a high grade of homogeneous, uncored, hard carbon similar to that used in arc lamps, or from graphite. The former are generally known as "carbon electrodes," while the latter are termed "graphite electrodes." Carbon electrodes are cheaper, but disintegrate more readily. The end of the electrode should be rounded off, but care should be taken not to bring it to a sharp point. In some cases, tapered electrodes are used. The carbon or graphite electrodes used vary in size from ¼ to 1½ inch in diameter. The following have been found, by trial, to be approximately the proper values of current for different sizes of carbon electrodes: ¼ inch in diameter, up to 100 amperes; ½ inch in diameter, from 100 to 300 amperes; ¾ inch in diameter, from 300 to 500 amperes; and 1 inch in diameter, from 500 to 1000 amperes. Graphite electrodes may be used with higher current values. They are not extensively used, however, because they are more expensive. The filling material used with carbon electrodes should be of the same kind and quality as the material being welded, except that a somewhat higher percentage of carbon in the welding material is desirable, inasmuch as some of the carbon is burnt out in the welding process.

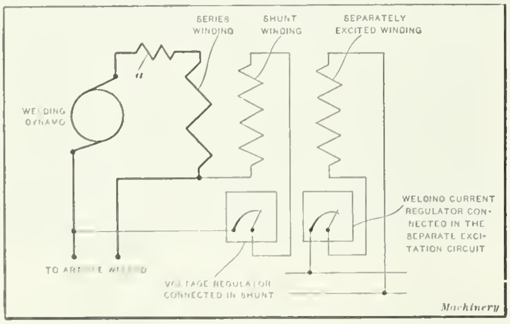

SERIES WINDING
SHUNT WINDING
SEPARATELY EXCITED WINDING
WELDING DYNAMO
WELDING CURRENT REGULATOR CONNECTED IN THE SEPARATE EXCITATION CIRCUIT
VOLTAGE REGULATOR CONNECTED IN SHUNT
Machinery

Fig. 11. Wiring Diagram of Kramer Electric Welding Machine

Metallic Electrodes

The size of the metal electrode used varies with the nature of the work and the current required, but it is ordinarily made from 3/32 to 5/32 inch in diameter. It is necessary in every case to have the proper relation between the current strength and the size of the electrode, because the heat of the arc must be sufficient to raise a spot on the work nearly to the point of fusion, in order that there may be an actual union of the metal from the electrode with the work. Unless the temperature is high enough for this union, the weld will be imperfect and the metal from the electrode will not join properly with that of the work. On the other hand, if the metal is heated to too high a temperature, there is danger of burning it and oxidation also takes place more rapidly, thus impairing the weld. In addition, greater heating and cooling strains are set up in the weld. Therefore the current must be regulated to produce a proper temperature rise in the work, and the size of the electrode must be so selected that there is no danger of overheating or oxidizing the metal when deposited. On the other hand, the electrode must not be too large for the current used, as this would produce an imperfect union, the fusion being slow and imperfect and the welds unsatisfactory.

Metallic electrodes for welding steel or iron are obtainable from supply houses generally, from makers of steel and iron wire, or from the various companies that manufacture electric arc-welding equipment. The electrodes used in connection with practically all welding equipments consist of rods from 1/16 to 1/4 inch in diameter and about 12 inches long; the largest size of electrode is used for cast-iron welding only.

The Wilson Welder & Metals Co., 52 Vanderbilt Ave., New York City, supplies metal electrodes in sizes of from 1/16 to 9/32 inch in diameter, the standard size being gage No. 9, which is approximately 5/32 inch in diameter. These electrodes are furnished in five different grades, suitable for boiler repair, steel welding, cast-iron welding, filling castings, and bronze welding, respectively. Experience has shown that in order to secure satisfactory results in electric welding, the use of a proper grade of metal is of as great importance as having a properly designed machine. Recognizing this fact, the Wilson Welder & Metals Co. has developed specially prepared welding metals that are not adversely affected by the heat of the arc. These metals are used in the form of an electrode. This metal is a homogeneous alloy combined with an excess of manganese to compensate for losses while passing through the electric arc, thus insuring a substantial amount of manganese in the welded joint, which is essential to its toughness. In addition, a manganese-copper alloy welding electrode has been developed, which is composed of iron

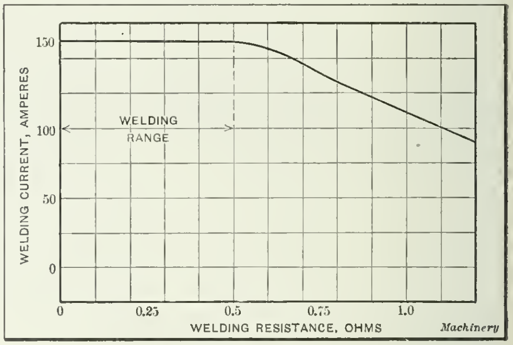


Fig. 12. Diagram of Current in Relation to Resistance

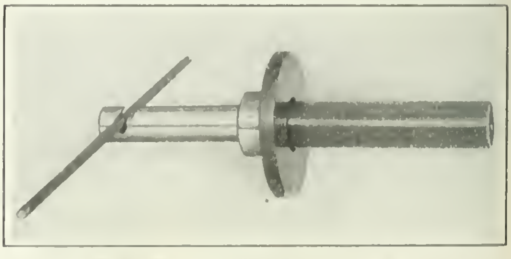


Fig. 13. General Electric Co. Metallic Electrode-holder for Electric Arc Welding

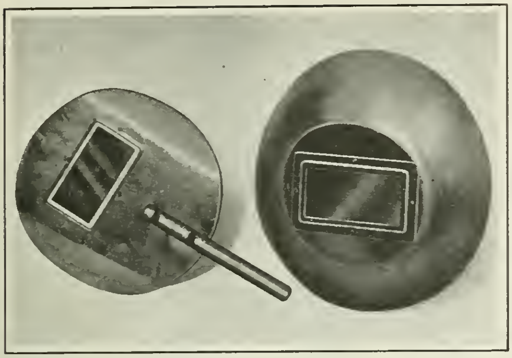


Fig. 14. Front View of Two Types of Welding Shields

homogeneously combined with such an excess of manganese and copper over the amount lost in the arc as will insure to the welded joint an additional degree of toughness and ductility, and at the same time will leave it soft enough to be machined.

The C & C Electric & Mfg. Co., Garwood, N. J., states that, with the company's constant-current low-voltage (16 to 20 volts) system of electric welding, electrodes of Swedish iron (mild steel) are best for all-around welding of steel. They can be used for welding overhead work, as well as vertically (as, for instance, in the welding of flues), without any of the limitations encountered when using electrodes that fuse at an unusually low temperature. One of the great advantages of Swedish iron welding electrodes is that the material always may be depended upon to be uniform.

The Lincoln Electric Co., Cleveland, Ohio, furnishes metallic electrodes 1/8, 5/32 and 3/16 inch in diameter. The smallest electrode is used on sheet metal 1/8 and 3/16 inch thick, and also for welding flues into flue-sheets in locomotive shops. The 5/32-inch electrodes are more generally used than any other size, and are employed for boiler-plate welding in general. The 3/16-inch electrode is used principally for "building up," as, for example, in the building up of worn parts of steel castings. It may also be used for welding when speed is more important than the quality of the work.

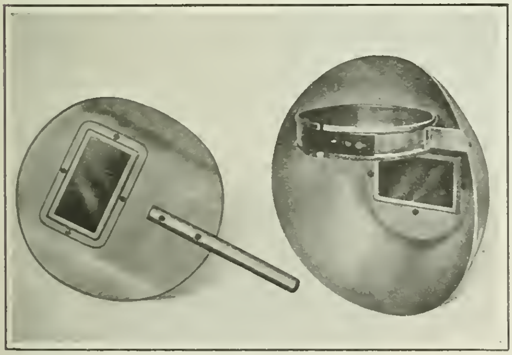


Fig. 15. Rear View of Welding Shields shown in Fig. 14

Current and Voltage for Carbon Arc

The voltage across the arc varies from 35 to 50 volts, depending partially upon the amount of current being used, but still more upon the length of the arc. The current ranges from 200 amperes up, depending upon the type of work being done. For light work, small electrodes and current values less than 200 amperes can be used. The average type of welding done by the carbon arc requires from 300 to 400 amperes. For cutting, or, more correctly, burning, from 400 to 600 amperes, or more, are required.

Current Required for Metallic Arc Welding

The current required for the metallic arc is smaller than for the carbon arc and seldom exceeds 175 or, at most, 200 amperes for the heavier classes of work; it ranges from this maximum down to 12 or 15 amperes for thin sheet metal work. The generated voltage varies from 16 to 75 volts, according to the make of the equipment used. Metal electrodes also require smaller voltage than carbon electrodes. The voltage at the arc is ordinarily from about 15 to 25 volts. The current and voltage used in electric welding depend to a large extent upon the size of the metal electrode used, as well as upon the composition of the electrode and the nature of the work to be welded. The metallic electrode can be used on much lighter stock than the carbon electrode, but in welding it requires greater ability on the part of the operator on account of the shortness of the arc and the consequent difficulty of maintaining it. The metallic arc is more unstable than the carbon arc, and the operation is more difficult to master, but this is compensated for by the fact that certain classes of welding can be done by the metallic arc process that cannot be done in any other way, as, for example, the welding of overhead or vertical surfaces.

Data on Current and Voltage

According to a report submitted to the convention of the Association of Railway Electrical Engineers and reprinted in the *Railway Review*, December 2, 1916, 1/8-inch mild steel electrodes used for welding 2-inch flues require a current of from 60 to 90 amperes and a voltage of from 14 to 16 volts; 5-inch flues using a 5/32-inch mild steel electrode require a current of from 110 to 140 amperes with a voltage of from 16 to 20 volts. Mild steel electrodes, 3/16 inch in diameter, require a current of from 150 to 180 amperes with a voltage of from 18 to 25 volts. When carbon electrodes 3/4 inch in diameter are used for cutting, a current of from 250 to 350 amperes and a voltage of from 35 to 50 volts are required. For cutting or burning with carbon electrodes 1 inch in diameter, a current of from 350 to 500 amperes and a voltage of from 35 to 50 volts are required. In some outfits, however, carbon electrodes much smaller in diameter are used, one company employing electrodes only 3/16 inch in diameter.

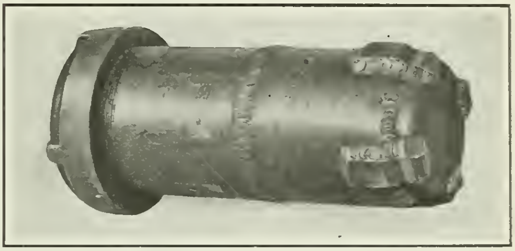


Fig. 16. Six-inch Arc-welded Wrought-iron Pipe tested at Pressure of 1000 Pounds per Square Inch

Sheet Metal Welding

Very thin sheet metal is welded by metallic electrodes with low current values. The General Electric Co., Schenectady,

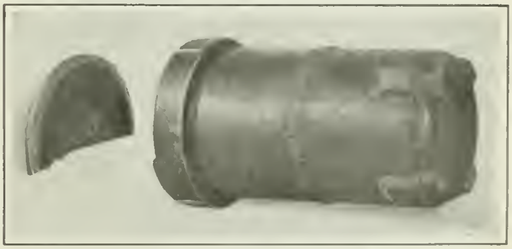


Fig. 17. Eight-inch Arc-welded Wrought-iron Pipe tested at Pressure of 800 Pounds per Square Inch, which was withstood by the Welds but not by the Cap

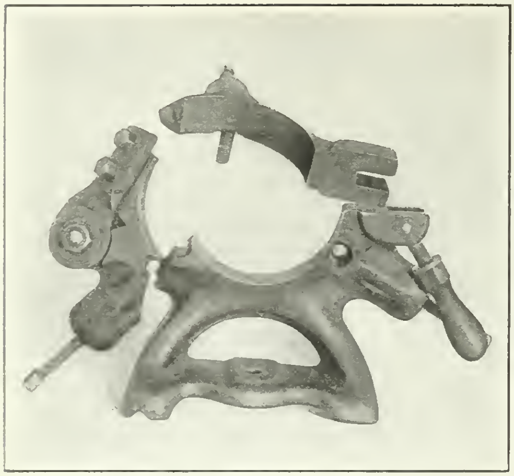


Fig. 18. Broken Lathe Steadyrest

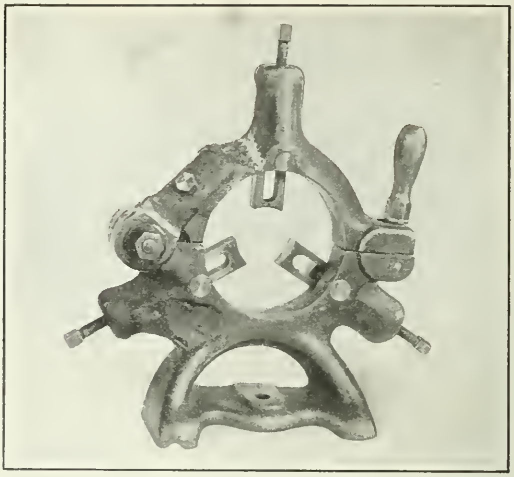


Fig. 19. Lathe Steadyrest shown in Fig. 18 repaired

gives the following data for sheet metal welding based on cost of labor at 30 cents per hour and current at 2 cents per kilowatt hour:

Metal, No. 20 gage or less; metal electrodes, less than 1/16 inch in diameter; current, 10 to 25 amperes; speed, 30 feet per hour; average cost, 1 1/2 cent per foot.

Metal, No. 18 gage to 1/8 inch; metal electrodes, 1/16 inch in diameter; current, 35 to 40 amperes; speed, 30 feet per hour; average cost, 2 cents per foot.

Metal, 1/8 to 3/16 inch; metal electrodes, 3/32 inch in diameter; current, 30 to 50 amperes; speed, 25 feet per hour; average cost, 2 1/2 cents per foot.

Metal, 3/16 to 1/4 inch; metal electrodes, 1/8 inch in diameter; current, 50 to 100 amperes; speed, 20 feet per hour; average cost, 3 to 3 1/2 cents per foot.

Metal, over 1/4 inch; metal electrodes, 5/32 inch in diameter; current, 75 to 150 amperes; speed, 18 feet or less per hour; average cost, 5 cents and up per foot.

The General Electric Co. estimates that the cost of welding 1/4-inch plates by the arc-welding method is about 50 per cent of the cost of welding similar plates by the oxy-acetylene method. To weld steel plates 1/2 inch in thickness with the electric arc will cost less than 40 per cent of the cost with the oxy-acetylene process, and for plates 1 inch in thickness, the cost of arc welding is estimated to be less than 15 per cent of the cost by oxy-acetylene welding.

Advantages of Electric Arc Welding

The following claims of superiority are made for electric arc welding as compared with other methods of welding for materials and conditions for which the method is suitable: First, the high temperature of the electric arc makes it possible to rapidly reduce the metal to be welded to a molten state; the heat being applied rapidly is not carried away from the point of the weld by the heat conductivity of the metal fast enough to lower the temperature at the weld appreciably. Second, the tools for performing the weld are comparatively easy to manipulate and the apparatus required is simpler and easier to handle than that used with gas-welding outfits. Third, for all work, except very thin materials, it is the cheapest welding method available. Fourth, the voltage of the current is so low that the process is perfectly safe, and if the operator is provided with a proper hood or shield to protect him from the light and heat of the arc, he is not exposed to any danger. The heat and light from the carbon arc is much greater than from the metallic arc. Fifth, there is no danger from explosions.

The most important advantage of all, probably, is that welds can be made overhead and on vertical seams by the metallic arc. The arc actually carries the metal particles from the electrode into the weld with considerable force, so that even

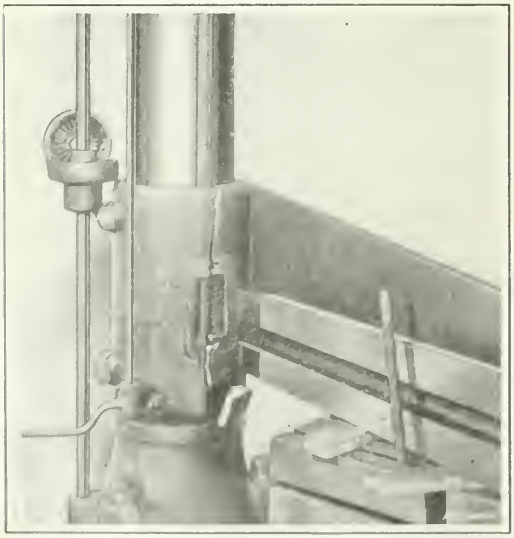


Fig. 20. Broken Arm of Radial Drilling Machine

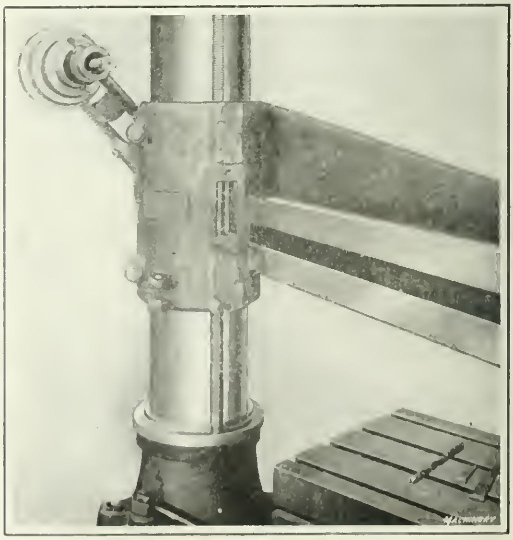


Fig. 21. Arm of Radial Drilling Machine repaired

Fig. 22. Steam Plate for Hydraulic Press welded to withstand 150 Pounds per Square Inch Steam Pressure

with an overhead weld, the metal is forced clear through the space between the adjoining surfaces, welding them securely. Overhead welding cannot be done by any other means, and vertical welding only with great difficulty by other methods. The simplicity of electric welding for overhead and vertical seams is, therefore, one of its strongest claims in many instances.

Metals that can be Welded

The metals that are most commonly welded by the electric arc are steel, steel castings, and cast iron. For mild rolled steel and steel castings, electrodes or filling rods of soft iron, preferably Swedish iron, are used; tool steel may also be welded with Swedish iron electrodes. For cast iron, rods of cast iron high in silicon are used. Copper has been welded to steel by using a copper electrode, and brass has also been welded with copper electrodes. In the welding of bronze, a bronze electrode is used. Electric arc welding, however, is most successful in the welding of steel, steel castings, and cast iron; but on account of the great heat of the arc, it cannot be used successfully, except by expert welders, for welding cast-iron sections that are thinner than 1/4 inch. It is not practicable to weld aluminum with the electric arc, the oxy-acetylene process being best for this metal. It is also likely that the oxy-acetylene welding process is preferable for the welding of copper, brass and bronze, although there may be instances when these metals must be welded overhead or along vertical seams, in which case the arc-welding process would have to be used.

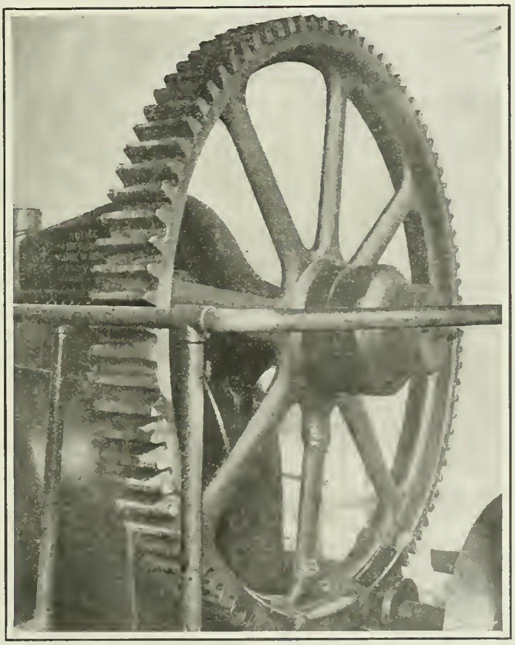


Fig. 23. Cast-iron Gear repaired by Arc Welding

Carbon electrodes are used for filling in large cavities in cast iron, by melting into place a cast-iron rod of, say, 1/2 inch diameter. A cast-iron metallic electrode of a diameter of about 1/4 inch may also be used. Some makers of electric welding equipment recommend the use of soft iron electrodes on cast iron as well as on steel, and one concern uses a specially prepared soft iron electrode containing manganese.

Preparing Work for Welding

The preparation of the work for welding depends upon the kind of work to be done, the thickness of the parts to be welded, and their shape. In Figs. 1 and 2 are shown a number of examples of work to be welded, and in each case the method of preparing the work for welding, and the appearance of the weld after the work is completed, is shown. In Fig. 1 is indicated at *A* the method of preparing sheets less than 1/4 inch in thickness. For sheets up to 1/16 inch in thickness, space *D* should be 1/32 inch. For sheets between 1/16 and 1/8 inch in thickness, it should be about 3/32 inch; and for sheets from 1/8 to 1/4 inch in thickness, space *D* should be about 5/32 inch. At *B* is shown the preparation of sheets from 1/4 to 1/2 inch in thickness, where space *D* should be 3/32 inch. At *C* is shown plate above 1/2 inch in thickness; here space *D* should be 5/32 inch. A study of the various conditions illustrated in Figs. 1 and 2 will give a good idea both of the possibilities of electric welding and the method by which it is accomplished.

Preheating

Cast and malleable iron can be successfully welded by the electric arc process, but it is generally necessary to preheat the castings, either by the use of the carbon electrode or by means of gas, coal or oil fires; the preheating is continued until the work is brought up to a red heat, and the heat is carried well back from the welding surfaces so as to avoid cooling strains and cracks when the metal cools after welding. The work must be kept hot during the time the weld is made, and means must be taken to have it cool down slowly after welding.

Equipment Required for Arc Welding

The simplest possible outfit for arc welding would consist of any source of direct-current supply, an adjustable resistance for regulating the current and bringing the voltage down to that required in the welding circuit, and an electrode holder. The present arc-welding outfits, however, are made somewhat more elaborate in order to obtain greater economy. The current is usually furnished by a low-voltage generator which is driven by a motor or sometimes by other means like a belt or chain drive. Generally, motor-generator sets or dynamotors are used for the power supply. The equipment further includes a switchboard having on it the starting apparatus for the motor end of the outfit, if motor-driven; the control and indicating apparatus for the generator, consisting of a field regulator, voltmeter, and ammeter; and a regulating apparatus for the arc circuit, consisting of a set of current-regulating switches with resistance, and usually some form of automatic switch or contactor. Where several welders use the same stationary outfit, there is, in addition, a control panel for each welding station or circuit. The operator's tools and equipment consist of electrode holders with cables for each welding station, and face shields

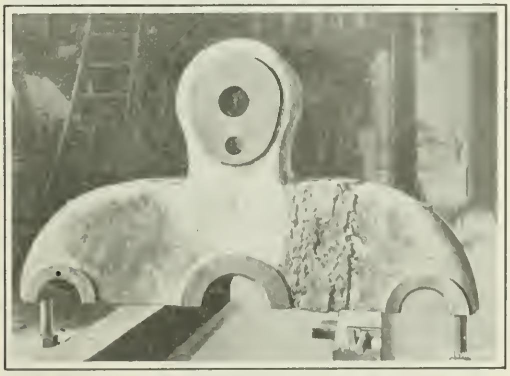


Fig. 24. Bearing Cap for 500-ton Punch Press repaired with Carbon Arc

or hoods for protection against the light and heat.

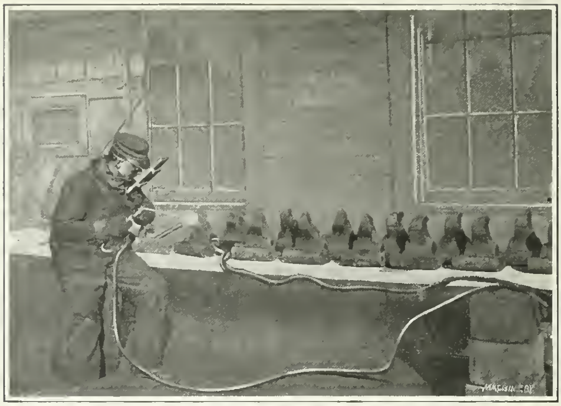


Fig. 25. Reclamation of Worn Freight Car Knuckles

Motor-generator Sets

As the alternating-current arc varies from a maximum to a minimum at each reversal of the current, it is not suitable for electric arc welding. The direct-current arc, on the other hand, is practically steady; so direct current is used; only a low voltage is required. The metallic arc requires from 15 to 25 volts, while the carbon arc requires from 35 to 50 volts, according to the equipment used. Special welding equipment in the form of generators and control apparatus is used only in order to obtain current at the required voltage economically. As far as the welding is concerned, work can be done with the 250-volt direct current having the necessary resistance ballast; but it would be necessary to reduce the voltage from 250 volts to the low voltages required in the welding circuit. As this is done by inserting resistance in series with the arc to absorb the excess voltage, it is plainly an inefficient process, as the voltage absorbed by the rheostat is wasted. Assume that the supply circuit is 250 volts and that the arc requires 25 volts; then it is obvious that nine-tenths of the energy taken from the mains is wasted in the rheostat; and in the extreme case of a supply circuit of 550 volts and a metallic arc using only 15 volts, the energy used would be so small a fraction of the energy taken from the line that practically all the energy of the supply circuit would be wasted.

In order to avoid these losses, therefore, the various manufacturers of electric welding apparatus have developed special low-voltage generators and methods of control that give the maximum of efficiency combined with flexibility and circuit protection. The generators are usually furnished as part of a motor-generator set, although they can be furnished for belt drive if desired. The motor-generator set, however, is the most desirable equipment for several reasons: It is a self-contained unit; it does not demand constant attention when running; the maintenance cost is low; and the welding circuits and the shop circuits are electrically independent, so that short-circuits in the welding circuit will not seriously interfere with the shop circuits. The voltage on the welding circuit can be regulated to suit the work being done by various methods of control, these methods differing according to the make of the equipment. There are three types of equipment on the market, which may be described as the constant-voltage, the variable-voltage, and the constant-current types:

The constant-voltage type is a motor-generator set that takes power from the shop mains and delivers on the generator end a practically constant low voltage. A resistance ballast is used between the generator and the welding arc to determine the current and to limit the current at short-circuit. The power used in the resistance ballast is, of course, wasted. In stationary outfits, the low-voltage direct-current power is carried over the shop on heavy cable to the welding outlets.

The variable-voltage type is a motor-generator set in which the voltage supplied by the generator is variable, the generator delivering practically the voltage required by the arc.

The constant-current type is a motor-generator set that takes power from the shop mains and delivers on the generator end the current required for welding without the use of resistance ballast. The inherent characteristic of the generator is such that the short-circuit current is limited without the use of resistance ballast. Inductive ballast is used to stabilize the arc. This type of equipment is usually furnished in the portable type, and the low-voltage distribution system is thus eliminated. The motor is fed directly from the shop lines. The constant-current type of welder has been developed to meet the demand for an outfit that will produce a welding current

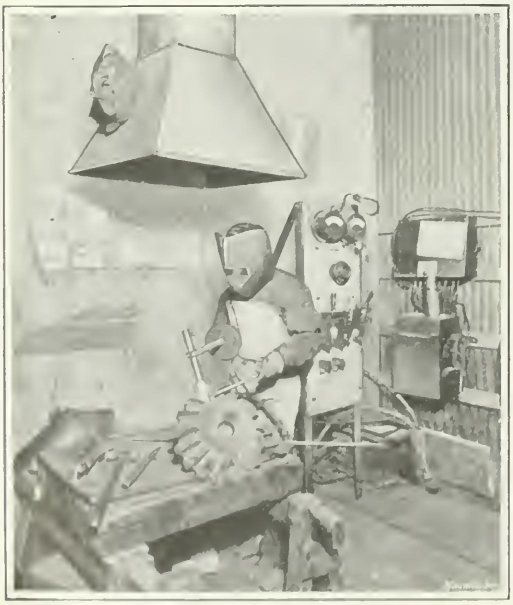


Fig. 26. Broken Teeth in Bevel Pinion repaired

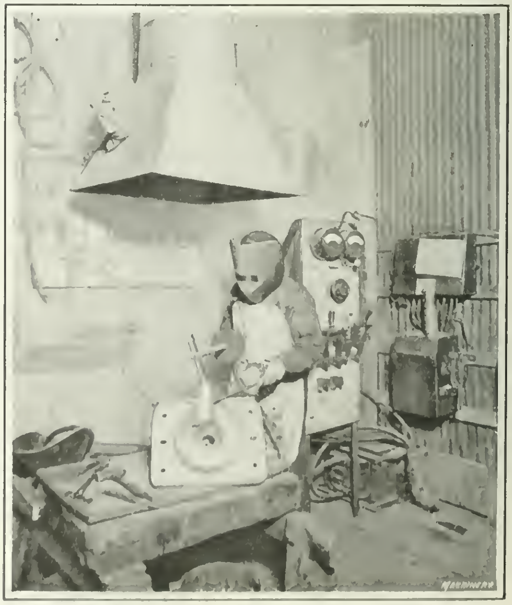


Fig. 27. Filling in Blow-holes in Castings by Electric Arc

of constant value, regardless of the length of arc, and that can be installed at any desired location in the shop. Machines of this type are so made that the voltage varies automatically as operating conditions change, thereby keeping the current at the predetermined amount. Provision is also made to adjust the current to different values to suit various classes of work, thereby making apparatus of this type suitable for all kinds of shops. These machines may be connected to the shop circuit like other motor-driven devices.

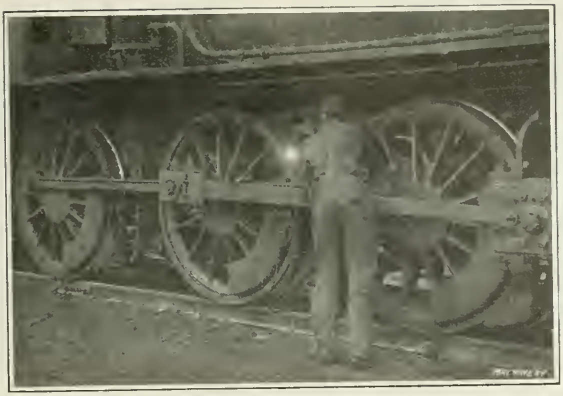


Fig. 28. Building up Flat Spots on Locomotive Drivers

As examples of constant-voltage machines may be mentioned the generators of the Wilson Welder & Metals Co., which are wound for voltage of 35 volts, and those of the General Electric Co., which are wound for voltage of from 60 to 75 volts, it being in no case necessary to have a generator of higher voltage than this for welding.

The Lincoln Electric Co. supplies a variable-voltage equipment. At the instant of short-circuit, the voltage is very low—from two to three volts. When the operator is welding with the metallic arc the voltage across the arc is from twenty to twenty-five volts. Carbon electrode welding requires from thirty-five to fifty volts. When the machine is running, but the operator is not welding, the voltage may be from sixty to eighty volts. The C & C Electric & Mfg. Co. makes a constant-current machine, working on the principles outlined

Single-operator units of either type may be made portable. Large constant-voltage multiple-operator units must be located at definite points, although the welding panels may be made portable if the low-voltage distribution system is heavy enough to prevent interference between operators due to line-drop.

Dynamotors

The C & C Electric & Mfg. Co. uses, in some cases, a dynamotor instead of a motor-generator set on direct-current circuits. The dynamotor is a single machine, duplex-wound, combining the functions of both the motor and the generator. Dynamotors are somewhat lower in price than motor-generator sets, and are lighter and therefore desirable for portable outfits.

Examples of Welding Equipment

Figs. 3, 4, 5, 6 and 8 show a number of welding outfits. That shown in Fig. 3 is a motor-generator set of 500 amperes capacity, the control equipment being shown in the background. This set is made by the General Electric Co., Schenectady, N. Y. In Fig. 4 are shown two outfits made by the Lincoln Electric Co., Cleveland, Ohio, together with the control switchboard. A welder is shown at work, this illustration giving a clear idea of the conditions under which the work is done. Two portable equipments are shown in Figs. 5 and 6, the former being the product of the C & C Electric & Mfg. Co., Garwood, N. J., this particular outfit being wound for operation on a direct-current circuit; outfits wound for operation on alternating-current circuits are also supplied, the latter being made by the General Electric Co. These portable outfits consist of motor-generator sets with switchboards mounted directly on a truck. Fig. 8 shows a complete installation made by the Wilson Welder & Metals Co. It will be seen that there is one motor-generator set and six separate control panels, one for each welding circuit.

Switchboards

It is generally preferable to have the apparatus for controlling the motor and generator on a separate panel from the welding control circuits, as this makes it possible to install the welding machine with its panel in a separate room, if desired, and to mount welding station panels near the work. In this way, the distribution circuit can be run from the control panel throughout the shop, and the welding panels can

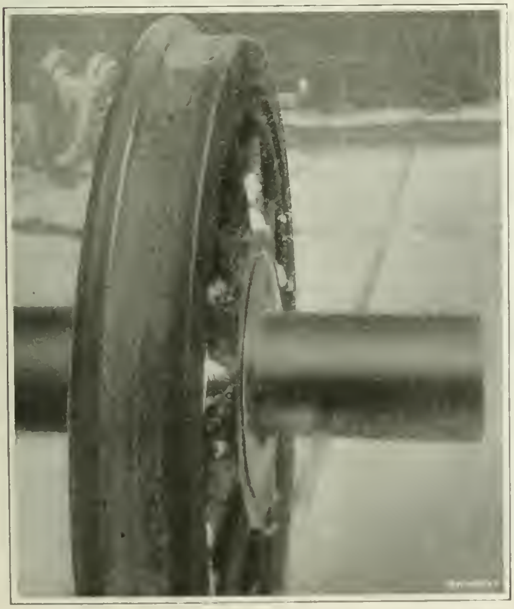


Fig. 29. Locomotive Trailer Wheel with Flat Spot Ready for Welding

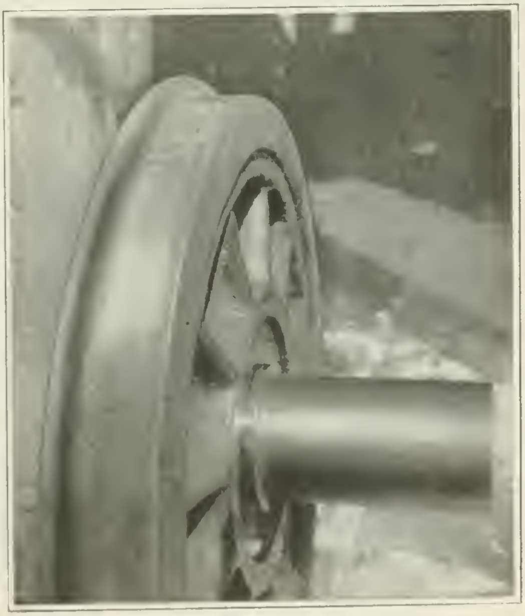


Fig. 30. Locomotive Trailer Wheel with Flat Spot built up by Arc Welding

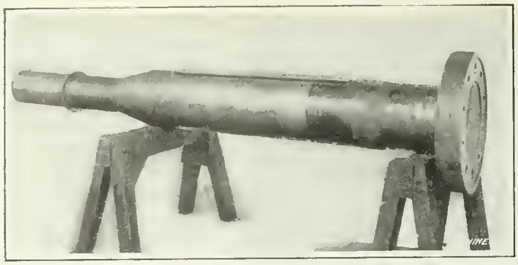


Fig. 31. Ten-inch Electric Generator Shaft machined 1/16 Inch too Small in Diameter

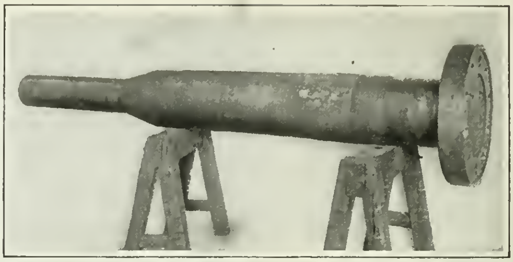


Fig. 32. Same Shaft as shown in Fig. 31 after being built up by Welding, Ready to be machined

be tapped from this circuit the same as motors. Fig. 7 shows a diagram of connections for a C & C Electric & Mfg. Co.'s constant-voltage outfit. This gives automatic control of the welding current at all times. When the operator brings his electrode into contact with the work, the current is limited by all the resistance in the circuit, but when he draws his arc, the automatic contactor cuts out part of the resistance and allows the current to come up to the amount required for welding. Upon stopping work, the contactor drops back and all the devices are ready for further operation without attention. Should the operator attempt to use more current than has been determined to be proper for the job, a self-closing circuit-breaker acts immediately, interrupting the circuit, but permits resumption of welding, without it being necessary to close the circuit breaker manually.

The control of the welding circuit differs, as mentioned, according to the make of the welding outfit. In the General Electric Co.'s outfit, the control consists of a main generator panel and a separate panel for each operator. Double circuit panels are also provided, so that two operators can work from the same panel through separate equipments. If the circuits are duplicates, a set of switches can be provided for connecting the entire capacity of both circuits to one electrode. This is sometimes done for carbon electrode welding or cutting. A convenient type of switch is provided for adjusting the resistance in series with the arc and providing a number of steps in changing the current. Means are provided so that a large number of operators can work from the same machine, since trouble on any one operating circuit is localized and does not affect any other. Circuit-breakers are mounted on the main generator panel, which will open the circuit in case of a short-circuit in the cables or in the event of an excessive load being thrown on the generator. Fig. 9 shows the connections of a G.E. arc-welding control panel for a generator and one welding circuit, while Fig. 10 shows the connections of an auxiliary arc-welding control panel for one welding circuit.

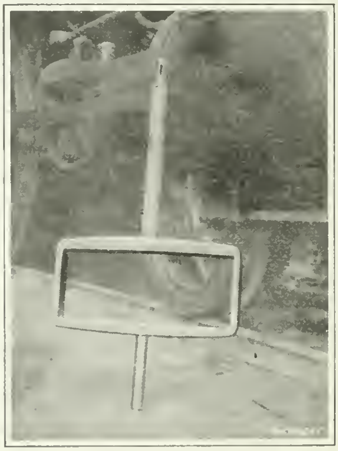


Fig. 33. Worn Valve-yoke Stem built up by Welding, Ready for Machining

The Wilson Welder & Metals Co. has a special constant-current control panel for welding and cutting which makes use of a so-called "carbon pile" held under compression by one or more helical springs, the pull of which is opposed by a solenoid through which the current to be regulated is passed. This control outfit was described in detail in the February, 1917, number of MACHINERY.

A large foreign concern developed a machine some time ago for utilizing the welding energy without losses. This machine generates energy at the required voltage directly, and always supplies current of the same value, notwithstanding considerable resistance fluctuations in the welding circuit. At the same time, a steady arc is obtained. The heat flowing to the article welded is, therefore, quite constant, which is of importance for satisfactory welding. The peculiar property of this welding generator of giving a constant current with a variable resistance is obtained by means of a threefold field excitation, as may be seen from the diagram of connections in Fig. 11. One field winding is a differentially connected series winding, the second is a shunt, and the third, a separately excited winding which receives

Fig. 34. Welding a Lug to End of Steel Forging for a Center

Fig. 35. Manufacturing Gear Guards from Sheet Steel by Electric Welding

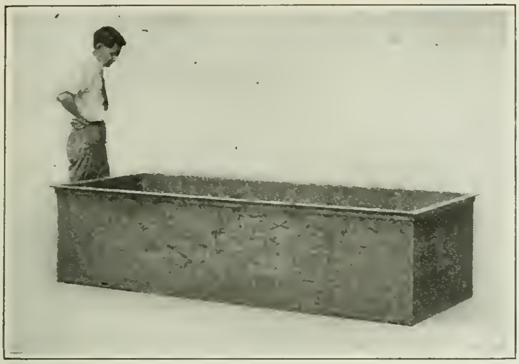


Fig. 36. Electrically Arc-welded Plating Tank

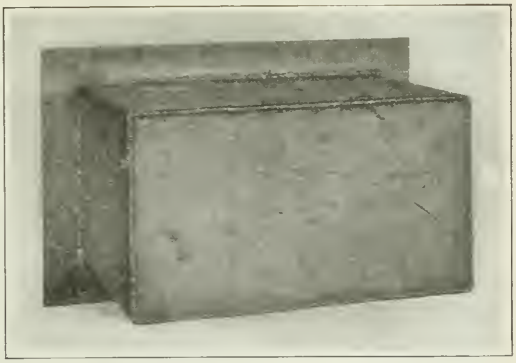


Fig. 37. Electrically Welded Tank, showing Character of Welds

current from a special circuit with a constant voltage. Any given welding current most suitable for the work can be obtained by adjusting the regulator for the separate excitation. The voltage of the machine may be altered by the regulator for the shunt excitation. Thus a finely graduated adjustment of the current and voltage may be obtained by suitably arranging the two regulating resistances, so that the machine can be adapted within wide limits to the requirements for the welding work in hand.

Fig. 12 illustrates the value of the current for the machine adjusted for a welding current of 150 amperes. It shows clearly that the welding current remains constant even when the arc resistance varies from zero (*i. e.*, short-circuit) to 0.5 ohm. Only after attaining a still higher resistance does the current begin to fall gradually.

Operation of a Welding Outfit

As mentioned, the control of the General Electric Co.'s constant-voltage arc-welding outfit consists of a main generator panel and a separate panel for each operator. The dial switch on the auxiliary panel controls the amount of resistance in series with the arc and, therefore, controls the current used. This is regulated as required by the work to be done. The automatic control equipment gives thorough protection to the generator without affecting other operators whose welding circuits may be connected to the same generator. This equipment consists of a protective relay controlling a shunt contactor in the welding circuit. The relay is provided with an oil dashpot and, therefore, will not operate on momentary fluctuations of current. Before starting the arc, the operator sets the dial switch for the amount of current required for the work, so that, on starting, the circuits are in the normal running position. Thus there is no necessity for having any relays or switches open or closed, or in any way disturbing the electrical circuit in order to weld.

However, if the operator leaves the electrode in contact with the work too long, or takes too much current after having drawn the arc, the protective relay opens the contactor exciting coil, which, in turn, opens the welding circuit. In order to resume operations, it is necessary only for the operator to lift the electrode, breaking the circuit, whereupon the relay drops out, closing the contactor and restoring the circuits to the normal operating condition. This system gives complete protection to the generator and assists the operator by making it unnecessary for him to leave his work to close the circuit-breaker, or to lose time in any other way. Other operators, whose welding circuits are connected to the same generator, are not involved in any way, since this protection affects only the circuit in trouble. In case of an extremely heavy load or a severe short-circuit in the cables, the circuit-breakers on the main panel will open the generator circuit.

Aside from the use of judgment in the application of the electric arc-welding process, there are three rules that the operator must observe in order to obtain the best results in welding: (1) Hold a short arc. (2) Use a low current. (3) Always work on clean metal.

Electrode Holders and Cable

The electrode holders are generally designed in a simple manner mechanically, and provided with means for holding the electrode firmly. Generally a new electrode is held in the holder about half way down on the electrode, and moved out as required. The holder is insulated where the hand grips it, and provides for the connection from the source of current supply to the electrode. In the design of electrodes, small, flimsy, or light projecting parts should be avoided, as they are likely to be broken off or bent. It is highly important in the design of a holder to make it fool-proof to the extent that it is practically impossible to burn or damage it by accidental contact, so that it would become inoperative. Fig. 13 shows a recent design of electrode holder.

The cable leading to the electrode holder should be exceedingly flexible, so that the operator has absolute control of the holder and the arc. The cable generally specified is extra-flexible, stranded, dynamo cable, with varnished cambric insulation, covered with weather-proof braid. The following sizes of cable have been found suitable: Up to 200 amperes, size of cable, 225/24 of 90,000 circular mils; from 200 to 500 amperes, size of cable 375/24 of 150,000 circular mils; from 500 to 1000 amperes, size of cable, 650/24 of 260,000 circular mils. The figures indicating the size of the cable designate

Fig. 38. Welding Oil Stills by Electric Arc

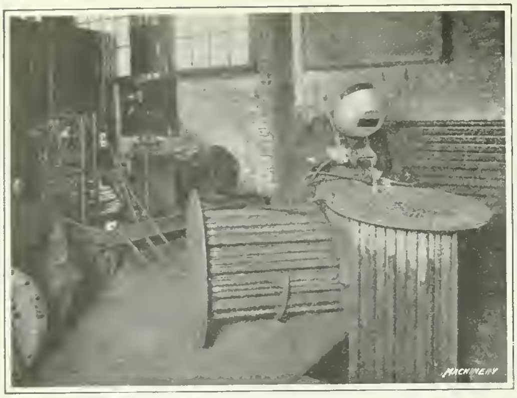


Fig. 39. Welding Air Compressor Intercoolers by Electric Arc

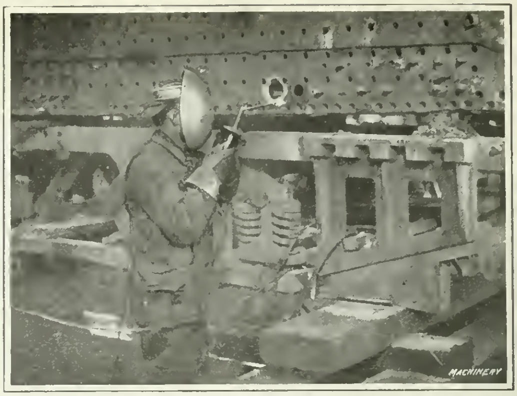


Fig. 40. Repairing a Locomotive Boiler by Arc Welding

the stranding; for example, a 225/24 cable is one formed by stranding together 225 wires, each of which is No. 24 Brown & Sharpe or American standard wire gage.

Striking Arc and Handling Electrodes

The arc is established by momentarily touching the electrode to the work and then withdrawing it a short distance. Practice is necessary in order to manipulate the electrode so as to maintain an approximately constant length of arc while welding. Skill in this respect is of importance to a welder, as variations in the length of the arc, in strictly constant-voltage machines, cause corresponding variations in the amount of current, which, in turn, causes variations in heat and thus in the quality and uniformity of the metal in the weld. As the carbon arc is considerably longer than the metallic arc, it is more stable and less likely to break. The metallic arc is very short, being only from 1/8 to 1/4 inch long. After the arc is established, it can be moved about along the work by merely moving the electrode. The carbon electrode is frequently used for preheating such work as castings, the preheating being extended a distance from the weld by keeping the electrode moving rapidly enough so as not to melt the work. In welding with the carbon electrode, the operator holds the electrode holder in one hand and feeds the rod of filling material into the arc with the other. The filling material is melted into the weld and mixes with the molten material of the work, forming a homogeneous mass of metal in the weld. As mentioned, the carbon arc is largely used for building up worn surfaces, owing to the rapidity with which a large amount of metal can be built up; but there are certain advantages in using the metal electrode for some classes of work, as will be mentioned in connection with the application of electric arc welding to railroad shops.

When heavy plate is welded with more than one layer of metal in the joint, the operator should brush off the layer of oxide from the metal with a stiff brush, commonly known as a "casting brush" or a "painter's wire brush." This is done in order that the metal throughout the weld may be free from slag and oxide. If this is not done, there will not be a proper adherance between the two layers of metal, which may result in a leaky or spongy weld. In work on tanks that will contain liquids under pressure, and where a homogeneous weld free from blow-holes is necessary, a short arc and slow speed in the work, with a comparatively low current, the metallic electrode being used, will insure the best results.

Protection of Operator

Owing to the intensity of the light and heat rays from the arc, careful protection of the operator's hands, face, and eyes is extremely important, especially in the case of the carbon arc, where the volume of light and heat is very great. Heavy gloves serve to protect the hands, while for the face, some form of shield held in the hand or supported from the head is used. This is provided with an opening filled with several thicknesses of ruby or blue glass, which affords protection to the eyes and still permits the welding operation to be closely followed. A satisfactory shield for building-up operations can be made of a soft pine board or sheet metal with a small slot in it for the protective glass. Firebox work requires a head shield which should be made of hard fiber. The color combination in the protective glass is of importance. Two red glasses and one blue glass or two reds and a green give good results. Special glass put out under various trade names is also satisfactory. As a rule, the operator tries several combinations until he finds one that seems to suit his eyes best. While the operator is working outside the firebox, the other men should be protected from the light of the arc by screens. Portable screens should be used where

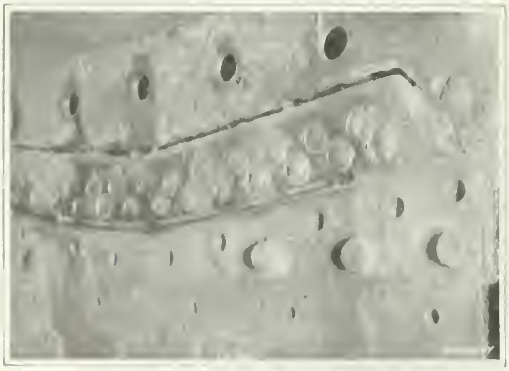


Fig. 41. Patch riveted to Mud Ring Ready for Welding

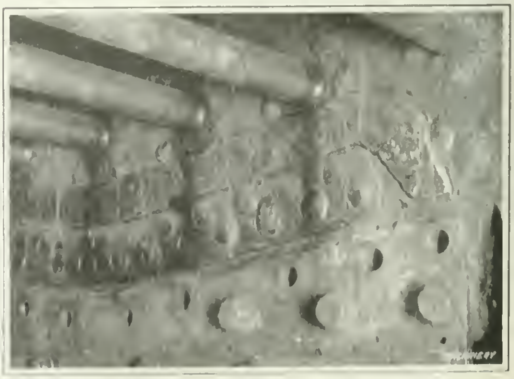


Fig. 42. Patch shown in Fig. 41 after being welded in Place

work is done on the floor. Where there is a regular welding bench, permanent curtains should be provided. The screens should always be designed to protect the crane operators from the flash of the arc. Figs. 14 and 15 show front and rear views, respectively, of two types of face shields used by the General Electric Co. A number of the illustrations in this article showing operators at work also indicate the different types of shields that are employed.

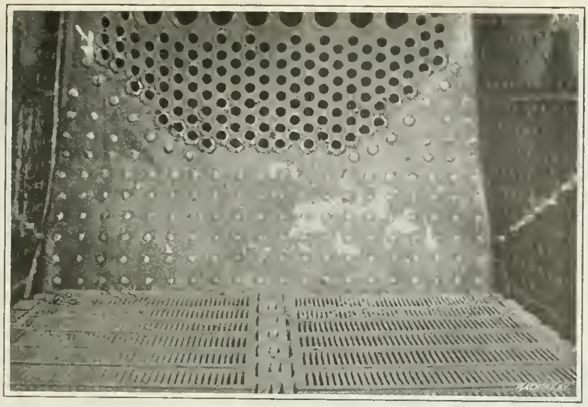


Fig. 43. Locomotive Firebox with Electrically Arc Welded Flue Sheets, Side Sheets, Flues, Superheater Tubes, and Brick Arc Studs

Capacity of Outfits

The C & C Electric & Mfg. Co., Garwood, N. J., builds constant-voltage equipments in sizes of from 300 to 1500 amperes, and constant-current machines from 25 to 600 amperes. The company recommends the constant-current type on the score of economy and higher efficiency in the welds. For large castings and forgings and, in general, for all sections of from 1 to 6 inches in thickness, machines of from 400 to 600 amperes capacity are required. Large shafting or parts of very heavy section require machines of from 600 to 900 amperes. In steel foundries, for example, machines of from 750 to 900 amperes are used, providing there is not much cutting or burning to be done. In the latter case, when heavy risers are removed and similar work is done by the arc, a capacity of from 800 to 1000 amperes will be required. The welding of sheet metal and steel plate does not require more than a maximum of 200 amperes, according to the thickness of stock used.

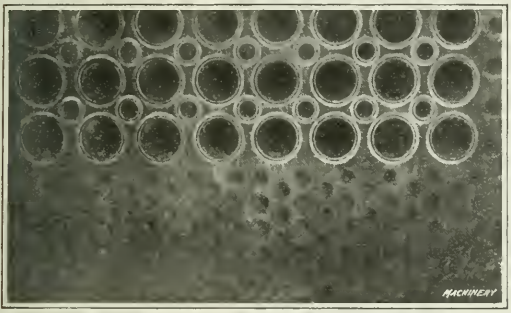


Fig. 44. Superheater Flues Ready for Welding

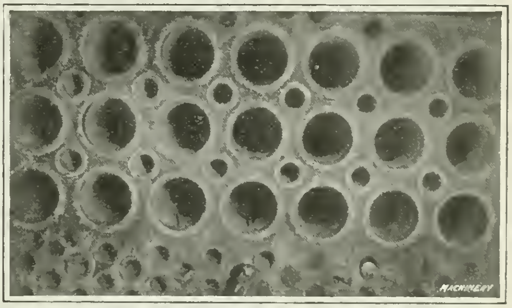


Fig. 45. Superheater Flues after Welding is completed

Fig. 46. Locomotive Bell welded by Arc Process

The General Electric Co., Schenectady, N. Y., builds outfits in capacities from 200 to 1250 amperes for stationary use, and from 200 to 400 amperes for portable use. For metallic electrode welding, machines having 200 amperes capacity are sufficient for one operator, and where a number of operators are working from one set, under average conditions, from 125 to 150 amperes per operator should be provided. For light welding by the carbon electrode, about 200 amperes is sufficient; for medium welding, up to 400 amperes; and for heavy welding, up to 500 amperes. For cutting or melting, from 300 to 1000 amperes is needed, according to thickness of metal.

Cost of Electric Arc Welding

It is difficult to give accurate figures covering the cost of welding, whether the work be done by the electric arc or by some other method. The work varies to such an extent that it would be impossible to give the exact cost of any particular job in advance. Furthermore, the cost of the current, the wages paid, and the skill of the welder will vary. All these factors, of course, have a direct influence on the cost of making the weld. Of the three factors mentioned, the first—the cost of the current—varies between the widest limits, as wages are fairly well standardized for this work, and the time required for making the weld should not vary much where good welders are employed. The costs in the following paragraphs are figured on the basis of labor at 30 cents per hour; at the present time the cost of labor will be higher than that, plants employing arc welding as a regular manufacturing process paying good welders as much as 50 cents an hour.

The C & C Electric & Mfg. Co. furnishes the following data showing the time required for, and the cost of, a number of actual jobs done with the company's 70-volt constant-voltage arc-welding outfit, labor being paid at 30 cents per hour and current figured at 2 cents per kilowatt hour: Forged steel locomotive frame broken in two places: time, 20 hours; cost, $18.28. Welding 67 cracks in old firebox (saving over $1000): time, two weeks; cost, $52.60. Steel shaft, 2 inches in diameter: time, 1 hour; cost, 60 cents. Cutting off riser of steel casting 4 by 4 inches: time, 4 minutes; cost, 5 cents. Building up 2-inch armature shafts worn in journals: time, 3 hours; cost, $1.80. These figures, of course, include only labor and current required, and not overhead costs. As regards the comparative cost of electric arc welding and oxy-acetylene welding, it is generally conceded that oxy-acetylene welding is cheaper for the welding of steel plate thinner than 1/8 inch, but that arc welding is cheaper when the plate is thicker than 1/8 inch, and the cost is materially reduced by arc welding for plates as thick as 1/2 or 3/4 inch.

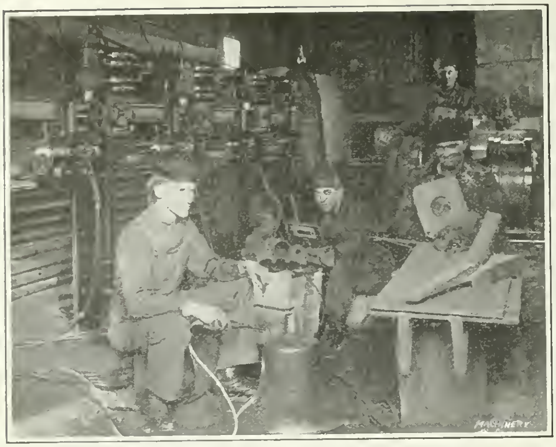


Fig. 47. Four Operators working independently from Same Generator

The Lincoln Electric Co., Cleveland, Ohio, in comparing the cost of welding with that of riveting, estimates that the ratio of the cost of labor for arc welding to the cost of labor for riveting is as 6.5 to 10. The cost of power required for arc welding as compared with that of riveting is as 1 to 2. The investment required by the arc-welding apparatus is about 25 per cent higher than the cost of riveting machinery, but this is easily offset by the lower operating and power cost.

Strength of Electric Welds

By careful selection of metal electrodes and skill in making the weld, it has been found possible to make welds having a tensile strength of from 95 to 97 per cent of the strength of the original section, but for average conditions it may be assumed that the electric arc weld has a strength of from 80 to 90 per cent that of the metal. It is possible, however, to reinforce the welded section in many instances by building up at the point of the weld, thereby making the cross-section of the weld greater than the metal itself. Electrically welded joints are stronger than riveted joints, and when the joint is hammered while hot the ductility of the metal will be increased.

Foster superheater flues made by the Power Specialty Co., and welded by the C & C Electric & Mfg. Co.'s outfit, were tested at Columbia University with a hydraulic pressure of 5500 pounds per square inch without leakage or fracture. A receiver made of 1/2-inch steel plate with 5/8-inch flat heads, all joints being welded, was tested with a pressure of 3600 pounds per square inch, without leakage or fracture.

In order to test the relative values of different kinds of welded joints, steel plate 3/8 inch thick was welded. If the original piece of steel be assumed to have a strength of 100 per cent, the electric arc-welded lap-joint was found to have a strength of 93.5 per cent, and the electric arc-welded butt-joint, a strength of 81.5 per cent. A riveted lap-joint, single riveting, had a strength of only about 60 per cent. With heavy sections like boiler plates, the strength after welding, given in the case of butt-joints, if properly made should average about 90 per cent of the original strength of the plate. The elongation in the welded material is less than in the original plate, because it is not as tenacious, but the ductility can be improved by hammering the weld while still hot, and this is frequently done on heavy sections.

In one case, 200 steel specimens welded together by the arc welding method were tested to determine the strength of the weld. The results of these tests indicated that the elastic limit of the original specimens was 46,900 pounds per square inch and of the welded specimens, 45,600 pounds per square inch. The ultimate strength of the original specimens was 61,500 pounds per square inch, and that of the welded specimens, 48,600 pounds per square inch. These specimens were steel bars, 1 1/2 by 3/8 inch, gripped 18 inches apart. The bars tested had been beveled on both sides and welded.

Figs. 16 and 17 show two interesting examples of electric welding, the welds having been tested for strength. Fig. 16 shows a six-inch standard wrought-iron pipe on which one cap at the end and one seam at the center were welded by the electric arc. A cap was then screwed onto the other end and the pipe subjected to a test pressure of 1000 pounds per square inch, which it withstood successfully. Fig. 17 shows an 8-inch standard wrought-iron pipe welded in the same manner. Here, when subjected to an internal pressure of 800 pounds per square inch, the cap screwed onto one end of the pipe broke as indicated, but the welds did not fracture. These tests were made by the General Electric Co. Fig. 22 shows the electric welding of a steam plate for a hydraulic press. Two 3/4-inch steel plates are held with keys and the joint between them is welded. The size of the plate is 40 by 40 inches and the steam pressure is 150 pounds per square inch. Of course, the keys in this case take the main strain, as far as holding the parts together is concerned, but the welding provides for a steam-tight joint at the pressure mentioned.

Quality of Weld

With regard to the nature of the weld, the Lincoln Electric Co. calls attention to a fact that should not be overlooked, namely, that the new metal in a weld is simply metal that has been melted and cooled again, and it partakes of the properties of cast metal rather than of rolled or wrought metal. For instance, in welding two pieces of boiler plate, the weld will have nearly as great a tensile strength as the original plate, but the weld is really cast steel, and therefore has not the ductility that the rolled steel plate possesses. By the use of special welding material, however, the Wilson Welder & Metals Co. has produced welds that will bend, when tested, almost the same as wrought iron or mild steel; this has also been the experience of the C & C Electric & Mfg. Co., when using its constant-current machine and regular Swedish iron electrodes, as advocated by this company.

It has often been stated that the welds are too hard to be machined, but this is a mistaken idea. A properly made electric arc weld can be machined as readily as a steel casting or a piece of flange steel. This characteristic of the weld has made it possible to employ the arc-welding process not only for repair work, but also in regular manufacturing practice.

Tank Welding

The best method to employ when welding tanks from plates that are 1/4 inch or more in thickness is to make a lap-joint and weld at the joint on both sides. In making lap-welds, the plates are overlapped an amount about equal to that required for single-row riveting. The best way of holding the plates

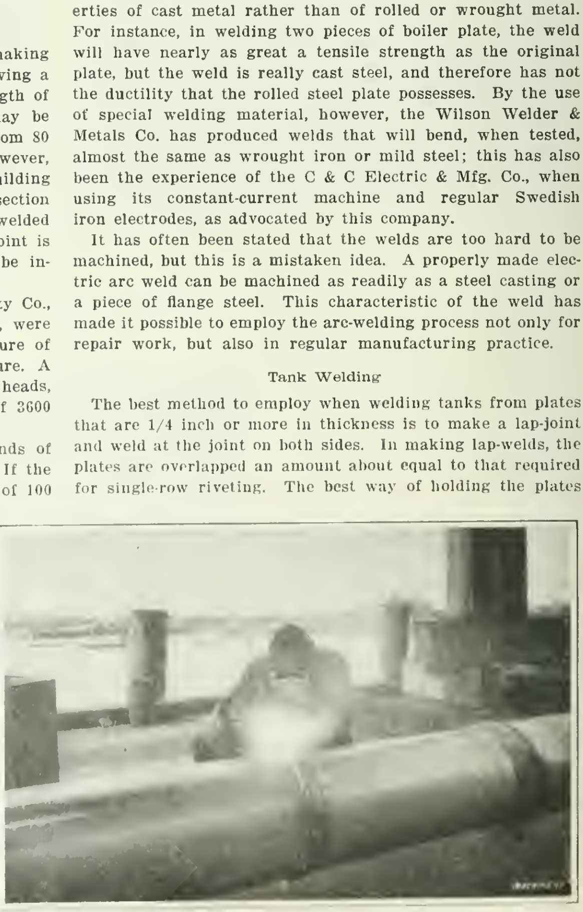


Fig. 48. Welding Bronze Sleeve of Steamship Tailshaft

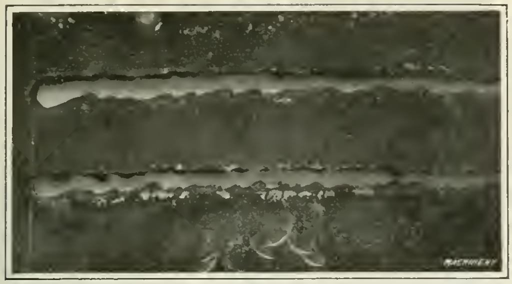


Fig. 49. Appearance of Cuts made by Carbon Electrode

together while welding is by drilling holes for bolts about 18 inches or 2 feet apart, and inserting bolts to hold the plates together while welding. When the welding is completed, the bolts are removed and the bolt holes are filled up by using the carbon arc and some filling material. The cost of making joints by lap-welding, when the preparation in handling the plates is considered, should be less than for butt-welding, because it is easier to assemble and hold the plates for lap-welding. When plates are greater than 1/4 inch in thickness, however, they may be beveled and butt-welded. For plates more than 1/2 inch in thickness, it is best to bevel the plates from both sides toward the center, forming a vee on each side, and then weld the plate from both sides. As this reduces the amount of filling by 50 per cent, the time may be considered as reduced to 40 per cent. This method can be applied, of course, only when both sides of the plate are accessible.

For plates 3/4 inch and heavier, carbon or graphite electrodes are sometimes preferable to metallic electrodes. Especially is this true when plates 1 inch thick or over are welded.

Fig. 50. A Collection of Castings with Heavy Risers which are cut off by a Carbon Arc

Applications of Electric Welding in Repair Work

Electric welding is used in the machine industries both in repair and manufacturing work. It provides a rapid and simple means for quickly repairing broken castings, so that machinery that has broken down may be rapidly put back into operation. By the aid of the electric arc, machines with broken parts may be put in running condition in a few hours, where it might require days or weeks if the parts had to be cast and machined. Fig. 18 shows a broken lathe steadyrest, and Fig. 19 shows the same steadyrest after being welded. Fig. 20 indicates the value of electric arc welding in cases of a serious breakdown. Here the arm of a radial drilling machine is broken at the post. In this case, the making of a new casting and the machining of the arm would have required considerable time. Fig. 21 shows the break welded and the drill ready for operation. In Fig. 24 is shown another large welding job in a casting that would be costly to make in the foundry and equally costly to machine. This is a bearing cap for a 500-ton punch press. The carbon arc was used in making this repair. This work was done at the Pressed Steel Products Co.'s plant with a C & C Electric & Mfg. Co.'s equipment.

Broken gears can be successfully welded with the electric arc, both in the case of broken arms and rims and broken teeth. In the latter case, of course, the tooth that has been built up must be machined. Fig. 23 shows a large spur gear with one arm broken in two places and the rim fractured in three places, which has been successfully repaired by a General Electric Co.'s equipment, while Fig. 26 shows an example of repairing the teeth in a bevel pinion with a Lincoln Electric Co.'s equipment. This illustration also shows a good form of face and head protector.

Another important field for electric arc welding is that of building up worn parts and filling in holes or defects in castings that would otherwise be scrapped. In Fig. 27 is shown an example of a casting with a large blow-hole that is being filled in and built up by using the carbon arc and a metal filling rod, so as to save the casting. In Fig. 25 is shown the reclamation of worn freight-car knuckles by building up the worn parts on the knuckles so that they can be used again. On one railroad line alone it is stated that the saving in one year in the reclaiming of freight-car knuckles that would otherwise be scrapped amounts to more than $20,000. This work is done with the Wilson Welder & Metals Co.'s equipment.

An interesting application of the electric arc is in building up flat spots on locomotive and car wheels. In Fig. 28 is shown an example of how the welding is done on a locomotive driving wheel in place on the engine. The cost of building up a flat spot amounts to about $2, and the saving is estimated at about $200. In Fig. 29 is shown a locomotive trailer wheel with a flat spot, the wheel having been prepared for welding by the electric arc. Fig. 30 shows the same wheel with the flat spot built up by welding.

Saving Worn or Wrongly Machined Parts by Building up by Welding

An important and interesting application of electric arc welding is met with in cases where parts that fit other machined surfaces are worn to such an extent that they would have to be scrapped. By building up by welding it is possible to replace enough metal on the worn surfaces so that they may be again machined to fit the parts into which they are assembled. This method is also applied in cases where shafts may have been machined too small for the journals into which they fit, or where, by an error, a boss or small projection may have been omitted in a casting or forging. The electric arc provides a cheap and simple method of correcting errors of this kind. In Fig. 33 is shown a valve yoke on which the stem has been built up by welding so that it can be again machined

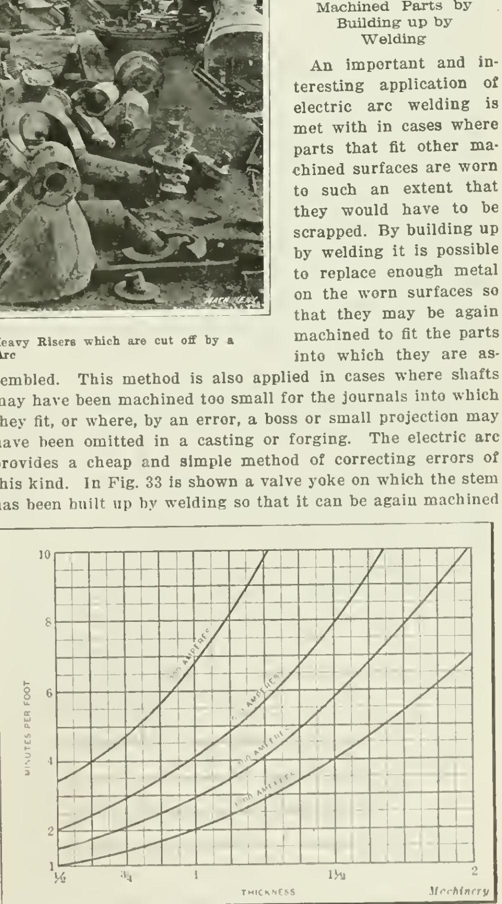


Fig. 51. Cutting Speeds when cutting Sheet Steel by Carbon Electrode

to full size. In Fig. 31 is shown an example of a 10-inch electric generator shaft which has been machined 1/16 inch too small. The scrapping of this shaft would have meant a considerable loss, but by building up on the surface that was too small in diameter, as indicated in Fig. 32, and remachining, the shaft was saved.

Fig. 34 shows an example of a forging that required a center in one end, which was not to be present in the finished piece. A lug for the center was omitted in making the forging. It therefore became necessary to weld a small punching onto the end of the forging for a center. This simple means of providing a projection on the end saved these forgings from being scrapped. Incidentally, the illustration shows the C & C Electric & Mfg. Co.'s face shield, which provides ample protection for the face and throat, as well as the upper part of the head.

Application in Manufacture of New Work

In addition to its use for repair and reclamation work, electric arc welding is employed to a great extent in the manufacture of many sheet-metal articles. Fig. 35 shows the welding of steel sheets for gear-cases, the outfit used in this case being that of the Lincoln Electric Co. The lugs on the inside of the gear-case are also welded into place. The welding of annealing boxes, oil-tempering tanks, etc., by means of the arc process has been found to be not only the most successful, but also the cheapest method of making these boxes and tanks. Fig. 36 shows a plating tank that has been electrically welded. This tank is 8 feet long, 3 feet wide and 2 feet high, and is made from 1/4-inch plate with a rim around the upper edge of 1/4 by 1 1/4 inch angle-iron. A tempering tank made from 3/16-inch sheets with a rim of 1/2-inch boiler plate is shown in Fig. 37. The size of the tank is 30 by 21 by 15 inches. The illustration shows clearly the nature of the welded seams. Fig. 38 shows some very large work being done by the arc-welding process. The work consists of oil stills at the Standard Oil Co.'s plant in Whiting, Ind., welded by the General Electric Co.'s equipment. The stills are riveted, but the joints are made tight by means of electric welding. Another example of the application of the electric arc to manufacturing work is shown in Fig. 39, where the tubes of air compressor intercoolers are welded in place at the plant of the Worthington Pump & Machinery Corporation, Cincinnati, Ohio.

Another example of electric arc welding is found in the welding of steel barrels by the Standard Oil Co., using the C & C Electric & Mfg. Co.'s equipment. In these barrels, the longitudinal seam is welded electrically. The bulge of the barrel is then obtained by hydraulic pressure, showing that the efficiency of the weld is high and that the heat of the arc has not affected the strength of the steel to any appreciable extent.

Application of Electric Welding to Railroad Shops

There are a great number of instances where electric arc welding may be used to advantage in railroad shops. In fact, the railroad shop offers one of the greatest opportunities for the application of the process. It is used to a large extent in many shops in building-up operations. Practically every steel casting on a locomotive is subject to wear at several points. Where worn, the metal may be built up again, by means of the metal electrode process, both cheaply and rapidly. Most of these building-up operations are done with a 5/32- or 3/16-inch electrode. The use of smaller electrodes is not economical, owing to the slow progress of the operation. The use of larger electrodes is inadvisable on account of the difficulty in controlling the metal. Metallic electrodes should be used in preference to carbon electrodes for welding of this kind, for the following reasons: (1) Steel castings welded with a carbon arc would have to be annealed, which entails additional cost and delay. (2) The metal can be deposited at the exact place where it is required more accurately by the metal electrode process than by the carbon electrode method; and, therefore, while the carbon arc process is somewhat more rapid than the metallic arc method, the time saved in the welding operation by the carbon arc would be lost in the machining operation on account of the inaccuracy of the location of the deposited metal. (3) The operator requires less skill in the use of the metallic arc than in the use of the carbon arc when the process is used for building-up operations; when applying metal with a metallic electrode, the operator is forced to move along as fast as the metal is deposited; with the carbon electrode, he may dwell longer, but is, however, likely thereby to produce a burned spot. (4) Hard spots are not produced when the metal electrode process is used for building up.

Flue Welding

Electric arc welding is also frequently used for welding in the firebox and for flue welding. The process recommended by a sub-committee of the Association of Railway Electrical Engineers is as follows: Welding in the firebox should be done with a 1/8- or 5/32-inch electrode. The best metal is obtained in the weld with these sizes. The amount of heat is as small as can be economically used. It is evident that, owing to trouble from expansion and contraction, the quantity of heat it is possible to use in welding flues or firebox sheets is limited. The ideal preparation of a set of flues for welding is as follows: (1) Put flues in exactly as if they were not to be welded. (2) Fire the boiler, or, better still, send the engine out for a run. The object is to burn the oil out from under the beads of the flues. (3) The flue sheet should then be brushed with a stiff wire brush or sand-blasted. The object is to eliminate, as far as possible, the scale of oxide on the flue sheet and flues. Iron oxide is not a good conductor of electricity and causes difficulties with the arc, which, in turn, may produce a poor weld.

The welding of 2-inch flues is best done with a 1/8-inch electrode. On sand-blasted flue sheets, from 90 to 100 amperes is enough current. Flue sheets that have a thick coat of oxide require from 120 to 130 amperes with this size of wire, and the weld will not be satisfactory. Five-inch flues should be welded with a 5/32-inch electrode and with from 120 to 140 amperes, depending upon the condition of the flue sheet.

Cracks or Seams

Cracks and patch seams offer the most difficult problems to the operator. A crack should be located and a ½-inch hole drilled at least two inches beyond each end. The edges of the crack should then be beveled so that the operator can reach them to make the weld. On horizontal cracks, the lower edge does not need to be beveled, but should be chipped to produce a square edge. The upper edge should be beveled at least 45 degrees. Vertical cracks should be beveled from 30 to 45 degrees on each side. The less material removed from the crack the better. All welds should be made with the least possible amount of metal between the edges of the original material.

If the crack or seam is a long one, the metal should be put in alternate sections of from four to six inches long. The operator should put one layer of metal in each of these alternate sections, starting near the center of the seam or crack. The open sections can then be filled, starting at the coolest point. Successive layers of metal can then be applied until the seam is completed. Wherever possible, at least 30 per cent of reinforcing should be applied so that the cross-section through the weld is 30 per cent greater than the section of the original plate. After each layer of metal is welded into the seam, it should be thoroughly brushed with a stiff wire brush to remove as much of the oxide as possible. Where the sand-blast is available and can be used on the job, the results will justify the expenditure of time necessary to clean the metal between the layers. The same general care should be taken in the welding of locomotive frames as in the case of the boiler plate of the firebox.

A number of examples of the application of electric welding to railroad work are shown in Figs. 40 to 47, inclusive. Fig. 40 shows the repairing of a locomotive boiler at the Toledo & Ohio Central shops at Bucyrus, Ohio, the metallic arc with the General Electric Co.'s outfit being used. Figs. 41 and 42 show a patch 10 inches wide and 5 feet long being riveted to the mud ring of a locomotive on the Central Railroad of New Jersey. The vacant space indicated is left for welding. Fig. 42 shows the patch after being welded in place. Figs. 44 and 45 show the application of electric welding of superheater flues on the Atlantic Coast Line, the work shown in Figs. 41, 42, 44 and 45 being done by using a C & C Electric & Mfg. Co.'s equipment. Fig. 44 shows the flues ready for welding, and Fig. 45, the job completed. Fig. 43 shows a locomotive firebox with electric arc-welded flue sheets, side sheets, flues, superheater tubes, and brick arc studs, indicating the wide range of work for which the process is adapted.

Welding Non-ferrous Metals

An interesting application of electric arc welding is that of welding locomotive bells. Fig. 46 shows the cracked bell repaired, the dotted lines indicating the weld. The cost of this welding is $2.60, and the saving by welding is $7.50. This example of electric welding is especially interesting on account of the fact that bell metal is being welded. Fig. 47 shows the welding work on the bells being carried out. The work is done by the carbon arc, using a filling-in rod. Other welders are also shown at work using current from the same generator, but each welder having a separate control panel. The control equipment shown in the background is that of the Wilson Welder & Metals Co.

Another example of the welding of non-ferrous metals by the electric arc is shown in Fig. 48, where a General Electric Co.'s equipment is used for welding bronze sleeves for a steamship tailshaft by using a bronze electrode. The shaft is 13 inches in diameter and the sleeve is welded together from three sections, the total length of the sleeve being 13 feet. The metal being welded is 3/4 inch thick; the edges are beveled preparatory to welding.

Cutting or Melting Metal with a Carbon Electrode

When cutting or melting metal with the electric arc, a carbon electrode must be used. The electrode is operated in a manner similar to that used when employing a gas torch for metal cutting. The electric arc actually melts the metal away, it being held at one point until fusion occurs and the melted metal runs off, after which the arc is slightly advanced, and in this way a path through the metal is gradually melted. The width of the groove cut depends upon the size of the electrode used and on the skill of the operator in advancing the electrode along a straight line. The cut will be slightly wider than the diameter of the electrode, and is also wider for thick sections than for thin ones, as the electrode will melt away more metal when the arc has to be played on the bottom of the cut. It is not possible to obtain very smooth edges of the cut on account of the fact that some parts of molten metal will not run away evenly, and also because the arc has a tendency to jump from one point to another, causing an uneven cut. Fig. 49 shows an illustration of cuts made by the carbon arc in 1/2-inch boiler plate. For cutting steel plate where a smooth edge is required and much cutting is to be done, the oxy-acetylene process is conceded by the makers of arc-welding apparatus to be preferable, because a smoother cut is obtained. For cutting cast iron, however, the electric arc is equal or superior to the gas torch, and for cutting off heavy risers in the foundry on both steel and iron castings, and for cutting up scrap where a ragged edge is of no importance, the electric arc is used to advantage. Fig. 51 shows a diagram of approximate cutting speeds for different thicknesses of sheet steel and for various current values. The cutting speed is lower than is possible with the gas process, which burns away the metal rather than melts it, but with a reasonable power rate, the cost of cutting by the arc is much lower than the cost of cutting by means of gas, in a great many cases. Where the metal is rusty or where blow-holes are encountered in steel castings, the electric arc will cut the metal with equal ease, while the gas process cannot be employed in cases of this kind. The metallic electrode cannot be used for cutting metals.

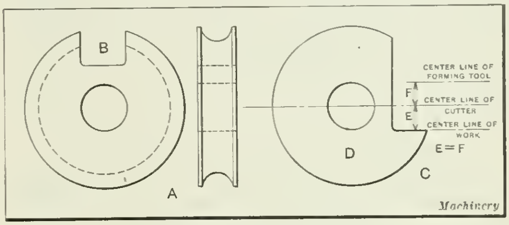
Fig. 50 shows a number of steel castings in the shops of the Marion Steam Shovel Co., showing heavy risers which are to be cut by means of the electric arc.

In the preparation of this article on electric arc welding, the writer has been assisted by the C & C Electric & Mfg. Co., the General Electric Co., the Lincoln Electric Co., and the Wilson Welder & Metals Co., to all of whom he is indebted for the courtesy shown and the assistance they have rendered.

MAKING A FORMING TOOL

BY FRED J. MILLER[1]

Many articles have been published in technical journals explaining how to develop the curves of a forming tool that when set either above or below the center of the work will reproduce the form of the templet made to fit the work. All this is entirely unnecessary if we remember that, when finishing a forming tool in the lathe, the shaping tool should be placed as much above the center of the cutter being turned as the cutting edge of the cutter will be below the center of the work when it is in use. This will automatically modify the form of the cutter and will do it with absolute precision without any necessity for developing curves or for making any calculations whatever. In the illustration at *A* is a forming cutter, and if we mill a gap in this cutter as shown at *B*, the outline formed by the intersection of this gap with the periphery of the cutter will be the same at both sides of the gap. This principle when applied to the forming of the cutter is shown at *C*, where *D* is the cutter, set with respect to the center line of the work as shown; cutter *D* is supposed to have been formed by a forming tool placed on the upper line indicated, and this forming tool should be the exact shape of the work to be produced. It may thus be made from the work itself or from a templet prepared for the purpose, which represents the form of the work and may be of thin steel clamped in a suitable holder.



Position of Cutter Forming Tool

This same principle can be and has been applied to fly cutters such as are used for temporary jobs in cutting gears, etc., in a milling machine; clearance is obtained by forming the cutter when its face is set a certain distance back of the center line, the cutter being afterward used with its face set the same distance ahead of the center line. The same principle is also applicable to form milling cutters which have what is known as "rake" in the cutting teeth. Not only is it true that by this method a great deal of time and labor are saved in developing curves, making templets, forming tools, etc., but much better and more accurate results are obtained than can possibly be obtained by the method of calculation and development.

* * *

THE LIBERTY MOTOR

The recently designed "Liberty" motor is shown by tests to be an especially efficient engine, and it will be used on all U. S. airplanes and motor trucks; the twelve-cylinder engine has surpassed the expectations of its designers. While this motor will be made with four, six, eight and twelve cylinders, the design allows the maximum interchangeability of parts; thus the valves, camshaft drive, pistons, single cylinders, and many other parts can be used on any of the four models. A twelve-cylinder engine can be made up from eight-cylinder parts with the addition of the extra cylinders, etc., and the crank-case and crankshaft. In the same way a six-cylinder engine can be made up from four-cylinder parts with ease. Although this motor has been developed largely by two engineers, one connected with the automobile industry and the other with aviation, it is a combination of the best features of engine design, both American and foreign. It has been so designed that it can be manufactured cheaply in great quantities, and differs from the best foreign engines in the elimination of the great amount of hand work the latter require.

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ORGANIZATION AS AN ASSET

It is said that Carnegie, when asked what would happen if his mills should be destroyed by fire, or if he should suddenly lose all his material wealth, answered: "If I had my organization intact, I could regain it all in ten years." No doubt the remarkable success of Carnegie as a steel manufacturer was partly due to his realization that the physical assets of his business in buildings and machinery were but a minority of the factors that contributed to the building up of his fortune, and that the important one was an organization of men properly trained and willing to cooperate toward a common end. Many manufacturers lose sight of this fact. They appear to look upon the machinery and the buildings as the main assets of their business, and prize but lightly the organization that stands, or should stand, behind the physical assets. A strong man may be able to manage successfully an organization that is only loosely tied together; but as soon as he hands the reins over to someone without executive ability, the whole organization may go to pieces. Everyone who has observed the history of industrial business has seen examples of this. It is of the highest importance, therefore, to the permanency of any business that the organization be such that it can continue in the absence of any one man, and also such that the people who compose it are so closely tied to the organization on account of the appreciation of its ideals and the things that it stands for, that they do not scatter when some break occurs. Recently we saw an example of an excellent organization that was greatly impaired because one executive left and took with him a dozen other of the best men, forming a new concern; and he was able to do this because, in the old organization, nothing had been done to tie those men to the enterprise either by sympathy, cooperation or otherwise. As to physical assets, the old company is as well off as ever. All its machines and all its buildings are there; but the men who could get the best results out of the machines have gone, and a considerable part of the assets has gone with them.

* * *

IMPORTANCE OF MECHANICAL TRAINING

The European war has demonstrated the vital need of machinery and mechanical training in carrying on the conflict. We know that the mechanical engineer is the moving spirit of our modern life, in which machinery plays so important a part; but the effect of the training received by the mechanical engineer on his mental attitude is not so fully appreciated. As a result of his training and experience, he has learned to reason straight, to separate cause from effect, and to accept no effect without a cause. He has become imbued with the spirit of cooperation, and therefore is liberal minded. The training of the mechanical engineer should make him broad and constructive, while the training of some professions often tends to produce opposite results.

We venture the prediction that in fifty years the so-called classical education now often inflicted on young men will be greatly modified. Instead, they will be trained to think and act. Culture for culture's sake will be at a discount. The change will come because of greater liberality and democracy and the elimination of caste. The training received by the mechanical engineer should fit him for any business activity; that is, his educational foundation is a basis on which any business man may work effectively. Engineers will be trained not merely to be engineers, but to be business men having the capacity to grapple with the mechanical problems incident to manufacturing, railroading, transportation, municipal government, etc. The prime cause of much inefficiency in municipal government, as well as in business generally, is that the men at the head do not think straight and have little capacity to organize and direct.

* * *

SIMPLICITY OF FASTENING DESIGN

Machine designers often miss a golden opportunity for saving in the cost of manufacture of details by being too careful in proportioning the fastening details. It is not uncommon to find a machine well designed in all its essential mechanism which requires a large variety of screws, studs and bolts to hold the parts together. The screws may have been carefully selected with due consideration of their respective stresses and functions, but that scrupulous care may have resulted in carrying out the design with too little regard for the cost of production. It might have been better, from the manufacturing standpoint, to have made some of the screws larger than actually required for strength, or to have used two small screws in place of one large one so that as many as possible could be of one size and type. Thus time would be saved in drilling and tapping, and less variety of screws would be required in stock.

An eighteen-inch engine lathe is being built in which the fastening screws, with a few exceptions, are $\frac{5}{8}$ inch diameter and of the same length. In some places, of course, a $\frac{5}{8}$-inch screw is too large, and in others it is necessary to use two screws instead of one. Some holes have to be drilled and tapped deeper than is really necessary; but the gain outweighs the loss. By standardizing to one diameter and length of screw only, much time is saved in machining and assembling, and the job of making and keeping stock is simplified.

Substantial economies have been effected in the manufacture of typewriters by standardizing machine screw body sizes and heads and by eliminating many odd shapes and lengths. Instead of using thirty different screws in a carriage, only seven are used in the same part of a new machine. The same company has also discontinued using some gages of sheet metal stock and now uses as few as practicable. In these times, when it is extremely difficult to get anything but standard sheets from the mills, it is highly important that the use of odd gages be avoided; but if their use can be avoided in abnormal times, why not always in the interests of simple stock keeping and efficient manufacture?

Bolts fitted in reamed holes rarely, if ever, require hexagon or square heads. The fit of the body in the hole should be sufficient to resist the torsion of the nut when tightening or loosening it, but the practice of using forged hexagon head bolts is general in locomotive building and repair shops. Considerable saving can be made by using round head bolts with narrow shoulders under the heads. The height of the head need not be more than three-fourths the body diameter. Bolts of this shape can be turned from bar stock when needed for quick repairs.

TOOL DESIGN IN THE MANUFACTURE OF MUNITIONS

BY D. B.

Not many months ago the writer was a toolmaker in a watch factory that had turned its plant over to the making of time-fuse parts. The work was of unusual interest on account of the numerous accurate gages, jigs, fixtures, and special machines that had to be designed and built. It was a line, in fact, that put to the test all the skill acquired in sixteen years' experience as a general machinist, tool-, die-, and gage-maker. In love with the work and with no reason to complain of conditions, the writer might have been there yet had not one of those pests that occasionally trouble the best of us—a tool thief—gone off with one of his pet tools. To the layman this might be passed over lightly as a matter of only a few cents, but to the real toolmaker it is a most serious matter. So when a second tool was missed, "wanderlust" seized the writer, with the result that he answered an advertisement for tool designers on time-fuse parts. As the place was near by, the writer was soon on his way, although his previous efforts to get on to the board with various concerns were unsuccessful, notwithstanding the fact that he had had some night-school and correspondence-school work. In the interview that followed, the superintendent said that he wanted a designer, a man of ideas, rather than a draftsman, but he finally decided to give the writer a trial even though he had no drafting-room experience.

The plant he now entered had all new equipment, which had cost close to a million dollars. Its drafting department for nine months had been in charge of a draftsman who had been paid about $30 a week. He was a good draftsman but had no shop experience, which is absolutely essential to a thoroughly efficient tool designer; yet he had been put in charge of the most important and vital part of the plant. The result was that some of the tools were too complicated and costly, as well as inefficient for the work for which they were intended, while other tools were as crude and elementary as if they were designed for only a dozen pieces rather than for the thousands they were expected to handle. To make matters worse, practically all the tools had been built in quantities that had been estimated as sufficient to finish the contract, or were in process of construction at the time the writer was employed. Thus the design of new tools and the redesign of such as could be made to answer the purpose meant the scrapping of thousands of dollars' worth of tools, jigs, and fixtures; but it was done, and results proved that it paid.

Before this was done, however, it was necessary to reorganize the drafting department, which consisted of about half a dozen draftsmen, none of whom had had shop experience along toolmaking lines. They were men with technical education and a knowledge of drafting, and were slow to grasp new ideas or to originate such as could be put to practical use, and so required constant attention and instruction on every detail.

The drawings were being made on detail paper and turned over to a tracer to be inked in on tracing cloth, and this took so much time that it often required several days to get out a comparatively simple drawing. Realizing that the drawings would only be used for a short time, or until the tools were made and in use, and were not likely to be required for a permanent record over a course of years, the writer decided to eliminate the tracing as far as possible. Yet, as a number of blueprints were required for use in the various tool shops engaged on work for the plant, it was necessary to make the drawings on some transparent medium. After various trials a tracing paper called "Vellum" was adopted, being very transparent, fairly easy to work on, and of fair erasing quality. Except for work that required very accurate lay-outs, all drawings were made directly on this paper with a soft pencil, about 2H or 3H. Excellent blueprints could then be made direct from the original drawings without the necessity of inking in. This change speeded up the work of the department considerably, but did not give the kind of men wanted, so an advertisement was published for toolmakers with a knowledge of drafting for a tool-designing department. For this the writer was roundly criticized by one of the men, who said that it looked as though toolmakers rather than draftsmen were wanted. This was the case, as he discovered when he received his next pay check. That the plan of using toolmaker tool designers was satisfactory was proved by the number the superintendent transferred to more responsible positions in the organization, and by the writer's advancement two months later, when the tooling proposition was well in hand, to the position of assistant superintendent.

Changes Made in a Canadian Plant

Later, an attractive offer from a Canadian firm engaged in the same line took the writer to Canada, ostensibly to become tool-room foreman but actually to improve upon methods. Conditions there were much the same as they had been with the firm he had just left. The drafting department consisted of two men. One, who had the title of chief draftsman and received $25 a week, was as fast a worker as the writer has met, but he had absolutely no knowledge of shop practice and could only work to sketches or at the direction of someone else. The other man was employed as a tracer. Ideas had been furnished by the various department heads and by the superintendent. The former had little knowledge of time-fuse manufacture, while the latter, though a fine mechanic, had his attention so taken up with his executive duties that it was impossible for him to give the matter the attention that was needed.

The principal trouble was with the large parts of the time fuse, namely, the body, rings, cap and base plug. The brass forgings were extremely hard and gritty, probably having been made of sweepings and other miscellaneous scrap metal. In fact they were so bad that the New Britain chucking machines used on the roughing operations were not strong enough and consequently were frequently in need of repairs. Also, the tool-heads, each of which required a half dozen tools, were designed to take square tool bits through broached holes, which are almost impossible to machine accurately. As a result, no two heads were standard in that respect, so that the tools had to be ground according to the head for which they were intended. Later heads were made to take a form tool that could be ground on the face and always retain its shape, and care was exercised to make them interchangeable.

For the finishing operations on the body and cap, the firm had designed semi-automatic machines, which were built in shops that were more familiar with agricultural implements, or wheel-barrows than with the exacting requirements of high-grade tool work. All fits on the machines had been "cataleptic." The spindles (2½ to 3 inches in diameter) were made from a poor grade of wrought iron, were full of seams, and were run direct in cast-iron bearings; but oftentimes the oil-holes had no connecting oil-grooves, although the machines were designed to run at speeds of about 1500 revolutions per minute. These machines, over thirty all told, were designed primarily to do the work ordinarily done on plain turret screw machines. How well they served the purpose may be gathered from the writer's experience with them.

The machines that were intended to form the outside of the cap had two slides working up and down in a vertical plane; one of these carried the roughing tool and the other the finishing tool. These slides received their motion from cams, which had to have a rather long dwell, as they were driven direct from the work-spindle, which had to be stopped with a hand-brake. This brake consisted of a block of wood that was wedged in between the belt and the frame of the machine after the overhead clutch was thrown out. The caps were screwed onto an arbor that was operated by means of an eccentric stud and a socket wrench. As the production per machine never exceeded 500 caps per day, ten machines had been built for a daily production of 5000 caps. As a matter of fact, it took all ten machines to get a production of from 1000 to 1500 caps per day, for there was a continuous procession of these machines to and from the tool-room, in the care of toolmakers, machinists, and belt men.

As the oil-holes were uncovered, they served as excellent catch-alls in which were collected the flying particles of brass thrown off by the tools when the machines were in use. The result was the wearing away, in a twenty-four-hour run, of as much as one-sixteenth inch of metal from the top of the bearings, where the pressure of both the cut and the pull of a heavy four-inch belt came. In addition, the cap forgings were not uniform in size, so the machines frequently stalled, jamming the cutters into the work and often breaking the threaded arbor on which the work was held.

The writer fitted all these machines with hollow spindles of pack-hardened and ground machinery steel that were fitted with draw-back arbors operated by a hand-lever at the left, of similar construction to that found on the usual run of hand screw machines. The automatic slides were replaced by a heavy cross-slide operated by a rack and pinion and a hand-lever; this also was like a screw machine cross-slide except that it was about seven inches wide while in screw machines of approximately the same size the slide is about four inches wide. A roughing and a finishing tool were mounted on this cross-slide, one in front and the other at the back. Felt wipers placed in grooves cut at the bottom of the bearings and sight-feed oil-cups insured a good supply of oil to the bearings. The production immediately rose from a possible 500 to an actual 2000 rings per day per machine, and the procession of machines to the tool-room ceased.

Besides, there were seven of these cap shavers that could then be converted to other purposes. These were, therefore, fitted up the same as the machines just described, with the exception of the chucks and tools and were then used for turning the bevel and facing the rings. These operations had previously been done on No. 4 Stark bench lathes, fitted with simple expansion chucks and using the regular compound cross-slide, with a special tool-block fitted up to take two tools. This change, from a light and inadequately powered machine, to a high power and efficient one, raised the production from about 1500 to 4000 rings a day. In addition, it gave the nucleus of a bench-lathe equipment for the tool-room, something that was badly needed. As some grinding attachments, collets, countershafts with grinding counters attached, etc., that had been ordered long before were received at this time, the plant then had the necessary equipment for making the hundred and one kinds of small gages that had previously been made outside, as well as bushings for drill jigs, etc. The lack of this equipment had handicapped the plant, for large machines that were badly needed for other purposes were frequently tied up with this work.

These are only a few of the many instances where changes were made. Machinery, jigs, fixtures, and tools were discarded and in most instances replaced with better that not only cost less money, but increased production greatly. For instance, a special milling machine that weighed about a ton and had cost, duty and all, probably a couple of thousand dollars, failed to produce sufficiently accurate work, was always getting out of repair, and never produced more than 1200, good, bad, and indifferent pieces, so it was replaced by a milling machine that was built in the tool-room, weighed less than seventy-five pounds, and cost less than $200, but which had a capacity of 5000 pieces and could be depended on to produce uniformly good work.

Economies Effected by Rearrangement of Plant

Recently the writer was asked by a man for whom he once worked, and who is mechanical superintendent of one of the plants of a very large concern, to join his organization, if only for a month, and help push through the tooling up of a new job. The work was along the same lines as that they had just completed, but there were some changes in size and construction; the plant employs about 6000 men, most of whom are machine operators. As it was possible for the writer to get away from the work he was then on, arrangements were made whereby he was able to join the organization for two months.

This plant had just finished a large contract on a certain class and size of work, and the men were, or should have been, familiar with all the best methods for producing this particular line. Yet it was possible for the writer after going through the plant under the guidance of the chief draftsman one Saturday afternoon, to lay out between then and the following Monday, changes that saved in labor costs alone upward of $5000, and this with very little expense. This alone would pay the writer's salary for the period he was there several times over, even though he accomplished no more. A few days later, while strolling through the plant, his attention was called to a group of men who were coiling lead cable on reels as it came from the extrusion presses. There were thirty-two reels in the installation, sixteen being wound at one time while the others were spare reels mounted alongside the live reels and were used as soon as the others were filled. Sixteen men were required, one man to a reel, so the writer immediately tried to devise some way to do the work by machinery and do away with the men. At once the bobbin winder on the common household sewing machine came to his mind, so it only remained to put the idea in practical shape and to keep the cost low enough to make it a paying proposition. He was told that to be on the safe side he should figure the job as if it were only to last three months. On that basis, a winding mechanism was designed the estimated cost of which did not exceed $2000. At this rate and estimating the time of the fourteen men that it will replace, two being kept to change the cable from the full reels to the empty and to look after the oling, etc., of the machinery, the saving would amount to about $3000. Should the work last longer than the three months, as it undoubtedly will, the saving would be greater in proportion.

In practically every instance, the loss occasioned by these mistakes would have been avoided had an experienced tool designer been put on the job in the first place and been allowed to devote all his attention to this work. Some may say that it is hard to get such men, but to statements of this kind there is only one answer. "Pay the price and the men can be had." Their salary, no matter how large it may seem, will be very small in proportion to the price that will be paid for such mistakes as those that have been described and which seem to be very common in munition work. These mistakes are also due to the tendency of executives to turn their hands to tool design rather than place the matter entirely in the hands of specialists, and make them entirely responsible for the results.

Lessons Taught by Experiences of Munitions Manufacturers

Summing up the results of his experience, it would seem to the writer that there is an unlimited field for the mechanic draftsman, and toolmaker tool designer to replace the technical mechanical draftsman. The former, at least the kind the writer has in mind, has put in the greater part of his working life at the actual making and designing of tools in the shop where they are to be used, and more often than not he has had to set them up and give them a thorough trial before they were turned over to the manufacturing department. He has learned from experience about what any given piece of metal will stand before it will break, and his judgment is not based on the working out of elaborate formulas of strength of materials, but is quite frequently the result of failures on the part of the technical draftsman to use a high enough factor of safety when designing the part. In other words, the best part of his knowledge has frequently been gained through the mistakes of others. In addition, he has a knowledge of cutting tools and their action and has had the opportunity of sharpening them in different ways and of noticing how they worked under different conditions. He has also run them to the breaking point in the effort to find out their limitations and the limitations of the machines in which they were being used. Speeds, feeds, and many other things for which there are no formulas have become matters of instinct, to be used when and where they are needed without hesitation. Besides he has been handling the work of other draftsmen in the form of blueprints, etc., from the time he entered the shop as an apprentice; he has been in a position to criticize their work, to discriminate between the good and the bad, and if he has had the initiative he should have to be a success, there have probably been many times when he has been allowed to work out his own ideas as opposed to the ideas sent out from the drafting department. He cannot have failed to notice the innumerable useless dimensions put on the average drawing, and having noticed, and being in a position to know very nearly what his brother mechanic will require, his drawings will not have this fault. Knowing also the methods that will be used in machining every detail of the parts which he designs, each part is machined mentally as it takes form under his pencil, and so, as he puts himself in the place of the man at the machine, he is very careful to see that so far as possible difficult machining operations are eliminated from his designs. Also, as the work on the board progresses he is mentally assembling the parts one by one in the rotation the man in the shop will afterward use, and in that way he avoids the expensive mistakes, which are all too common, of forgetting to allow proper clearance. For instance, not long ago an expensive and elaborate jig was given to the writer to assemble, the rough work on the parts having already been done by various machine operators who had not seen the assembly drawing or were not in position to criticize it. This jig had been designed by a young man fresh from school who was not accustomed to work of this kind, and while it looked all right on paper, at first glance, a shouldered spindle could not be placed in its bearing because of its length, another bearing in front of it interfering; this bearing was also too small for the spindle to pass through and into its own bearing. As a result, the parts had to be scrapped and a new design made. Had this jig been assembled, even mentally, as it was being drawn, this mistake would not have occurred. And so, henceforth, give the writer men who have had their hard knocks in the shop first; even though they cannot write the name of some famous school on their application blank, if they have been students of the "College of the Midnight Lamp" they will not go very far wrong.

* * *

PIECEWORK PRICES

A workman is paid for what he does, no matter whether he is working by the day, week or month. Actual production, in the last analysis, is what determines his rate of pay. Hence, the piecework system under which a workman is paid directly in proportion to effort is undoubtedly the most equitable and satisfactory system of compensation, when honestly administered, that has ever been devised. The difficulty with the piecework system is the lack of mutual honesty. Secretary William C. Redfield of the Department of Commerce and Labor, at an editorial conference meeting in New York in October, quoted from an address of the Right Hon. Christopher Addison to the British Parliament on the work of the administrator of munitions in Great Britain, as follows:

> Nothing in the relations between labor and capital gives rise to more difficulty and distrust than two customs which are dependent upon each other. The first is the cutting of rates of pay on piecework, so as to limit the increase of earnings when improved methods of manufacture leading to a greater output are introduced. It is not the practice of the best employers, but it is adopted by many. This practice, or the fear of it, has inevitably led to the second and retaliatory practice of the reduction of output. The influence of these two practices in our industrial life is poisonous. We must establish a system whereby both classes have a direct interest in the introduction of improved methods. Without it our progress will inevitably be accompanied by endless disputes. The accounting side of the ministry has abundantly proved that modern methods of production are not only well able to afford good wage rates, but are benefited by so doing.

* * *

On account of the present high price of coal in the Scandinavian countries, a wrecking company has started work in an effort to recover a cargo of 1200 tons of coal that has lain at the bottom of the Great Belt, a mile north of Nyborg, Denmark, for thirty-four years. The cargo was that of the steamer *Dorka*, which sank in 1883. It is believed that nearly a thousand tons can be recovered. Samples recovered show the coal to be undamaged by its long immersion.

COMBINED TWISTING AND BENDING MOMENTS[1]

BY VICTOR M. SUMMA[2]

It would seem that an article on the subject of combined twisting and bending moments should not require publication, as the subject is dealt with in all text-books and handbooks on the strength of materials and machine design. However, there seems to be considerable confusion, not only among mechanical men generally but also among well-informed engineers, as to the proper application of the formulas that are available in the engineering handbooks, the two most well known being the Rankine formula and the Guest formula. Hence, an elementary article on the subject, stating the conditions in simple language, will probably be of value to many. The writer would say at the start that in his opinion there is absolutely nothing the matter with either of the two formulas

$$T_e = M + \sqrt{M^2 + T^2}$$

$$M_e = \tfrac{1}{2}M + \tfrac{1}{2}\sqrt{M^2 + T^2}$$

which are generally known as the Rankine formulas, and in which

T_e = equivalent twisting moment due to combined bending and twisting stresses;

M_e = equivalent bending moment due to combined bending and twisting stresses;

M = bending moment due to bending stresses alone;

T = twisting moment due to twisting stresses alone.

The two formulas above are based upon two others, namely,

$$P_1 = \tfrac{1}{2}(S + \sqrt{S^2 + 4S_s^2})$$

$$P_2 = \tfrac{1}{2}\sqrt{S^2 + 4S_s^2}$$

in which S = unit stress in tension or compression;

S_s = unit stress in shear;

P_1 = greatest unit stress in tension or compression produced by the simultaneous stresses S and S_s;

P_2 = greatest unit stress in shear produced by the simultaneous stresses S and S_s.

In order to show the application of these formulas, a few examples will be worked out. It should be noted at this point that in the derivation of these equations no account is taken of the shape of the cross-section of the strained body and that the formulas are, therefore, of general application. The only assumption made is that an "indefinitely small particle of material" is subjected to stresses, as indicated in Fig. 1; that is, that the tension or compression stress and the shear stress act normally to each other at that point. The examples that follow will make this clear.

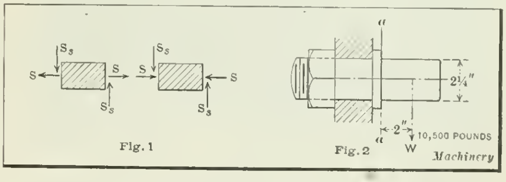

Fig. 1 Fig. 2

Figs. 1 and 2. Notation used in Formulas and Examples

Example 1—It is required to find the maximum resultant unit stress in a ¾-inch square rod, subjected to a longitudinal pull of 7500 pounds and at the same time to a transverse shear of 5000 pounds.

It is first necessary to find the values of the unit stresses S and S_s. These are obtained by dividing the given forces by the area of the cross-section of the rod. Thus,

$$S = \frac{7500}{0.75^2} = 13{,}330 \text{ pounds, and } S_s = \frac{5000}{0.75^2} = 8880 \text{ pounds}$$

Then, by substitution, we have as maximum stresses:

$P_1 = \tfrac{1}{2}(13{,}330 + \sqrt{13{,}330^2 + 4 \times 8880^2}) = 17{,}770$ pounds per square inch in tension, and

$P_2 = \tfrac{1}{2}\sqrt{13{,}330^2 + 4 \times 8880^2} = 11{,}000$ pounds per square inch in shear.

Example 2—A pin 2¼ inches in diameter supports a load of 10,500 pounds as shown in Fig. 2. Find the greatest stresses.

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[1] See also MACHINERY, August, 1914, "Compound Stresses," and March, 1916, "Formulas for Combined Bending and Torsional Stresses."

[2] Examining Engineer, American Brake Co., St. Louis, Mo.

These stresses obviously occur at cross-section a–a, where there is a combination of shear and bending.

In this case, the unit values of S and S_s are

$$S = \frac{M}{Z}, \text{ and } S_s = \frac{W}{A}$$

in which M is the bending moment of load W about a–a; Z, the rectangular modulus of resistance of cross-section a–a; and A, its area; or

$$S = \frac{10{,}500 \times 2 \times 10.2}{2.25^3} = 18{,}800 \text{ pounds per square inch, and}$$

$$S_s = \frac{10{,}500}{3.14 \times 1.125^2} = 2640 \text{ pounds per square inch}$$

Then their maximum combined effects are:

$P_1 = \frac{1}{2}\,(18{,}800 + \sqrt{18{,}800^2 + 4 \times 2640^2}) = 19{,}160$ pounds per square inch in tension or compression, and

$P_2 = \frac{1}{2}\sqrt{18{,}800^2 + 4 \times 2640^2} = 9760$ pounds per square inch in shear.

Example 3—A square shaft is subjected to a torsional moment of 80,000 inch-pounds and at the same time to a bending moment of 100,000 inch-pounds. Find the size of the cross-section required to withstand the combined moments safely, taking the working unit-stresses of the material at 12,000 pounds in tension and 9600 pounds in shear.

Let a be the side of the required square. Then the unit stresses are:

$$S = \frac{100{,}000}{a^3 \div 6} \text{ and } S_s = \frac{80{,}000}{2/9\,a^3}$$

where $a^3 \div 6$ and $2/9a^3$ are the rectangular and polar section moduli for square sections. Substituting, we have:

$$12{,}000 = \frac{1}{2}\left(\frac{100{,}000 \times 6}{a^2} + \sqrt{\frac{100{,}000^2 \times 36}{a^6} + \frac{4 \times 80{,}000^2 \times 81}{4a^6}}\right)$$

from which

$$a^3 = 64, \text{ and } a = 4 \text{ inches}$$

Similarly, as we were requested not to exceed 9600 pounds in shear, we must ascertain the value a would have in shear. So, by using the second formula, we have also:

$$9600 = \frac{1}{2}\sqrt{\frac{100{,}000^2 \times 36}{a^6} + \frac{4 \times 80{,}000^2 \times 81}{4a^6}}$$

$a^3 = 48.8$, and $a = 3.66$ inches, thus showing that the side of the required square must be 4 inches, as found by the first equation.

These examples will suffice to give a fair idea of the many and varied uses to which the two fundamental equations

$$P_1 = \frac{1}{2}\,(S + \sqrt{S^2 + 4S_s^2}) \text{ and } P_2 = \frac{1}{2}\sqrt{S^2 + 4S_s^2}$$

can be put, and of their great value in structural and machine designing. There are few cases in practice where some member at least is not subjected to a combination of simultaneous strains, such as pull and twist, bending and cross-shear, or a wrenching of some sort; and the steel designer could learn nothing more useful than these formulas.

Now we will return to Rankine's well-known expressions

$$T_e = M + \sqrt{M^2 + T^2}$$

and

$$M_e = \frac{1}{2}M + \frac{1}{2}\sqrt{M^2 + T^2}$$

As already stated, there is, in the writer's opinion, nothing the matter with them except that they have been widely misunderstood and, of course, misapplied.

Take the case of a round shaft subjected to a bending moment M and at the same time to a twisting moment T. Then, remembering that for circular cross-sections the modulus of section for torsion is double the modulus of section for bending, that is, that $Z_p = 2Z$, we have as unit stresses:

$$S = \frac{M}{Z} \text{ and } S_s = \frac{T}{2Z}$$

By substituting these values in the formula for P_1 given above, we have:

$$P_1 = \frac{1}{2}\left(\frac{M}{Z} + \sqrt{\left(\frac{M}{Z}\right)^2 + 4\left(\frac{T}{2Z}\right)^2}\right)$$

$$= \frac{1}{2}\left(\frac{M}{Z} + \frac{1}{Z}\sqrt{M^2 + T^2}\right)$$

$$= \frac{1}{2Z}\,(M + \sqrt{M^2 + T^2})$$

$$P_1 = \frac{M + \sqrt{M^2 + T^2}}{2Z}, \text{ or } P_1 = \frac{\frac{1}{2}M + \frac{1}{2}\sqrt{M^2 + T^2}}{Z}$$

The numerator $M + \sqrt{M^2 + T^2}$ of the first fraction, being divided by $2Z$ (or Z_p), that is, by the polar section modulus, is called the "equivalent torsional moment," abbreviated T_e; while the numerator of the second fraction, being divided by the section modulus for bending, is termed the "equivalent bending moment," abbreviated M_e. Hence, the two important results:

$$T_e = M + \sqrt{M^2 + T^2} \text{ and } M_e = \frac{1}{2}M + \frac{1}{2}\sqrt{M^2 + T^2}$$

These expressions refer only and always to P_1, that is, to the tensile or compressive stress, and not to P_2, the shear stress, as is generally thought when the equivalent torsional moment is used. It is also clear, now, why it would be an error to apply them to non-circular bars, as is too often done, to the discredit of Rankine and his formulas. The fact to keep in mind is that the metamorphosis of $P_1 = \frac{1}{2}(S + \sqrt{S^2 + 4S_s^2})$ was made possible because the Z_p and the Z for circular cross-sections happen to be one double the other, as the following values clearly indicate:

$$Z_p = \frac{\pi d^3}{16}, \text{ and } Z = \frac{\pi d^3}{32}, \text{ for solid shafts;}$$

$$Z_p = \frac{\pi(D^4 - d^4)}{16D}, \text{ and } Z = \frac{\pi(D^4 - d^4)}{32D}, \text{ for hollow shafts.}$$

But the same thing cannot be said of other sections; and an inspection of the following values for square and rectangular shafts, as an instance,

$$Z_p = \frac{2a^3}{9},\ Z = \frac{a^3}{6};\ \text{and } Z_p = \frac{2}{9}\,ab^2,\ Z = \frac{ba^2}{6}$$

proves that Z_p is far from being double Z.

In a similar way, $P_2 = \frac{1}{2}\sqrt{S^2 + 4S_s^2}$ would become:

$$P_2 = \frac{\sqrt{M^2 + T^2}}{Z_p}, \text{ or } P_2 = \frac{\frac{1}{2}\sqrt{M^2 + T^2}}{Z}$$

and we could write down two more important results, *viz.*,

$$T_{es} = \sqrt{M^2 + T^2} \text{ and } M_{es} = \frac{1}{2}\sqrt{M^2 + T^2}$$

where T_{es} and M_{es} are, respectively, the equivalent torsional and the equivalent bending moments for shear, corresponding to T_e and M_e, the equivalent moments for tension or compression.

The second of these two expressions is known as the Guest formula, since Mr. Guest seems to have been one of the first to prove experimentally the correctness of an otherwise purely theoretical deduction. The dropping of the coefficient before the radical is due to the fact that he gives to P_2 (the safe working stress in shear) a value in tension which is assumed as twice that in shear. In other words,

$$P_2Z = \frac{1}{2}\sqrt{M^2 + T^2}$$

can take the following specific forms:

$$6000Z = \frac{1}{2}\sqrt{M^2 + T^2}, \text{ or } 12{,}000Z = \sqrt{M^2 + T^2}, \text{ or}$$
$$SZ = \sqrt{M^2 + T^2}$$

S standing, of course, for the maximum allowable working stress in tension or compression.

The meaning of Guest's formula deduced above does not agree with that given by G. B. Upton, and published in MACHINERY, March, 1916. There seems to be a great deal of confusion as to the exact meaning of the symbols in this formula, and further discussion is invited. It has been generally understood, we believe, that Guest's formula is empirical, and probably the attempt at a mathematical deduction above accounts for the discrepancy. In Guest's original paper, published in the *Philosophical Magazine*, July, 1900, he does not specify whether S is to be understood as maximum working stress in tension or in shear; hence some have interpreted the formula one way and some another.—EDITOR

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The Pennsylvania Railroad, on the lines east of Pittsburg and Erie, was employing, at the beginning of August this year, in the operating department alone, 2360 women in positions formerly filled by men. These included signalwomen, dispatchers, station cleaners, draftswomen, messengers, station agents, ticket sellers, pump attendants, block operators, machine hands, watch women and drawbridge tenders.

RUSTPROOFING IRON AND STEEL

ADVANTAGES AND LIMITATIONS OF PHOSPHATIC TREATMENT

BY JOSEPH W. WUNSCH[1]

THE object of this article is to show the principles of the phosphatic treatment of iron and steel as a preventive of rusting. There has been no intention to convey information that will enable the reader to engage in processing, cook-book fashion. The various patented processes have been merged and presented so as to be most easily understood by the engineer and machine builder. The basic principle of all processes lies in the deposition of a coat of insoluble ferrous phosphate on the iron or steel to be protected. The obstacles encountered have been in the control and regulation of the processing, particularly in obtaining a permanent deposition, and the developments during the past decade have been mainly improvements in that direction.

Iron, when placed in a solution of such acids as hydrochloric, sulphuric or nitric acid, is attacked and dissolved, precipitating ferrous salts. If a dilute phosphoric acid is used, a more or less adherent coat of insoluble ferrous phosphate is formed, which in the presence of an oxidizing agent becomes basic in character and black. If a piece of iron is placed in a hot basic solution of ferric chloride or ferric sulphate, a black basic salt is formed which adheres to the metal. When the iron is removed and placed in a hot solution of an alkali phosphate, such as disodium or trisodium phosphate, the adherent film becomes permanent.

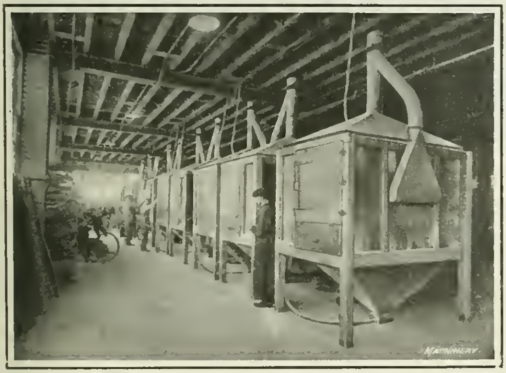

Fig. 1. Section of Sandblast Department of Parker Rust-proof Co., Detroit

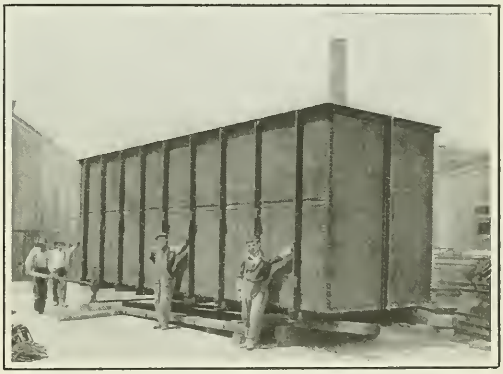

Fig. 2. Tank in which Two Ford Cars can be processed at One Time

The governing of these reactions is quite difficult and the various processes described here differ essentially only in the chemical or mechanical agencies introduced for the more efficient regulation and control of the processing. In the earliest application of the phosphatic process, the iron was treated with a solution of glacial phosphoric acid in water.

Iron Phosphate Process

Thomas Watts Coslett, an English chemist, was granted letters patent in 1907 for a process in which dilute phosphoric acid is employed, with iron in the form of iron filings or ferrous phosphate as the regulating agency. A solution that has been found to give satisfactory results in rustproofing iron and steel contains 1 ounce of iron, in the form of powder, 4 fluid ounces of concentrated phosphoric acid, and 160 fluid ounces of water.

In carrying out the process, a quantity of this solution is placed in an enameled iron bath and heated to the boiling point. The article to be treated, after being thoroughly cleaned, is then immersed and the solution evaporated until the desired coating of ferrous phosphate has been deposited. The articles are then withdrawn from the solution and, after being wiped and dried, may be oiled to set the tone of the deposit.

Zinc Phosphate Process

In a later process, zinc is employed as the controlling agent. By this method the iron is subjected to the action of phosphoric acid in the presence of zinc, zinc oxide, or zinc phosphate. The solution obtained by the action of the phosphoric acid upon the zinc is preferably made in concentrated condition. The concentrated solution may afterward be separated from any sediment or excess of zinc, and then applied to the iron or steel articles in concentrated or dilute solutions. The concentrated solution has about the following proportions: zinc, 6 ounces; phosphoric acid, 1 pint; water, 1 pint. A suitable dilute solution contains one ounce of the concentrated solution to one gallon of water.

Under certain circumstances, it may be of advantage to treat the iron or steel with a solution containing not only zinc phosphate, but also iron phosphate. In such cases, the iron filings or ferrous phosphate is dissolved with the zinc, or zinc compound, in the phosphoric acid; or the solution of zinc phosphate may be added to the solution in which the deposit of phosphate of iron on the article is being effected. The effect of the zinc-phosphate solution on the surface of the iron or steel under treatment is similar to that of the phosphoric acid on metallic zinc, as a certain amount of zinc must be dissolved to form phosphate of zinc before any deposition is formed. The coating consists essentially of normal zinc phosphate mixed with small amounts of normal ferrous phosphate and free phosphoric acid. The latter can be reduced by thorough washing. The normal ferrous phosphate is formed by the interaction of the free phosphoric acid with the metal treated. Iron or steel coated with phosphate of iron may be subjected to the zinc solution.

The formation of the deposit on iron or steel may be accelerated by passing an electric current through the dilute solution, as when electroplating. Iron plates are connected with the positive pole of the battery or low-voltage dynamo and the article to be rustproofed is connected to the negative pole.

Manganese and Iron Phosphate Process

A permanent protective phosphate deposit on iron and steel may also be obtained by the use of a solution of manganese dioxide dissolved in phosphoric acid. A satisfactory deposit, which consists, substantially, of manganese and iron phosphates, may be obtained after an immersion of from thirty to ninety minutes in a solution prepared by dissolving manganese phosphate in phosphoric acid and diluting to an acidity of 0.1 per cent.

The manganese phosphate may be prepared by decomposing the sulphate with phosphate of sodium. The process is car-

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[1] Address: Care of Wunsch & Washburn, 207 Center St., New York City

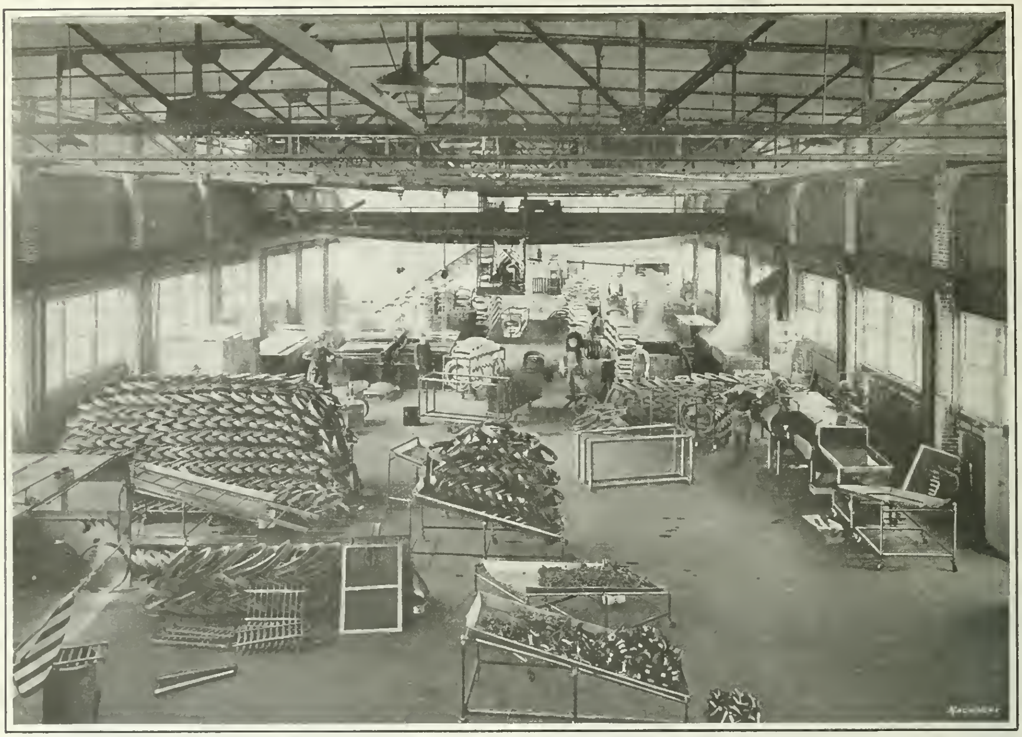

Fig. 3. Main Processing Plant of Parker Rust-proof Co.

ried out by heating the solution nearly to the boiling point and immersing the metal articles to be treated. A very small amount of the iron goes into solution and some hydrogen is set free, gradually diminishing to a slight reaction after about half an hour. The metal remains in the hot solution for from one to three hours, or until all action ceases, and the surface of the metal is changed to basic phosphates, which cannot be penetrated by the acids of the bath. The articles are then removed, dried and oiled. Fresh pieces of iron placed in the bath will be acted upon at once until the bath is exhausted. This process has a great advantage over that employing manganese dioxide, for the solution is clear and can be adjusted in strength at the beginning to suit the different classes of articles to be acted upon. The bath remains a solution of manganese phosphate until the introduction of iron or steel upsets the equilibrium of the solution by some of the iron being dissolved.

Alkali Earth Metals and Iron Phosphate Process

The violent reactions of free phosphoric acid with the iron in the processing solution may also be avoided by the use of an acid phosphate salt of the alkali earth metals (calcium, magnesium, etc.) in the presence of hydrated manganic oxide. As the radical PO_4 is in union with the alkali earth metal, calcium, for example, it will not readily form soluble iron phosphate, but forms the insoluble ferrous phosphate at the points of contact when iron is introduced. The soluble acid calcium phosphate, $2Ca\ H_4(PO_4)_2$ (monocalcium phosphate), is converted into the insoluble acid calcium phosphate $Ca_2H_2(PO_4)_2$ (dicalcium phosphate). If during the formation of the deposit of ferrous phosphate an oxidizing agent is present, some ferroso-ferric phosphates are formed and the surface of the iron becomes black. The reaction is probably as follows:

$$4CaH_4(PO_4)_2 + 8Fe + 2O_2 = 2Ca_2H_2(PO_4)_2$$
$$+ Fe_3(PO_4)_2 \cdot Fe_3O_4 \cdot Fe_3(PO_4)_2 + 6H_2$$

The oxidizing agents used are hydrated manganic oxide, $Mn_2O_3H_2O$, and air, which is forced up through the solution in fine sprays. It is noteworthy that practically no free phosphoric acid is present in this solution and that the affected surface of the article of iron or steel, in the solution, has no tendency to separate from the body of the article. As the acid radical is in union with the calcium, it will not form the soluble iron acid phosphate, as in the case where free phosphoric acid is used.

Ferric Phosphate Process

In the ferric phosphate process, the iron is oxidized outside the bath. Ferric phosphate prepared by any well-known method is dissolved in phosphoric acid, forming a soluble acid ferric phosphate. One of the advantages of this method is that the strong solution of acid ferric phosphate can be shipped to factories ready for use by diluting with water, thereby producing an oxidizing bath of known acid ferric phosphate content; the bath is made of approximately the same acid strength as previously mentioned.

Preparation of Articles for Rustproofing Bath

Articles to be treated by the phosphatic process must be chemically clean to insure a perfect deposition of the protective coat of phosphates of iron. The articles are cleaned much the same as in electroplating, using the sandblast, acid pickling and alkali washes to remove coarse dirt, scale and grease, respectively. Sulphuric acid has generally been employed for the pickling bath.

Patents have recently been granted for the use of a strong phosphoric-acid pickling solution. It is claimed that the pickling cannot be properly performed by sulphuric acid for the reason that the removal of all traces of its basic salts is practically impossible, and as these basic sulphates are insoluble in the rustproofing bath, blotches result which rust almost immediately upon exposure to the air. This is also true when hydrochloric and nitric acids are used. It is well to remember that when phosphoric-acid pickling is employed and the acid is permitted to dry on the articles to be treated, or time is allowed for the action of the adherent acid phosphate solution, ferrous phosphates will be deposited upon the articles to be treated, which, when once formed, will not dissolve in the rustproofing bath. But when the articles are taken from the hot, strong, phosphoric-acid pickling bath and plunged immediately into the rustproofing bath, before the solution can evaporate, no such insoluble salts will be formed; the acid clinging to the articles will be taken up by the rustproofing bath and there will be formed on the articles the desired black surface of basic phosphates of iron.

Finish of Rustproofed Articles

The natural finish from the process is a steel gray, which when oiled becomes a uniform soft matte black. The phosphatic process may be often employed advantageously in combination with any other finish that may be desirable. Articles that are to be painted are not oiled, and the metal is left just as it comes from the chemical bath. The surface of the phosphatic processed metal is exceptionally well adapted for enameling, since there is a fine microscopic etching that helps to bind the enamel. If for any reason the enamel should crack, the exposed surface of the processed article will not rust, and consequently no peeling off of the enamel will occur, as is the case with enamelware that is not rustproofed. In cases where two or more coats of enamel are given to articles, one coat over the phosphate rustproof deposit may give better results.

The electroplating of the non-ferrous metals on iron and steel articles may also advantageously be preceded by phosphatic treatment, resulting in a more durable protective deposit and not seldom in a reduction in cost. In electroplating with nickel, the article is first finished, then greased, buffed, dipped in a hot potash solution, brushed with pumice, dipped in cold water, copper-plated, buffed, dipped in a potash solution and in hot water, brushed with pumice, dipped in cold water, and then nickel-plated. By employing the phosphatic process previous to the nickel-plating, the operations may be reduced to finishing the article, immersion in the phosphoric-acid solution, and immediately nickel-plating.[1]

Advantages and Limitations of Process

The field for an effective and economical rustproofing process is really limitless as long as iron and steel will rust. The predominant advantage of the process is its effect of increasing the longevity of iron and steel, because, when they are thoroughly processed, such metals are positively immune from corrosion due to atmospheric attack. Government statistics show that 23 per cent of all the iron and steel output in a year is "junked" because of rust. All forms of iron and steel articles can be processed, from dental needles to structural steel beams. The rustproofed article has its selling power increased to an extent that it would be difficult to estimate. Ranges, radiators, hardware, ornamental ironwork, iron fences, steel furniture, in fact, all iron and steel articles can be made commercially 100 per cent more valuable if rustproofed.

Another economical feature of rustproofing, particularly in the machine-building industry, is the substitution of processed iron and steel for articles heretofore made of copper, brass and aluminum. The substitution of rustproofed steel for an expensive alloy for automobile carburetors resulted in the saving of from sixty cents to over a dollar on every carburetor.

While the phosphatic processed article is absolutely immune from corrosion when exposed to severe atmospheric corrosive agencies, it will not withstand actual exposure to hydrochloric, muriatic, acetic, sulphuric or similar acids. Neither is it protected against corrosion when subjected to the constant attack of chemical fumes, although it will resist intermittent attacks well enough. Sterilizing solutions have no effect on processed iron and steel.

The mechanical equipment of a processing plant consists essentially of sandblasting apparatus, pickling tanks, tumbling barrels, and special tanks for the phosphatic processing. The latter are double steel tanks equipped with steam coils to cause a constant and uniform agitation of the solution. The accompanying illustrations are from a well equipped plant, in Detroit, that covers an area of four acres, and has a processing capacity of 200 tons of metal a day.

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[1] For the rustproofing of iron and steel by processes of zinc-deposition, see "Protective Electroplating," in MACHINERY for June, 1917.

ANNUAL MEETING OF A. S. M. E.

The annual meeting of the American Society of Mechanical Engineers will be held in New York City, December 4 to 7, inclusive, the Engineering Societies Building being the headquarters. On Tuesday, December 4, honorary membership will be conferred upon Major-General George W. Goethals. On Wednesday morning, following the regular business meeting, there will be what is known as the "keynote session" of the meeting, dealing with "the service of the engineer to the public in times of crises," opened by the presidential address of Dr. Ira N. Hollis on "Universal Public Service in Peace and War." The technical papers to be presented follow:

"Preventable Waste of Coal in the United States," by David Moffat Myers.

"The Cooling of Water for Power Plant Purposes," by C. C. Thomas.

"Bagasse as a Source of Fuel," by E. C. Freeland.

"The Steam Motor in the Automotive Field," by E. T. Adams.

"The Transfer of Heat between a Flowing Gas and a Containing Flue," by Lawford H. Fry.

"A Study of Surface Resistance with Glass as the Transmission Medium," by H. R. Hammond and C. W. Holmberg.

"Cooling and Drying Air and the Removing of Infinitesimal Dust Therefrom," by W. J. Baldwin.

"Recent Developments in Balancing Apparatus," by N. W. Akimoff.

"Plotting Blower-test Curves," by A. H. Anderson.

"Cross-current Predeterminations from Crank-effort Diagrams," by Louis Illmer.

"An Account of the Engineering Work of E. D. Leavitt," by F. W. Dean.

"Expenses and Costs," by H. L. Gantt.

"By-product Coke and Coking Operations," by C. J. Ramsburg and F. W. Sperr, Jr.

"The Submarine," by C. H. Bedell.

"Combined Stresses," by A. L. Jenkins.

"The Trumble Refining Process," by N. W. Thompson.

"The Logic of Inspection," by A. L. DeLeeuw.

"The Relation of Inspection to Product," by F. A. Waldron.

"General Principles of Government Inspection and Relations between Inspectors and Manufacturers," by Col. B. W. Dunn.

"Labor-turnover Records and the Labor Problem," by Richard B. Gregg.

"Accident Prevention in the Textile Industry," by David S. Beyer.

"The Moisture Content of Textiles and Some of Its Effects," by William D. Hartshorne.

"The Engineer, the Cripple and the New Education," by Major Frank B. Gilbreth.

In addition to the papers read, there will be an industrial safety session on Wednesday afternoon, when several codes will be presented for discussion by the sub-committee on protection of industrial workers, among them the codes of safety standards for elevators and wood-working machinery.

The machine shop session will take place on Thursday afternoon, when there will be a topical discussion on the subject of inspection. On Friday morning there will be a management session, including a topical discussion on the employment of women in the skilled industries, with particular reference to war conditions; and also a power-test hearing, preliminary to a proposed revision of the power-test code of the society which comprises rules for conducting tests on prime movers of different types and auxiliary apparatus.

There will be a reception to the president and president-elect on Tuesday evening, a smoker and acquaintance meeting for members on Wednesday evening, and a lecture by Dr. John A. Brashear on "The Beautiful in Commonplace Things" on Thursday evening.

* * *

The first locomotive for American war-service railroads in France was completed by the Baldwin Locomotive Co. in twenty working days, and thirty engines of this type are now being turned out each day. This is in spite of the fact that the superheater boiler is used and must be constructed especially for this engine. The locomotive weighs about 166,400 pounds, and with the tender, about 275,000 pounds. Like all the equipment, it is painted battleship gray and bears the letters "U. S. A."

PERIPHERY OF THE ELLIPSE

BY J. J. CLARK[1]

Many formulas have been printed concerning the periphery of the ellipse, all of which are practically worthless when the ratio of the axes exceeds 8 or 9 to 1. The only exact expression for the periphery is by means of formulas that contain an infinite series, and no simple expression for the sum of these series has yet been derived. For about twenty-five years, the writer has been seeking a formula that would give reasonably accurate results for all ellipses, but without success. Several years ago he was desirous of checking the accuracy of an approximate construction of an ellipse by circular arcs by comparing the peripheries of the approximate ellipses with the corresponding true ellipses, but could find no formula that would apply to flat ellipses. However, a table was found in a well-known mechanical engineer's reference book that looked as though it would answer the purpose; but, unfortunately, the table was so full of errors that it could not be used. Later, the writer recalculated the table and found that of ninety-nine printed values only twenty-five were correct. The errors were evidently caused by not using a sufficient number of terms of the series.

In order better to understand the nature of the difficulty, let:

p = periphery;
a = semi-major axis;
b = semi-minor axis;
D = long diameter $= 2a$;
d = short diameter $= 2b$;
n = ratio of difference and sum of axes $= \dfrac{D-d}{D+d} = \dfrac{a-b}{a+b}$;
r = ratio of axes $= \dfrac{D}{d} = \dfrac{a}{b}$;
k = a constant.

Then:

$$p = \pi(a+b)k = \frac{\pi}{2}(D+d)k \qquad (1)$$

$$k = 1 + \left(\frac{1}{2}\right)^2 n^2 + \left(\frac{1}{2\times 4}\right)^2 n^4 + \left(\frac{1\times 3}{2\times 4\times 6}\right)^2 n^6 + \left(\frac{1\times 3\times 5}{2\times 4\times 6\times 8}\right)^2 n^8 + \text{etc.} \qquad (2)$$

Before discussing this series, it will be well to establish the relation between r and n, which is easily done; thus:

$$\frac{a-b}{a+b} = \frac{\dfrac{a}{b}-1}{\dfrac{a}{b}+1} = n = \frac{r-1}{r+1} \qquad (3)$$

From Equation (3):

$$r = \frac{1+n}{1-n} \qquad (4)$$

The limits of r are 1 and ∞, and the limits of n are 0 and 1; in other words, as n increases from 0 to 1, r increases from 1 to ∞. Thus, from Equation (3), for $r = 1$, $n = 0$, and from Equation (4), for $n = 1$, $r = \infty$. Moreover, comparatively small values of r give values of n that approach 1; and the nearer n is to 1, the greater must be the number of terms used in Equation (2) to obtain an accurate value of k. For example, for $n = 0.90$, $r = 19$, that is, the ratio of the axes is 19 to 1; and to obtain k correct to five significant figures, it will be necessary to use about twenty terms of the series. When the writer calculated the table above referred to, he extended the series (the law of which is evident) until the last term used gave a value less than 0.000000005, the result being to obtain the value of k to eight decimal places, with a possible error of one unit in the last place, but guaranteeing the correctness of the figure in the seventh place. For $n = 0.98$, it was necessary to use eighty-four terms of the series. But when $n = 0.98$, $r = 99$; hence when n increases from 0.98 to 1, r must increase from 99 to ∞. In fact, if n exceeds, say, 0.70 (for which $r = 5\,2/3$), it becomes increasingly difficult to obtain an accurate value for k.

When $r = 1$, the axes are equal, and the ellipse becomes a circle; n is then 0, and by Formula (2), $k = 1$. When $r = \infty$, $b = 0$, and the ellipse becomes a right line, the periphery being equal to twice the major axis, or $4a$. Substituting in Formula (1), $k = \dfrac{4}{\pi} = 1.2732395+$. Therefore, the limits of k are: for $n = 0$, $k = 1$; and for $n = 1$, $k = 1.2732395+$. A little consideration of the limits of r, n, and k will make it evident why it is so difficult to obtain a formula that will work well for all values of r. The best formula that the writer has been able to find is one that was published about twenty years ago by Carl G. Barth, which is as follows:

$$k = \frac{64-3n^4}{64-16n^2} \qquad (5)$$

This formula is evidently an approximate summation of the series in Formula (2), since when the numerator is divided by the denominator,

$$k = 1 + \frac{1}{4}n^2 + \frac{1}{64}n^4 + \frac{1}{256}n^6 + \frac{1}{1024}n^8 + \text{etc.} \qquad (6)$$

The series in Formula (2) becomes, when reduced,

$$k = 1 + \frac{1}{4}n^2 + \frac{1}{64}n^4 + \frac{1}{256}n^6 + \frac{1}{656.36}n^8 + \text{etc.} \qquad (7)$$

The first four terms of Formulas (6) and (7) agree; but, beginning with the fifth term, this agreement ceases, and the two formulas drift apart rapidly. It recently occurred to the writer that a formula might be obtained based on the values calculated for the table, and by means of these values the following formula was derived:

$$k = 1 + 0.002011n + 0.228989n^2 + 0.075834n^3 - 0.09974n^4 + 0.066146n^5 \qquad (8)$$

This gives very good results for all values of n, as will be seen by comparison with the tabular values in the following table:

n	Formula k	Table k	Error
0	1	1	0
0.1	1.00256	1.00250	+ 0.00006
0.2	1.01003	1.01003	0
0.3	1.02261	1.02263	— 0.00002
0.4	1.04042	1.04042	0
0.6	1.09224	1.09224	0
0.5	1.06357	1.06354	+ 0.00003
0.7	1.12679	1.12683	— 0.00004
0.8	1.16781	1.16781	0
0.9	1.21619	1.21600	+ 0.00019
1.0	1.27324	1.27324	0

As might be expected, the greatest departure is between 0.9 and 1. Since Formula (5) will give five significant figures correct up to $n = 0.70$ (by Formula (5), $k = 1.126775+$ for $n = 0.70$), and since it is easier to apply than Formula (8), it occurred to the writer than it would be well to use Formula (5) for all values of n up to 0.70, and to derive a new formula for values of n between 0.70 and 1. The formula thus obtained is:

$$k = 0.147202 + 5.355178n - 13.197449n^2 + 16.892262n^3 - 10.613854n^4 + 2.689901n^5 \qquad (9)$$

This must not be used for values of n less than 0.70, for which $r = 5\,2/3$. The following table shows a comparison between values calculated by Formulas (8) and (9) and the table, for values of n between 0.90 and 1:

n	Formula (8) k	Table k	Error	Formula (9) k	Error
0.90	1.21619	1.216001	+ 0.00019	1.215999	— 0.000002
0.91	1.22148	1.221268	+ 0.00021	1.221264	— 0.000004
0.92	1.22686	1.226625	+ 0.00024	1.226629	+ 0.000004
0.93	1.23233	1.232074	+ 0.00026	1.232071	— 0.000003
0.94	1.23788	1.237620	+ 0.00026	1.237620	0
0.95	1.24353	1.243266	+ 0.00026	1.243270	+ 0.000004
0.96	1.24928	1.249016	+ 0.00026	1.249028	+ 0.000012
0.97	1.25512	1.254878	+ 0.00024	1.254897	+ 0.000019
0.98	1.26106	1.260859	+ 0.00020	1.260885	+ 0.000026
0.99	1.26710	1.266972	+ 0.00013	1.266997	+ 0.000025
1.00	1.27324	1.273240	0	1.273240	0

The right-hand error column shows that Formula (9) will give at least five significant figures correct for all values of n between 0.70 and 1, or, in other words, for all values of r between $5\,2/3$ and ∞; it is therefore sufficiently accurate for all practical purposes. In the following table, which may be used instead of the formula, the values of k have been limited to five significant figures, because if they were given to a greater number of figures, it would be necessary to use second and even third differences for the larger values of n, when interpolating for intermediate values of k:

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n	k	n	k	n	k	n	k
0	1	0.25	1.0157	0.50	1.0635	0.75	1.1465
0.01	1.0000	0.26	1.0170	0.51	1.0662	0.76	1.1506
0.02	1.0001	0.27	1.0183	0.52	1.0688	0.77	1.1548
0.03	1.0002	0.28	1.0197	0.53	1.0716	0.78	1.1591
0.04	1.0004	0.29	1.0211	0.54	1.0743	0.79	1.1634
0.05	1.0006	0.30	1.0226	0.55	1.0772	0.80	1.1678
0.06	1.0009	0.31	1.0242	0.56	1.0801	0.81	1.1723
0.07	1.0012	0.32	1.0258	0.57	1.0830	0.82	1.1768
0.08	1.0016	0.33	1.0274	0.58	1.0860	0.83	1.1815
0.09	1.0020	0.34	1.0291	0.59	1.0891	0.84	1.1862
0.10	1.0025	0.35	1.0309	0.60	1.0922	0.85	1.1909
0.11	1.0030	0.36	1.0327	0.61	1.0954	0.86	1.1958
0.12	1.0036	0.37	1.0345	0.62	1.0987	0.87	1.2007
0.13	1.0042	0.38	1.0364	0.63	1.1020	0.88	1.2057
0.14	1.0049	0.39	1.0384	0.64	1.1053	0.89	1.2108
0.15	1.0056	0.40	1.0404	0.65	1.1088	0.90	1.2160
0.16	1.0064	0.41	1.0425	0.66	1.1123	0.91	1.2213
0.17	1.0072	0.42	1.0446	0.67	1.1158	0.92	1.2266
0.18	1.0081	0.43	1.0468	0.68	1.1194	0.93	1.2321
0.19	1.0090	0.44	1.0490	0.69	1.1231	0.94	1.2376
0.20	1.0100	0.45	1.0513	0.70	1.1268	0.95	1.2433
0.21	1.0111	0.46	1.0536	0.71	1.1306	0.96	1.2490
0.22	1.0121	0.47	1.0560	0.72	1.1345	0.97	1.2549
0.23	1.0133	0.48	1.0585	0.73	1.1384	0.98	1.2609
0.24	1.0145	0.49	1.0610	0.74	1.1424	0.99	1.2670
0.25	1.0157	0.50	1.0635	0.75	1.1465	1.00	1.2732

Example—Find the periphery of an ellipse, the long and short diameters of which are 7 feet, 5 inches, and 9 inches, respectively. Since 7 feet, 5 inches = 89 inches, $n = \frac{89 - 9}{89 + 9} = 0.816326$. From the table, obtain by interpolation $k = 1.1723 + (1.1768 - 1.1723) \times 0.6326 = 1.1751$. The value $0.6326 = \frac{0.816326 - 0.81}{0.82 - 0.81}$. Hence, by Formula (1),

$$p = \frac{3.1416}{2}(89 + 9) \times 1.1751 = 180.89 \text{ in.} = 15 \text{ ft., } 0.89 \text{ in.}$$

* * *

AIR-RIFLE PISTON DIES

BY W. B. GREENLEAF[1]

The accompanying illustrations show the piston for an air rifle and the dies for making it. In Fig. 1 the piston is shown, with the main spring in position and the leather washer riveted on the end, ready to go into the air barrel of the rifle. The projection on the lower side is engaged by a lever to compress the spring and also by the trigger. The metal used is 0.065-inch steel and the strip is wide and heavy. Considerable clearance must be left between the guides for variation in width, so that four pilots are necessary to obtain the required accuracy; three automatic trigger stops locate the strip from the first to the last stroke. In Fig. 2 are shown the stages in the development of the piston. *A* is the blank, *B* shows the second stage, and *C* is the completed piston.

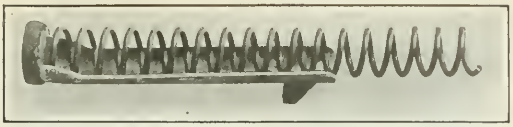

Fig. 1. Air-rifle Piston with Spring in Position

As shown in Figs. 3 and 4, the blanking die is a double follow die, with the two blanks interlocking, so that the waste is reduced to a minimum. A forming station is set between the piercing and blanking stations to bend the web, which makes the lever and trigger hold. This forming punch is made in one piece with a large heavy pilot which enters the triangular hole and locates the strip at the second stroke; there is also a pilot on each blanking punch.

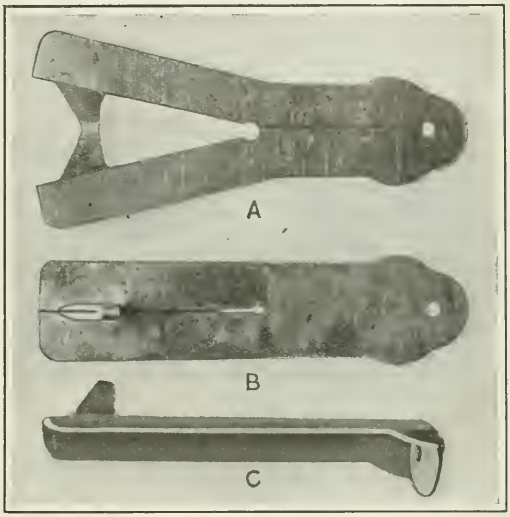

Fig. 2. Stages of Development of Piston

The second-operation die, Fig. 5, bends the two legs of the blank together edgewise, and forces out and douhles up the web, which has already been started in the blanking die. The working parts of the punch and die are the same, each being

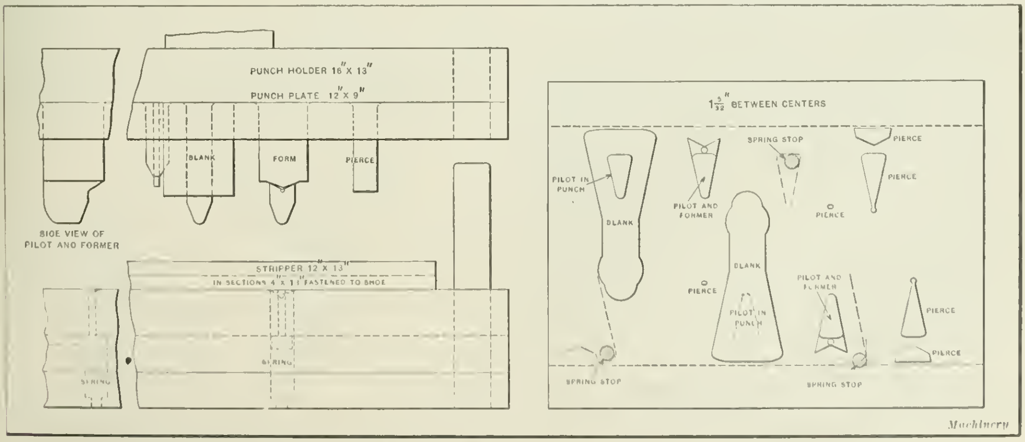

Fig. 3. Arrangement of Blanking Punch and Die

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[1] Address: Plymouth, Mich.

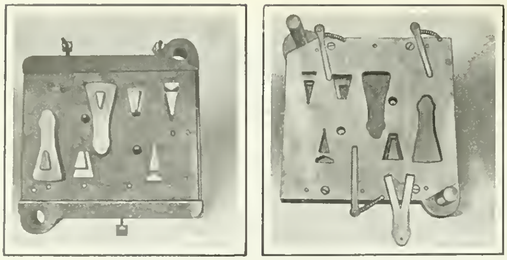

Fig. 4. Blanking Punch and Die for forming Air-rifle Piston

a piece of steel with a slot 0.09 inch wide and just deep enough to take one leg, or half the finished piece. A recess across the face, 0.065 inch deep, takes the web when it buckles out, and flattens it into shape. Two pins across the slot in the die locate the piece endwise. Two spring pads in the punch, with vees in the lower ends and keyed to prevent their turning, cause the piece to enter the upper slot.

Fig. 6 shows the third, and final, die, with a blank from the second operation in place ready to be formed. The piece rests against a guide and on a spring pad at the left, while the folded web drops into a slot in a spring pad at the right. The right-angle bend is made first, and at the bottom of the stroke the half-round body and saucer-shaped end are formed.

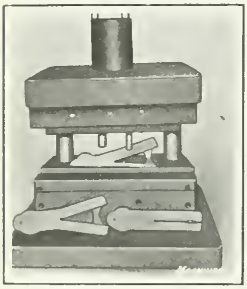

Fig. 5. Punch and Die for obtaining Shape B, Fig. 2

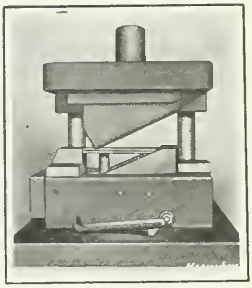

Fig. 6. Punch and Die for finishing Piston

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FLEXIBLE TURBINE GEARING

BY MARK MEREDITH[1]

The problem of insuring equal distribution of pressure over the whole surface of the wide fine-pitched gears now coming into use for marine-turbine speed reduction is being tackled in many ways. John H. Macalpine, who was the first to offer a practical solution of the matter, supports the pinion in a rocking, or floating, cradle designed to permit of a continuous self-adjustment of the pinion to the wheel. In one of his arrangements, the frame supporting the pinion is constructed so that the solid metal affords a certain amount of spring whereby, when the tooth pressure becomes unduly heavy on one side of the gears, due to unavoidable imperfections in gear-cutting or lack of alignment of the two shafts, that side yields just enough to allow the pressure to spread equally over the whole face. In another arrangement, the same effect is obtained by sustaining the pinion bearings on interconnected hydraulic pistons. The Macalpine device has been tried on both large mercantile vessels and battleships; and, though there has been a good deal of discussion, the device may be said to have shown its superiority over the usual type of gearing in respect to efficiency, durability, smoothness, silence of working, amount of lubrication required, degree of reduction possible, and weight of gearing set.

Sir Charles Parsons believed the solution lay in eliminating, as far as possible, the inaccuracies that the teeth of all large gears revealed, and set to work to discover and eliminate their source. He arrived eventually at the ingenious methods by which the errors in the master gear of the gear-cutting machine are distributed over the face of the cut gear. By this means a considerable improvement was effected in the working of reduction gears without interfering with the solidity of the pinion-journal supports. But it is doubtful whether even absolute initial accuracy, could that be obtained, would give as good results as some system of automatic continuous self-adjustment. Initial gear-tooth errors are only one part of the derangements of alignments that have to be provided against; there are also the torque of the pinion, gradual wear of bearings, and distortion of gear under varying loads.

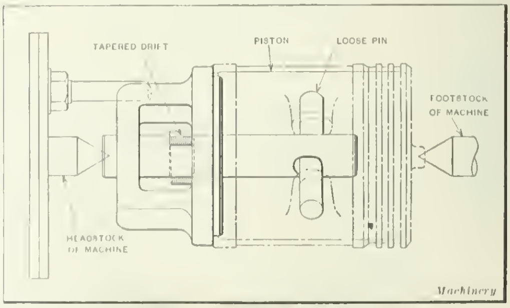
A third solution of the problem consists of building up the main gear with a series of disks, chambered at the sides, threaded upon the second-motion shaft. When put together, these disks are in close contact both at the hubs and at the rims, and the built-up gear blank is turned and cut just as though it were a solid gear; but when the cutting is finished, a parting tool is run between each pair of disks, so that the gear in its final working form appears as a row of disks secured rigidly to the shaft and to each other at their bosses, but separate at their peripheries. The teeth are, of course, cut helically. The effect of this construction is that when, in working, undue pressure comes upon any disk at any point of its circumference it deflects sidewise, and thereby allows the load to spread over the rest of the disks. The proportioning of the disks, particularly as regards strength and contour of cross-section, requires careful calculation and experiment in order that the lateral deflection may at no time involve fiber strains, which could possibly cause destructive fatigue, but a very small side movement is sufficient to afford even distribution of load across the entire surface of the gear. This type of flexible disk has been successfully applied to eighty sets of turbo-generators and is being tried as a turbine reduction gear for steamships.

* * *

PISTON GRINDING FIXTURE

The illustration shows a simple and effective means of holding a piston for grinding. Simply slide into place the loose pin that fits snugly into the wrist-pin holes of the piston, slide the back-plate onto the base of the piston, then drive the drift in until all are bound together. It is then ready to be placed on the centers. The driver is furnished by the bridge part of the back end, which engages a driving pin. To remove the piston, knock out the drift and withdraw the pin. All parts of this fixture should be hardened, except the base. In several concerns where this fixture is in use, from twenty-five to thirty-five pistons, 3½ to 3⅞ inches diameter, are produced per hour, removing from 0.025 to 0.030 inch stock to 0.001 inch limit, there being three diameters to grind.

The operation is performed by sizing the body over the entire length, which is the largest diameter. This is done by two methods: by feeding the wheel straight in for a full width cut (no traverse), using a wide wheel, or by stroking the work with a 2-inch wheel. Then grind the two bottom rings, the next largest diameter, with a straight-in cut, and the ring or smallest diameter, also with a straight-in cut, and the piston is finished. Two fixtures are usually used, the operator loading one while the cut is being taken on the piston mounted on the other.—*H. W. Dunbar in Grits and Grinds*



Grinding Fixture with Mounted Piston

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ECONOMICAL PRODUCTION OF ACCURATE HARDENED GEARS

METHODS AND FIXTURES USED BY PROGRESSIVE AUTOMOBILE MANUFACTURERS

BY F. B. JACOBS [1]

To produce hardened spur gears, such as are used in automobile transmissions, economically involves many operations of equal importance, as the quality of the finished product depends on the care exercised in the various stages of manufacture. Not all the operations described here are found in one manufacturing plant, but they are used in the plants of progressive manufacturers of the Middle West. In the manufacture of transmission gearing, the grinding wheel plays an important part; it furnishes a rapid and efficient means of turning out accurate work and also a means for correcting the errors due to the expansion and contraction of the metal during the annealing and hardening processes.

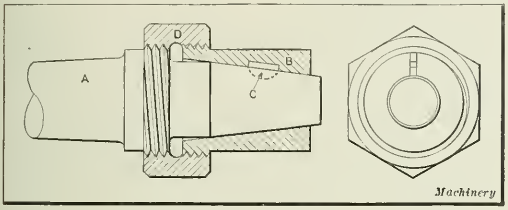

Fig. 1. Nose Arbor for holding Gear Blank when turning Periphery and facing Side

The gear adopted by many prominent automobile manufacturers is made of forty-point carbon steel, and in the process of manufacture goes through five principal stages, *viz.*, machining to rough dimensions, annealing, machining to finish dimensions, oil tempering, and grinding. The first step is to chuck the blank by its largest diameter, bore and ream the hole, and face the hub and one side. This operation is simple and well known; the method used is familiar to every mechanic who has had occasion to watch a Gisholt, Potter & Johnston or other machines used for similar purposes in operation. Due care is, of course, exercised, and the operator is provided with limit gages for maintaining the correct dimensions.

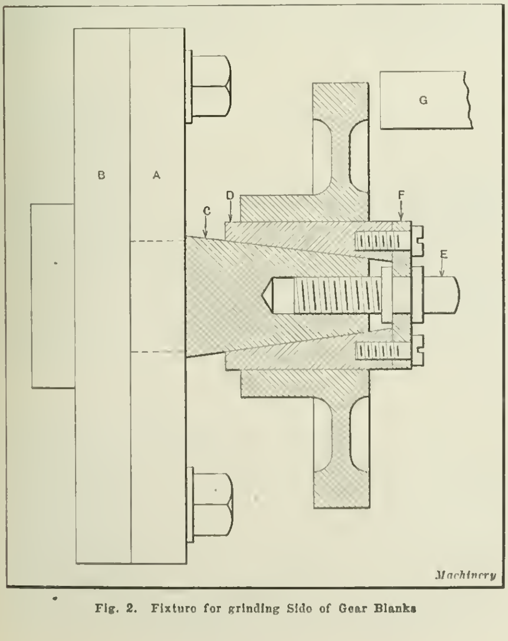

Fig. 2. Fixture for grinding Side of Gear Blanks

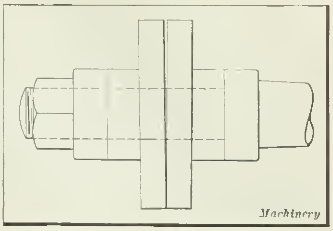

Fig. 3. Result of using Arbors that do not run True

The next operation is to rough-turn the periphery and face the other side of the gear. This is generally done on a heavy-duty engine lathe, the blank being preferably held on a nose arbor, as this method facilitates taking heavy cuts, thus keeping production up to the maximum. A good design of arbor for this purpose is illustrated in Fig. 1. It consists of an arbor *A* with a taper shank to fit the tapered hole in the spindle, an expanding bushing *B*, which is prevented from turning by the key *C*, and a substantial nut *D*, which is provided with a coarse right- and left-hand thread. This is a convenient device, as a half turn of the nut is sufficient to grip the work firmly and the action of the right- and left-hand threads quickly collapses the expanding bushing when the work is to be removed, thus eliminating the necessity of resorting to the lead hammer. The latter tool has its uses, but it has been the means of springing and thus unfitting for accurate use many expanding holding devices that often fail to operate readily. This arbor can be made of tool steel or thirty-point carbon steel; in either case, the parts should be hardened to prevent undue wear and the arbor and bushing should be ground to insure accuracy.

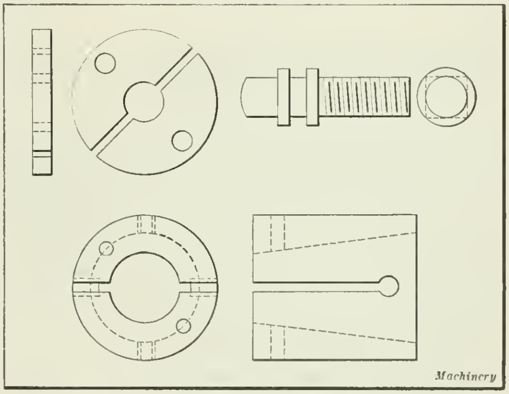

Fig. 4. Details of Fixture shown in Fig. 2

To insure quiet-running gearing, so necessary in the modern high-powered car, it is of absolute importance that the teeth be both concentric and parallel with the axis. Through carelessness on the part of the operator, as well as through the use of arbors that do not run perfectly true, it is easy to bring about the condition shown in Fig. 3, which represents two gears placed back to back on a gear-cutting arbor. The sketch is exaggerated to illustrate the error and shows what happens when the sides of the gear are not parallel with the hole. When the nut is tightened the gears are sprung together. Although when in this position the teeth cut are parallel with the axis, as soon as the pressure is removed the blanks spring back to their original position, which results in faulty teeth that are bound to produce an unsatisfactory gear. To eliminate this difficulty, a preliminary grinding operation is brought into play before the teeth are cut.

First, the gear blank is located by its hole and one side of the rim is trued, as shown in Fig. 2, where *A* is a faceplate fixture which is bolted to the faceplate of a universal grinding machine. Care is taken, of course, to see that it shows true when tested with a dial indicator. The faceplate of the grinder is shown at *B*. The faceplate *A* is provided with a taper arbor *C*, over which is fitted a bushing *D* that carries the gear. The bushing is expanded to grip the gear blank by means of the screw *E* and the collar *F*. The grinding wheel is shown at *G*. For the sake of the tool designer who may wish to utilize this feature, the bushing, collar and screw are illustrated in detail in Fig. 4, which is self-explanatory. As the face grinding is in reality the first finishing operation, it is done after the gear blanks have been annealed.

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The next operation is to rough-grind the hole. This is done by locating the blank by the ground surface just finished on the fixture shown in Fig. 5, which consists of a faceplate *A* and three blocks *B* for locating the gear by its periphery. Three straps are also provided for clamping the gear in place. This faceplate is bolted to the faceplate of an internal grinding machine, care being used to see that it runs true. The hole is ground to within 0.0001 inch of the finish size, this amount being allowed for grinding after the gear is hardened.

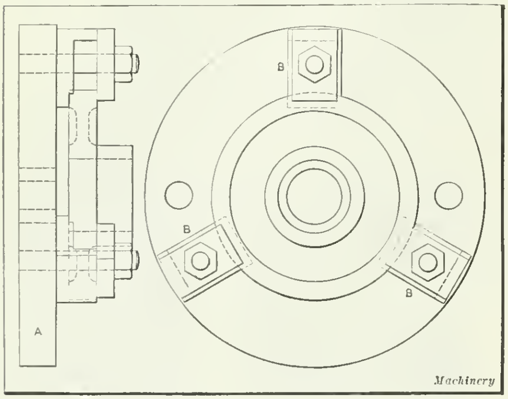

Fig. 5. Fixture for rough-grinding Hole in Gear Blank

The next operation is to turn the outside diameter of the gear true with the hole. This is generally done with an arbor like the one shown in Fig. 1, although some manufacturers prefer to do this operation on the grinder. As a matter of fact, it can be done on a heavy type of grinding machine in a very efficient manner if a holding device similar to the one shown in Fig. 2 is used. To many it may appear to be an undue precaution to size the outside diameter of a gear by grinding, but modern grinding practice often furnishes a quicker means of removing stock than the engine lathe, within reasonable limits, and the results are generally far more accurate.

Cutting Teeth of Automobile Transmission Gears

The teeth of automobile transmission gears can be cut in three ways: on an automatic gear-cutter of the type carrying but one cutter working on one tooth at a time, although a multiple cutter for cutting two or three teeth at once may be used; on the Fellows gear shaper; or on gear-hobbing machines of the Barber-Colman type. Whatever type of machine is used, care should be exercised to see that the arbor for holding the gear blanks runs true when tested with an indicator. This may seem unnecessary to those who expect arbors used on production machines to run out of true a little, but true gears cannot be cut on an arbor that runs out of true. One object of the rough-grinding of the hole is to make a good fit on the gear-cutting arbor, so if the arbor runs out, this precaution is needless.

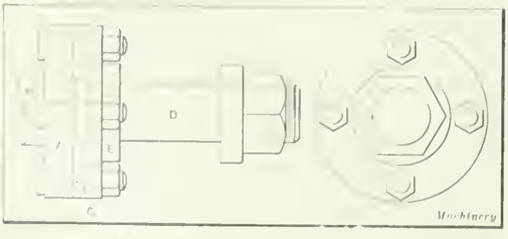

Fig. 6. Gear-cutting Arbor of Novel Design

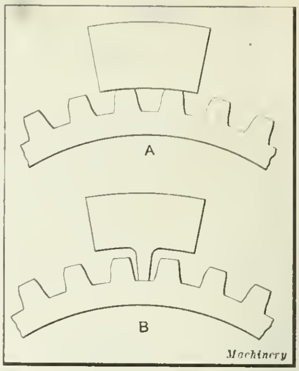

Fig. 7. Two Methods of locating Hardened Gears for grinding Holes

In Fig. 6 is shown a gear-cutting arbor of novel design that is used on a Barber-Colman gear-cutting machine with great success. The faceplate *A*, which is made integral with the shank *B* that fits the taper hole in the spindle, is a machine-steel forging. After being finished, it is driven securely into place, as it is to remain there indefinitely; then the face *C* is carefully finished by grinding. This operation is done with a portable center grinder fastened to the machine for this purpose. It is evident that a surface finished in this manner is bound to run true with the spindle, which is the object desired. The arbor *D* and the inner face of the plate *E* are also finished by grinding, great care being taken to see that they are true and square with each other. Thus, when the two members are securely bolted together by means of the four bolts shown, it is an easy matter to get the arbor to run dead true by means of a dial indicator. Several arbors to accommodate different sized gears can be provided to fit the permanent faceplate, and while it takes a little time to indicate them after placing them in position, the accuracy gained more than compensates for the time spent.

It is not the writer's intention to enter into a long discourse on gear cutting; it will suffice to say that the cutters should be sharp and correctly ground. The depth of the teeth should be kept within close limits, preferably by testing on a vernier gear measuring machine, as this means allows slight errors to be readily detected. While a varied mechanical experience is not necessary to operate a gear-cutting machine, the gear-cutting department should be in charge of a man who has specialized on gearing and understands both the technical and the practical sides. After cutting, the gears are hardened and then tested for the proper degree of hardness and to determine freedom from cracks; they are then ready for the final grinding.

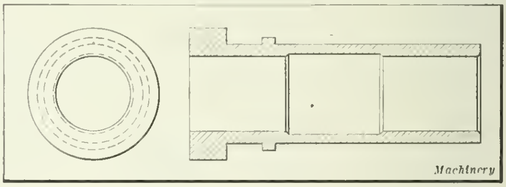

Fig. 8. Quill Gear ground in Fixtures shown in Figs. 9 and 10

Grinding Hole in Hardened Gears

The production of accurate hardened gears is a difficult problem, but if care is exercised in grinding the hole after hardening, particular attention being given to the manner in which the gear is located in the grinding operation, commercial accuracy is possible even when it is necessary to turn out a large number of gears in a given time. To facilitate production as much as possible, the grinding should be done in an internal grinding machine designed especially for economical production. There are three methods employed for locating hardened gears for grinding the holes: locating the gear by the outside

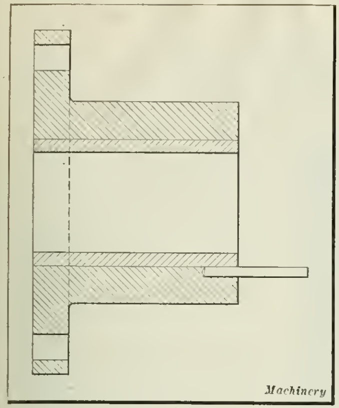

Fig. 9. Chucking Device used in grinding Hole in Gear shown in Fig. 8

diameter as shown at *A*, Fig. 7; locating from the bottom of the teeth, sometimes termed "root control," as shown at *B;* and pitch-line control, as illustrated in Fig. 10. The first-named method would be correct if the gear were not hardened and if it were positively assured that the teeth were concentric with the axis of the gear. The second method would give excellent results on soft gears, provided the bottoms of the teeth were not rough, which is sometimes the case with planed gears, or gears the teeth of which are generated by planing. The third method is an ideal one to use with hardened gears, and if the grinding fixture is correctly designed and constructed, excellent results will be obtained. The pin should be the same diameter as the tooth opening at the pitch line; it could locate a little above or below the pitch line and perhaps cause no harm. The chucking fixture consists of a body *A* which is fastened directly to the faceplate of the grinding machine by means of bolts put through from the back; a split collapsible ring *B* that grips the gear through the medium of eight pins; and a tapered ring *C* that collapses the split ring by screwing into the body of the chuck as shown. The fixture should be carefully made and the tapered rings casehardened and finished by grinding. Care should be exercised to see that the outside of the chuck and the flat wearing surface for the collapsing ring are concentric with each other, as the chuck is indicated to run true by means of a dial indicator each time it is set up on the grinding machine faceplate. If these surfaces are concentric, it is easy to true up the chuck by indicating its outside. The chuck could be provided with a thread and boss for screwing it directly to the grinding machine spindle; experience, however, has proved that the design illustrated is more economical and productive of better work, as it is easy to keep the fixture running perfectly true at all times. [illegible] of the chuck can be made of cast iron, but where [illegible] thousand gears are to be made it should be forg[illegible] machine steel and protected from undue wear by casehardening. In this case the thread should be a rather loose fit to allow for errors that are bound to develop in hardening.

The quill gear illustrated in Fig. 8 is comparatively long for its diameter. A good way to finish-grind this gear is to chuck it by its teeth, using the type of fixture shown in Fig. 10 fitted to the plain grinding machine, where the outside diameter is ground to size, the end of the work being supported by a special center. In finish-grinding the hole, it is necessary that the hole be concentric with the outside; otherwise a noisy-running gear will result. The hole is ground on the internal grinder by means of the simple chucking device shown in Fig. 9, which consists of a cast-iron piece bushed with hardened steel. This fixture is strapped to the faceplate of the machine and carefully trued up by means of a dial indicator every time it is placed in position. The hardened bushing should be a nice fit with the gear, which is prevented from turning by a pin, fitting loosely between two of the teeth. The grinding operation is simple in itself, as it does not differ from any other operation of the same kind.

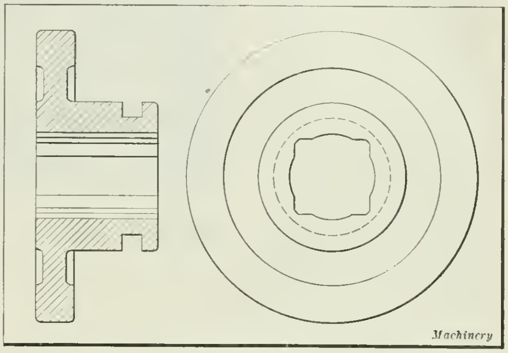

Fig. 11. Square-hole Type of Shifting Gear, which is held in Fixture shown in Fig. 10

The square-hole type of shifting gear illustrated in Fig. 11 is sometimes considered a difficult piece to machine in cases where accurate, quiet-running gears are desired. Inasmuch as this gear is bound to warp to a certain extent in hardening, it is good practice to grind the hole to bring its axis concentric with the pitch-line circle. To grind a square hole accurately is sometimes considered a difficult and expensive problem, but if a suitable fixture is provided for the work and the operator exercises due care in the grinding operation, satisfactory and economical results are possible.

The gear, after hardening, is chucked in the type of fixture illustrated in Fig. 10, which in this case is made to fit the faceplate of a Brown & Sharpe or other universal grinder. The grinding wheel fixture used is shown in Fig. 12. It is fastened to the wheel-base platen, if a Brown & Sharpe grinder is used, in the position occupied by the internal grinding fixture, or speed spindle, as it is sometimes called. It is driven by the pulley *A*, which, in turn, drives the wheel-spindle *B* through the medium of a round belt, running over the grooved pulleys *C*. In making this fixture, care should be used in getting dimension *D* correct to bring

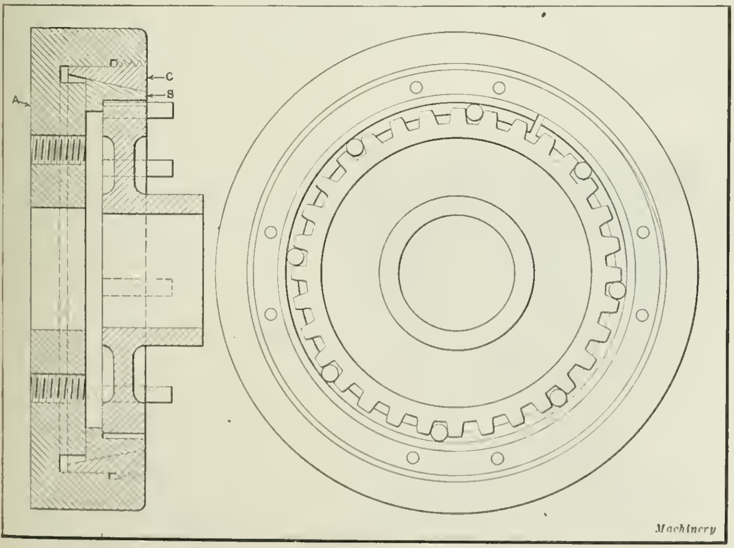

Fig. 10. Fixture in which Gear is located by Pitch Line

the grinding-wheel spindle approximately central with the headstock spindle. Also, dimension *E* should be slightly less than the diameter of the hole to be ground.

To perform the grinding operation successfully, attention must be paid to the wheel speed. In ordinary internal grinding, it is permissible to use a peripheral speed as high as 6000 feet per minute. In the present case, however, where the side instead of the periphery of the wheel is utilized, the surface speed of the outside diameter should not exceed 2500 feet per minute; otherwise the wheel will glaze and burn instead of cutting. The grit and grade of the wheel should be suited to the work, and in ordering these wheels, which are special, the grinding wheel manufacturer should be furnished with full data regarding the work to be performed, type of machine used, finish desired, kind of material to be ground, wheel speed, etc., for this is a special grinding operation and cannot be performed well with wheels picked up at random.

In the grinding operation, the work must be carefully chucked and the wheel brought to bear lightly against the side of the hole away from the operator. The wheel is then fed in and out of the hole by means of the automatic feed until it sparks but faintly. The spindle is then indexed around 90 degrees and another surface ground. After all four surfaces have been ground, the hole is tested for size by means of a square plug gage, and if undersize, a few more cuts are taken. The operator has to work in the dark, as it were, as he has to grind four sides before gaging the work each time; a little practice, however, soon brings about efficient results.

In conclusion, it can be safely stated that the several operations necessary to produce accurate gears of the kind described in this article are really simple in themselves; the secret of success lies in a few simple, accurate tools, as here described.

BRASS FOUNDRY PROBLEMS[1]

With the introduction of oil as a fuel, the utilization of labor-saving machines of all kinds, and the advent of the efficiency engineer and the chemist, brass foundry operation is quite a different proposition to what it was thirty years ago. Still the resourcefulness of foundries is frequently taxed. A proposition recently put up to one foundry was the manufacture, commercially, of duplex thermostatic plates. These plates had to contain, when finished, 50 per cent nickel steel and 50 per cent brass alloy, the nickel steel and the brass plates being cast or otherwise fused together. The brass alloy had to be of such a nature that it could be rolled down to sheets 0.003 inch thick, and even less. Curiously, only one brand of zinc was found that would consistently give satisfactory results in the alloy.

A common foundry problem is when and where to commence using metal patterns for repeat work. Because of the ease with which changes in design may be made, wooden patterns are preferred at the beginning. If these patterns are coated, by means of a Schoop pistol, with copper or lead, they become much better able to resist the wear and tear incident to the molding process.

Another difficult problem is the manufacture of aluminum castings that will take a high polish. Castings made from the standard alloys are invariably full of small black specks, due to gas in the metal; but the addition of from 8 to 10 per cent of tin to the alloy produces satisfactory castings. To make this aluminum-copper-tin alloy, it is necessary to make up a rich alloy and then add bars of it to the aluminum at the proper time.

Tough, perfect, homogeneous brass and aluminum parts are now made by the pressed-metal process. A hot blank is forced into a steel mold of the exact design and dimensions of the desired metal part, powerful hydraulic presses being used. The enormous pressure to which the blank is subjected raises the temperature of the metal and causes it to flow into every part of the mold. By this process, it is possible to make the most intricate shapes; the parts are formed so accurately to size and the surfaces are so smooth that in many cases no machining is required, and the parts are absolutely free from air- and gas-holes and sand. Because of their strength, it is often possible to substitute pressed metal parts for bronze and English gun metal parts.

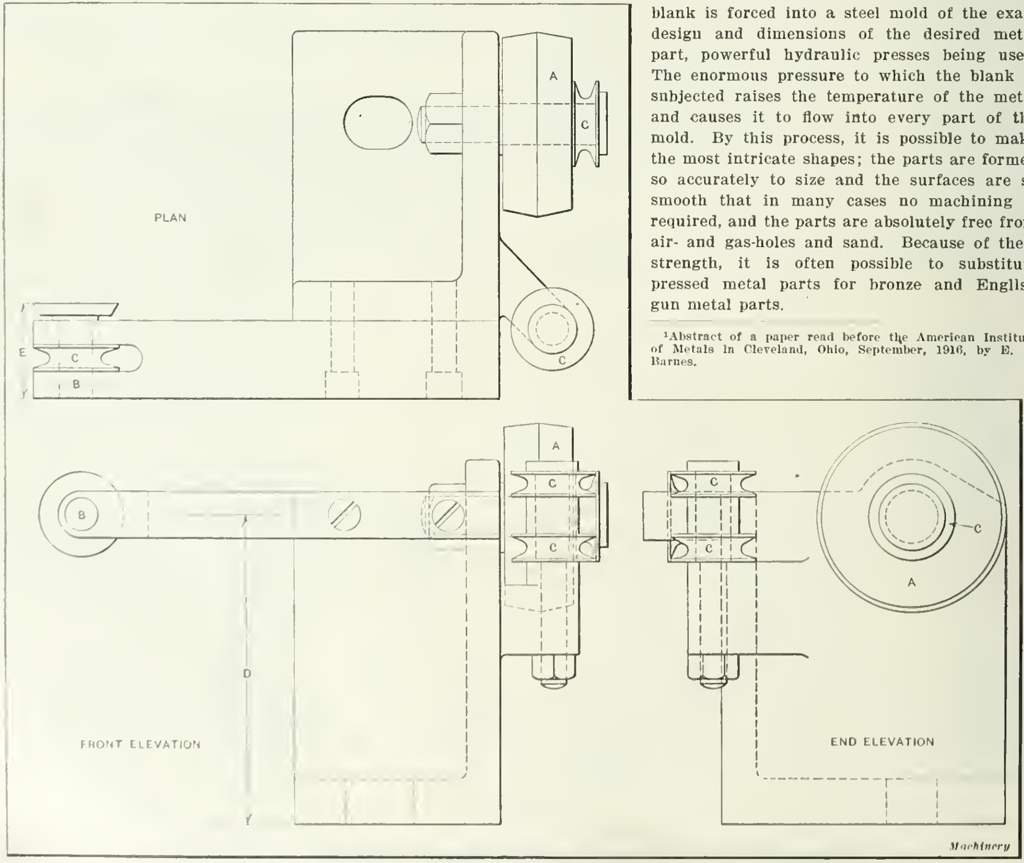

Fig. 12. Grinding-wheel Fixture for grinding Gear shown in Fig. 11

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[1] Abstract of a paper read before the American Institute of Metals in Cleveland, Ohio, September, 1916, by E. A. Barnes.

TAPPING MACHINES AND ATTACHMENTS[1]

AUXILIARY APPLIANCES FOR TAPPING ON DRILLING MACHINES—VARIOUS TYPES OF SPECIAL TAPPING MACHINES—METHODS OF HOLDING WORK WHILE TAPPING—TAPPING SPEEDS

BY FRANKLIN D. JONES[2]

THE machines used principally for tap driving include drilling machines, turret lathes, automatic screw machines, and special tapping machines. The type of machine or attachment used for tapping may depend altogether on the relation of the tapping operation to other operations. The number of holes to be tapped and the advantages or disadvantages of doing both drilling and tapping on one machine should also be considered. Regular drilling machines are extensively used for tapping, because the latter operation naturally follows the drilling of the hole. In many cases, the work is so large and cumbersome that there is a decided advantage in tapping it on the same machine used for drilling. The drill press is also used for tapping a great many small parts, but when large numbers of pieces are required, special tapping machines are frequently used. Tapping operations in turret lathes, automatic screw machines, horizontal and vertical boring mills naturally follow the turning, drilling or boring operations in these machines. A special tapping operation is thus avoided and greater accuracy is secured between the tapped hole and other machined surfaces.

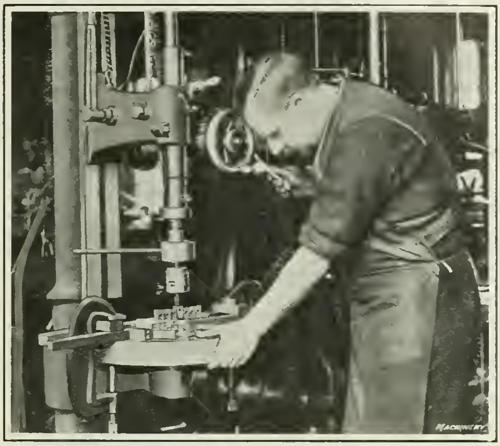

Fig. 1. Errington Automatic-reverse Tapping Chuck in Use on Drilling Machine

Auxiliary Attachments for Reversing Tap Rotation

When drilling machines are used for tap driving, the reverse movement for backing non-collapsible taps out of holes after the thread is cut to the required depth may be obtained either by reversing the spindle of the machine or by using a special chuck or attachment designed to reverse the motion of the tap. Many drilling machines are not equipped with a mechanism for reversing the rotation of the spindle and a special attachment is then required. An automatic-reverse tapping chuck or attachment (manufactured by the Errington Mechanical Laboratory, 39 Cortlandt St., New York City) is shown applied to a drilling machine in Fig. 1. This chuck has a taper shank which is inserted in the spindle of the machine. The body of the chuck and the gage *B* (Fig. 3), which may be used to control the depth to which holes are tapped, are both prevented from rotating with the machine spindle by a rod *A* which, in the case of a drill press, rests against the left-hand side of the machine column and slides up or down the column as the spindle is raised or lowered. When tapping a hole, the regular feed lever or handwheel of the machine is used to lower the spindle as the tap passes down into the hole; when the lower end of stop-rod *B* comes into contact with the face of the work, the direct forward motion drive is released and the tap stops revolving. The machine spindle is then raised; this movement, by the engagement of gearing within the chuck body, causes the tap to back out of the hole rapidly. Raising or lowering the machine table or work would have the same effect. The tap-holder used in conjunction with this automatic reversing chuck may or may not have an adjustable friction drive for safeguarding taps against breakage. For tapping holes in cast iron, brass, etc., or where blind holes are deep enough to prevent the tap from striking the bottom, the frictional form of holder may not be required. The latter is intended especially for tapping in steel or for bottom tapping. This automatic-reverse tapping chuck is sometimes used with advantage for tapping two or more holes at the same time. The exact method of arranging these chucks for multiple tapping operations depends to some extent upon the nature of the work. Fig. 2 illustrates how four holes were tapped in malleable iron gear-cases simultaneously. The chucks are prevented from revolving and are held in the right position by a plate or fixture at the top, which is special for this particular job.

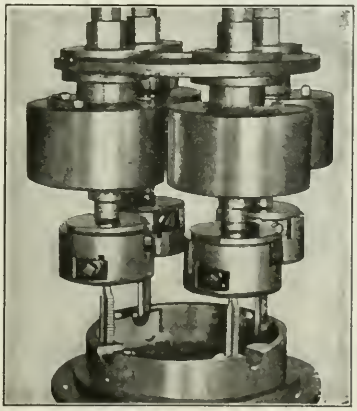

Fig. 2. Errington Multiple Tappor

Tapping Attachments having an Oscillating Movement

When tapping holes in steel and other hard materials with hand-operated taps, it is common practice to alternately advance the tool and then turn it back through part of a revolution in order to assist in breaking up and clearing the chips to prevent breaking the tap. This practice is duplicated automatically in a tapping attachment (see Fig. 4) manufactured by the Wahlstrom Tool Co., 5520 Second Ave., Brooklyn, N. Y. For tapping cast iron and similar materials, this oscillating movement is not required, and for work of this kind, provision is made for disengaging the oscillating drive and engaging a continuous forward drive. This change is made by turning the knob seen in front of the attachment. When either the oscillating or continuous forward drive is used, the tap is backed out by raising the lever that controls the hand feed of the drilling machine spindle. This results in positively clutching a continuous drive that backs out the tap at high speed. A special chuck furnished with the attachment grips the round shank of the tap as well as the squared end, so that the shank is supported right down to the end of the chuck.

Variable-speed and Reversing Attachment

The attachment illustrated in Figs. 5 and 6 has three forward speeds and a reverse motion, and it is adapted either for tapping operations or for speeding up small drills. The speed changes are controlled by turning the knurled knob at the front, which is provided with a suitable handle or lever that also serves to reverse the motion. Fig. 6 illustrates the geared speed-changing mechanism.

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[1] For information previously published on this subject, see "Taps and Tapping Equipment," in the November number of MACHINERY, and article there referred to.

[2] Associate Editor of MACHINERY

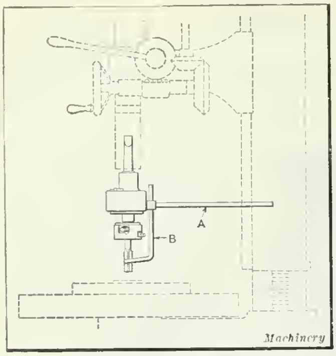


Fig. 3. Diagram illustrating General Arrangement of Errington Automatic-reverse Tapping Chuck and Application to Drilling Machine

These changes are effected by means of two positive clutches, which are shifted by turning the knurled knob referred to. When using the slow or direct speed for tapping or driving large drills, the gears run idle, the direct speed being the same as the spindle speed. Fig. 7 shows this attachment applied to a drill press. A bar extends from the attachment to the column of the machine to prevent the attachment from rotating with the spindle. The variable-speed feature makes it possible to drive a small drill at high speed, a large drill at the low or direct speed, whereas the reversal of motion may be used for backing a tap out of the hole after the tapping operation. The tapping may also be done at a slow speed and the tap backed out at a higher speed. This attachment is made by the McCrosky Reamer Co.

Tapping Mechanism of Drilling Machines

The tapping mechanism of a drilling machine for use with non-collapsing taps, may be arranged not only to reverse the rotation of a tap for backing it out of the hole, but also to safeguard the tool against excessive torsional stresses by means of an adjustable friction located somewhere between the tap and the source of power, which slips in case an unusual amount of resistance is encountered. A frictional chuck may be used for this purpose, or an adjustable friction may be introduced somewhere in the spindle driving mechanism of the machine. A tap reversing mechanism of the kind that is incorporated in the design of the machine instead of being in the form of an auxiliary attachment is shown in Fig. 8. This tapping attachment (which is applied to some of the vertical drilling machines made by the Cincinnati Bickford Tool Co.), when used in conjunction with the friction back-gear, provides for drilling at a fast speed, tapping at a reduced speed, and then backing out the tap at a relatively high speed. Motion is transmitted through the lower bevel gear shown, when tapping, and through an intermediate spur gear and the upper bevel gear for backing out the tap. The intermediate spur gear is mounted on a sector, so that it can be disengaged when not required for tapping. The forward and reverse motions are controlled by the lever shown, which operates a friction clutch connecting with the bevel gears previously referred to. The method of operating this attachment is to start the spindle backward at the same speed as that for tapping until the tap frees itself, and then the speed is greatly accelerated by a pull on the friction back-gear lever. The illustration shows the attachment with the gear guards removed. While tapping attachments on various makes of drilling machines differ somewhat as to their general arrangement, these variations usually pertain to details of construction, and as they all operate on the same general principle, other designs for upright drilling machines will not be described.

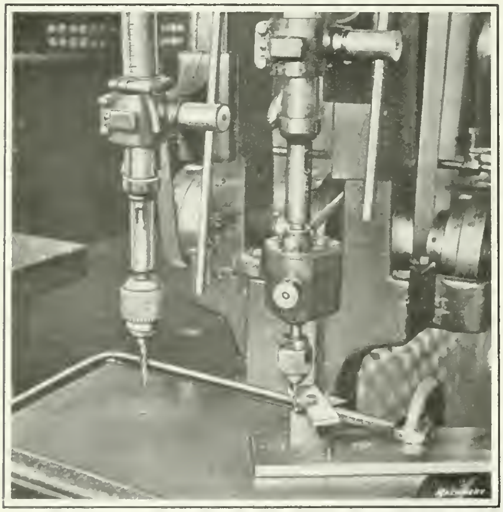


Fig. 4. Wahlstrom Tapping Attachment designed to give Tap an Oscillating Movement when tapping Steel

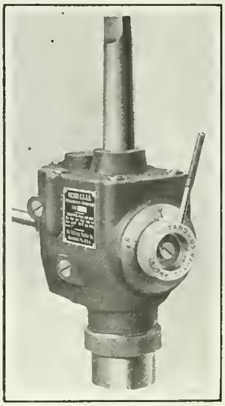


Fig. 5. "Wizard" Variable-speed and Reversing Attachment

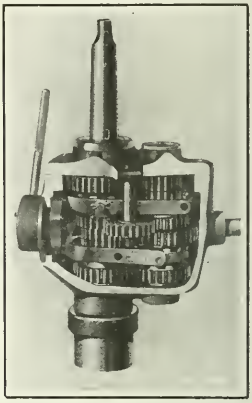


Fig. 6. Interior Mechanism of "Wizard" Variable-speed and Reversing Attachment

On radial drilling machines the mechanism used for tapping and commonly known as the "tapping attachment" is incorporated in the design of the drill spindle headstock. This mechanism, like that applied to an upright drilling machine, is simply a combination of gearing through which motion is transmitted for reversing the roation of the tap. The tapping attachment of the Fosdick radial drilling machine (Fosdick Machine Tool Co., Cincinnati, Ohio) is shown in detail in Fig. 9 as an example of this class of mechanism. Forward and reverse motions are obtained through the combination of three bevel gears shown. This reverse mechanism is mounted on the horizontal driving shaft *A*, which extends along the radial arm. The direction in which the driven shaft *B* revolves depends upon whether motion is transmitted through gears *C* and *D* or *E* and *D*. Either of the two bevel gears *C* or *E*

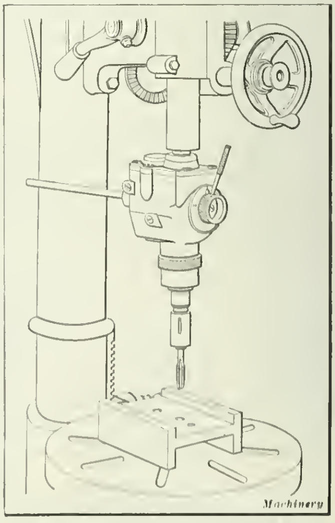


Fig. 7. Attachment illustrated in Figs. 5 and 6 applied to Drilling Machine

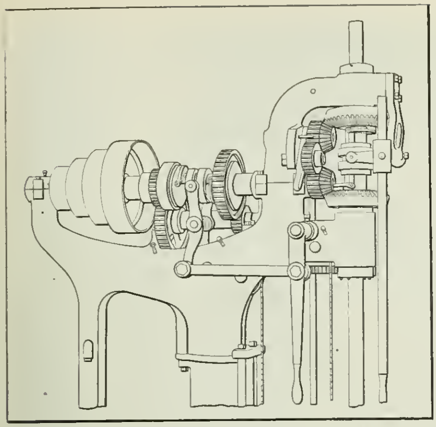


Fig. 8. Tapping Attachment of Upright Drilling Machine

is engaged with the driving shaft by means of expanding ring clutches controlled by a lever or handle located at the right of the lower end of the drill spindle. Motion is transmitted to the drill spindle through back-gears which give three forward and three reverse speeds, with ratios of three to one and nine to one. This back-gearing is controlled by a lever located at the left of the spindle. With this arrangement, taps may be backed out at the same speed as is used for tapping, or at three times or nine times the tapping speed, without changing the regular speed-changing mechanism of the machine.

Special Tapping Machines

Tapping machines may be intended either for general tapping operations or for use on one class of work, like the tapping of nuts. The designs vary considerably, including vertical and horizontal designs in single- and multiple-spindle types. The spindles may be adjusted on some machines for varying the center-to-center distance, or they may be fixed in the case of machines used exclusively for tapping duplicate parts. Tapping machines also vary in regard to the mechanism for obtaining the forward and reverse motions of the tap spindle and the method of controlling these motions. A common arrangement for obtaining the two motions is by means of a clutch which is interposed between two pulleys revolving in opposite directions and is alternately engaged with these pulleys. The clutch may be controlled by (1) a hand-lever connecting with the clutch; (2) a foot-lever connecting with the clutch; (3) pushing the work and its fixture forward until contact is made with a stop-rod or lever which shifts the clutch for backing out the tap; (4) pushing the work against the tap while tapping and by pulling in the opposite direction for backing out the tap, the clutch being shifted by the direct thrust from the part being tapped and the resulting longitudinal motion of the tap spindles. The latter method is applied only to machines used for the lighter classes of work. The characteristic features of well-designed tapping machines are convenience of control and, for small tapping operations, a sensitive drive that will transmit enough power for operating the tap under normal conditions but not enough to break it in case the resistance to rotation becomes excessive. Several different makes of tapping machines will be described to illustrate variations in design.

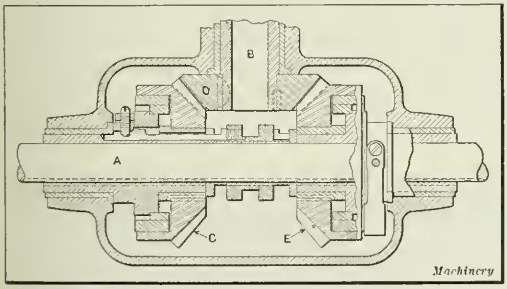


Fig. 9. Mechanism of Radial Drilling Machine for reversing Motion when tapping

Tapping Machines of Horizontal-spindle Type

A simple form of tapping machine, made by the Garvin Machine Co., New York City, is shown in Fig. 10. This machine has two belt pulleys driven by open and cross belts, so that they revolve in opposite directions. A clutch is located between the pulleys for controlling the forward and reverse motions. The parts to be tapped are supported by a pad *A* and are held, preferably, in a socket type of fixture designed to prevent the work from revolving with the tap and to permit rapid insertion and removal of the work. The part to be tapped is moved up into contact with the tap by hand-lever *B* connected to the tailstock spindle. The depth to which the tap enters the hole is controlled by an adjustable stop *C*. When this stop engages the tailstock, thus arresting the forward movement of the tailstock spindle, the tap immediately draws the tap spindle forward and disengages the clutch. When the feed lever is moved in the opposite direction the tap spindle is shifted over still farther, thus engaging the clutch with the reverse pulley, which is narrower than the driving or forward-motion pulley and is located nearer the chuck. This particular machine (which is the No. 2 size) has a capacity for taps varying from 3/16 up to 1/2 inch in diameter.

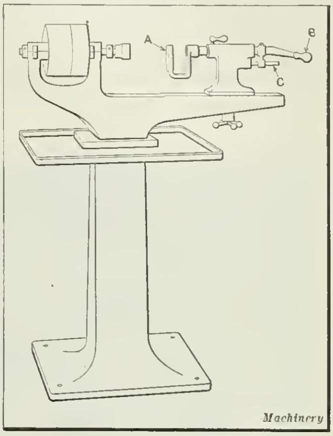


Fig. 10. Garvin Horizontal Tapping Machine

Another design of horizontal, single-spindle tapping machine is shown in Fig. 13. This machine (manufactured by the Rickert-Shafer Co., Erie, Pa.) derives its forward and reverse motion from a combination of three friction wheels, consisting

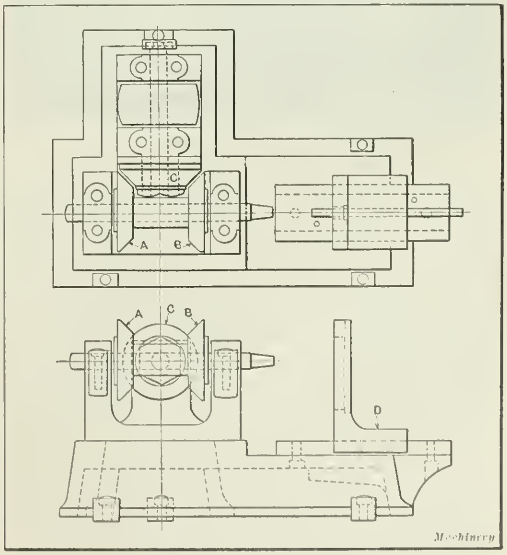


Fig. 11. Meriden Horizontal Tapping Machine

of two drivers and one driven wheel, which is alternately engaged with the driver. The driven wheel *A* is made of aluminum and is located between the driving wheels *B* and *C*, which have friction board driving surfaces. When the part to be tapped is pushed against the tap, the driven wheel is held against the rear driving wheel *C*, which is larger than *B* and revolves at a slower speed. As soon as the hole has been tapped to the required depth, a backward pull of the spindle forces the driven wheel *A* into contact with driving wheel *B*, thus reversing the direction of rotation and backing out the tap. This machine is driven by a single belt, which passes over the forward and reverse motion driving pulleys, as the illustration shows. These two wheels rotate, of course, in the same direction, but the driven wheel is reversed, because it engages pulley *B* on the rear side and pulley *C* on the front side. A work-holding fixture is not used for the particular tapping operations illustrated, because the tap first passes through a clearance hole which holds it in alignment, so that it is not necessary to provide means for holding the work, which is simply applied directly to the tap.

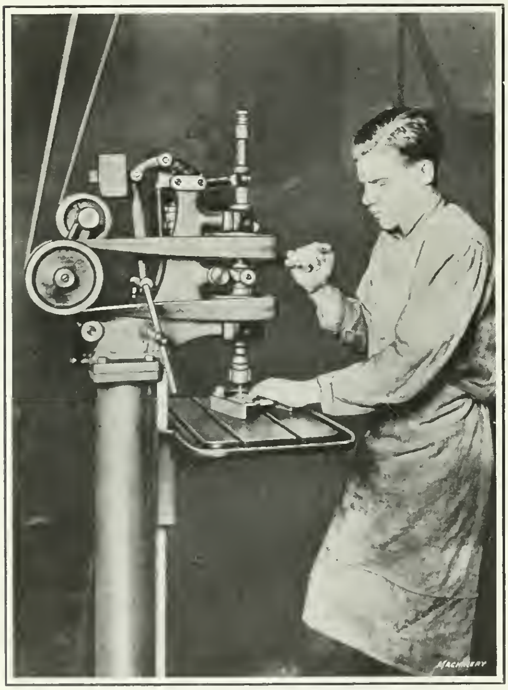


Fig. 12. Garvin Vertical-spindle Tapping Machine

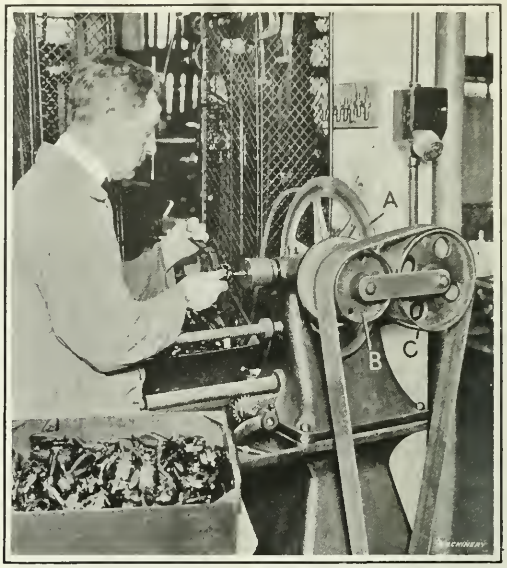


Fig. 13. Rickert-Shafer Horizontal Tapping Machine

The horizontal tapping machine illustrated in Fig. 11 (built by the Meriden Machine Tool Co., Meriden, Conn.) operates on the same general principle as the one just described, but differs in regard to the arrangement of the driving mechanism. The tapping spindle carries two bevel or conical faced wheels *A* and *B*, which are alternately engaged by a third conical faced wheel *C* mounted on the belt-driven driving shaft. The tap-carrying spindle has a free longitudinal movement, and when a piece of work is forced against the tap, the forward cone *B* is held in contact with the driving cone, thus causing the tap to revolve. When the tap has entered to the required depth and the work is pulled backward, the rear driven cone *A* is brought into contact with the driving cone *C*, thus reversing the rotation of the tap. The two driven cones are made of cast iron and the central driving cone is of cast iron faced with leather to increase the frictional resistance. The machine has a slide *D*, which is mounted on V-shaped ways, and is intended to hold whatever form of fixture may be needed. The slide has an adjustable stop-rod which limits the travel or movement of the work toward the tap. This machine is designed for tapping holes 1/4 inch in diameter or less. The horizontal tapping machines of the type previously described are adapted especially for small parts which are easily handled.

Vertical-spindle Tapping Machine

For many classes of work a machine with a vertical spindle is preferable to the horizontal type. One of the Garvin tapping machines of the vertical type is shown in Fig. 12. The spindle carries two belt pulleys which are driven in opposite directions by one continuous belt. A friction clutch between these two pulleys is brought into engagement with one pulley for starting the tap, by means of the operating hand-lever or by a foot-pedal on some machines. The connection between this lever and the friction clutch is through a

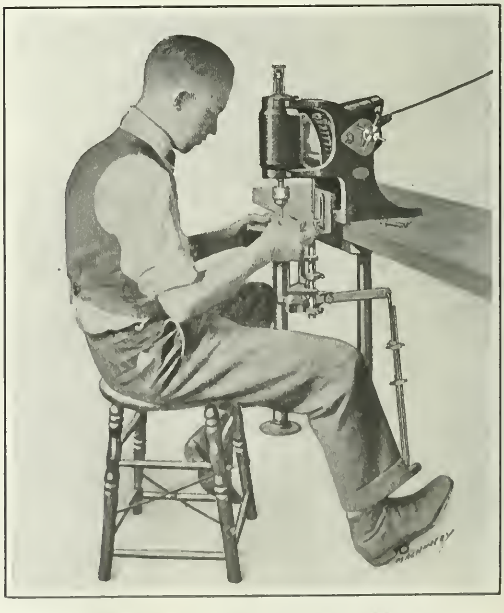


Fig. 14. Anderson Vertical-spindle Tapping Machine

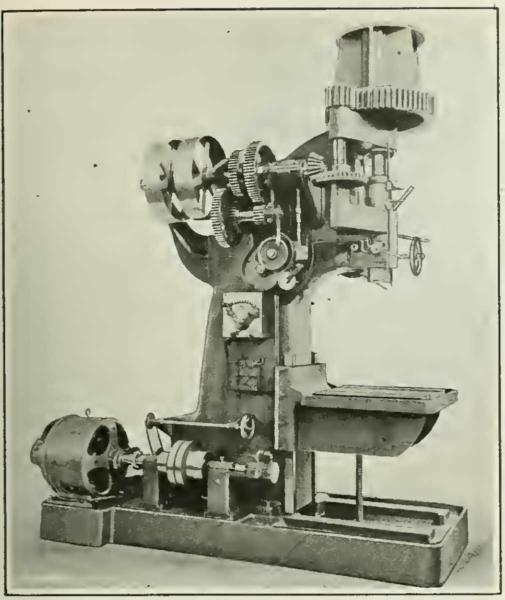
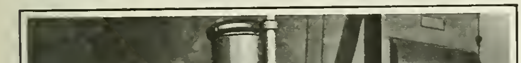


Fig. 15. Baker Sixteen-inch Tapping Machine

mechanism which provides an adjustment for varying the tension in order to safeguard taps against breakage. After the tap is started the machine operates automatically, the tap feeding down to whatever depth the machine is adjusted for and then backing out of the tapped hole. The point at which the reversal of the tap spindle occurs is controlled by an adjustable screw stop on the upper end of the spindle. This screw stop strikes a tripping lever on top of the machine and shifts the friction clutch located between the two friction pulleys. Fixtures for a machine of this general type should be so designed that the work will not be lifted by the screwing action of the tap.

The vertical-spindle tapping machine illustrated in Fig. 14 has a spherical friction driving disk which is mounted directly on the armature shaft of the motor. The tapping spindle carries two rollers, one being above the center of the driving disk and the other below it. The rotation is reversed by engaging the disk with first one roller and then the other. The motor is pivoted in the frame of the machine at the center of the spherical face of the friction driving disk. By inclining the motor and armature shaft to various angles, changes in the tapping and return speeds may be secured. With this arrangement, if the speed is reduced in one direction it will be increased in the opposite direction. For instance, if the spherical driving disk is so located that the spindle makes 1000 revolutions per minute in the forward and reverse directions and the position or adjustment is then changed to reduce the tapping speed to 500 revolutions per minute, the reverse movement will be increased to 1500 revolutions per minute. The work-table of this machine is moved upward by means of a foot-treadle, as the illustration shows, for bringing the work into contact with the tap. The connection from the floor to the machine is adjustable and is provided with a safety spring so that the leading movement of the tap will not be affected by a sudden application of pressure on the foot-treadle. The weight of the table is counterbalanced by an adjustable spring which gives a sensitive control of the table movement. The column supporting the table is hollow and may be filled with oil so that when tapping parts which permit the tap to go through the hole, the tap will dip into the oil. In this way, the tool is automatically lubricated and the chips washed off the end so that they will not injure the thread when the tap backs out of the hole. As this oil chamber gradually fills with chips, the oil level is automatically maintained. A spring at the upper end of the spindle can be adjusted to counterbalance the spindle weight. This machine is capable of tapping holes in cast iron ranging from 1/16 to 1/4 inch in diameter and for tapping holes in steel varying from 1/16 to 3/16 inch in diameter. The maximum depth to which holes may be tapped is 1½ inch. This tapping machine is built by the Anderson Die Machine Co., Bridgeport, Conn.



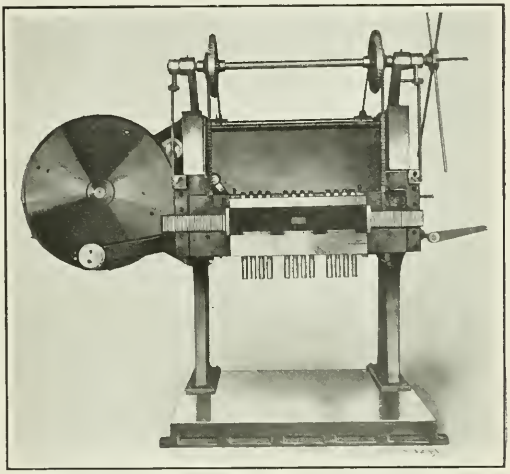


Fig. 17. Moline Multiple-spindle Tapping Machine

One of the large tapping machines made by Baker Bros., Toledo, Ohio, is illustrated in Fig. 15. This is a 16-inch size and is designed to tap cast-iron pipe fittings varying from 2½ to 16 inches in diameter. This machine is semi-automatic in its action, the reversal of the tap being controlled by means of a pneumatically operated reversing mechanism. The spindle is fed downward, when tapping, through change-gears which positively control the advance movement of the tap. These gears may be arranged for tapping either 8 or 11½ threads per inch, which covers the pitches of pipe threads for which the machine is intended. One of the interesting features of this machine is the method of driving the spindle. Attached to the top of the spindle there is a

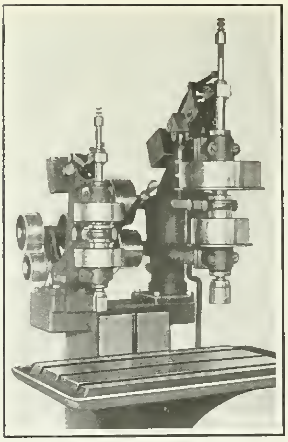


Fig. 18. Garvin Combination Tapping Machine

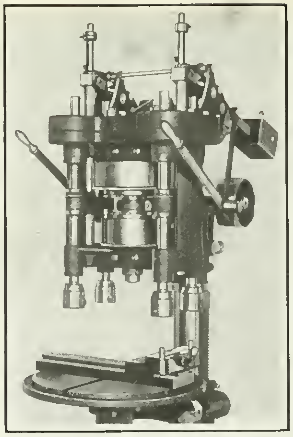


Fig. 19. Garvin Four-spindle Tapping Machine of Special Design

cross-arm, the ends of which engage vertical slots in a gear-driven driving head. This head is rotated through a pinion attached to a vertical shaft which connects through bevel gearing with a horizontal shaft that may be driven from the belt pulley shown, either direct or through backgearing. As the driving head engages the outer ends of the cross-arm on the spindle, there is a relatively low unit pressure on the bearing or driving surfaces; consequently, the frictional resistance to a vertical movement of the spindle is reduced and the spindle follows the tap more readily than it would if the drive were through a key or spline connecting directly with the spindle. This feature is of especial importance in a machine intended for such heavy work because considerable power is required for driving the large pipe taps. When the tap has fed down to the exact depth required, the spindle reverses and stops after the tap has locked out far enough to clear the work. This machine is also adapted to drilling and boring operations.

Vertical-spindle Tapping Machine of Radial Type

The tapping machine to be described is adapted especially for tapping parts that are so large and cumbersome that there is a decided advantage in being able to move the tap spindle from one hole to another. The tap spindle (see Fig. 16) is mounted at the end of a radial arm which not only swivels about the vertical column of the machine like the arm of a radial drilling machine, but is pivoted in the center as well. This is a Rickert-Shafer machine and the driving mechanism is similar to that applied to the horizontal machine previously described. The tap spindle carries an aluminum disk which is located between two paper-faced driving frictions. By means of the operating lever, the driven wheel may be engaged with either of the driving friction wheels for obtaining the forward or reverse motions. The aluminum driven disk has about the same coefficient of friction as cast iron, but its centrifugal force is only about one-third as great. The radial arm is supported by the vertical column. The driving motor is carried by the outer section of the pivoted arm and it drives the friction wheels through gearing. This machine will tap any hole within a radius of 48 inches and by folding the radial arm, the tap may be located within 8 inches of the column. The machine has a capacity for holes in steel varying from 1/4 to 1/2 inch and for holes up to 5/8 inch in diameter in cast iron.

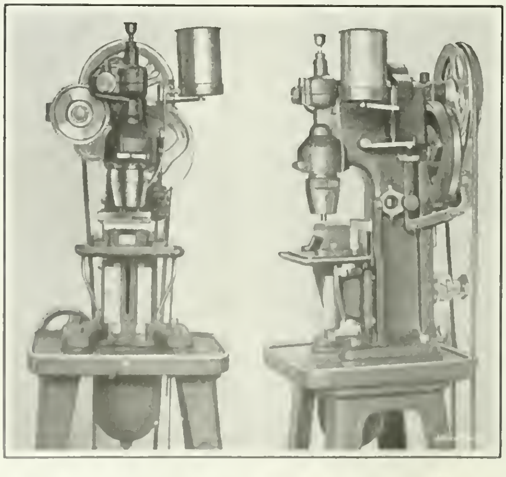


Fig. 20. Langelier Semi-automatic Multiple-spindle Tapping Machine

Multiple-spindle Tapping Machines

Multiple-spindle tapping machines are usually intended for special classes of work, although they are sometimes arranged for general tapping operations. The two-spindle machine illustrated in Fig. 18 is a Garvin combination type. This particular machine is especially applicable when there are two holes to be tapped in a part that differ in size to such an extent that it would not be advisable or practicable to have both heads of the machine of the same capacity. The machine is equipped with foot-treadles so that the operator's hands are free for manipulating the work.

A four-spindle machine is shown in Fig. 19, the spindles being operated in pairs which are controlled by independent levers. One pair of spindles is intended for rough-tapping, and the other pair for finishing. The parts tapped on this particular machine are made of tool steel and have a comparatively deep hole to be tapped. The work is held by a transverse slide or fixture which, after the rough-tapping, is simply moved over to locate the holes under the finishing taps. The general operation of these two machines is the same as that of the regular Garvin tapping machines previously described.

The special multiple-spindle tapping machine illustrated in Fig. 17 was made by the Moline Tool Co., Moline, Ill., for performing multiple tapping operations on automobile cylinders which are cast in block and for a variety of other tapping operations of the same general class. The spindles of this machine are driven from the large crank at the left which connects through a rod with a horizontal rack from which motion is transmitted to the spindles through pinions meshing with the rack. The crank gear, which drives the reciprocating rack, is driven through a train of spur and spiral gears which receive motion from a shifting belt. The upper end of each tap spindle has a shell lead-screw of the same pitch as the tap. The part to be tapped is held either on a wheeled jig or on the table. The cross-rail is lowered against a positive stop for locating the ends of the taps in position for entering the holes in the work. When the machine is started, the crank gear makes one complete revolution which causes the taps to feed downward a predetermined distance and then withdraw, after which the machine is stopped by a brake. This crank and rack control is employed when it is necessary to tap to an exact depth. A machine of this type may have either fixed or adjustable tap spindles. This is, of course, a special design and ordinarily would be constructed to meet the particular requirements of a given class of work.

Semi-automatic Multiple-spindle Tapping Machine

The multiple-spindle tapping machine illustrated in Fig. 20 has spindles located fixed distances apart and is intended for tapping large numbers of duplicate pieces. The machine may be adapted for tapping almost any number of holes grouped within

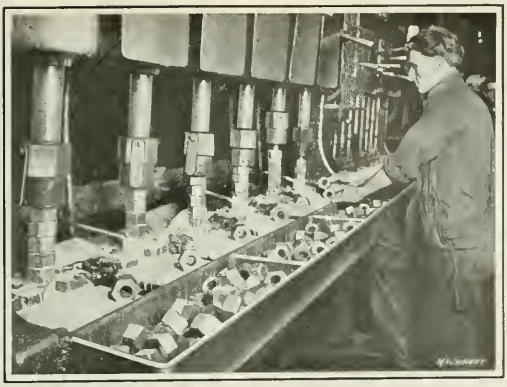


Fig. 21. Acme Six-spindle Nut-tapping Machine

a five-inch circle. The head carrying the tap spindles is arranged to suit the work. Each spindle is fitted with a special compensating device which allows every tap in the head to follow its own lead. This feature also permits operating taps of different pitches simultaneously. The main spindle is driven through spiral and spur gearing from a set of three grooved pulleys mounted side by side at the back of the machine near the top. The inner of the three pulleys drives the taps forward and operates the mechanism which raises the machine table at the proper rate for the pitch of tap being used. The outer pulley reverses the taps and also lowers the table at twice the tapping speed. As soon as the taps clear the work or jig, the machine stops automatically for a long enough period to permit removing the tapped piece and inserting another blank. The driving belt is then shifted mechanically and the cycle of operations repeated. The central pulley is an idler to which the belt is shifted for stopping the machine. This shifting of the belt is controlled by a pilot gear which is driven through change-gears. Adjustable dogs on this pilot gear operate the belt-shifting fork. One dog shifts the belt to the idler pulley for stopping the machine and the other one shifts it to the outer pulley for reversing the motion of the taps and the table movement. The position of the dog that shifts the belt to the loose pulley remains the same, but the reverse dog is set with reference to the thickness of the part being tapped. The vertical motion of the table is derived from a face cam formed on the side of the pilot gear. This machine is the product of the Langelier Mfg. Co., Providence, R. I.

Nut-tapping Machines

Some of the most highly developed and ingenious tapping machines are used for tapping nuts. These machines are made in reversing and non-reversing types and may be hand-operated, semi-automatic, or fully automatic. Reversible machines are used for tapping nuts having closed ends which make it necessary to reverse the tap and back it out. The non-reversible machines may be so arranged that the nuts pass onto a long tap shank from which they are removed periodically, or the tap may be so held and driven that the tapped nuts pass over it completely without removing it or stopping the machine.

The six-spindle nut-tapping machine illustrated in Fig. 21 is manually operated, a foot-treadle being used to raise the tap spindle each time a blank is inserted under the tap, which is done by hand as the illustration shows. The spindle and tap feed downward by their own weight and meanwhile the operator is inserting a blank nut beneath the next successive tap, so that the machine operates continuously. The vertical tap spindles carry gears which mesh with long pinions, allowing the spindles to be raised or lowered without interfering with the drive. A lever that projects outward in front of each spindle is used for controlling the drive, and enables any one spindle to be stopped independently of the others if necessary. This machine may be used for tapping either square or hexagon nuts. While nut tappers of this general type have been used extensively, the semi-automatic design to be described represents a more modern type.

Semi-automatic Nut-tapping Machine

The semi-automatic nut-tapping machine is so arranged that vertical movements of the tap spindles are controlled mechanically instead of manually. When the six-spindle machine illustrated in Fig. 24 is in operation, the square or hexagonal nuts, as the case may be, are placed by the operator in adjustable chutes. Each of these chutes or magazines holds a sufficient number of nuts to supply the tap which it feeds for some time. The chutes are placed in front of the machine, above the nut storage space provided in the bed, and are at an angle of from 30 to 45 degrees with the axis of the tap spindle, and a distance to the right depending on the size of the nut. On the top end of each tap spindle and revolving with it is mounted a special form of hardened steel worm. This worm performs the work of raising the spindle. When the spindle and tap are in the lower position, caused by the tap feeding through the nut, a finger or key is automatically projected into the space between the worm threads. The finger is stationary in the vertical plane and the worm engaging it travels upward and raises the spindle a distance equal to the length of the worm cylinder. The spindle and tap are then lowered and the tap enters the blank nut, which is in position under and in line with the tap.

An arrangement of adjustable counterweights almost balances the weight of the tap spindle, so there is no appreciable shock imparted to the tap when entering the nut. The nut is delivered from the base of the chute to the tapping position, by a swinging arm that derives its movement from the mechanically lifted tap spindle. This swinging arm carries a relief device, so that in the event of any obstruction in the

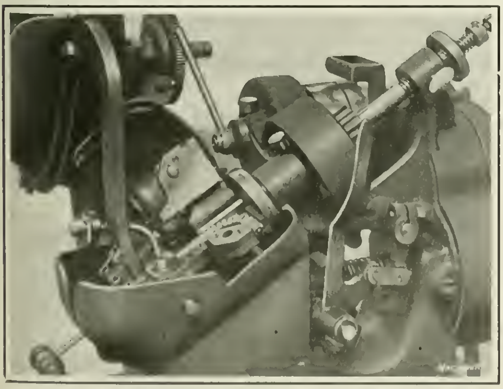


Fig. 22. National Automatic Nut-tapping Machine

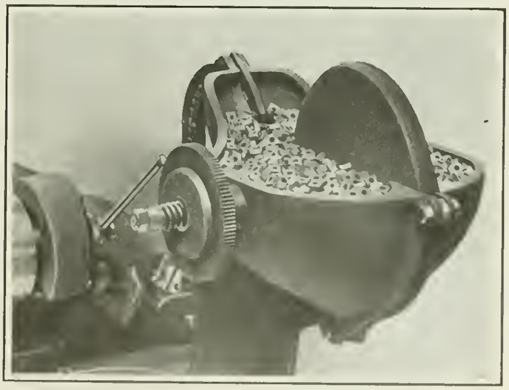


Fig. 23. Hopper from which Blank Nuts are fed automatically

path of the nut, the parts delivering the nuts are relieved from undue strain. When the tap shank is filled with nuts, the spindle automatically ceases to rise, but continues to revolve. This function is controlled by the tapped nuts on the shank of the tap, so that the tap spindle continues to rise after each nut is tapped until the tap shank is filled. The operator then raises the spindle with the foot-treadle, removes the tap from its socket, empties the nuts from the tap shank and returns the tap to the socket; the work then continues automatically. The sockets or chucks for holding the taps are designed to permit rapid insertion or removal.

The automatic feature of raising the tap spindle and delivering the blank nut to the tap is an individual one with each spindle, so when the operator is removing nuts from one tap, the other spindles continue to work automatically. A small latch or lever attached to each spindle enables the operator to discontinue the automatic lifting function on one or more spindles if desired. The nut-holder plates are fitted with adjustable hardened steel blocks that can be adjusted to suit any size nut within the range of the machine. The front block is attached to the adjustable chute and the chute is fastened to the holder plate. The gear through which each spindle is driven meshes with a long driving pinion and moves vertically over the face of the pinion. This produces an action free from tendency to raise the nut from the holder plate during the tapping operation. Power is transmitted to the machine by means of cone pulleys, giving a range of speeds necessary for each size nut within the capacity of the machine. A suitable compound is supplied by a rotary pump, each tap having an individual spout and control cock. The machines shown in Figs. 21 and 24 are manufactured by the Acme Machinery Co., Cleveland, Ohio.

Automatic Tapping Machine of Bent-tap Type

Many attempts have been made to design tapping machines that would operate automatically and continuously. The principal problem has been to separate the tapped nuts from the tap without removing the tap from its holder. One method of securing continuous operation and avoiding the reversal of the tap spindle is by the use of a tap having a bent or curved shank. This shank is curved to form a right-angle bend of rather large radius and it is held in a groove in the tap-holder. This groove is large enough to allow the tapped nuts to slide over the shank. The right-angled bend of the tap shank causes the tap to revolve with the spindle and the tap is steadied by the nuts which are continually passing over the shank when the machine is in operation. An automatic nut-tapping machine in which the bent tap principle has been utilized successfully is illustrated in Figs. 22 and 23. In Fig. 22 the tap-holder is opened to show how the tapped nuts pass over the curved tap shank before being ejected at the end. The nut blanks are fed automatically from a hopper (see Fig. 23) down through a chute to the tap. The nut blanks are delivered from the hopper to the feed chute by means of a vane feed and they are carried down by gravity against the plunger or "starter" which starts them onto the tap. There are four of these feed vanes which are enclosed in a case in the center of the hopper to prevent interference from the mass of blank nuts in the hopper. The vanes are rotated through a ratchet and pawl mechanism. The ratchet is held between friction flanges so that in case there is any wedging in the nut groove and retardation of the feed vanes, the ratchet merely slips and damage to the mechanism is avoided.

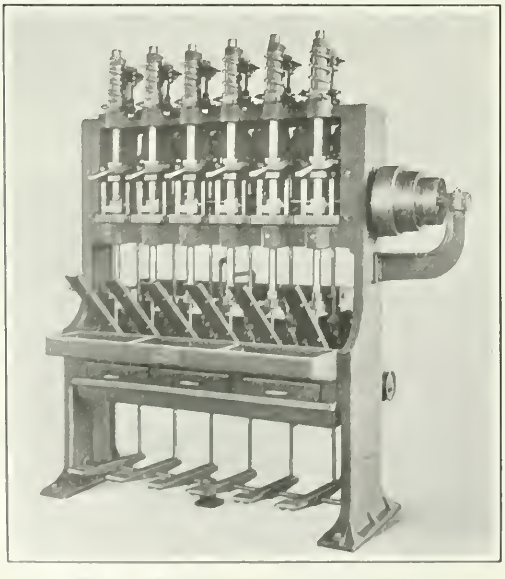


Fig. 24. Acme Semi-automatic Nut-tapping Machine

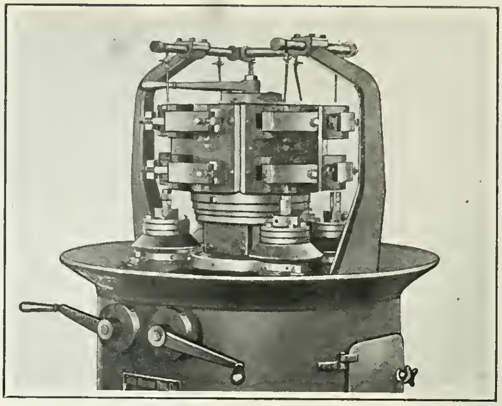


Fig. 25. Baush Station-type Tapping Machine

The tap spindle is inclined at an angle as shown in Fig. 22. The starter which transfers the blank nuts from the lower end of the chute to the tap is also inclined. The nut blanks leave the end of the chute at a corresponding angle so that they are in the proper position for starting on the tap. The tap spindle has a slight lateral travel or the equivalent of a floating movement. After a blank has been fed part way onto the tap by the starter, the spindle descends during the completion of the tapping operation. With this arrangement the blank is held stationary while being tapped instead of pulling it through a nut-holder or guides. This machine was designed primarily for tapping square nuts although hexagon nut blanks of good quality can also be tapped with it. One of these machines may also be arranged for tapping several different sizes and by making a simple gear change the number of nuts tapped per minute can be regulated to suit the work. For instance, on a 3/8-inch machine forty nuts of "shop" size can be tapped per minute if the stock is free cutting, the holes of the proper size, etc. U. S. standard nuts, which are thicker, require more turns of the tap for each nut, so that the production would be reduced to thirty nuts per minute. A similar reduction would have to be made if the nut blanks were of tough stock or the holes smaller than they should be. This type of machine is manufactured by the National Machinery Co., Tiffin, Ohio.

Station-type Tapping Machine

A special design of tapping machine intended for tapping the receivers and bolts of military rifles is shown in Fig. 25. The work-holding fixtures are mounted on the six faces of a central turret, and surrounding this turret are five tapping spindles. This leaves one blank position which is located at the front of the machine for the purpose of removing the finished product and replacing new blanks. The taps work progressively for tapping the holes to the required depth. The five spindles carry pinions which mesh with a common central driving gear. At the lower end of the central gear shaft there is a combination clutch and bevel gear type of reversing mechanism by means of which the forward and reverse motions for the tapping spindles are obtained. The reversing clutch operates automatically. The rate at which the taps are fed to or withdrawn from the work is governed by independent lead-screws of the proper pitch. The indexing movement of the turret is effected by the hand-lever seen above the turret. When this lever is moved to the right it withdraws a locking bolt and allows the turret to drop onto a ball bearing track over which it is suspended. The same lever is then moved in the opposite direction to advance the work to the next station, after which the locking bolt springs into place. A slight additional movement of the index lever then lifts the turret off the roller bearing track and its upper face comes into contact with the finished face of an aligning block. The fixtures attached to the turret are designed in accordance with the part being tapped. The usefulness of the machine is not confined to the tapping of rifle parts, as it may also be applied to other classes of work. This machine is made by the Baush Machine Tool Co., Springfield, Mass.

Work-holding Fixtures for Tapping

Parts to be tapped may be held in position during the tapping operation either by their own weight or by some kind of special fixture in the case of comparatively light parts. A simple and effective method of holding pieces on the table of a drilling machine, provided the work is light enough to center itself with the tap, is illustrated by diagram *A*, Fig. 26. Two parallel strips *a* are bolted to the table of the machine far enough apart to allow whatever piece *b* is to be tapped to slide freely into position. These parallel strips simply prevent the work from rotating when the tap is entering or backing out of the hole. Fig. 1 illustrates the use of long parallel strips for holding rectangular blocks while tapping holes in the ends. If the work does not have parallel sides, an auxiliary plate may be used to hold it. This plate may simply have a pocket or depression shaped to receive the work. In any case, the arrangement should be such that the part may be inserted and removed as rapidly as possible. By having the parallel strips under-cut to form a T-slot as shown, the screwing action of the tap cannot lift the work away from the machine table. Parts to be tapped in this way are first drilled and then tapped instead of performing the drilling and tapping operations without rehandling the work, as is frequently done when tapping pieces that are clamped to the machine table or are too heavy to center themselves when the tap enters the drill hole.

When tapping nuts, small blocks, etc., on a drilling machine, instead of placing one untapped blank at a time between the parallels, there may be an advantage in having a row of parts which is advanced for tapping each successive part, whenever an untapped blank is inserted at the feeding end of the parallels. With this method, the untapped pieces are pushed in between the parallels at one end and the tapped pieces are ejected at the other. These parallels, with whatever modification may be necessary, are often convenient for holding rods, etc., while tapping holes that extend crosswise through the work. The sketch at *B*, Fig. 26, illustrates how an auxiliary plate *c* may be used for holding a cylindrical part *d* when tapping a hole in the end. The work is clamped against the V-shaped side of the plate opening by a set-screw.

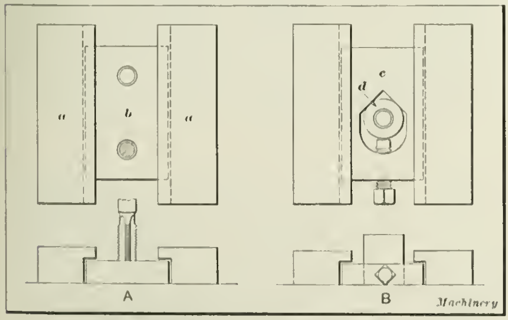


Fig. 26. Simple Methods of holding Work while tapping

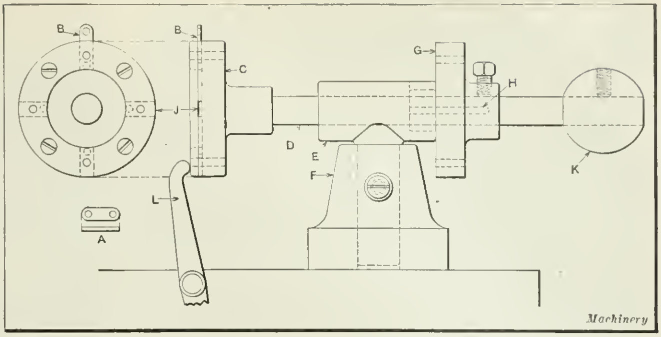


Fig. 27. Design of Fixture which, with Modification, has been extensively used for holding Small Parts while tapping

The special tapping fixtures sometimes used on tapping machines for holding duplicate parts are, as a general rule, so designed that the work is held by some form of pocket or arrangement of stops so that clamping is unnecessary. It is also important to so construct the fixture that the tap cannot lift or draw the work out of place during the tapping operation. The tapping fixture illustrated in Fig. 27 embodies these fundamental points, and the general features of this construction are found in many fixtures of the class used for holding small duplicate parts which are tapped in large quantities. The small sheet metal part held in this particular fixture is shown at *A*. The fixture is provided with slots or pockets for holding the work in position as indicated at *B*. The flange-shaped member *C*, in which the work-holding slots are formed, is mounted on the end of a spindle *D* which is free to slide through the bearing *E* attached to the stand *F*. The shape of the slot for receiving the untapped blanks may, of course, be varied according to the shape of the work. In this particular instance, plain radial slots serve the purpose. Bearing *E* may be adjusted vertically in stand *F* to align the tap clearance hole of whatever fixture *C* may be carried by spindle *D* with the tap of the machine. Fastened to spindle *D* there is an index plate *G* provided with holes spaced to correspond with the work-holding slots in part *C*. These index holes are engaged by a pin *H*, which is fixed to the rear side of bearing *E*. When this fixture is in use, the operator with his left hand inserts an untapped blank as each slot arrives at position *J*; the spindle *D* is pushed forward or withdrawn by the right hand, which grasps knob *K*. When applied to one design of tapping machine, the spindle of the fixture is pushed forward until the hole has been tapped and engagement with lever *L* causes a reversal of motion; spindle *D* is then forced backward by the action of the tap, and as soon as the tap is withdrawn from part *C*, the latter is turned one-quarter revolution as determined by the engagement of pin *H* with a hole in plate *G*. This indexing movement locates the blank, previously inserted at *J*, in the tapping position. By means of a foot-treadle, the tap is again reversed so that it rotates in a forward direction and then the cycle of movements is repeated. As the tapped parts are indexed around they fall out of the fixture by gravity. The index pin *H* is of such a length that it will not release plate *G* until the tap clears the end of the fixture. A great many tapping fixtures for small work have been designed on this general principle, the details being modified more or less according to the requirements in each case.

Speeds for Tapping

The speeds for tapping vary between 15 and 30 feet per minute, according to common practice, these figures representing the surface or peripheral speed of the tap. When tapping cast iron, drop-forgings, or tough alloy steels, a surface speed of about 18 or 20 feet per minute is common. For tapping the softer grades of steel, such as Bessemer, open-hearth, screw stock, etc., the speed is generally increased to 20 or 25 feet per minute and may be higher under favorable conditions. In the case of tool steel, the speed may be reduced to 10 or 12 feet per minute. Speeds for tapping brass are, as a rule, several times as fast as speeds for cast iron or steel, there being a wide variation owing to the difference in the composition of alloys designated as brass. While taps are frequently operated at approximately the same speed as dies, the speed is usually somewhat less for tapping, partly because taps, as a class, do not discharge chips as readily as dies nor cut as freely; moreover, cooling compounds or oil may, as a rule, be applied more effectually to dies than to taps. In most shops where tapping is done, the speeds in feet per minute are not known. In many of these shops, it has been demonstrated by actual practice—which may in some cases extend over a long period—that if the driving belt of the machine is on a certain step of the cone pulley, or the speed controlling levers are set in a certain position, the tap will be driven at the proper speed. There is no particular reason why the speed in feet per minute, or even revolutions per minute, should be determined, which suggests an important point regarding all speed and feed data, namely, that at best they are only guides, and that the correct speed for a given tap, material, and other conditions affecting the speed, should, in each case, be determined by actual tests.

* * *

INDUSTRIAL ASSOCIATION OF CLEVELAND

A society known as the "Industrial Association of Cleveland" has been formed, the object of which is to create better understanding between employers and employes. The chief classes of membership in the society are employers and salaried employes, the general affairs of the association being in the charge of a governing board composed of twenty-five employers and twenty-five employes. The routine business of the association is conducted by an executive committee consisting of seven members elected by the governing board. It is worthy of note that in the election of members of the governing board, only employer members can vote for employer representatives and only salaried employes can vote for salaried employe representatives on the board.

The purpose of the association, as stated in a leaflet issued by the approval of the executive committee, is to educate, enthuse and energize, to make men more efficient and to harmonize effort. In general, the object is to accomplish cooperation in the industry and to organize the men in industrial work in one efficient organization for economic and industrial betterment. The officers and executive committee are as follows: Charles Woodward, president; H. B. Bole, vice-president; Edward Hobday, counsel and secretary; Melvin Pattison, treasurer; James H. Foster, C. E. Thompson, Willard Fuller, and W. H. Watkins, members.

* * *

Statements have been made in the press to the effect that there were prospects that the government would commandeer machine tools and machinery. This belief apparently has been due to the fact that some manufacturers of machine tools have been asking customers to state the purposes for which machine tools and machinery ordered by them were intended. This has been taken to be an indication that the government will assume control of the machine tool and machinery situation. However, this idea is due to a misconception. Machine tools that are to be used on government orders for the manufacture of war materials are given priority by request of the Ordnance Department; hence orders that are not intended for the manufacture of war material will have to wait until those orders that are directly connected with the prosecution of the war are completed. There does not seem to be any other foundation for the belief that the government intends to control the machine tool industry unless some unexpected developments should make it necessary.

WAR-TIME ECONOMY

BY J. S. M.

General Sherman said something when he uttered that famous definition of war; yet, while we in the mechanical field are making every effort to meet the demands of the times, and everyone is prating about war-time economy, there seems to be, through lack of efficient management or cooperation, much wasted effort.

Many of the young men of the profession have volunteered; many have been taken in the selective draft. Good, capable, dependable men are not nearly so numerous as a year or so ago, and some of the engineering offices look lonesome. Yet, in many cases, due recognizance of this fact is not apparent. For instance, corporation A, under government direction, sends out drawngs for estimates on cost, time, etc., to corporations or companies B to Z, yea, more than the characters of the Chinese alphabet. Each one of these must carefully estimate the weight of all the intricate details entering into the design; whereas, if corporation A had done this work and stated the weights clearly on the drawings, it would not have been necessary for a hundred or more concerns to take up the time of their depleted forces going over the same ground. This is a sample of war-time economy.

Again, a lot of machinery of various kinds is needed, and perhaps the concerns who manufacture these machines are so loaded up with work that they cannot turn them out in the desired time. What are they loaded up with? Often work out of their line and for which they are not properly equipped. They are going along without jigs, fixtures, gages, etc., and doing the work in primitive fashion, or to equip themselves, are expending labor that should not be so spent when Sam Jones in the neighboring town has all the machinery for this very line but is devoting his energies to something for which he is probably not any better equipped.

Concern S is shy on designers and draftsmen but is taking orders for tools in a new line and will have to design them from the ground up, putting the design into the hands of men who are not familiar with the class of machinery at all. The tools are wanted in a hurry, yet the designer has to familiarize himself with an entirely new machine, while a dozen other concerns have been building this class of machines for years, have all the experience, designs, patterns, tools, jigs, etc. It seems to the writer that if concern T cannot build these machines on account of limited output, the government should say to T, "Lend drawings, patterns, jigs, even foremen if necessary, to S." Of course, S may swipe T's designs and go into the business later on; besides it may batter up T's jigs, etc. Well, what of it? Cannot a written agreement be entered into which will protect T? Or perhaps S suffers from false pride and does not wish to build from T's designs, but blindly expends time to prepare new designs that are no better but are different. It seems as though such unpatriotic short-sightedness should be shown where to get off. There are by far too many concerns and men working their heads off at tasks they cannot perform economically, while the concerns and men who can do the trick with ease and rapidity are given some other task.

All sorts of strange things crop up. For instance, concern A controls B and owns outright C. A places an order with X, which sublets part to B, which, in turn, sends to C an order for castings that it sends to A for machining. B does some fitting and ships to X, which has sublet other parts that go through similar perigrinations, does part of the work in its own shop, assembles and ships it to A. A consigns to Y, which has sold to Z. Is this war-time economy?

* * *

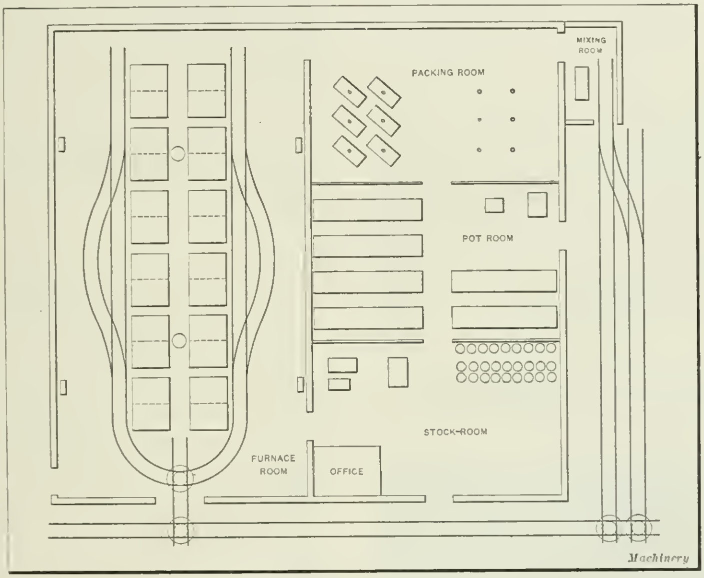
In recent experiments on Canadian railways, telephone messages were successfully sent from the dispatcher's office in Moncton to the moving train. The experiment was made on a double-track line where the rails were properly bonded for the block signal, the transmission to the car being made through the wheel and axle. It is claimed that as good results can be obtained on any track where the rails are similarly bonded, even if there is no block signal.

A WELL-ARRANGED CARBURIZING PLANT

BY C. B. LANGSTROTH[1]

From the ever-increasing use of alloy steels, one would believe that the process of carburizing low-carbon steel was on the wane. This may be the case with many concerns, but the Barnes Mfg. Co., of Indianapolis, Ind., still finds carburizing profitable, and the New England branch of this company has one of the most up-to-date plants for this class of work that is to be found. This plant has so simplified the process of carburizing and has brought the cost so low that it has completely done away with most of the objections to this method of treating steel.

When designing the buildings for this plant, the aim was to have the work progress from beginning to end without unnecessary handling, to perform the required work as cheaply as possible, and to have the working conditions of the employes as clean and comfortable as the work would permit. The modifying factor was that the primary cost must not be excessive. The buildings adopted were of standard mill construction, steel, with brick walls and concrete floors, 54 feet wide by 100 feet long. As shown in the accompanying illustration, two of these buildings are placed side by side and have one side wall in common. One building has a lantern type roof and contains the furnaces, while the other has a flat roof and is used for storage, packing, pot room, etc.



Plan of Well-arranged Carburizing Plant

The furnaces are oil-burning, of the over-fired twin-chamber type. They are entirely encased in steel plates and are securely tied together with steel binding rods. The walls and arches are built of the best quality firebrick and there is a double layer of insulating brick outside. The furnaces are arranged in two rows down the center of the room, with a four-foot walk between the rows. Under this walk is an opening, which contains all the oil, air, water and pyrometer pipes and other accessories. This opening is covered with steel latticework that is easily removed, thus making it accessible at any point. A two-foot space between each pair of furnaces allows the attendant to pass between the furnaces to adjust the valves. Over the burned-gas ports and the shelf in front of the furnaces is a steel hood, which is connected to one of the two unlined steel stacks; these hoods and stacks carry off the spent gases, heat and dust from the furnaces. The hood in front of the furnaces over the shelf, or lattice-iron grate, on which the carburized parts are dumped before being raked into the quenching bath, takes away the greater part of the smoke and dust due to this operation. All the work is quenched as quickly as possible after dumping, in order to avoid slow cooling, as this is one of the causes of exfoliation.

In front of the furnaces is a track sunk level with the floor, upon which are run the tanks for the quenching bath of water or oil and the cars for the used compound. The compound cars fit directly under the grates where the pots are dumped, so that the used compound falls directly into them. Both the quenching tanks and the cars for old compound are fitted with roller bearings, so that they may be easily moved by one man. A switch on each side of the room permits the cars to pass one another.

In discharging a furnace, only two men are needed, although in summer it is the practice to employ four men working in pairs. One man takes the pots out of the furnace, dumps them, and places the empty pots on a steel buggy. For this purpose he uses the regular U-shaped fork, which is suspended from an overhead track and works on ball-bearing rollers, so that it is easily handled. The second man knocks the cover off the pots and rakes the carburized parts from the grate into the quenching bath. After the quenched parts have cooled, the outlet and inlet of the quenching-medium pipes are disconnected and the car is pushed to the end of the room. Here an overhead motor-driven hoist lifts the basket containing the work out of the tank and carries the work to the tumbling barrels, where the work is cleaned. Before leaving the department, a part of each heat is tested by a representative of the inspection department.

The other building, used for the packing and storage, is divided into approximately three equal sections. The first section has large reservoirs below the floor for the fuel and the quenching oils. The reservoir for the quenching oil contains coils of pipes by which the oil may be cooled or heated; a secondary system of cooling coils, located on the roof, is put into service during the summer months. The quenching oil is thus always kept below 100 degrees F. The pumps for keeping both the quenching and the fuel oils in circulation are on the main floor. The remainder of the space is taken up as a storage room for the parts to be carburized. A small overhead electric crane facilitates the storage and handling of the barrels of work.

In the middle division, or pot room, all the various sizes of pots are stored. The pots, after being dumped, are carried by the steel buggies and left near the outside door of this room; when cool they are taken inside and stored in the section allotted to their particular size. Pots that are warped are laid to one side until a sufficient number have accumulated for it to be worth while starting the furnace in which they are heated for the straightening machine. This machine is simply a press that pushes the red-hot pots down over a form, and at the end of the down stroke pushes the four sides against the form. Besides the pots, all the spare castings, forks and other parts for the department are stored in this room. A visible record is kept of the supplies used by each furnace man.

The rest of the building is given over to the packing. The compound is stored in steel bins overhead and is brought down to the packers by chutes provided with the necessary shut-offs; there are two chutes for each packer. The absence of all benches, pots, and the like makes it easy to keep the room clean, which is quite the opposite from most packing rooms. Adjoining the packing room is a building in which the compound is sifted, weighed and mixed. The cars carrying the used compound are left outside this building until the compound is cool, when it is removed to the sifter, where all the clay, scale and foreign substances are removed. Then the old compound is weighed and placed in the mixer with the proper proportion of new compound. The blended compound is taken from the mixer to the overhead storage bins by a conveyor.

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In routing the material through the carburizing department, the orders are sent to the stock-room, where the quantity of work for one furnace is weighed out and placed on the shelf of a truck and the routing card is placed in a convenient steel pocket on the truck. These steel trucks are about thirty inches in height and of sufficient size to carry the pots for one furnace side by side. The truck is then taken into the pot room, where the required number of pots of the proper size are placed on it. The trucks are then sent to the packing room and placed under the proper compound chute. As the packer has the pots, work and compound all ready for assembling and everything is at hand, the work is accomplished in an amazingly short time. As soon as one truckload is finished, the packer has only to turn around to begin work on a truckload that is waiting to be assembled under the other chute. When the packing is completed the truck is taken to the furnace room, where the pots are luted. As soon as the proper furnace is empty, the pots are charged into it and the truck is returned to the stock-room, where any excess work is weighed and returned to the stores.

For the control of the temperatures, four multiple recording instruments are used; these are located on the side aisles, half way between the ends of the room and the center. The attendant obtains the temperature for the work from the routing card, which is carried by the truck with the packed work, and puts down on the card the time that he charges and draws. By this means the company has a complete record, along with the pyrometer chart, of the work the entire time that it is in the furnace. Most of the work receives only one quenching after carburizing, but where it is desired to give the work a second treatment the parts are placed on a number of large pans and charged into the furnace. This method has been found the most convenient for handling a large output of small parts.

* * *

LIMITATIONS AND WARRANTIES

BY CHESLA C SHERLOCK [1]

Manufacturers, wholesalers and jobbers do business every day that involves the law of warranties in some form or other. One of the closest questions under this subject is the proposition of when the statute of limitations commences to run in case of breach of warranty on the sale of chattels. Generally speaking, the statute of limitations provides that one having a cause of action must bring it before the courts within a specified time or any claim that he might have arising thereunder will be forever barred. Suppose, for instance, a jobber of machinery purchases some defective engines, which a little later he sells to a retail dealer, who, in turn, sells them to the "ultimate consumer." The time required to move the engines from the manufacturer to the consumer, though, has been long enough to get beyond the local statute of limitations. As soon as the purchaser attempts to use the engines, he finds that they are of faulty construction and are not as represented, and so turns to the retail dealer, who, in turn, looks to the wholesaler. The wholesale dealer finds a lot of defective engines thrust back upon him and stands to lose a large sum of money unless he can compel the manufacturer to make good his warranty on the goods. The questions very naturally arise: Did the statute of limitations commence to run at the time of the original transaction or sale between the manufacturer and the jobber? or, did it commence to run as soon as the defective condition of the machinery was discovered by the purchaser? It is needless to say that if the answer to the first question is in the affirmative, that the wholesaler or jobber will be made the victim of the circumstances and will be unable to cover his losses; if the second question is answered in the affirmative, the primary liability in warranty cases must forever rest upon the manufacturer.

The courts have very pointedly held that the statute of limitations does not commence to run until the breach of warranty has been discovered, or should have been discovered, by the retailers. The particular case under consideration by the courts was where the sale of canned goods to a wholesale grocery house was being brought up on a breach of warranty. The court said that this proposition, so far as it related to canned goods, should hold where it was not practicable for the wholesaler to open the cans for inspection. It might be said in passing that this ruling will hold true in the case of other chattels where it is not practicable for the wholesaler to make thorough tests of the particular goods he might be handling.

Much depends on the nature of the warranty as to whether or not it is present or prospective. The courts have disagreed over this proposition. Some have held that the warranty is present and broken as soon as made and that the statute of limitations commences to run at once; others have held that the warranty is prospective, as relating to some future event, and is not broken until the happening of that event. If a warranty as to the quality of an article is assumed to be present, the general rule is that the breach occurs as soon as made and the statute of limitations will commence to run at once. This rule is predicated upon the theory of law that ignorance of the fact that one has a cause of action, apart from mistake, trust relations, fraud or laches, does not prevent the statute of limitations from commencing to run. It is self-evident under these cases that the statute of limitations commences to run before there is an opportunity for the aggrieved party to discover that fraud has been done. And it is very probable that the entire time under the statute of limitations might run before there was even a reasonable opportunity offered for the injured party to discover the deceit.

The earlier decisions in the law of warranties were overwhelmingly in favor of the proposition that the breach was a present one and the statute of limitations would commence to run at once. The later cases, especially in recent years, have been leaning, as nearly as it is consistent for courts to do so, toward the proposition that they are prospective and do not take place until some future time and upon the happening of an event at such time. Probably the first case that turned the attention of the bench to the fact that it was not equitable to hold the breach of warranty as a present one was where a farmer purchased a high-grade bull that had been warranted as a breeder. He had had no opportunity to try out the warranty thoroughly until after the statute of limitations had run. The representation had been made on the sale of the animal that upon satisfactory proof of barrenness, the purchase money less the value of the beef would be refunded. The court said that the statute did not commence to run until such proof had been made. Since that time there has been an ever-increasing gap between the line of decisions as to when statutes of limitation commence to run.

The rule in such cases may be summed up as follows: Where the defect is apparent or readily ascertainable by the immediate purchaser, the breach is present and the statute of limitations commences to run as soon as the warranty is made; where there is no means of the immediate purchaser examining the goods or testing the warranty as made, and where such an examination cannot be made except upon the happening of some future event, as a resale to one in a position to make the test, then the warranty is prospective and the statute of limitations does not commence to run until the breach of warranty is discovered.

* * *

At this time, when the cost of writing ink has increased fully 100 per cent, some readers of MACHINERY may be interested in the fact that very satisfactory ink can be made from worn-out copying typewriter ribbons. The stores department of the M. K. & T. Ry. has called the attention of its departments to the possibility of making this ink as follows: Fill a quart bottle with water and allow the ribbon to soak twenty-four hours until the coloring matter has been dissolved. The result will be a good grade of writing ink—as good as can be purchased on the market. It may be used in fountain pens.

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SCREW MACHINE TOOL EQUIPMENT—2[1]

TOOL EQUIPMENT AND ATTACHMENTS FOR THE GRIDLEY MULTIPLE-SPINDLE AUTOMATIC SCREW MACHINE

BY DOUGLAS T. HAMILTON [2]

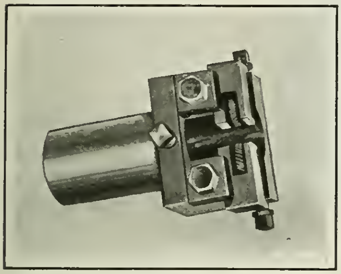

Fig. 16. End-working Knurl-holder for Gridley Automatic

In the preceding installment, published in the October number, the standard holders were illustrated and described; these holders serve to carry various types of end-working tools, such as drills, reamers, counterbores, etc. The bushings used in connection with them are made to conform to the shape of the tool used. When straight-shank drills are used, a plain bushing is all that is necessary; these were shown in Table 3 in the October number. But when the drill is of the taper-shank type having a tang, it is necessary to use a special bushing. Boring-tool holders generally consist of a plain split bushing, which can be clamped on the shank of the tool.

End-working Knurl-holder

The type of end-working knurl-holder used on the Gridley automatic is shown in Figs. 16 and 17. This holder is provided with a shank, which is gripped in a standard holder. The knurls are held in slides, which may be adjusted by collar-head screws, Fig. 16; the slides fit in grooves in the holder proper and are held by clamping blocks when adjusted to the desired position. This type of knurl-holder can be used only when it is possible to advance it longitudinally with the work, and it cannot be used for knurling behind shoulders. When knurling behind a shoulder is necessary, a holder must be fitted up on either of the forming slides, preferably the front.

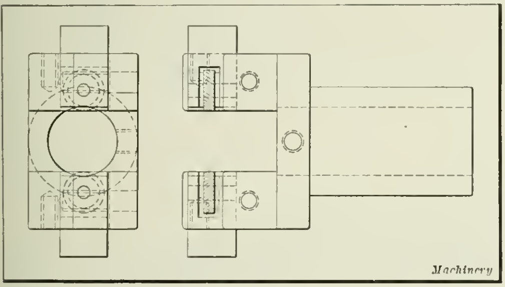

Fig. 17. Detail View of End-working Knurl-holder shown in Fig. 16

Under-cutting Tool-holder

Fig. 18 shows what is known as an under-cutting tool; this is attached to the tool-slide by bolts and T-nuts. It presents the turning tool radially to the work, instead of tangent to it, as is the case with the regular turners. This type of tool can be used to better advantage for facing and light cuts than the tangent cutter, and is adjustable for height; the entire holder is adjustable for position along the tool-slide in the regular manner.

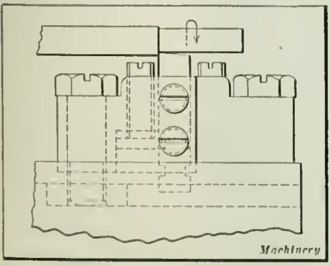

Fig. 18. Under-cutting Tool-holder for Use on Tool-slide

Internal Recessing Tool-holders

When it is necessary to enlarge a hole back from the front end of the bar, a recessing tool must be used. Fig. 19 shows a tool-holder used on the tool-slide for recessing purposes. This holder depends for its traverse movement on a bracket attached to the forming slide of the double-tool type. The top part of the forming slide is provided with two tapped holes in which screws are inserted for holding the bracket. The bracket carries an adjusting screw, which comes in contact with the movable slide of the recessing tool when the forming slide is advanced. The adjustable slide that carries the cutting tool is forced forward against the tension of a spring, which returns it to its normal position as soon as the pressure is removed. In order to use this internal recessing tool, it is necessary to furnish a special cam for the forming slide, so that the slide can be brought up to the desired position, and then made to dwell there while the necking tool is advanced longitudinally with the work. The depth of cut is controlled by the advance of the forming slide, which forces the tool into the work. When the operation has been completed, the forming slide is withdrawn and the tool-slide moves the recessing tool away from the work. This tool can be used in the second or third position.

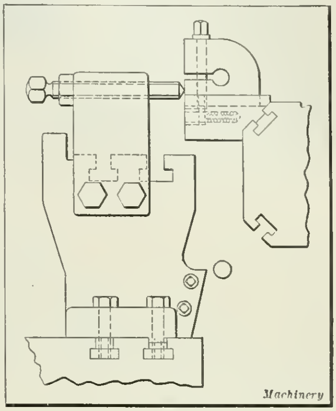

Fig. 19. Internal Recessing Tool-holder for Use in Second Position

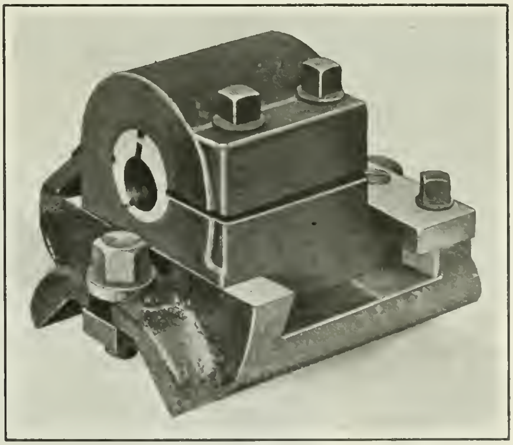

Fig. 20. Internal Recessing Tool-holder for Use in Second and Third Positions

Another type of recessing tool is shown in Fig. 20; this is adapted for use in the second and third positions. The tool-

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[1] The first installment of this article was published in the October number.

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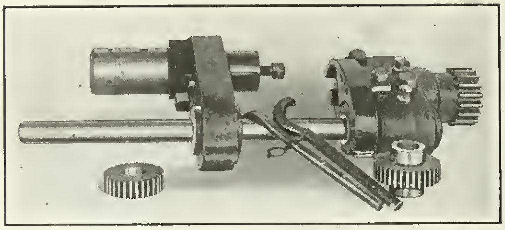

Fig. 21. High-speed Drilling Attachment for Use in First and Second Positions on ¾- and 1¼-inch Machines

holder is attached to the tool-slide, and is additionally supported and controlled when in operation on the work by the slide that ordinarily carries the die-spindle bracket. The movable member of the holder carries two cutting tools of the circular type, which are sharpened like a regular circular forming tool.

Careful inspection of this special tool will show that it is provided with two slides. The lower slide is attached to the tool-slide, and consequently moves with it, whereas the top slide is attached to the top bracket that connects the two ends of the machine. The tool-holder must have two movements; one to advance the tools into the work to the required depth, relative to the end of the work or the face of the spindles, and the other to produce the required depth of cut. The movement for position is controlled by the forward movement of the tool-slide in conjunction with the stud held in the special Y-shaped bracket on the tool-slide, which carries the stop-rod shown; this rod is provided with a nut which can be adjusted for position. The other movement is controlled by the special bracket on the tool-slide. The cutting tool in the second position is used for roughing the recess, while that in the third position is used for finishing.

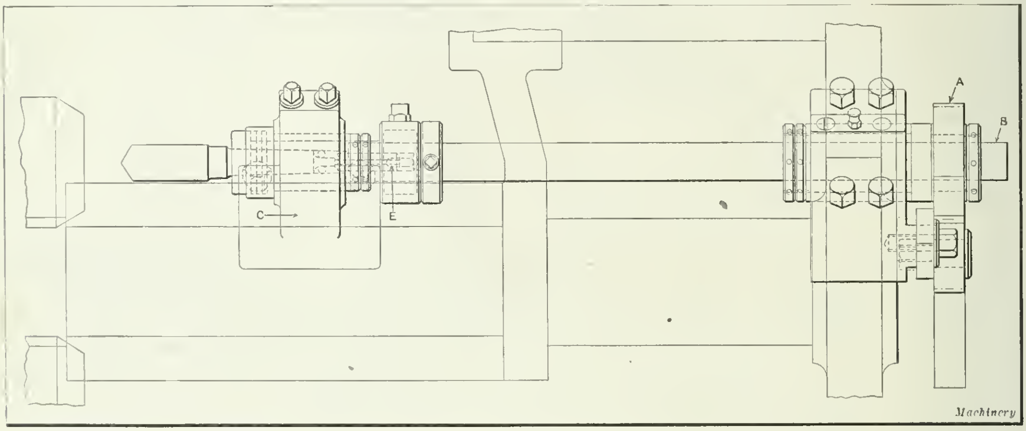

Fig. 22. Detail View of High-speed Drilling Attachment shown in Fig. 23

Set-over Tool-holder

The tool-holder shown in Fig. 24 is used for enlarging holes of comparatively little depth or for counterboring. It is also sometimes used in the place of a drill for holes that are not more than 1½ times their diameter in depth. The cutting tool works and acts the same as a forming tool, but instead of cutting on the outside surface of the bar, it cuts on the end. The tool-holder has a set-over adjustment, so that the same cutting tool can be used for machining various diameters of holes. It is not necessary to use a starting drill in connection with this tool, and it can be used for producing accurate work.

High-speed Drilling Attachments

Although the tools of the Gridley automatic are held rigidly to the tool-slide, it is necessary in some cases to rotate the drill as well as the work in order to increase the cutting efficiency of the tool. For this purpose a high-speed drilling attachment, one type of which is shown in Fig. 21, is used. This attachment is of the universal type and can be used in either the first or second positions on the ¾- and 1¼-inch machines.

Fig. 27 shows a sectional view of the attachment, which, when in use, is held on the main upright frame of the machine and is driven from the spindle gear through a gear *A* carried on a shaft *B*. Gear *C* on shaft *B* meshes with a gear *D* on the main drive shaft *E*, which has a spline its entire length and carries a sliding gear *F* which is keyed to it. This gear *F*, through an idler gear *G*, drives the gear *H* that is carried on the drill spindle. Gears *F*, *G* and *H* are enclosed in a case, which is formed into a bracket attached to the tool-slide. As this forward member moves with the tool-slide, the splined shaft permits the gears *C*, *D*, *F*, *G* and *H* to drive the drill at a positive speed, irrespective of the position of the tool-slide. The drill spindle is of the collet type and is operated from the rear end by

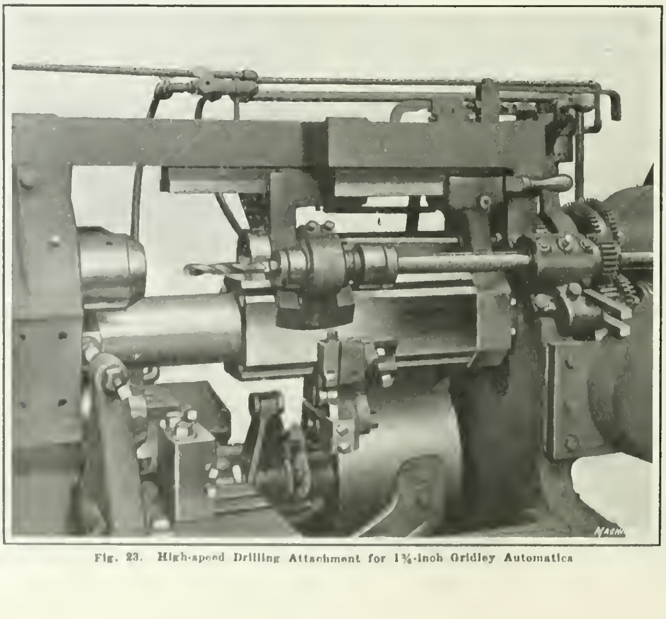

Fig. 23. High-speed Drilling Attachment for 1¾-inch Gridley Automatics

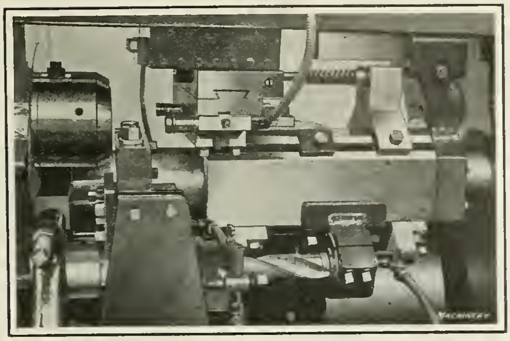

Fig. 24. Set-over Type of Tool-holder

means of a nut. It is also provided with a split bushing of the required size to fit the shank of the drill. With this arrangement of gearing it is possible to increase the speed of the drill greatly, and therefore operate a small drill at its proper cutting speed.

Figs. 22 and 23 show the high-speed drilling attachment for use on the 1¾-inch Gridley automatic; this particular attachment can be used only in the second position. It is driven in the same manner as the one just described, with the exception that the set-off arrangement makes the drive direct, and consequently no idler gears are necessary. In order to get the correct speed for certain size drills, it is necessary to use an idler or intermediate gear at the source of power, as shown in Fig. 23. This gear is held on an adjustable arm, and can be swung into contact with the gear on the pulley spindle. The drive, as shown in Fig. 22, is then direct through gear *A* on shaft *B* to the drill. Spindle *B* is supported in a bracket on the frame of the machine. This bracket is so placed that the spindle *B* is made to line up directly with the tool-holder *C* which is clamped to the face of the tool-slide. Adjusting collars are held on the main spindle to provide for wear due to end thrust.

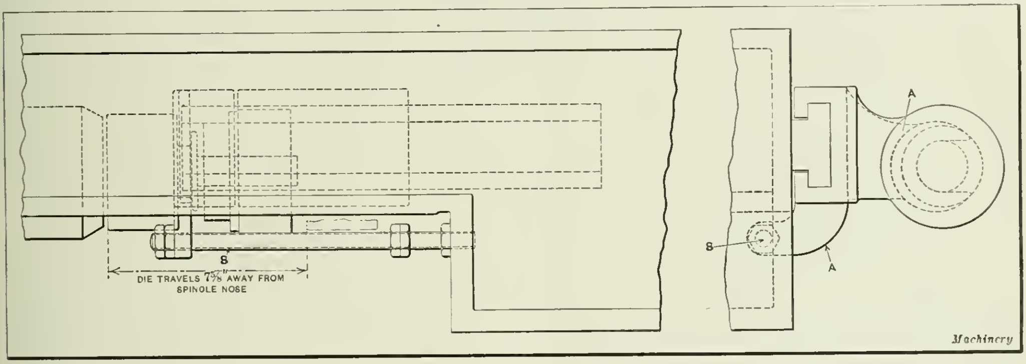

Fig. 25. Special Attachment for operating Automatic Dies on Gridley Automatics

The drill spindle is arranged to carry taper-shank drills, and is provided with a drift slot for removing them; this is covered by a collar, which is held in place by a lock-nut. To remove the drill, the headless screw in the lock-nut is released, and the collar pulled back, exposing the drift slot; the drill can then be removed in the usual manner, a plug *E* serving to force it out of the socket.

Die-spindle and Die-holder

The die-spindle has been described in a previous article, where it was mentioned that the spindle was operated entirely independently of the movement of the tool-slide, and was driven by a separate spindle through gearing and a clutch mechanism. Fig. 26 shows a close view of the die mechanism with the die-spindle advanced to the position that it occupies when feeding on to the work, just before the clutch is disengaged. It will be noticed that the die-holder is a separate member held in the die-spindle, and that it is moved back and forth by a yoke that forms a part of the die-slide. The die-holder is free to rotate in this yoke, and end play is taken up by adjusting collars. The spring screw die which is being used in this case is held in the holder by means of a screw hidden by the knurled collar that protects it. A button die can also be used by substituting a holder designed for that purpose.

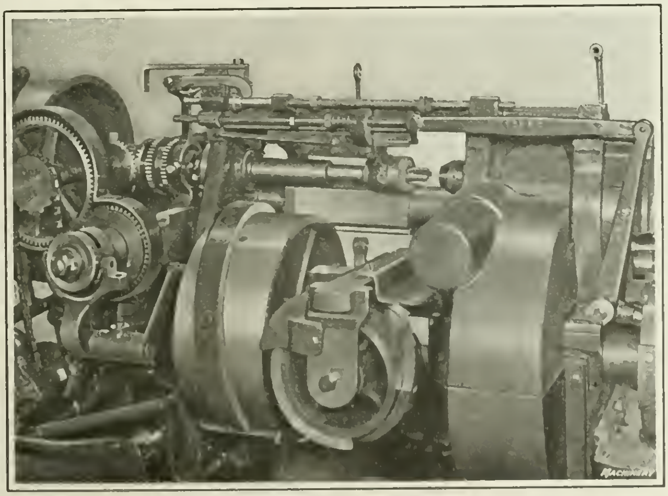

Fig. 26. Die-spindle and Die-operating Mechanism of Gridley Automatics

When it is desired to use an automatic die on the Gridley automatic, a separate attachment, illustrated in Fig. 25, is necessary. The automatic die is held in the die-spindle by its shank, and is opened and closed by a forked arm *A*, which is made in the form of a slide and fits on the same member as the die-slide. The forked arm has an extension that is drilled to fit over the operating rod *B*. This rod is carried in a bracket attached to the tie-member that connects the two ends of the machine and also carries the die-slide. Adjustable lock-nuts are carried on rod *B*, which can be set to open and close the chasers at the desired point of travel of the die-head.

The first and second installments of this article on the tool equipment of the Gridley multiple-spindle automatic screw machine have covered forming and cutting-off tools and holders, turners,

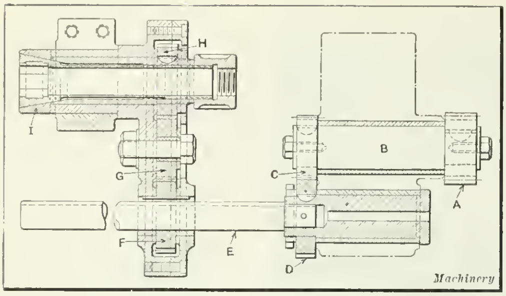

Fig. 27. Detail View of High-speed Drilling Attachment shown in Fig. 21

back-rests, tool-slide tool-holders, knurl-holders, recessing tools, drilling attachments, and die-holders. The next installment will deal with self-opening die-heads, spring screw threading dies, speeds for threading, reaming attachment, and taper-turning attachments.

* * *

HEAT-TREATED GEARING

BY W. H. PHILLIPS[1]

Steel gears may be divided as to material and structure into two general classes—alloy steels and carbon steels. Alloys of nickel, chrome-vanadium and similar elements with steel produce a strong, tough gear, which, however, because of its high cost, is practicable only for a few special uses. The great field of gearing is served by carbon steel products with entire satisfaction. Since it is possible by heat-treatment to increase the life of carbon steel gears by as much as 200 to 400 per cent, with a cost increase of but 25 to 50 per cent, these processes have received much attention. There are now three general classes of treatment; oil, casehardening, and a special treatment. The first two classes mentioned were introduced in the above sequence and have met many problems. Each has its advantage for different services and has proved very efficient. There are conditions encountered, however, in which these two grades are not applicable. The third grade mentioned has been developed after a careful study of actual conditions and embodies the best qualities found in both former grades.

There are applications where the service is so light that the resultant long life and low maintenance cost does not recommend a high-grade product. There are other services where the gear must transmit a uniformly high torque without sudden jars or dynamic blows, in which case it is a question of wear alone, requiring such surface hardness as is found in the casehardened product. There are other applications where the load to be transmitted is uniformly low but with occasional shocks. This last-named condition requires a gear with only medium hardness but with high ductility, such as the first class or oil-treated gear. There are installations where the service imposes heavy duty with its resultant wear, and shocks with the liability of breakage. It is for such service that the third class or special grades have been developed. By analyzing the conditions and selecting the proper grade, it will be possible to obtain the best results.

With the ever-increasing knowledge of steel and its heat-treatment being accumulated year by year, the first two grades were improved gradually until now they have been perfected as far as possible, and the metallurgist for some time has been looking to other fields for a grade that would include the good qualities of both the other grades and yet supply what they lacked and, if possible, reduce the cost of the heat treatment. As stated before, the alloy steel had to be eliminated because of its cost, and the only course left was to develop a treatment for carbon steel that would give the required results. Several of these so-called special grades were introduced, one of the most notable being the BP grade manufactured by the R. D. Nuttall Co., Pittsburg, Pa.

It was found that by slight changes in chemical structure, a combination could be obtained, which when subjected to a special treatment would produce physical properties peculiarly adapted for gearing. The hardness at the surface of the steel is from three to four times that of untreated steel, and grades off slightly toward the center of the tooth until it is from two and one-half to three times as hard as untreated steel. This reduction in hardness is in a straight line ratio, and each fiber of the steel from the surface to the center, or neutral axis of the tooth, which may be slightly to one side of the geometric center, will be stressed in proportion to its ability to carry the load, so that, when the tooth receives a blow or shock, every fiber is carrying its share of the load. The ductility of this steel is comparatively high and is in inverse ratio to the strength. The metal is homogeneous, there being no line of demarcation between any two fibers. While the surface of the tooth is hard, it is of a tough hardness and will not check nor spall. It is often advisable to treat the pinion only of a combination, it being the weaker and harder worked member. A pinion so treated, due to the nature of the hardness, is not likely to cause excessive wear on the meshing untreated gear. It can be readily seen that a gear of this type, which is of moderate price, will have a great tendency to overcome breakage and at the same time give a high resistance to wear. It should at least triple the life of untreated gearing, and eliminate the cost of consequential damage and delays caused by gear breakage.

If by increasing the cost of gearing from 25 to 50 per cent a gear is produced that will more than triple the life of the untreated steel gear and at the same time eliminate breakage with its consequent damage, there can be no doubt of its economy. A few of the advantages to be derived by such a step are: lower ultimate cost of gearing; reduction of time loss; reduction of labor maintenance; and reliability. For example, the untreated gear costs twenty dollars and runs one year, while the treated gear costs thirty dollars and runs three years. This would show a saving of thirty dollars on initial cost. If it requires two hours to make replacement, it would require six hours to replace the untreated gear three times and but two hours to replace the treated gear; thus four hours is saved in labor, and four hours is saved in the production of the machine. The hazard of breakage with its consequences is an unknown factor, but it may be serious in some services.

The wide application of the heat-treated gear, not only in the railway and automobile field but also in many branches of the industrial field, among the more notable being the steel mills, foundries, glass plants and mines, has been so successful that it is not a question of heat-treated versus untreated gearing, but rather the selection of the proper grade of treated gear for the service to be performed. With many industries of the country working over capacity, the necessity for reliability of machine parts was never before so urgent or the consequences of breakdown so costly. A careful study of the gear situation in the plant or mine should be made, and any changes insuring this reliability acted upon at once.

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UNITED STATES EXPORTS

Since the beginning of the European war, exports from the United States to the neutral world have doubled, and those to the belligerent world have trebled. In the government's fiscal year of 1917, the total exports to the neutral world were $2,252,000,000, as compared with $1,061,000,000 in 1914, and to belligerent Europe, $4,042,000,000, against $1,304,000,000 in 1914. The increase in exports to the non-European world was 110 per cent; to the entire neutral world, 112 per cent; and to the belligerent countries of Europe, 210 per cent. The chief gains in this exportation to the neutral countries outside of Europe occurred in the trade with Canada, Mexico, Cuba, Argentina, Brazil, Chile, China, Japan and India. These countries have increased their purchases from the United States largely by reason of the difficulty in obtaining merchandise from Europe. South America drew from Germany about $175,000,000 worth of imports in the year before the war; from Austria-Hungary, about $10,000,000; from Great Britain, approximately $250,000,000; and from France, approximately $75,000,000

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SNAPSHOTS ON THE ROAD

THE GENERAL MACHINE SHOP—STARTING THE NEW JOB RIGHT—GIVING A FELLOW A CHANCE—A FISHERMAN'S GUIDE—LAYING OUT A FOUR-PITCH THREAD—EFFICIENCY AND COOPERATION

BY THE FIELD EDITORS

THE days of the general machine shop, the kind that would repair anything made of metal, are certainly numbered, and to find a real example of this kind is a rarity. We discovered one of these shops recently in a Connecticut seacoast town, and the aged proprietor told us of his work about as follows:

"Yes, business is pretty good—great variety, great variety. Why, just yesterday a farmer drove in here to have his mowing machine repaired and ten minutes later in came an old Dutch musician to have the windpipe on his slide trombone soldered. Dutchy had been playing the night before at a charity ball and made several detours on his way home, leaning too heavily on his trombone. This just illustrates the class of work we get, and my chief difficulty is the fact that I can't get the right kind of men. I have one man who can handle a micrometer or a wheelbarrow with equal dexterity, but his kind are scarce."

We predict that this shop proprietor will find men of the last-mentioned type increasingly difficult to locate.

"—a farmer drove in here to have his mowing machine repaired and . . . in came an old Dutch musician to have the wind-pipe on his slide trombone soldered"

Starting the New Job Right

We often hear some good stories of the early days of men who have made good, and here's one from a successful superintendent whom, for the sake of brevity, we'll call Ed: Back in the shop where Ed served his apprenticeship he was considered a pretty good planer-hand, and because of this fact, he had worked on the planers in the old shop for a year after he finished his time. So naturally he wasn't worried when he applied for a planer-hand's job in the Dayton Ship & Engine Co.'s plant. "Yes, sir," he told the employment manager, "I've run planers for the best part of four years, and I'll take a job as a planer-hand if you have one." So Ed was hired and went down into the engine shop and was assigned to a machine. But when he saw that planer his heart nearly dropped two feet, because the planer they had assigned to him was twelve feet between the housings, with a table thirty feet long! The man who had run the machine for years and was considered the planer expert of the shop had met with an accident and was laid up with a broken leg, and no one else in the shop had had the courage to start that machine.

Ed was a pretty cool-headed young chap and one of those fellows who "never says die"; so without making any comment he started to set that big planer up for the first job. Meanwhile the other men of the shop were watching him out of the corners of their eyes to see what would happen. After a few hours of setting-up time, Ed had the big engine bed located, strapped down and ready for the first cut. He ground up the big tools and located them in the right positions in the heads ready to start. He knew the eyes of the shop were on him and he wasn't any too sure that things were right himself; nevertheless it wouldn't do for him to show the white feather at this time. So, when all was ready, he walked around the table to the starting box, and without paying any attention to the chaps who were stealing glances at him, he reached up with his foot and kicked the starting lever over carelessly, as though he had started a big planer so many times he was bored at the thought of doing it again. That little act was enough. As soon as the other chaps around the shop saw the careless way in which he started the machine, they made up their minds that he was master of the planer. Ed had the stuff to back up his confidence, because he did know planers, and he had no trouble in showing that shop he could fill the old planer-hand's shoes—not a little credit of which was due to the way he started.

Giving a Fellow a Chance

There are many factory clerical jobs that are filled by bright young fellows who have ambition to rise, but rising through the medium of factory clerical work is generally conceded to be difficult, if not impossible. A certain young clerk with a prosperous up-to-date factory, realizing the limitations of his position and noting a recent vacancy in running one of the large, complicated machines in the department, asked his foreman for an opportunity to be transferred from his work to the machine. The foreman laughed at the young fellow, the first thought coming to his mind being the difficulty of breaking a new man in on the clerical job, which this fellow could do to perfection. Because of his insistence, however, the foreman took the matter up with the superintendent, who is a man of some foresight. The superintendent said, "By all means, give the boy a chance. We can get somebody else for clerking, and why isn't that a logical way to secure coming young men for our organization?" This young man proved to be a star operator and his previously obtained knowledge of the systems in vogue in the shop soon made him one of the most valuable men in that department. He studies constantly, and if he doesn't contain the material for a future superintendent or manager, the present indications are misleading.

A Fisherman's Guide

MACHINERY'S HANDBOOK is generally conceded to be useful, ornamental and in every way helpful to the practical man. It covers almost every subject that pertains to modern mechanical work, but one of our readers apparently finds the chapters on "Cutting Herringbones" and "Fishtail Cutters" helpful on his fishing trips. We arrived at this conclusion after receiving his order last Thursday for a handbook which read as follows: "Enclosed please find $5 for a copy of MACHINERY'S HANDBOOK. Please send so that I will receive it before Sunday, as I am going fishing and want it." That is our deduction; what is yours?

"—finds the chapters on 'Cutting Herringbones' and 'Fishtail Cutters' helpful on his fishing trips"

Laying Out a Four-pitch Thread

Down at the old windlass plant, we dropped in to see our friend Jones, the superintendent. Jones is a philosophical sort of chap and he always sees the interesting things in life, the writing of which helps to make bread and butter for the man who has a nose for news. This time it was an interesting story with a moral that he had to tell.

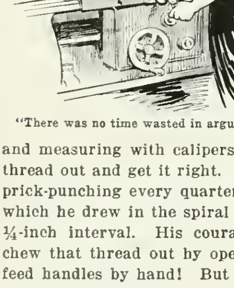
"A bright-looking young chap came into the office the other day and wanted a job.

To my questions as to what he could do, he assured me that he could do anything, and when a man tells me that, I'm always suspicious. I told him we had an opportunity for a lathe-hand on the night shift, and he promptly informed me that he was a good lathe-hand, so I started him in. His first job was to cut a big windlass screw with a four-pitch square thread. It afterward developed that this chap had never even seen a lathe before, let alone run one, or cut a thread. By some hook or crook he found out how to get his shaft on centers and how to put on the power, and as the man before him had left a tool in the lathe, his common sense helped him to find out how the feed handles operated. But cutting the thread was certainly some mystery to him! After much study of the drawing and measuring with calipers and scale, he decided to lay that thread out and get it right. So he carefully laid out the shaft, prick-punching every quarter inch for the entire length, after which he drew in the spiral around the circumference at each ¼-inch interval. His courage was fine, for he intended to chew that thread out by operating the cross and longitudinal feed handles by hand! But about the time he got fairly well into a cut, and had wobbled along a little way, I came up and looked over his shoulder. There was no time wasted in argument; we both understood. He reached for his coat and beat it."

"There was no time wasted in argument"—

Efficiency and Cooperation

A state of efficiency in an organization is certainly highly desirable, and attempts to arrive at this state have been made in many ways. Along these lines we recently noticed a framed motto in the factory of a successful New York manufacturer. It is in the form of a suggestion to be kept constantly before the employes and reads as follows: "The efficiency of this organization depends upon the cooperation of its units." This is mighty good logic, and there is hardly an organization in existence that could not apply this motto to its everyday transactions. The need of cooperation among departments is as great as among individual employes. The departments of many large concerns often consider that they have very little to do with the other departments, and the result is internal bickering rather than efficient co-working. The manager who can instill into the employes the principle of this motto is assured of a stable and efficient organization.



"It is in the form of a suggestion to be kept constantly before the employes—"

* * *

According to a recent bulletin issued by the Bureau of Mines, 100,000,000 gallons of gasoline was obtained from natural gas by the compression and condensation method. This gasoline can be blended with naphthas that otherwise are unsatisfactory for use in the automobile and made into an acceptable motor spirit. By the absorption process, which has been but recently perfected, the gasoline in natural gas, though extremely lean, can be absorbed in oil, from which it is separated by distillation. Natural gases yielding less than one pint of gasoline from each thousand cubic feet have been treated with commercial success, where formerly this gasoline had gone to waste and had constituted a source of much trouble and expense in the pipe lines.

PATENTS OWNED OR CONTROLLED BY AN ENEMY[1]

The Act of Congress, approved on October 6, known as the "Trading with the Enemy Act," gives the president the authority to grant licenses for the use of patents owned or controlled by an enemy, or ally of an enemy, provided he shall be of the opinion that such a grant is for the public welfare and that the applicant is able and intends to make use of the patent. This power and authority he has vested in the Federal Trade Commission.

Such a license will be a complete defense to any suit at law or in equity instituted by the owners of the patent against the licensee for infringement, or for damages, royalty or any money award on account of anything done by the licensee under such a license. The act provides that a license fee not exceeding $100 shall be charged, and not exceeding 1 per cent of the sum deposited with the alien property custodian. This sum is not to exceed 5 per cent of the gross sums received by the licensee from the use of the patent, or 5 per cent of the value of the use as established by the Federal Trade Commission, and is to be a trust fund for the licensee and for the owner of the patent, to be paid from the treasury of the United States upon order of the court in case the owner of the patent may, after the end of the war, file a bill in equity against the licensee in the District Court of the United States for recovery for the use of the patent, and the court may adjudge and decree to the owner payment of a reasonable royalty from this fund. If no suit is brought within one year after the end of the war, the licensee shall not be liable to make any further deposits, and all funds deposited by him shall be repaid. For this fund the licensee must file with the Federal Trade Commission semi-annually, and oftener if required, a full statement of the extent of the use of the licensee, and of the prices received from the sale for use of the patent. If suit is brought, the court may at any time terminate the license and may issue an injunction to restrain the licensee from infringement thereafter, or in case the licensee shall have made investment of capital based upon the possession of a license, the court may continue the license for such a period as it shall find to be just and reasonable.

Applicants for such a license are required to file a verified statement with the commission covering the following points:

1. If an individual, that he is a citizen of the United States, or if a corporation, that it is organized within the United States.
2. That the patent desired to be licensed is owned or controlled by an enemy or an ally of an enemy, and what the nature and origin of the control is.
3. There shall be attached to the application a Patent Office copy of the patent and a certified abstract of title to it, and a certified copy of the petition and all powers of attorney in the file of the application.
4. That there is a demand for the patented article or the product of the patented process which is not being met.
5. That the applicant is able to make the patented article or exercise the patented process. Specifically, that the applicant is technically and otherwise equipped to undertake or procure the manufacture or operate the process, and is in fact able to do so.
6. That the applicant intends to do so in good faith.
7. The application must be verified by the person applying for the license and in case of a corporation, by an officer thereof acquainted with the facts recited.

Each application shall be accompanied with a remittance of $100. The application should be prepared in duplicate, and for convenience in filing, on good unglazed paper, 8 inches by 10½ inches, directed to the Federal Trade Commission, Patent, Trademark and Copyright Division. If the licensee is not to be the actual manufacturer, the licensee will be held accountable for the observance of the terms of his license by the actual manufacturer of the article.

The burden of establishing affirmatively the facts upon which licenses may be granted is placed upon the applicant for license. Licenses shall continue during the terms fixed in the license, or during the term of the patent, and upon violation by the licensee of any of the provisions of the act or conditions of the license, the license may be cancelled.

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[1] Abstract of "Instructions, Rules and Forms Concerning Patents, Trademarks, Prints, Labels and Copyrights," issued by the Federal Trade Commission under Section 10 of the Trading with the Enemy Act.

POWER REQUIRED FOR DRIVING REAMERS

In order to determine the amount of power required for driving chucking reamers, a series of tests was made at the Worcester Polytechnic Institute by Leon H. Rice and F. Stanley Riggs, seniors in mechanical engineering. While the primary object of these tests was to ascertain the effect of reamer design on the power required for driving reamers of different types, it was found that the general type of reamer and the form of its flutes is of far less importance, so far as the necessary driving power is concerned, than the keenness of the cutting edges. The results of these tests are not regarded as conclusive, since there was no method of standardizing the keenness of the cutting edges nor of determining the relative effects of sharpness and the shape or contour.

The apparatus used consisted of an upright drilling machine, a special form of dynamometer for measuring the torque and platform scales for weighing the downward pressure or endwise thrust. The test piece was held in a lathe chuck mounted upon the dynamometer, which was supported by the platform scale. The dynamometer has a circular table 12 inches in diameter, and a strap made of annealed clock spring was attached to the periphery of this table. The other end of this strap connected with a weighing scale of the spring type which gave the torque readings. In order to avoid inaccurate results due to a turning tendency of the platform of the scale used for recording the downward pressure, this platform was stayed by means of rods and knife-edge bearings. This method proved successful and interfered little, if any, with the vertical action of the platform itself. In addition to this equipment, it was found necessary to use an oil dashpot to prevent the pointer of the torque scale from vibrating to such an extent as to make it almost impossible to obtain readings. This dashpot consisted simply of a pail containing heavy cylinder oil and a large disk submerged in the oil and connected to the table of the dynamometer by means of suitable rods and an intervening bell-crank. With this dashpot connected to the table, any sudden motion of the latter was reacted upon by the resistance of the thick oil as it flowed from one side of the submerged disk to the other side.

The pieces to be tested were made of a good grade of gray cast iron and each one was tested for hardness. New reamers, furnished by the Cleveland Twist Drill Co., were used and were for 1-inch, 1½-inch and 2-inch holes, respectively. The two principal types of reamers tested were the straight and spiral fluted forms. The number of flutes varied from four to fourteen, the four-fluted spiral reamers resembling a four-fluted drill in their action. These reamers were all of the so-called chucking reamer type and cut mostly on the end, very little material being removed along the sides. The holes in the test pieces were cored to 7/8 inch, 1 3/8 inch and 1 3/4 inch diameters, and were drilled, prior to the reaming test, to diameters of 15/16 inch, 1 7/16 inch and 1 15/16 inch, respectively. The torque fluctuated considerably when drilling these holes, which was due to the irregularity of the cored holes. When reaming the holes, these excessive fluctuations did not occur. Readings to determine the general variation in the hardness of the cast-iron test pieces were taken by drilling 3/8-inch holes in the ends of the pieces and measuring the pressure, the average pressure being used in the comparison. The drill was also tested for sharpness by drilling into a sample test bar. Four test pieces were used for each reamer tested, and in this way, by taking the average of the readings, a mean value for the variations in the castings was obtained.

The tabulated results of these tests are given in the accompanying table. The four-fluted chucking reamers gave the lowest pressure and the least torque in inch-pounds, although this type of tool left a comparatively rough hole. The spirally fluted reamers having ten, twelve or fourteen flutes required a little more power than the straight-fluted ones. This difference might have been greatly reduced if the amount of metal removed had been less. The increase in pressure for the spiral flutes could easily be accounted for, since the flutes were left-handed and inclined backward with reference to the direction of rotation. As the table shows, the pressure was always less where there was a reduction of the number of cutting edges.

TORQUE AND PRESSURE FOR DRIVING CHUCKING REAMERS OF DIFFERENT KINDS

Reamer Diameter, Inches	Number of Flutes	Form of Flutes	Reamer Speed, R.P.M.	Torque, Inch-Pounds	Pressure, Pounds
1	10	Straight	125	45.00	31.75
1	10	Spiral	125	51.06	57.25
1	4	Spiral	125	42.12	27.50
1¼	12	Spiral	76	54.75	39.60
1¼	10	Straight	76	57.00	36.75
1 5/16	10	Spiral	76	100.00	68.00
1½	12	Spiral	76	103.80	56.50
1½	12	Straight	76	76.20	40.25
1½	8	Straight	76	70.92	34.25
1½	4	Spiral	76	64.02	20.25
1 9/16	12	Spiral	76	75.00	138.00
2	8	Straight	76	147.72	46.25
2	14	Straight	76	126.00	51.00
2	14	Spiral	76	126.72	63.00
2	4	Spiral	76	93.00	27.50

Note: Feed of reamers per revolution, 0.0153 inch

In making experiments to determine the effect of the keenness of the cutting edges, a reamer approximately one inch in diameter was used. This reamer had been used in the shop for some time, but did not appear to be very badly dulled. The torque and pressure readings were 126 inch-pounds and 134.5 pounds, respectively. The tool was then sharpened and the torque was reduced to 45 inch-pounds and the pressure to 31.7 pounds, thus giving a reduction of 64.3 per cent in torque and 76.4 per cent in pressure. This difference showed very decidedly that the sharpness of the tool has far more influence than the design on the amount of power consumed. Reamers from the tool-rooms of local manufacturing plants were tested, and the results emphasized the fact that, for the same degree of sharpness, the amount of power required to drive chucking reamers of different styles would not differ greatly. The design of the tool, however, might have a decided effect on the length of time that the cutting edge remained sharp. It was not considered practicable to make tests for durability. The tests showed that the most important requirement is keeping the reamer sharp.

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SKILLED MECHANICS REQUIRED BY THE GOVERNMENT

The War Department announces that the army air service needs many more skilled workmen behind the lines abroad. These men must be recruited continuously. The air fighters need the backing of skilled men to keep each airplane ready for instant and constant service, to bring up supplies, ammunition, etc., and to construct and maintain airdromes. There is room for men with special qualifications to become non-commissioned officers. Men are being enrolled from various classes of skilled workers. These men will be given special training according to their vocation in the actual work on airplane motors, trucks, airdrome construction, etc., that they will be required to do in France. Among the skilled workers needed are automobile engine repair men and machinists acquainted with automobile work, electricians, repair men for instrument work, machine gun repair men, machinists and blacksmiths in general, motorcycle repair men, mechanical draftsmen, magneto repair men, metal workers in general, automobile engine testers, airplane propeller makers, airplane assemblers, toolmakers, welders, molders and patternmakers. Applicants must be physically sound and from eighteen to forty years of age. Applications should be sent to the Aviation Section of the Signal Corps, Volunteer Bureau, 119 D St., N. E., Washington, D. C. The application need merely state as follows: "I desire to enlist as a skilled workman in the Aviation Section of the Signal Corps," giving the name and address of the applicant, his present employer, the name of his trade, the number of years he has been employed in the trade, and whether he expects to be drafted under the selective service provisions or not.

CUTTING BOLT CAMS IN RIFLE RECEIVERS

BY H. C. EVANS

In all fixture work there are certain operations, now and again, that present special difficulties because of the peculiar shape of the cut to be taken or the inaccessibility of the surface to be worked upon. In the manufacture of rifle receivers the operation of cutting the bolt cams was one in which both of these difficulties were encountered, and they were overcome by means of the special fixture described in the following article:

The front end of this receiver is shown in section in Fig. 1. The problem presented was cutting away two diametrically opposite corners at the ends of the bolt splines. The purpose of this is to furnish two spiral faces, on which the recoil lugs of the bolt will be drawn forward out of the splines to their position against the face *AB* when the bolt is rotated a quarter turn in pushing the handle down. These two faces, which are alike, are portions of right-hand spirals of 1½ inch lead, and extend 34 degrees from the corner *G* of the bolt splines. The cutter, which is shown at *C*, Fig. 2, is similar to a boring tool with radial cutting edges, being held in the slot of a boring-bar by means of the set-screw *D*. It differs from an ordinary boring cutter only in the angles of rake and clearance, for it must be borne in mind that, instead of moving like a boring tool with only the slight advance per turn necessary for feed, this cutter must move along a spiral of 1½ inch lead, making the direction of the cut along *EF*. It is also evident that as soon as the proper corners have been cut off, the cutter must recede along a left-hand spiral in order that the other corners will remain untouched. This receding movement must be sufficient to bring the cutter into the position shown in Fig. 2, clearing face *AB* as indicated, where it must remain until it has turned to the point where it must begin to cut the opposite corner. This motion was imparted by means of the barrel cam *G*, which was clamped on the boring-bar and turned with it. While the construction and lay-out of this cam will be taken up later, it is well to explain here that two forward and backward movements were given in each revolution, both edges of the cutter doing an equal share, and working on each cut in alternation.

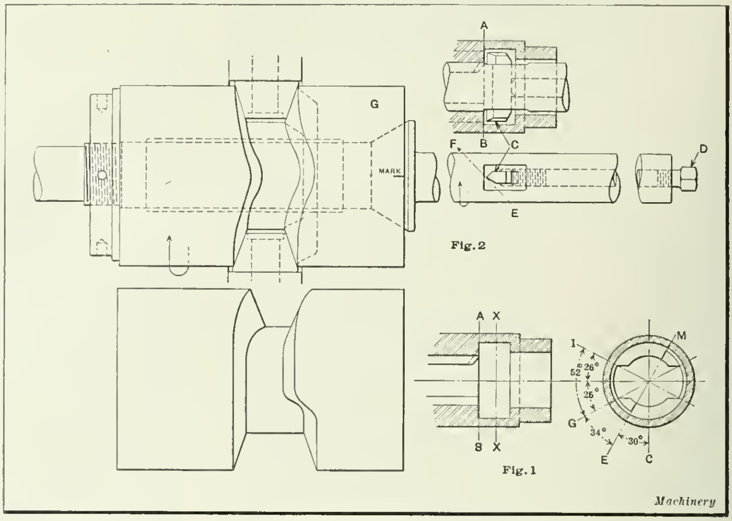

Fig. 1. Front End of Receiver. Fig. 2. Barrel Cam, Cutting Bar and Cutter

Fig. 3 shows the top and front views of the fixture. This was used on a plain milling machine, the feed being to the right as is shown. The cutter-bar *A* turns in the two bushings *B* and *C*, both of which are sliding fits in their supports. The bushing *C* is retained by a slotted spacing piece *D*, swinging on the stud *E*. By lifting this spacing piece out of the way, the bushing *C* may be withdrawn and the receiver slipped onto the cutter-bar, the latter having been turned to bring the projecting ends of the cutter horizontal, allowing them to pass through the bolt splines which have already been cut. A

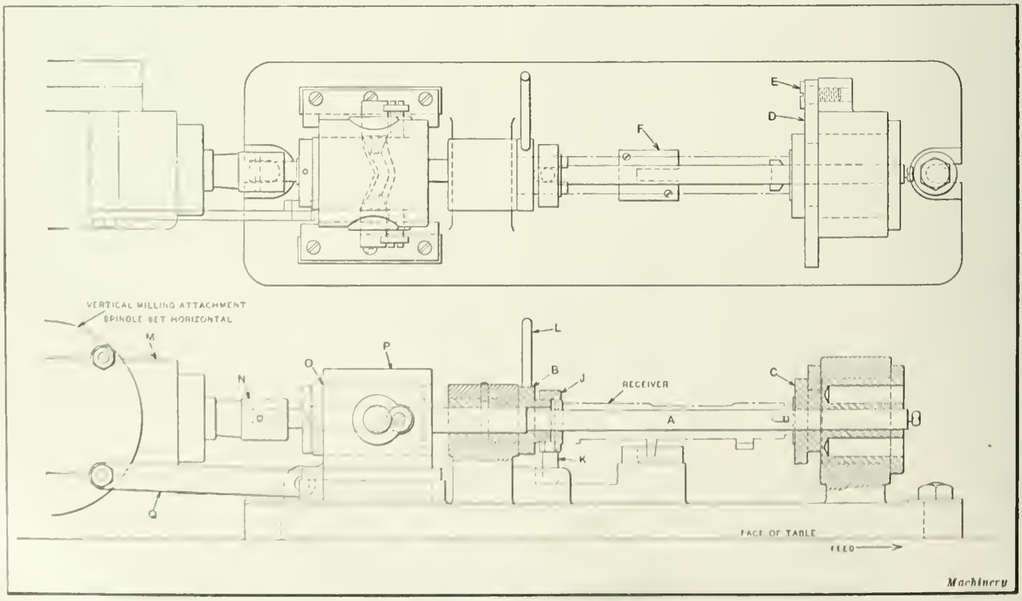

Fig. 3. Fixture for cutting Bolt Cams in Rifle Receivers

slotted plate *F* on the base engages the projecting lug on the receiver and prevents it from turning. The bushing *C* is then replaced and the spacing piece *D* swung down to retain it. The threaded nose of the other bushing *B* carries a nut *J*, which is prevented from turning by the projecting stud *K*. The latter is engaged in a slot in the base, so that by giving bushing *B* a partial turn by means of the handle *L*, nut *J* is brought against the rear end of the receiver, clamping it firmly in place. An ordinary vertical milling attachment was utilized for driving the cutter-bar. Its spindle was set horizontal and provided with a special collet *N*, driving the cutter-bar by means of a slot and pin so as not to interfere with its longitudinal movement. The barrel cam *O*, referred to above, which is carried on the cutter-bar, turns in the housing *P*. This housing, which carries the studs on which the cam rolls turn, is of cast iron and is arranged to slide in guides on the base. A link *Q* between the frame of the milling attachment and the housing *P* serves to keep the latter stationary regardless of table travel, so that the cutter always describes the same path in space. Evidently when the table feed is thrown in, the fixture bearing the work will be carried to the right and the work fed against the revolving cutter. The table movement is small, less than 3/8 inch, and the fixture is so set up that at first the cutters barely clip the corners to be cut off, each chip being a little wider until the required depth is reached.

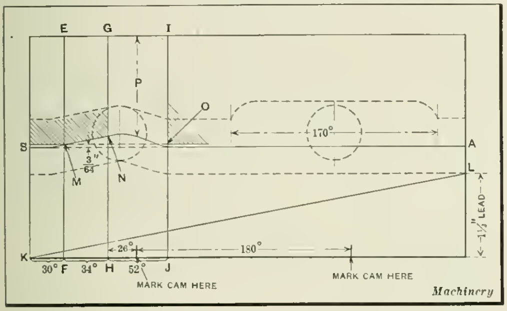

Fig. 4. Development of Cutter Path

To return to the cam. It was at first thought that there must be two waves opposite each other, since two throws were needed per revolution, but a little study revealed the possibility of using a cam with but a single wave and obtaining two throws per revolution by using two cam rolls placed diametrically opposite. The appearance of this cam is shown in Fig. 2. The active path, which contains but one wave, extends over an arc of 190 degrees. It is evident that this single wave, acting in alternation on two diametrically opposite cam rolls, produces exactly the same effect as two diametrically opposite waves acting on a single cam roll. Thus during the dwell the action passes from one roll to the other, and the cam path is widened for the remaining 170 degrees so as not to interfere with the inoperative cam roll. The advantages of this plan are obvious, for if one wave of a two-wave cam differed slightly from the other, one lip of the cutter would take a thicker chip than its mate. Furthermore, the cost of the cam is materially reduced.

A development of the path of the cutter is reproduced in Fig. 4. This was obtained by laying in a development of the work on the developed cam surface as follows: The line *AB* is first drawn to represent the position of the cutting edges during the dwell. As this occurs while the cutters are opposite the face *AB*, Fig. 1, there must be a clearance between them, so a line 3/64 inch above line *AB* can be taken to represent this face. The left-hand boundary represents point *C*, Fig. 1. A line *EF*, 30 degrees from this, represents point *E*, Fig. 1, or the beginning of the cut, and *GH* and *IJ* at intervals of 34 degrees and 52 degrees represent the corners of the bolt spline *G* and *I*, Fig. 1. Next the lead of the spiral—1 1/2 inch—is laid off at the right of the diagram and *KL* is drawn to obtain its slope. A line *MN* parallel to this is drawn through *M* and represents the spiral cut which is to be taken. As is indicated by the shading, we have now a complete picture of one of the cuts to be taken, and the missing portions of the cutter path can be readily laid in, only taking care to have it clear point *O*, as this corner of the work must remain untouched. The diagram also indicates how the cam path is cut away where necessary to clear the inoperative cam roll. Now if the left-hand part of the development is redrawn on a 10:1 scale, the successive values of *P* at 2-degree intervals can be readily scaled off and tabulated, giving the necessary information for cutting the cam. It should be noticed that what we have drawn is really a development of the cutter path and not of the cam roll path, and that in cutting the cam the distance *P* is to be laid off from the bottom end of the cam instead of from the top end as measured in the diagram. This is due to the fact that since the cam is turning and the cam rolls are stationary, the path must swing to the right in order to move the cam and cutter to the left. In conclusion it may be said that while milling the cam it should be marked as shown, and it should be secured to the shaft with these marks opposite the edges of the cutter to insure correct timing.

* * *

FINANCING THE WAR

In a series of articles in *The Public* on the subject "Financing the War," Louis F. Post, assistant secretary of the Department of Labor, Washington, D. C., calls attention to some of the misconceptions in regard to the importance of money in carrying on the war. The subject is explained by Mr. Post as follows:

> Where will the money come from? This question in one form or another is on the tongue of most persons who talk about financing the war, and at the pen-tip of most of those who write about it. The unusual but absolutely true answer is that very little money will come from anywhere, and that not much would be needed if it came.
>
> The war cannot be financed with money. This is not a dogmatic pronouncement, but a statement of fact which needs only to be considered thoughtfully in order to be recognized as true. No wars are financed with money. It is not money that is borrowed when war bonds are issued, nor money that is confiscated when war taxes are levied. *Labor products, not money, are the things needed and used in war.*
>
> The few pieces of money that are paid for bonds or taxes are taken by the government only as tokens to be passed on for the consumable and destructible things it really needs. What it borrows with the bonds which it issues, or confiscates by the taxes which it levies, is not the money even when it takes money in payment. *Money can neither be eaten nor worn, nor yet loaded into guns and shot at the enemy.* The subjects of governmental borrowing or confiscating for war purposes are the food, the clothing, the munitions, and the like, which come to the government as the pieces of money it happens to take pass on and round-about—mere counters in the flow of exchanges.
>
> Except as a temporary makeshift until equitable and efficient tax legislation for war necessaries can be formulated and adopted, bonds have no justifiable place in the prosecution of a war for democracy. By every democratic test, they at their best are worse than taxation at its worst. In this connection let the economics of war supplies be remembered. Whether borrowed on bonds or taken by taxation, *war supplies must be got from the labor of the present time. They cannot by any possibility be got from the labor of the future.*

* * *

HIGH-POWER RADIO STATION

The Navy's new high-power radio station in the Hawaiian Islands is the most powerful in the world. It is designed for direct communication with Washington and the Philippines. Messages have been exchanged between the stations at Sayville, Long Island, and Honolulu, a distance of approximately 5000 miles, which is the world's record for long-distance exchange of communication by radio. Communication between Washington and the Philippines will easily be accomplished with a relay through the Hawaiian station. This station is one of a chain of high-power radio stations under construction by the Navy Department; the other stations in this chain are Arlington, Darien (Canal Zone), San Diego, Cavite (Philippines), Guam and Tutuila. Each station consists of three steel self-supporting masts to support the aerial. The apparatus is of the Poulsen arc type.

FORMING CARDBOARD SHAPES[1]

BY G. R. SMITH[2]

In the April number of MACHINERY there is a request for information on the blanking and forming of pasteboard, paper, cardboard, plaque and pressboard shapes. As the writer has had quite an extensive experience in this line of press work, he will give a brief description of the manufacture of this product, confining it chiefly to the machines employed. Contrary to general belief, a large, powerful machine is required to form and draw cardboard shapes successfully. The cutting and blanking may be done on small light presses, but the drawing and forming, to be permanent and successful, must have a press with sufficient power to force the cardboard to its required shape and hold it there briefly under great pressure. In nearly all paper and cardboard forming, such as pie plates, picnic plates, candy dishes, labels, covers, drawn pasteboard boxes, etc., the shape must be blanked, or cut, first, as the forming dies cannot be so constructed as to blank and form with the same stroke, as in metal drawing, and the dies for such blanking are the regular solid steel punch and blanking die, both of which are hardened. These dies may be of the two- or four-post, bolster, sub-press type, or the push-through type, depending on the nature of the work to be done and the degree of accuracy required.

About all the average cheap paper and pasteboard forms are blanked, several sheets at a time, on automatic-feed presses with push-through dies. The die must not be too hard, for with dry cutting of this nature, chipping takes place very easily, which soon destroys the dies. These dies are generally drawn down just a trifle softer than dies required to cut sheet metal, and they cannot be of the water-tight, ground-to-fit style. Of course, if they are too loose a fit, the paper will be torn off and not cut, but, on the other hand, if a perfectly tight punch and die is used on this dry work, the stock flakes off and clogs the dies, causing no end of trouble. The fit of the punch and die is largely a matter of individual choice, dependent on the thickness and nature of the stock to be cut. The writer has found a good working fit for tools used to cut paper and cardboard from 0.005 to 0.060 inch in thickness is obtained by grinding the punch from 0.004 to 0.005 inch smaller than the die, which gives a 0.002 inch clearance all around, and then lapping the die 0.010 to 0.012 inch well up to the cutting edge. If the dies are so built, clogging will seldom, if ever, occur, except on pulpy stocks. Of course, it is understood that the thinner stocks, such as tissues and bonds, are always blanked several sheets at once and work perfectly on these dies. This work is cut and blanked dry unless the pulpy or composition stock being worked has a tendency to cling to the punch, when a little clean water or wood alcohol is used to wash out the dies and keep them from clogging. On hard-paper stocks, from 0.004 to 0.015 inch thick, three to ten sheets are cut at a time, while with the pulp papers and heavy cardboards fewer sheets may be cut at one stroke, in some cases but one thickness.

For single-action presses for blanking cardboards and papers, such styles as the Bliss No. 21 is generally used. It is very efficient, as it is inclinable, arranged for gravity feeds, and has many automatic attachments. If automatics are preferred, which really are the producers for such work, a press like the Bliss "No. 3½ Special" may be used. This press takes a sheet up to 40 inches square, or can be arranged to take rolled stock 40 inches wide, and is a full automatic. The stock is placed on a feed belt, which is fitted with adjustable stop-fingers that hold the sheet in position while several blanks are being cut at one stroke of the press. These presses are extensively used on plain sheet, cover, card and blanking work, where only average accuracy is required.

For blanking from lithographed or printed sheets, a press like the Bliss No. 20—PE, zigzag feed, should be used. This press takes the sheets on an automatic sheet carrier, and after the sheet is placed in position, the operator trips the press, but gives it no more attention until it automatically stops when the last blank in the sheet is cut. The sheet carrier then returns to its initial position ready to receive the next sheet. This carrier feeds very accurately and is adjustable so that the printed matter on the sheet will register accurately with the dies. All scrap is divided from the work as it is cut, and the press may be used for heavy cardboard, pasteboard and plaques.

For smaller work, such as cards, labels, etc., the Bliss No. 103 is very efficient. This press takes the stock in strips or rolls and is equipped with a blank-holder and a trip gong, which rings when the pile of blanks reaches a certain number; the number may be varied at will. This press is adjustable, universal, and very rapid, as well as accurate; one operator is able to attend to from one to four presses. Aside from the increased production and room space, the automatics are a great safety factor, as the operator's hands need never be very close to the working dies. This feature alone should commend their use in all shops and on all classes of work for which they are adapted. Their saving in production and accidents more than pays for their initial cost.

After the blanks are cut and ready to be formed, or drawn, they are steamed or dampened. This is as essential an operation as is annealing in sheet-metal working. Of course, it is understood that all grades of paper or cardboard will not form, any more than all grades of metal will draw. The stock must be of such grade as to withstand the stress of drawing, or forming, as well as any excessive local stress that may exist in the shape being manufactured. After steaming or dampening, the blanks are ready for the forming, or embossing, press. Either the forming dies or the bedplate of the press to which they are bolted are steam heated; that is, they contain a chamber through which live steam is conveyed, thus keeping the dies hot at all times. The dies may be made of almost any shape or size and of cast iron, machine steel or tool steel. There is little choice in regard to the metal in the dies, as they are subject to little wear or strain.

Steam-heated dies are required, for they dry the blank as it is held in position under considerable pressure, thus making a permanent shape. The presses generally used for such work are those like the Bliss "No. 55 Paper Drawing" press. The upper die is bolted to the top plate of the press and remains stationary. This plate may be adjusted for pressure, arrangement of dies, etc., by means of the bolts at the top of the press. The amount of pressure required is entirely dependent on the stock being run and the style of work manufactured, the same as when drawing sheet metal; but in any case very little pressure is required. The bottom bed, or bolster, to which the lower die is bolted moves upward and has an extra long dwell, thus holding the paper or cardboard form under pressure for a brief time while it dries in the dies. Thus, at the highest point of the stroke, the article assumes a permanent shape under the action of the steady pressure and heat.

There are many presses on the market for embossing work in metals, papers, cardboards, leather, etc., but the most satisfactory has an adjustable bed and is equipped with automatic die slide and feeds, so that the operator's hands are never very near the dies. Paper may be embossed on light presses, but for a successful emboss, even on light post-cards and magazine covers, a press should have sufficient pressure to smash the very texture of the paper into the forms so that it will assume a permanent shape. This takes a lot of power and requires a large, heavy press. While a great deal of forming and embossing is done dry on light single-action presses, the steamed stock under the action of steady pressure and heat makes a much better piece of work and is permanent, which cannot be said of the lightly formed or embossed goods. Besides the working on paper and cardboards, these presses are extensively used for forming and embossing leather goods, chair backs, furniture, and many wooden products, metals, pressboards, plaques, rawhides, compositions, etc.

* * *

The Minister of Munitions of Great Britain has issued an order by which all iron ore mines in the counties of Cumberland and Lancaster pass into the possession of the government, and under the management of the Ministry of Munitions.

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[1] For further information on this subject, see "Cardboard Forming," September, 1917.

[2] Address: 19 Pond St., Pittsfield, Mass.

LETTERS ON PRACTICAL SUBJECTS

WE PAY ONLY FOR ARTICLES PUBLISHED EXCLUSIVELY IN MACHINERY

PORTABLE TUBE-BENDING MACHINE

Having various sizes of tubing to bend and set up in different parts of the factory, it was decided to make, at small cost, a machine that could be brought close to the job being set up, and thus save the time spent in going to the machine to make the bend and then back to the work to try the tube in place. Most of the work was special and required more or less cutting and trying so as to make a good job. The machine designed is shown in the accompanying illustration. It was made in tandem so as to enable two men to work simultaneously or so that each side could be set for a different bend, thereby eliminating the necessity of changing the positions of the rolls. One of the air cylinders *D* is twelve inches by twelve inches and the other is eight inches by twelve inches, as these were on hand.

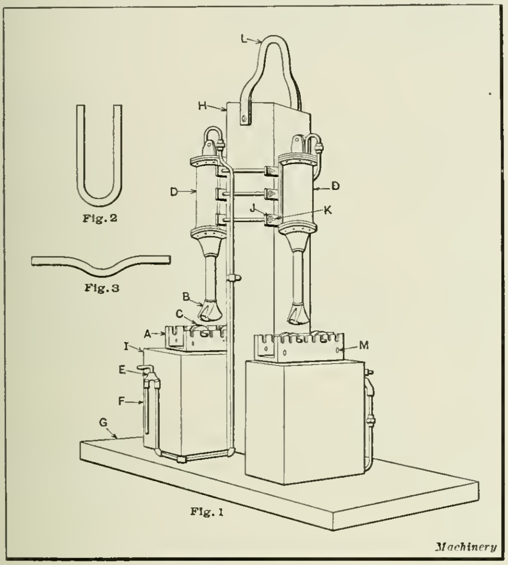


Fig. 1. Handy Tube Bender. Figs. 2 and 3. Bends that are made

The roll-holder *A* has several slots on each side, cut opposite each other, to hold the shaft that contains the rolls; these slots are spaced so as to obtain the necessary bends. The holes *M* are used for hold-down bolts (not shown) when bending pipe as shown in Fig. 3. The former *B* and the rolls *C* are made to suit the diameter of tube and the radii of bend. The control of the cylinders *D* is obtained by the air valve *E*, which is connected to the main line by a flexible shaft *F*. The frame of this machine, consisting of the base *G* and the uprights *H* and *I*, was made of heavy pine logs bolted together. The cylinders *D* are bolted to three steel straps, which are held to the column by six heavy bolts *J* and *K*. The bail *L* is for the crane hook. Figs. 2 and 3 show two of the bends that are made; right-angle bends can be made, if desired, by strapping down one end of the tube. Miscellaneous straps and bolts are used in connection with the bending, but are not shown. G. E. P.

MAKING STEEL TENSION COVERS

An order was received for some steel tension covers of the form shown at *B* and *C* in Fig. 1. Either cold-rolled or hot-rolled 20-gage steel could be used, and after studying the requirements, it was decided to do the work in an ordinary inclinable punch press with sufficient power to operate the compound punch and die used for making the covers. At *A* in Fig. 1 is shown the form of rectangular blank from which these covers were drawn and formed. This blank is 3/32 inch wider at the center than at the ends, to allow for the stock which is drawn toward the center due to the concave form of the cover. In order to overcome the tendency of the steel to warp slightly one way or the other, it was necessary to develop the work gradually so as to produce uniform shape and flexibility. In this connection it may be mentioned that when one of these covers is in use it must fit close at all points; and in order to meet this condition it is necessary to have a reverse curve in the cover, so that when it is put in place and tightened with a nut on boss *X*, the cover will settle 1/16 inch at the center, making it perfectly straight and at the same time putting sufficient tension on the nut to keep it from turning off through vibration or any other cause.

Fig. 2 shows the compound blanking punch and die in which these tension covers are made. In order to provide the necessary curvature in the work, blanking punch *B* is tapered 3/32 inch on the cutting edge and flanging section from center *D* to ends *E*. Blanking punch *B* consists of four triangular shaped sections made of tool steel and hardened in oil, three views of one of these sections being shown in detail at the extreme right-hand side of Fig. 2. In working out the design of these punch sections, particular attention was paid to simplifying the work of repairing and grinding the punches as far as possible. When it becomes necessary to grind a blanking punch, these triangular shaped sections are set up on a surface grinder and ground along the cutting edge and also on the 3/32-inch taper which runs horizontally from the center of the punch to the end of flange *Y*. When this flange has been properly ground, the inside of the punch is ground at

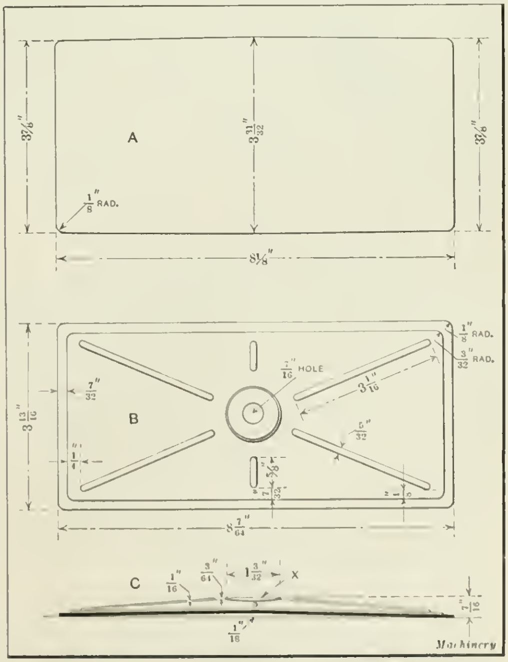


Fig. 1. Sheet Steel Blank A and Finished Tension Cover shown at B and C

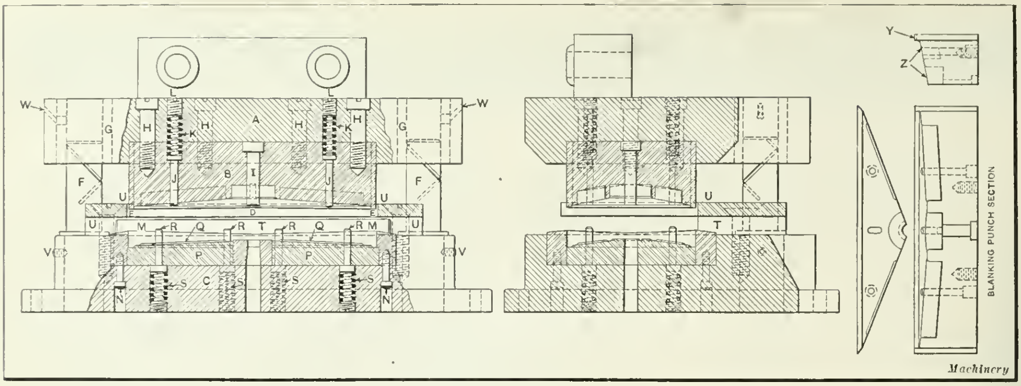


Fig. 2. Punch and Die used for Production of Steel Tension Cover shown at B and C in Fig. 1

the same setting in order to maintain the proper depth at face *Z*. The punch is then assembled ready for subsequent service.

Two views of the blanking punch and die are shown in Fig. 2. The die-shoe *A* and punch-shoe *C* are made of cast iron properly aligned by tool-steel guide pins *F* and bronze bushings *G*. Blanking punch *B* is seated in shoe *A* and held in place by screws *H*. In working out the design of this punch and die, perforating punch *I* was left long so that the perforating operation can be performed before the actual drawing and forming of the tension cover is commenced. In this way the hole is stretched and makes stripping of the cover an easy matter without danger of distortion. Knock-out pins *J* are made of machine steel and actuated by springs *K*, which, in turn, are held in place by set-screws *L*.

The blanking die *M* is made of four steel sections and seated in a cast-iron shoe and bolster plate *C*, being held by screws *N*. These sections have the proper cutting shear. Forming plate *P* is made of one piece of tool steel with an inserted section *Q* for forming beads in the cover. These sections are both hardened in oil, and the under-cut in section *M* assists in holding the forming section *P* in place. Knock-out pins *R*, actuated by springs *S*, serve to eject the finished cover instantly, and by the aid of gravity allow it to slide away through opening *T*. Stripper *U* is held in position by flat-headed screws. A positive stripper of this type was found desirable because it is safer than a spring stripper. As the stripper is held stationary, it cannot accidentally crush a workman's finger if he leaves his hand in an exposed position. Oil-holes leading to the bearings of guide-pins *F* are shown at *W*, these pins being of the stationary type and secured by set-screws *V*. Bolt holes in bolster *C* are used to fasten the die to the press bed.

Highland Park, Mich. ERNEST A. WALTERS

MACHINE DIAL FEEDS

Considerable difficulty was encountered in the manufacture of automatic-press dial feeds in a jobbing shop, the trouble arising in the arcs used for timing the movement of the dial. These arcs were cut by the aid of an indexing head and a milling cutter in a milling machine, but the indexing heads on hand would not give results accurate enough when dividing the periphery of steel disks 11⅞ inches in diameter. As a result, the following method was adopted, as it was more positive.

An angle-iron was laid out, as shown in Fig. 2, with a central hole coinciding with the central hole in the dial plate to be cut, and three small holes *A*, *B* and *C* were made at a given radius. Hole *A* was used to line up the center of the spindle of the milling machine, hole *B* was used for a stop during the operation of cutting the arcs, and hole *C* was used for a stop while milling the driving slots. This angle-plate was strapped to the table of the milling machine and a hole *A* ¼ inch in diameter was indicated up to the center of the milling machine spindle. The dial to be cut was then strapped to the angle-plate and twelve holes were bored through the dial near its periphery, as shown in Fig. 1. These holes formed the back end of the driving slots when the latter were finished as shown in Fig. 3. After these holes were bored, a stop was put through one into a hole in the angle-plate, the milling machine table was run back the required distance, a cutter 3⅜ inches in diameter was inserted into the milling machine spindle, and the arcs roughed out to within 1/16 inch of the correct radius around the dial plate. This cutter was then replaced by a fly cutter and finish cuts taken until the arcs and driving slots were true to a templet. The driving slots between the arcs were milled to maximum and minimum plug gages. There was very little file finishing to be done, and when the presses were assembled the timing of the dials was practically as good as it is possible to obtain.

New Haven, Conn. ERIC LEE

SIMPLE SPRING WINDING METHOD

A method of winding springs was given in the November number of MACHINERY by George Werner, Jr. The writer used this method years ago, and discovered a kink that may be of interest. Light springs of music wire about 0.025 inch in

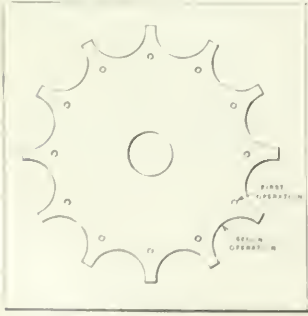


Fig. 1. Dial showing First Two Operations

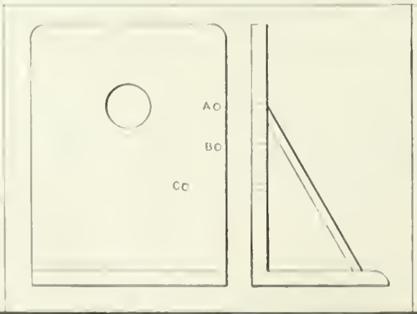


Fig. 2. Angle-plate Lay-out

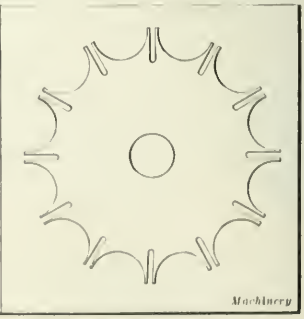


Fig. 3. Completed Dial

diameter were wound by the method described, but the spacer was continuously pressed toward the chuck, and the result was a closely wound spring on the arbor. When the spring was released, the coils expanded to the pitch determined by the pitch of the spacer. In this manner it was possible to make a much longer spring than the arbor ordinarily allowed.

Orange, Mass. H. F. MISENER

EFFICIENCY POINTS IN BORING FIXTURES

As extreme accuracy is the prime requisite in any boring operation, boring jigs and tools are generally more accurate than most machining fixtures. There are many points in boring-fixture design that are being contested, but the details shown in the accompanying illustration have been adopted by expert tool engineers in the production of United States aviation motors. The limits allowed on machined surfaces on this work are less than on much work of equal importance, so that the accuracy of the jigs cannot be disputed.

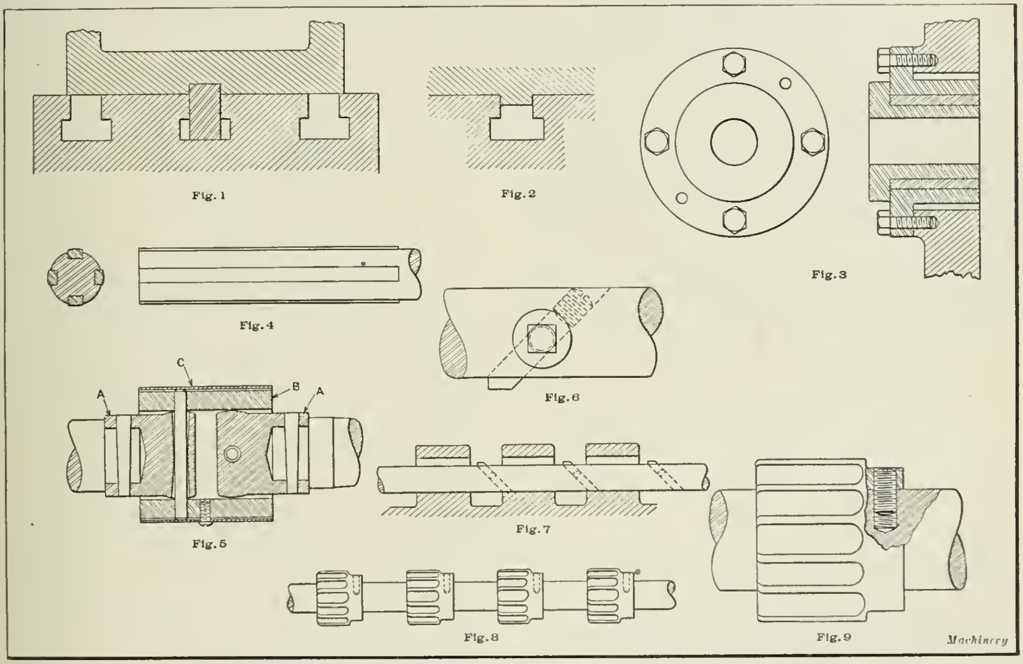
To line up the jig on the table of the machine a planed slot in the casting, used with a steel strip in the table T-slot, as in Fig. 1, seems to be preferred over the method of planing a tongue on the jig base, as in Fig. 2. In the latter method the tongue is likely to become battered and worn and cannot be replaced. The former method is the cheaper; and, besides, if the jig is made to fit a certain machine it cannot be used on a machine that has a narrower T-slot.

Fig. 3 shows an excellent design of guide bushings. The clearance between the large locating bushing and the cored hole in the jig permits a readjustment of the bearing after it has become out of alignment, which always happens in time. This bushing is doweled to the jig, so that to realign it the bushing is loosened, reset, drilled and again doweled. The guide bushing slips into a hardened steel stationary bushing inside the large locating bushing. This construction does not require the accurate boring of the jig at the beginning.

Wearing strips are provided on wearing surfaces of all boring-bars, as in Fig. 4. These are of hardened steel, inserted in four slots in the bar, and after being peened in place, they are ground to size with the bar. After wear takes place, the strips are removed, the bottom of the slot packed up, the strips replaced, fastened and reground to size on the bar. This method always insures the proper fit of the bars in the slip bushings.

Fig. 5 shows a simple, but effective, driving joint for boring- and reaming-bars. Rounded rims are turned on the knuckles *A*, which are pinned to the sleeve *B*, as shown, with pins at right angles to each other. The pin-holes in these knuckles are tapered from the center out, which insures a good driving surface for the pins. The sleeve *C* is merely a sheet-metal cover to keep the pins from falling out.

Single-point boring tools are used rather than the double-edged ones, Fig. 6. One favorable feature of single-point tools is that where several bearings are to be bored, covering a great length, the tools (one for each bearing) can be inserted, adjusted and tightened in the bar before sliding it into the fixture and casting. The guide bushings are removed and the bar slid through the fixture and through the casting with the tools pointing upward. This allows the bar to slide on the bottom of the cored hole and gives plenty of clearance, as shown in Fig. 7. The bars are inserted from the rear end, so that the table of the machine need not be removed after being set.



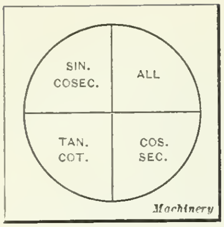
Figs. 1 to 9. Boring Fixture Details approved by Tool Engineers in Production of Aviation Motors

Fig. 8 shows an arrangement of reamers and reamer-bar for reaming a casting of several bearings. Shell reamers are used in this operation, and if the standard taper hole shell reamer were used, the bar would necessarily have several shoulders, one for each taper, giving the telescopic effect, and the smallest diameter of the bar would be entirely too small for accurate alignment. So the reamers are made with a straight hole and the bar has one diameter. The reamers are strung along the bar, and a disappearing driving screw with a shoulder pin is raised with a screwdriver into each reamer after it is put in place, as shown in Fig. 9.

Cincinnati, Ohio JOSEPH A. AHLEAS

TRIGONOMETRIC FUNCTIONS FOR ANY ANGLE

In the August number of MACHINERY an answer was given to an inquiry for an easy method of remembering the signs of the various trigonometric functions of an angle in any quadrant. The writer considers the following rule much simpler than the one that was submitted: It is necessary to



Positive Functions for Each Quadrant

memorize the following sentence: "*All* who *sin* are *tanned* as *cost* of transgression." The parts of this sentence that are in italics fit in the respective quadrants commencing at the first, and in this way give the positive functions of that quadrant; referring to the illustration, all functions are positive in the first quadrant, sine is positive in the second, tangent is positive in the third, and cosine is positive in the fourth. Of course, the signs of the cosecant, secant and cotangent have, respectively, the same signs as the sine, cosine and tangent, as they are the reciprocals of the latter. It follows that all the functions not positive in the various quadrants must takes the negative sign.

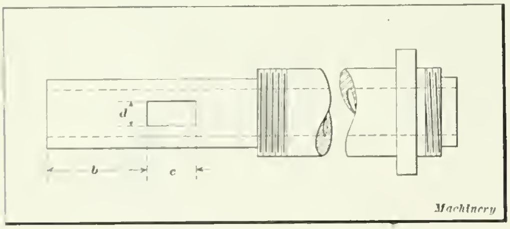
Sheffield, England G. S. Bowling

WHO BLUNDERED—THE DRAFTSMAN OR THE MACHINIST?

The writer read with interest the article in the November number entitled "Who Blundered—the Draftsman or the Machinist?" Mr. Baker's state of mind upon receipt of the spindles was evidently not an enviable one, but nevertheless, the shop was not entirely at fault. It is the contention of the writer that instructions should have accompanied the sketch, and for this reason the management should not be absolved from responsibility for the error, and neither the draftsman nor the machinist should shoulder the whole blame.

East Rutherford, N. J. George F. Kuhne

The writer finds the draftsman at fault in the article entitled "Who Blundered—the Draftsman or the Machinist?" on page 250 in the November number of Machinery. The accompanying illustration shows the correct drawing that should have been sent to the shop. The machinist should not be blamed for turning down the spindles as the sketch indicated. A blueprint of the entire spindle could have been used, with the changes denoted in red or black ink.



Correct Drawing of Screw Machine Spindle

Hartford, Conn. E. H. Bruce

Referring to the article entitled "Who Blundered—the Draftsman or the Machinist?" in the November number, it is the writer's opinion that the break of the spindle is incorrect, because it represents a straight spindle without a step. A break should only occur on a straight, or uniformly changing piece of material, and should not omit any details. The sketch shows a change in the diameter of the spindle in back of the flange and if it were not intended to be different from the original spindle it should have been dimensioned, to indicate that the scale was incorrect. The machinist, unless definitely instructed that the slot was to be the only change, would scale the drawing when he noticed that the sketch was different from the spindle, and assume that the dimension had been omitted and that it was to be the same as at the small end. I say that the draftsman blundered.

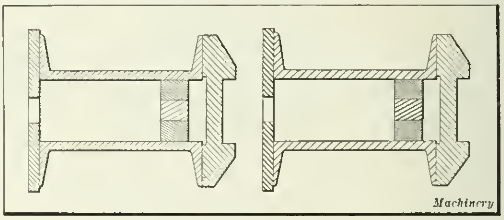
Rockford, Ill. H. T. Shram

In the November number of Machinery Donald A. Baker shows a sketch for altering some spindles and asks whether the draftsman or the machinist blundered. The answer, of course, will be unanimous. The machinist blundered. Possibly this sort of thing is new to Mr. Baker, but it occurs not only on work sent out, but on work done right in one's own shop. Too much care cannot be exercised in making drawings fool-proof. With no desire to excuse the machinist, it is nevertheless unfortunate that the part of the spindle directly to the right of the break in the sketch *B* scales the same diameter as the part that was to be slotted. In fact, it is unfortunate that anything beyond the break was shown at all. If nothing beyond the break had been shown, there would not have been the slightest excuse for even considering any other operation than slotting. Even at that, some bright youth might cut the spindle in two just beyond the slot without bothering to ask about the teeth.

Jersey City, N. J. H. D. Murphy

SPACING AND THICKNESS OF LINES IN CROSS-HATCHING

The clearness of a mechanical drawing is largely a matter of contrasts. The lettering and variations in thickness of lines make the drawing clear in proportion to the skill used in arranging them to secure the most effective results. The uses of various lines and letters are generally understood and adopted, yet one of the best ways of making a drawing clear is commonly overlooked, although no additional time or skill is required. The accompanying illustration shows the results obtained by varying the angles, thickness and spacing of lines used in cross-hatching. When skillfully used, this plan makes it possible to secure an effect having the appearance and easily comprehended qualities of a bas-relief.

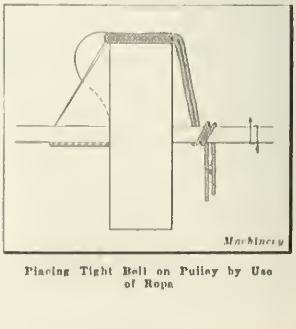


Spacing and Thickness of Lines in Cross-hatching

Pittsburg, Pa. F. D. Buffum

PLACING TIGHT BELTS ON PULLEYS

The writer has experienced the difficulty of placing a tight belt on a pulley, and the method employed was, in some respects, similar to that mentioned in the November number of Machinery, page 246, but by the following method the same results can be obtained with a greater degree of safety. A rope, the length of which should be at least three times the diameter of the pulley upon which the belt is to be placed, is folded over the belt and the ends made of even length. The ends are then passed over the pulley and wrapped once around the shaft, on the opposite side of the pulley from the belt, in the direction of rotation of the shaft so that the rope will unwind when the shaft is revolved. The belt is then raised to about the same position that it would be if thrown on the pulley in the usual manner, and the rope drawn tight. The power may now be applied, and as the belt starts up slowly it is automatically thrown on the pulley. During this time the rope should be held in the hand, and when the pulley has made about one-half revolution it will be clear of the pulley and tend to travel with the belt. One end of the rope should now be let loose, and pulled clear



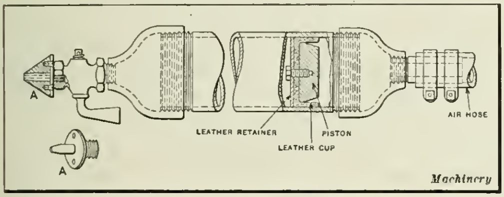
Placing Tight Belt on Pulley by Use of Rope of the belt by the other end. This method removes all danger from the rope hanging to the belt to become a menace to the belt and workmen when delivered to the driving pulley. After a few trials, a tight belt can be placed on the pulley with comparative ease by this method, and often without stopping the main shaft.

Moline, Ill. C. C. Hermann

GREASE GUN FOR FILLING NEW BEARINGS

By using the grease gun here shown, much time may be saved in filling new bearings. The usual way of lubricating new machines is for the man to screw on the grease cup, fill it with grease and screw down the cap to fill the bearing, then remove the cap and refill the cup. Oftentimes it is necessary to refill the cup several times before the bearings are full of grease; if the gun is used, the bearings are filled before the grease cups are put in place. The nozzle *A* is placed in the grease-cup hole and grease is forced into the bearings with air at a pressure of between sixty and one hundred pounds.

The gun is made of pipe that is bored smooth on the inside. To fill it, the lower reducing coupling, to which the valve and nozzle are attached, is removed and the piston is pushed back to the farther end. The nozzle *A* is protected with a rubber or leather cone as shown. This gun may be used to fill roller bearings, plain bearing grooves, grease holes, or other parts with grease, and as the grease is forced in, all the parts are well lubricated.



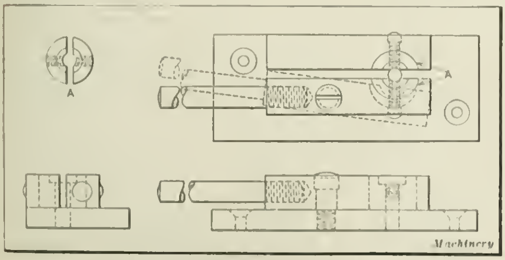
Grease Gun operated by Compressed Air

Flint, Mich. C. C. Spreen

DRILL PRESS WORK-HOLDER

The illustration shows a fixture that was designed for the purpose of holding in proper position pieces to be burred, countersunk or drilled, and handling them rapidly. It consists essentially of a stationary bed-plate, attached to the drill press, and a movable arm. In the movable arm is a semicircular recess opposed to a similar recess in the fixed piece. In these recesses are fastened bushings *A* of a size and shape corresponding to the exterior of the piece on which the work is to be done. The arm swings on a stud, and has a handle of suitable length to furnish sufficient leverage to hold the piece firmly in position during the operation. It opens or closes with a single movement, permitting the rapid insertion and withdrawal of the work, so that the speed to be attained depends only upon the quickness of the operator and the time required for the operation of the machine. By the use of different sizes and shapes of bushings, this device is adaptable for many drilling operations.

Boston, Mass. John A. Shand



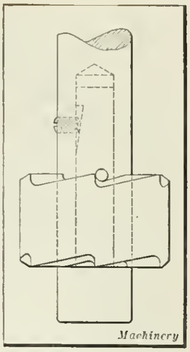
Device for holding Work on Drill Press

SPOT-FACING TOOL AND COUNTERBORE

The accompanying illustration shows a form of spot-facing tool and counterbore not included by F. B. Jacobs among the spot-facing tools described by him in the August number of Machinery. The economy of material and time in this form commend it, for each side is notched and ground for cutting. Projecting pins on the bar, engaging the notches not in use for cutting, serve as drivers, as shown in the illustration.

William S. Rowell

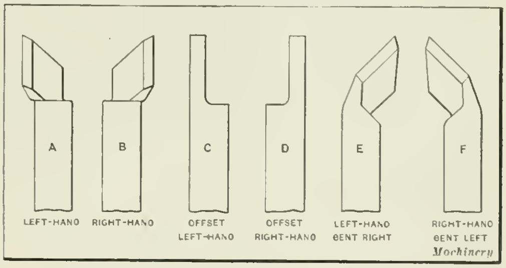
Wilkinsburg, Pa.



Spot-facing Tool and Counterbore

RIGHT- AND LEFT-HAND TOOLS

In the September number of Machinery, page 60, was an article on right- and left-hand tools, some of the statements in which the writer does not agree with. Suppose a workman, in picking up a tool, holds it with the butt end toward him and the cutting edge from him; if the cutting edge is on the left-hand side it is a left-hand tool because it cuts toward the left; if the cutting face is on the right-hand side it is a right-hand tool because it cuts toward the right. This is the opposite to the claim made in the article mentioned. The writer knows of a number of well-equipped and efficient machine shops where the terms here given have been adopted. These tools are shown in the illustration at *A* and *B*. In the writer's opinion the terms "left-bend" and "right-bend" are awkward. If a workman desired to cut close to a shoulder with a left-hand tool, he would require a tool bent to the right to give the desired result, or a left-hand tool bent right, and this wording would follow his line of thought. This contrasts favorably with left-hand tool right-bend. The terms "offset" and "bent" are also confused. "Offset" defines a tool on which the cutting edge retains the same relation to the shank as on an ordinary tool but is set either to the left or right, as illustrated by *C* and *D*. "Bent" defines a tool that has the line of the cutting edge bent either left or right at an angle with the shank as shown by *E* and *F*.



Names of Lathe Tools that are commonly used

It would seem that in these days of unskilled workers in the machine shops, the names of tools should be simplified in favor of the most obvious term. The writer is of the opinion that if several men who knew nothing of machines or tools were shown tools of various hands and bends, their definitions of the tools would coincide with his views. Therefore, if men new in the mechanical field define something in its most obvious form, which men long in the field admit but lack the courage to change, why place the new man under a handicap imposed by improper reasoning and custom? R. L.

ANGLE OF REST OF SHELLS

The angle of rest of shells can be found by a much simpler method than that given in the September number of Machinery; the method given in the following does not require an extensive knowledge of mathematics. The diagram given in that

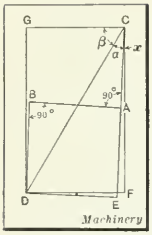


Diagram illustrating Angle of Rest of Shells

solution is slightly modified, and all unnecessary lines are omitted. Points C and D are the centers of the two given circles. The horizontal distance GC between the centers is 60 inches. The vertical distance DG between the centers is the sum of the radii of the circles minus the distance they would overlap, if their centers were in the same vertical line, or $(56 - 6) + 48 = 98$ inches. In the right triangle DGC, the length of hypotenuse $DC = \sqrt{DG^2 + GC^2} = \sqrt{98^2 + 60^2} = 114.90866$. In the right triangle, DEC, the side $CE = CA + AE = 48 + 56 = 104$ inches. Hence, $\cos \alpha = \dfrac{CE}{CD} = \dfrac{104}{114.90866} = 0.90507$ and angle $\alpha = 25$ degrees, 10 minutes. From the triangle DGC, angle β may also be easily found for $\tan \beta = \dfrac{DG}{GC} = \dfrac{98}{60} = 1.6333$; so $\beta = 58$ degrees, 32 minutes. The required angle x is therefore $90 - (\alpha + \beta) = 90$ degrees $-$ 83 degrees, 42 minutes $=$ 6 degrees, 18 minutes.

Fitchburg, Mass. V. Charushin

The following method of finding the angle of rest of shells differs somewhat from that given in the September number of Machinery; yet it produces absolute results. Using the dimensions given by L. J. F., in the accompanying illustration, $CD = 48 + 56 - 6 = 98$. $\tan \alpha = \dfrac{60}{98} = 0.61224 = \tan 31$ degrees, 28 minutes, 37 seconds. $AC = \dfrac{98}{\cos \alpha} = \dfrac{98}{0.85285} = 114.909$. $CF = 48 + 56 = 104$. $\cos \alpha = \dfrac{104}{114.909} = 0.90506 = \cos 25$ degrees, 10 minutes, 3 seconds. $\gamma = \alpha - \beta = 31$ degrees, 28 minutes, 37 seconds $-$ 25 degrees, 10 minutes, 3 seconds $=$ 6 degrees, 18 minutes, 34 seconds.

Another solution was suggested by one of the boys at the shop, W. J. Billerbeck. This method, with the figures presented by B. V. D., is also shown by the illustration. $CD = 0.125 + 0.045 - 0.05 = 0.12$. $\tan \alpha = \dfrac{0.16}{0.12} = 1.3333 = \tan 53$ degrees, 7 minutes, 45 seconds. $AC = \dfrac{0.16}{\sin \alpha} = \dfrac{0.16}{0.79999} = 0.2$. AE and EC are proportional to AH and CJ, respectively; therefore:

$$EC = \frac{CJ}{AH + CJ} \times AC = \frac{0.125 \times 0.2}{0.170} = 0.14706$$

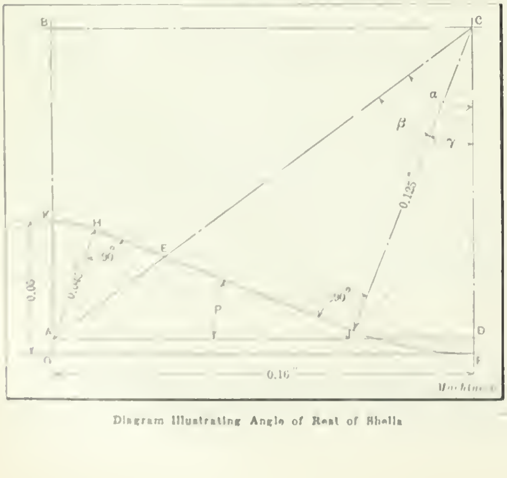


Diagram Illustrating Angle of Rest of Shells

$\cos \beta = \dfrac{CJ}{EC} = \dfrac{0.125}{0.14706} = 0.84999 = \cos 31$ degrees, 47 minutes, 20 seconds. $\gamma = \alpha - \beta = 53$ degrees, 7 minutes, 45 seconds $-$ 31 degrees, 47 minutes, 20 seconds $=$ 21 degrees, 20 minutes, 25 seconds.

Philadelphia, Pa. Harry S. Kartsher

BALANCING SCREW PROPELLERS

The method of balancing a propeller on horizontal ways shown on page 137 of the October number of Machinery appears to be incorrect; a balance so obtained on a screw originally out of balance on the ways might result in its being worse than before, when in actual service; especially a three-bladed wheel. The method is unsuitable when used with driving pulleys, but should never be applied to a ship screw.

We will assume that one blade A is light and that the overweight is due to insufficient thickness on the advancing side, or lack of density of the metal in the part, say near the periphery. All three blades might be of exactly the same weight, as shown by platform scales, yet unless the weight were equally distributed from hub to rim in all three, the assembled wheel might be out of balance on the testing ways.

That one blade is preponderant will be indicated on the horizontal ways (preferably knife-edges; and the arbor must be smooth and perfectly cylindrical). But this will not show whether the extra weight is equally distributed, or near the hub or the rim, or at the advancing or following edge of the blade in question. So, as the addition of weights to the light blade is not permissible, as in the case of driving pulleys, some weight must be taken off the two heavy blades until the propeller rolls easily and stays still with any one blade up.

If the deficiency on blade A should happen to be on the advancing edge and the other blades are lightened equally over their entire width, or still worse if they are chipped on the following edge, until the wheel is in indifferent balance (that is, stays put, no matter which blade is vertical) the wheel, when in service, will be more out of true than before the "cure." The heavy following edge of A will tend to cock that blade outward and forward, and the heavy advancing edges of B and C will tend to cock these blades outboard and sternward; especially when the wheel races as the ship pitches.

It is just as true of a ship screw as of a driving pulley or a millstone, that the only way to secure running balance is to mount the screw on a cock-head at its center of volume and run it about a vertical axis at the maximum speed at which it is to be driven in actual service. It stands to reason that a three-blade screw is more difficult to balance, either on ways or on a cock-head, than one with only two wings.

New York City Robert Grimshaw

WEAR IN MICROMETER SCREW

W. S. Rowell's article entitled "Wear of Micrometer Screw and Nut," on page 156 of the October number of Machinery, seems to need a few additions. It has correctly described adjustment and said little about wear. Wear will take place so differently in the two cases shown that it deserves attention; both cannot be right. The differential screw has been used (as shown) in a number of makes and styles of micrometers for years; but as part F has approximately twice the number of threads of part E, it should be the nut and take the thrust and wear, and E should be the auxiliary, or tension nut. In other words, a two-part nut, proportioned as shown, should be adjusted as in Fig. 2, so that twelve threads will take the thrust and wear, instead of as in Fig. 1 where but seven threads receive them.

All the thrust, and therefore the wear, on a micrometer screw is from the anvil, and adjustment should be made so as to receive it on a reasonable number of threads, leaving the smaller number to act as guides and producers of the desired friction, or "feel." Hence, if the lead of thread T is more rapid than that of screw M, part F should be screwed into the micrometer hub to obtain correct wearing conditions; if slower, it should be screwed out of the hub to obtain the correct wearing conditions shown in Fig. 2.

Buffalo, N. Y. WILFRID J. THOMPSON

PROBLEM IN TRIGONOMETRY

The method used in solving the "problem in trigonometry," on page 245 of the November number of MACHINERY, is unnecessarily laborious, as the problem does not involve any trigonometric computations at all. A line joining point *D* with apex *B* is exactly the same length as the line *DC*; therefore, $9/16^2 + (7\,1/4 - x)^2 = x^2 + 3\,11/16^2$. Expanding, cancelling, transposing and reducing gives $x = 2.709$. Then $DC = \sqrt{2.709^2 + 3.688^2}$. W. S. M.

In his solution of a problem involving a gear and three pinions, C. O. H. does not state that the pinions are of equal diameter, although his solution seems to indicate that they are. The following solution is much easier than the one given. Designating the triangle to the right of *BC* as *BCM* gives three similar triangles, *BCM*, *CEG*, and *EDF*. The dimensions of triangle *CEG* are exactly one-half the corresponding dimensions of triangle *BCM*. Hence, $GC = 2.125$ and $EG = 3.625$. $DF = 3.6875 - GC = 3.6875 - 2.125 = 1.5625$. Now $CM:DF = BM:EF$, or $7.25:1.5625 = 4.25:EF$. $EF = 0.91594$. $X = EG - EF = 3.625 - 0.91594 = 2.70906$. $DC = \sqrt{2.709^2 + 3.6875^2} = 4.5756$.

South Meriden, Conn. D. F. MORIARTY

DEOXIDINE PROCESS FOR CLEANING STEEL

In the October number of MACHINERY is an article entitled "Removing Iron Plate Rust." The method of removing rust suggested may be satisfactory for that purpose, but if paint should be applied over the surface thus treated, it would prove very unsatisfactory, owing to the fact that enough of the chemicals would be left to cause rust under the paint. In order to produce a satisfactory surface for painting, after applying the sodium acid sulphate and then washing with alkaline solution, the surface should be treated with a neutralizing agent such as "Deoxidine," a relatively new chemical which is being used extensively by the steel automobile body makers for preparing the surface for painting. This chemical removes all rust-forming substances and leaves a perfect surface.

New York City J. H. GRAVELL

KINK FOR CROSS-SECTIONING DRAWINGS

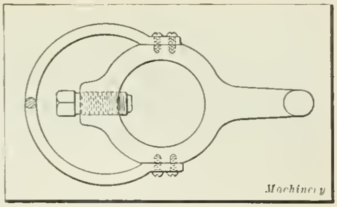
A suggestion for uniformly spacing cross-section lines on drawings, was made in the November number of MACHINERY, page 249, and the writer desires to make several criticisms. The draftsman would need to wait until the line drawn had become dry, before being able to draw the next one, as it is necessary to move the triangle over the line drawn in order to measure the distance to the next. The writer also contends that uniformly spaced lines are not required in drafting or engineering, and in some concerns the cross-section lines are simply drawn free-hand. The uniformly spaced lines do not add to the technical value of the drawings, but are used for appearance only.

Cincinnati, Ohio TAFT S. ARMANDROFF

STRAIGHTENING THIN-WALL TUBING

In the November number, page 252, H. E. G. requested information concerning the straightening of brass tubing. A large tube manufacturer in Waterbury, Conn., uses a straightening machine that is built by the Torrington Mfg. Co., Torrington, Conn. It contains twelve rolls having grooves to fit the tubing. The work is fed in at one end of the machine, and at the other end a man is stationed who receives the tubes and snaps them on a long wooden table. The machine does not straighten the tubes perfectly, but takes out the short bends and kinks, and by snapping them against the table they are made so straight that no error can be detected by the eye. The tubes are then rolled on a long, flat table for the purpose of inspecting.

WALLACE B. SMITH
Waterbury, Conn.



Dog with Safety Device

GUARD FOR DOG

The illustration shows an admirable safety appliance for a dog. A piece of round cold-rolled steel wire is bent and machined as shown, and then fastened to the finished sides of the dog by button-head screws.

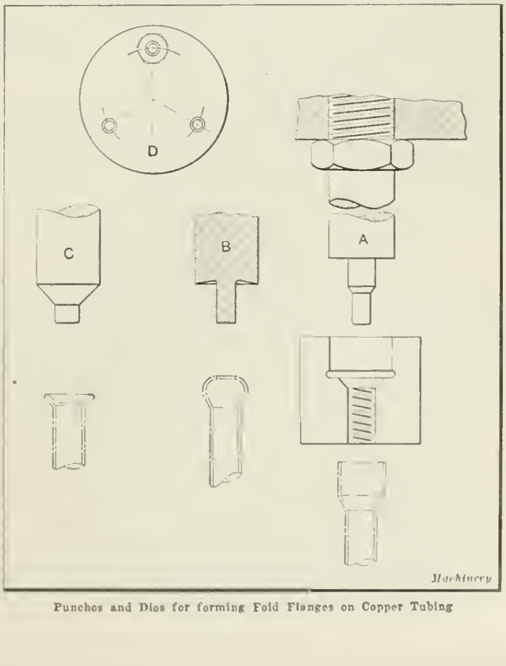
Milwaukee, Wis. FRED FRUHNER

PUNCHES AND DIE FOR FLANGING COPPER TUBING

A shop having a large quantity of copper tubing to be flanged for gasoline connections found it impossible to get a leak-proof fit unless a fold flange was made. Therefore the punch and die arrangement here shown was designed. The single die used is split in the center, one half being stationary and the other half being actuated by a cam and lever. The tubing is pushed into the die from the bottom and is held by the threads in the lower portion. A simple gage insures the tubing being pushed in the correct distance each time.

The first punch *A* merely enlarges the tubing slightly, the second punch *B* starts it in a curve toward the center, and the punch *C* presses it firmly upon itself, forming a well folded flange. These punches are screwed into a rotating plate *D*, which indexes about at each stroke, bringing the punches into line in rotation. They are threaded into this plate and are provided with lock-nuts for adjustment. This plate is set so that the center of the ram is directly over the punch in operation, and clearances are provided in the bed for the other two punches. This fixture works rapidly and the tubing is so flanged that no trouble is experienced in assembling. The press is turned on its side to make it easier to place the tubing in the die, and a conical recess is used to guide the piece.

Alma, Mich. LLOYD L. LEE



Punches and Dies for forming Fold Flanges on Copper Tubing

HOW AND WHY

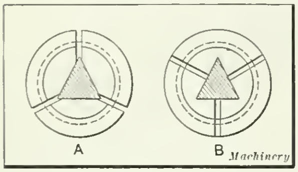
QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

GRADUATION OF TAPER ATTACHMENTS ON METRIC LATHES

T. A.—In furnishing taper-turning attachments on metric lathes for use in France, should the attachment be graduated in degrees or millimeters taper per meter?

A.—The taper attachment on metric lathes for use in France should be graduated in degrees and not in millimeters taper per meter.

WHICH WAY IS CHEAPER ?



Two Ways of slitting Taper Spring Chucks

R. G.—We recently had an order for several hundred taper spring chucks, to hold triangular stock, that could be slit in either of the ways shown here. Which is the cheaper method and how should the slitting be done?

RADIUS AND ARC

O. L. B.—What is meant by the term often used in toolmaking "formed to a radius"? I maintain that it is not correct.

A.—The term "radius" is often misused for "arc." The radius of a circle is the distance from the center to the circumference; and the arc is a portion of a circumference. To say that a tool is formed to a radius of ¼ inch is not strictly incorrect, but hardly good form. The meaning is that the tool is made with a cutting edge conforming to an arc having a radius of ¼ inch. A better expression would be "formed to an arc having a radius of ¼ inch."

EFFECT OF TOOL HEIGHT WHEN TURNING ANGLES

A. V. M.—The seat on a valve disk is faced off in a lathe with the compound rest set at an angle of 45 degrees. A cut is taken off the disk with the tool set on the level of the centers of the lathe. Now, if another cut is taken with the tool slightly above or below the lathe centers, will there be any change in the angle of the seat, the compound rest remaining set at an angle of 45 degrees?

A.—The tool point will turn the valve seat at an angle of 45 degrees only when set at the height of the lathe centers; if set above or below the level of the lathe centers, it will generate a curve, and the angle will differ. It is important when turning tapers and angles in the lathe always to set the tool point at the height of the lathe centers.

PROBLEM IN TRIGONOMETRY

F. L. L.—Will you please tell me how to find the angles of a right triangle when the difference between the hypotenuse and the greater leg is equal to the difference between the two legs?

A.—Referring to the illustration, C is the hypotenuse, A is the greater leg, and B is the shorter leg. Then, $C - A = A - B$, from which, $C = 2A - B$. But $C^2 = A^2 + B^2$. Substituting the value of C previously found, $4A^2 - 4AB + B^2 = A^2 + B^2$; from which $B = 3/4\,A$. Hence, when $A = 4$, $B = 3$, and $C = 2 \times 4 - 3 = 5$. Therefore, $\sin \beta = 3/5 = 0.6$, and $\beta = 36$ degrees, 52 minutes, 11.63 seconds. Angle $\alpha = 90$ degrees $- \beta = 90$ degrees $- 36$ degrees, 52 minutes, 11.63 seconds $= 53$ degrees, 7 minutes, 48.37 seconds. Any other value than 4 might have been substituted for A, and the result would have been the same.

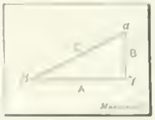


Diagram Illustrating Problem in Trigonometry

J. J.

STRENGTH OF CAST-IRON CYLINDERS

J. D.—The cast-iron cylinder A shown in the accompanying illustration is finished all over and has a stem B that is clamped in a bearing C by a cap D; is the cylinder safe against rupture at point E?

Answered by John S. Myers, Philadelphia, Pa.

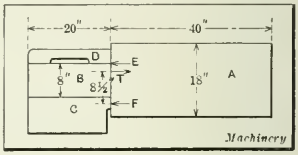


Diagram illustrating Strength of Cast-iron Cylinders

The question as propounded does not state the purpose of cylinder A or whether there are any external forces acting upon it. In the absence of such information it may be assumed that the weight of the cylinder is the acting force. The weight of the overhanging part is $W = 0.7854 \times 18^2 \times 40 \times 0.26 = 2646$ pounds. This force acts at the center of gravity of the cylinder, or a distance $L = 20$ inches from the face of the bearing. If the stem B extended through the bearing, was threaded, and had a liberal sized nut clamping the shoulder against the bearing, it would be proper to consider the influence of the shoulder. In this case a rough-and-ready approximation of what takes place is about all that the uncertainties of the problem seem to warrant. Such an approximation is to take the fulcrum point F about in the center of the shoulder, and the center of the tensile forces T about one-half the radius of the stem above the center line. These forces F and T are equal and opposite, and constitute a couple having a lever arm of 8½ inches. The bending moment is then $2646 \times 20 = 52{,}920$ inch-pounds, and the value of the tensile forces T is $52{,}920 \div 8.5 = 6226$ pounds. The area of metal resisting this force may be taken as one-third the area of the stem or, area $= 1/3 \times 0.7854 \times 8^2 = 16.75$, say 16 square inches. The tensile stress is then $6226 \div 16 = 389$ pounds per square inch, a very low stress.

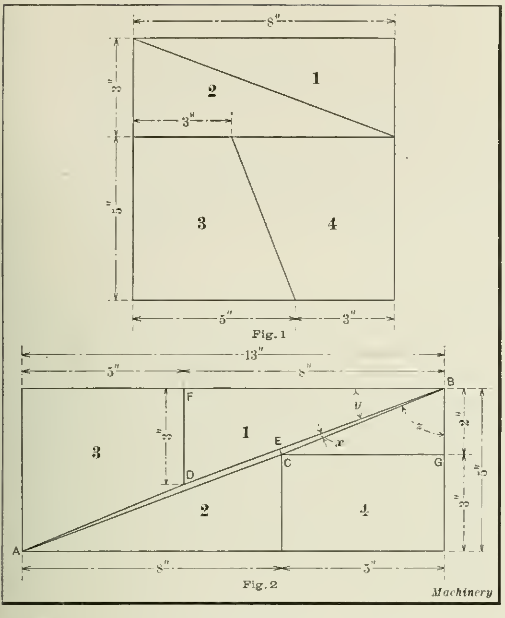
Without some such clamping medium as a nut on the back of the stem, it would not be good engineering practice to consider the influence of the shoulder. In this case, it is necessary to consider the bending moment as maximum a short distance inside the bearing, say 1 inch from the shoulder. The lever arm L is then 21 inches and the bending moment is $2646 \times 21 = 55{,}566$ inch-pounds. The section modulus of the stem is $\frac{3.1416 \times 8^3}{32} = 50.26$; say 50. The stress is then $55{,}566 \div 50 = 1111$ pounds per square inch, which is a safe value for cast iron. In constructions of this sort it is considered good practice, however, to put a liberal fillet in the corner where the stem joins the body of the cylinder, in order to avoid concentration of stresses at this point.

SOMETHING FROM NOTHING

The following gives an exact solution of the problem given by J. B. in the How and Why column in the July number of MACHINERY: Divide the figure as shown in Fig. 1 and arrange the parts as in Fig. 2. From Fig. 2 $ADBC$ is a parallelogram, AD being parallel to CB and AC parallel to DB, with CE perpendicular to DB. Hence its area $= DB \times CE$. To find CE, we must find the angle $EBC = x$, which equals the difference between the sum of the angles DBF and CBG and 90 degrees. Since $y + z + x = 90$ degrees, then $\tan (y + z + x) = \alpha$; and from trigonometry we have the relation:

$$\text{Tan } y \tan z + \tan y \tan x + \tan z \tan x = 1 \qquad (1)$$

From the right triangles DBF and CBG, we find $\tan y = 3/8$, and $\tan z = 5/2$. Inserting these values in Equation (1), we



Figs. 1 and 2. Diagrams illustrating Fallacy of attempting to obtain Something from Nothing

find $\tan x = 1/46$. Length of $CB = \sqrt{2^2 + 5^2} = \sqrt{29}$, and $CE = CB \times \sin x$. Since $\tan x = 1/46$, $\sin x = \dfrac{\tan x}{\sqrt{1 + \tan^2 x}} = \dfrac{1}{\sqrt{2117}}$. Then:

$$CE = \sqrt{29} \times \frac{1}{\sqrt{2117}} = \frac{1}{\sqrt{73}}, \text{ and } DB = \sqrt{3^2 + 8^2} = \sqrt{73}$$

Therefore the area of parallelogram $ADBC = DB \times CE = \sqrt{73} \times \dfrac{1}{\sqrt{73}} = 1$ square inch.

The above gives an exact proof that the area of the material in either figure is 64 square inches. The apparent possibility of this problem lies in the fact that angle x is a very small angle, *i. e.*, 1 degree, 14 minutes, 43.3114 seconds. W. W. J.

CONCERNING SHELL FUSE GAGES

J. J. W.—The inquirer sends two geometrical problems that he states recently came up in connection with shell fuse gages; he gives a trigonometrical solution and asks if there is a simpler solution.

A.—In the problem shown in Fig. 1, distances a, b and radius r are known and it is required to find x and y. The solution given is as follows: $c = \sqrt{a^2 + b^2}$; $\sin \alpha = \dfrac{c}{2} \div r$. This gives the value of α. $\beta = 90$ degrees $- \alpha$; $\tan \gamma = \dfrac{b}{a}$; $\theta = \beta - \gamma$; $x = r \times \sin \theta$; $y = r \times \cos \theta$. This solution is probably as simple as any that can be derived by trigonometry; the following, however, is much simpler. In the right triangles ODC and OBA, $CD = x$, $OD = y$, $AB = x + b$, and $OB = y - a$; hence:

$$x^2 + y^2 = r^2 \tag{1}$$

$$(x + b)^2 + (y - a)^2 = r^2 \tag{2}$$

Expanding Formula (2) and subtracting (1), we have:

$$2bx + b^2 - 2ay + a^2 = 0$$

from which:

$$x = \frac{2ay - (a^2 + b^2)}{2b}$$

Substituting this value of x in (1):

$$\frac{4a^2y^2 - 4a(a^2 + b^2)y + (a^2 + b^2)^2}{4b^2} + y^2 = r^2$$

Clearing of fractions, combining, reducing, and rearranging terms:

$$4(a^2 + b^2)y^2 - 4a(a^2 + b^2)y = 4b^2r^2 - (a^2 + b^2)^2, \text{ or}$$

$$y^2 - ay = \frac{b^2r^2}{a^2 + b^2} - \frac{a^2 + b^2}{4}$$

Solving this quadratic equation for y:

$$y = \frac{a}{2} \pm \sqrt{\frac{b^2r^2}{a^2 + b^2} - \frac{b^2}{4}}$$

This is a simpler solution, because it does not require the use of trigonometric functions and will give results correct to as many figures as are required; it also employs simpler branches of mathematics.

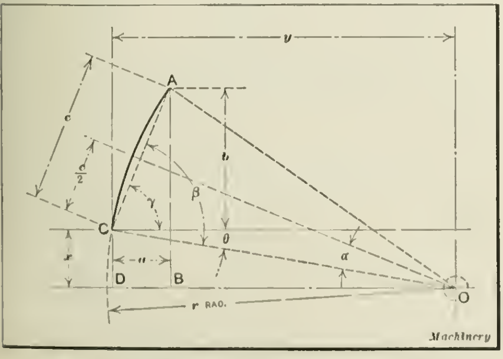


Fig. 1. Diagram illustrating First Shell Fuse Gage Problem

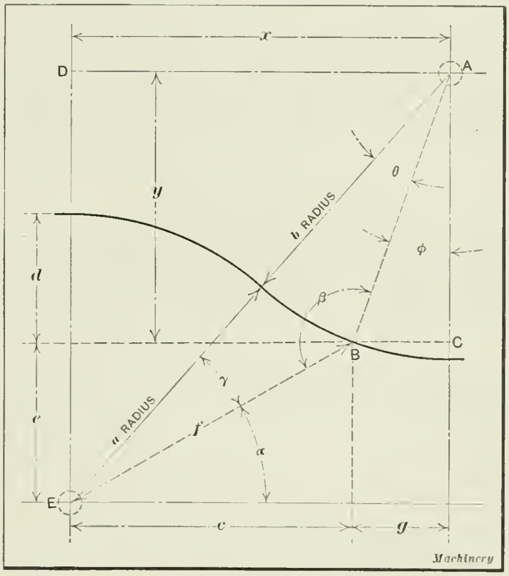


Fig. 2. Diagram illustrating Second Shell Fuse Gage Problem

In the problem shown in Fig. 2, the distances c and d and the radii a and b are known and it is required to find x and y. The inquirer's solution is: $e = a - d$; $f = \sqrt{c^2 + e^2}$; $\tan \alpha = \dfrac{e}{c}$; $\cos \beta = \dfrac{b^2 + f^2 - (a + b)^2}{2bf}$; $\sin \gamma = \dfrac{b \times \sin \beta}{a + b}$. Then, $x = (a + b) \cos (\alpha + \gamma)$ and $y = (a + b) \sin (\alpha + \gamma)$. As in the case of the first problem, there is a solution that uses only the most elementary principles of algebra and geometry. Consider the two right triangles ACB and ADE. $AC = y$, $BC = x - c$, $AD = x$, and $DE = a - d + y$. Hence:

$$y^2 + (x - c)^2 = b^2 \tag{1}$$

$$(y + a - d)^2 + x^2 = (a + b)^2 \qquad (2)$$

Equations (1) and (2) contain x and y and the four known quantities a, b, c, and d. Expanding:

$$y^2 + x^2 - 2cx + c^2 = b^2 \qquad (3)$$

$$y^2 + x^2 + 2(a - d)y + a^2 - 2ad + d^2 = a^2 + 2ab + b^2 \quad (4)$$

Subtracting (3) from (4), transposing and collecting terms:

$$2(a - d)y + 2cx - c^2 - 2ad + d^2 = 2ab, \text{ or}$$

$$y = \frac{2a(b + d) + c^2 - d^2 - 2cx}{2(a - d)}$$

To simplify the work, let $\frac{2a(b + d) + c^2 - d^2}{2(a - d)} = m$, and

$$\frac{2c}{2(a - d)} = \frac{c}{a - d} = n; \text{ then } y = m - nx \qquad (5)$$

Substituting in Equation (1):

$$m^2 - 2mnx + n^2x^2 + x^2 - 2cx + c^2 = b^2$$

Transposing and collecting terms:

$$(n^2 + 1)x^2 - 2(mn + c)x = b^2 - m^2 - c^2$$

from which:

$$x^2 - 2 \times \frac{mn + c}{n^2 + 1}x = \frac{b^2 - m^2 - c^2}{n^2 + 1}$$

Now let $r = \frac{mn + c}{n^2 + 1}$, and $s = \frac{b^2 - m^2 - c^2}{n^2 + 1}$; then $x^2 - 2rx = s$. Solving this quadratic, $x = r \pm \sqrt{s + r^2}$. In application, the method is very simple: first calculate the values of m and n; then calculate r and s; finally, calculate x, and substitute in Formula (5) to get y. In practice, it will be found that it will be necessary to use the minus sign in the double sign before the radical when finding x. While this solution may look somewhat complicated, it is in reality very simple, as will be seen when actual values are substituted. J. J.

BENDING I-BEAMS

H. D. M.—Are the I-beams used in road graders, etc., bent in the bulldozer, or are they drawn through special rolls? So far, we have had no success with the bulldozing process, as the flange on the inside of the curve refuses to upset, and therefore leaves the beam somewhat crooked, as shown by the dotted lines in Fig. 1.

Answered by John S. Myers, Philadelphia, Pa.

It is generally realized that the compression side of a member being bent does not upset as much as the tension side elongates, but the reason is perhaps not so well understood. If a body *A*, Fig. 2, is compressed between two surfaces *B* and *C*, it spreads out in the direction of the arrows *D*. Such a body is under an apparent compressive stress equal to the force with which the acting members *B* and *C* are pressed together. It is, however, also under a tensile stress acting in the direction of arrows *D*, the intensity of which is a stress that will produce a deformation in this direction equal to that produced in the same direction by the compressive force. Now, when a body is bent under the action of dies, the pressure of the dies acts on both sides of the member being bent and induces a tensile stress in the member as mentioned. This acts in direction *T*, Fig. 3, on the tension side, adding to the tension produced by the bending action; but on the compression flange *B*, it acts in the direction indicated by arrows *t* and opposes the upsetting of the compression flange. Another reason that the compression flange *B* does not upset as much as the tension flange *A* elongates is illustrated by Fig. 4. Here the dies in coming together bear upon the tension flange *A* at points *F* and bear upon the compression flange *B* at point F_1. The pressure applied on flange *B* at F_1 induces tensile forces, acting as at *t*, opposing the upsetting of the compression flange. The forces acting at *F* induce tensile stresses acting in the direction *T*, assisting the elongation of this flange; but the friction of the points *F* opposes motion with a force as indicated at *f*. This frictional resistance *f* and the extra elongation due to the forces *t* tend to bend the member as indicated by the dotted lines *C*. A suggested method of

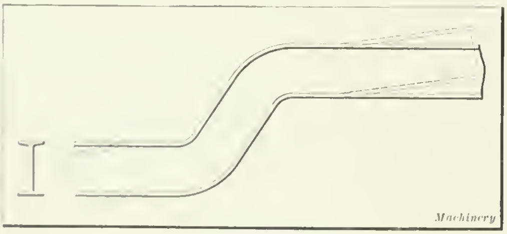


Fig. 1. Desired and Actual Results obtained with Bulldozing Process

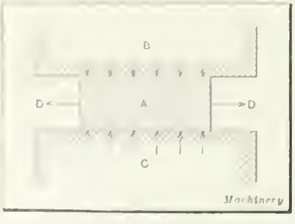


Fig. 2. Forces produced when compressing a Member

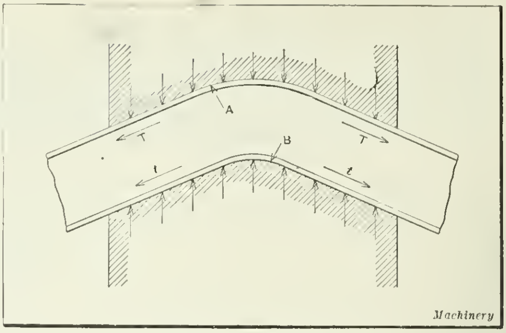


Fig. 3. Forces produced when bending a Body in Dies

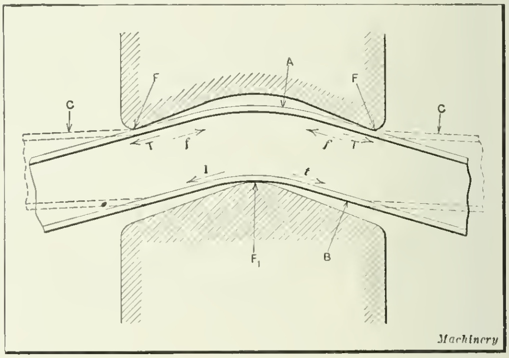


Fig. 4. Influence of Friction on Bending

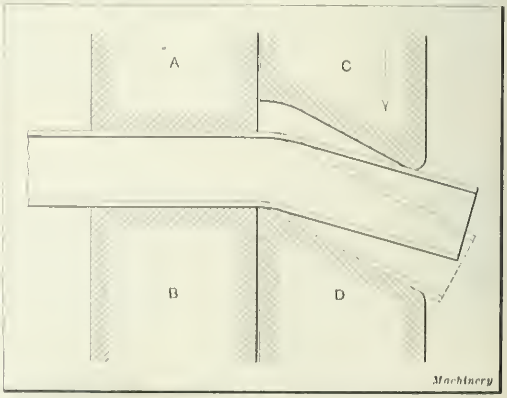


Fig. 5. Suggested Form of Bending Dies

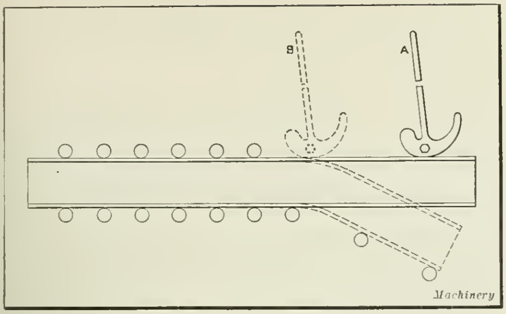


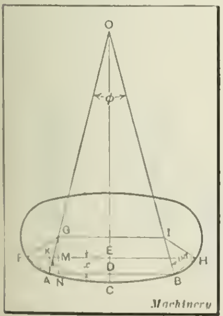
Fig. 6. Method of bending by Hand

overcoming this tendency is indicated in Fig. 5. Here the dies *A* and *B* clamp the beam and the dies *C* and *D* do the bending. When bending by hand on the bending floor, the preliminary bend is generally made by applying the force at some little distance from the actual point of bend, as at *A*, Fig. 6, and the bend is brought to the line more closely with the force applied nearer to the bend, as at *B*. This method is more natural and brings the member to the desired shape more readily; but even then it squirms out of shape and is afterward bent cold to correct the errors. This subsequent operation is called "fairing" among shipbuilders. In general, if a fairing operation is to be avoided, the peculiarities of the problem are to be noted and modifications of the bending dies made to rectify the errors.

DEPTH OF TANK PARTLY FILLED

J. F. F.—The illustration shows an oval tank that is 30 inches long. Radius *OA* is 20 inches, radius *GA*, 3 inches, and chord *AB*, 10 inches. What will be the depth *EC* when the tank is horizontal and contains 231 cubic inches of liquid?

A.—The area *FHBCAF* = 231 ÷ 30 = 7.7 square inches and is made up of two equal segments *FA* and *BH*, the segment *ACB*, and the trapezoid *FABH*. Denote the angle *AOB* by ϕ, angle *FGA* = *BIH* by v, and distance *ED* by x. Sin $\frac{\phi}{2} = \frac{5}{20} = 0.25$; whence $\frac{\phi}{2} = 0.25268$, and $\phi = 0.50536$. Area of segment $ACB = \frac{20^2}{2}(\phi - \sin\phi) = 4.24752$ square inches. Therefore, area *FHBAF* = 7.7 − 4.24752 = 3.45248 square inches. Draw *AK* perpendicular to *FH*. Angle $FAK = FAL - KAL = FAL - \frac{\phi}{2}$, and $FAL = \frac{\pi}{2} - \frac{v}{2}$; hence, $FAK = \frac{\pi}{2} - \frac{v}{2} - \frac{\phi}{2} = 1.5708 - 0.25268 - \frac{v}{2} = 1.31812 - \frac{v}{2}$.



Finding Depth of Liquid in an Oval Tank

$FK = x \tan FAK = x \tan\left(1.31812 - \frac{v}{2}\right)$, and area of trapezoid $FABH = \left(\frac{FH + AB}{2}\right)x = \left[10 + x\tan\left(1.31812 - \frac{v}{2}\right)\right]x$

Area segment $FA = \frac{3^2}{2}(v - \sin v)$, and area of segments *FA* and $BH = 9(v - \sin v)$; hence, area $FHBAF = \left[10 + x\tan\left(1.31812 - \frac{v}{2}\right)\right]x + 9(v - \sin v) = 3.45248$. Or,

$$f(v) = \left[10 + x\tan\left(1.31812 - \frac{v}{2}\right)\right]x + 9(v - \sin v) - 3.45248 = 0 \qquad (1)$$

This equation contains two unknown quantities x and v, and it is necessary to express x in terms of v. Draw *GN* perpendicular to *AB;* it will be also perpendicular to *FH*, which is parallel to *AB*. Since $AGN = \frac{\phi}{2}$, $GM = 3\cos\frac{\phi}{2} - x = 2.90474 - x$. Angle $GFM = \frac{\pi}{2} - \left(v + \frac{\phi}{2}\right) = 1.31812 - v$, $GM = 3\sin(1.31812 - v) = 2.90474 - x$. Solving for x:

$$x = 2.90474 - 3\sin(1.31812 - v) \qquad (2)$$

The procedure now is to assume a value for v, substitute it in Equation (2) and find x, and then substitute these values of x and v in Equation (1). To find a tentative value for v, note that x must be less than 3.45248 ÷ 10 = 0.345248; call it 0.34; then, $0.34 = 3\sin(1.31812 - v)$, from which $v = 0.292$, approximately. Substituting this value of v in Equation (2), $x = 0.33884$. Substituting these values of v and x in Equation (1), $f(v) = 0.24563$. Trying 0.282 for v, $f(v) = 0.06704$; and for $v = 0.272$, $f(v) = -0.10766$. Tabulating these values

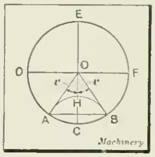
v	$f(v)$		
0.272	−0.10766		
		17470	
0.282	0.06704		389
		17859	
0.292	0.24563		

and using the second difference, $v = 0.27820$ when $f(v) = 0$. $DC = 20 - \left(20\cos\frac{\phi}{2}\right) = 0.63508$; for $v = 0.27820$, $x = 0.31763$, from Equation (2). Therefore, $EC = x + DC = 0.31763 + 0.63508 = 0.95271$ inch.

J. J.

GIVEN AREA OF LUNE TO FIND RADIUS

H. E. L.—Referring to the accompanying illustration, please show how to find the radius *AC* = *CH*, which must be such that the area of the lune *AHBC* shall be equal to one-tenth the area of the circle *ADEFB*.



Finding Radius of a Lune

A.—Let R = radius *OA*, x = radius *CA*, and v = angle $AOC = 1/2\ AOB$.

Area of segment *ACB*

$$= R^2(v - 1/2 \sin 2v) \qquad (1)$$

$$x = 2R\sin\frac{v}{2} \qquad (2)$$

Since angle $ACE = 1/2(\pi - v)$,

$$\text{Area of segment } AHB = \frac{x^2}{2}[(\pi - v) - \sin(\pi - v)]$$

$$= 2R^2\sin^2\frac{v}{2}(\pi - v - \sin v) \qquad (3)$$

Adding Equations (1) and (3),

$$\text{Area of lune } AHBC = R^2\left[v - 1/2\sin 2v + 2\sin^2\frac{v}{2}(\pi - v - \sin v)\right] \qquad (4)$$

But $1/2\sin 2v = \sin v\cos v$ and $2\sin^2\frac{v}{2} = 1 - \cos v$.

Substituting these values in Equation (4), and reducing,

$$\text{Area } AHBC = R^2[\pi - \sin v - (\pi - v)\cos v] = 1/10 \times \pi R^2 \qquad (5)$$

Equation (5) reduces to:

$$f(v) = \sin v + (\pi - v)\cos v - 9/10 \times \pi = \sin v + \pi\cos v - v\cos v - 9/10 \times \pi = 0 \qquad (6)$$

Now, substituting in Equation (6) the first three terms of the sine series and the cosine series for $\sin v$ and $\cos v$.

$$v - \frac{v^3}{6} + \frac{v^5}{120} + \pi - \frac{\pi v^2}{2} + \frac{\pi v^4}{24} - v + \frac{v^3}{2} - \frac{v^5}{24} - \frac{9\pi}{10} = 0$$

Clearing of fractions, combining, reducing, and letting $\pi = 3.1416$,

$$v^5 - 3.927v^4 - 10v^3 + 47.124v^2 - 9.4248 = 0 \qquad (7)$$

Solving Equation (7), $v = 0.4761$. Substituting this value of v in Equation (6), $f(v) = -0.00005$; substituting 0.4760 for v, $f(v) = 0.00006$; hence, $v = 4760 + 6/11 \times 1 = 4760.54+ = 0.476054$, after restoring the decimal point. Substituting this value of v in Equation (2),

$$x = 2R\sin\frac{0.476054}{2} = 0.47158R$$

If a table giving the angles in radians is not available, it will be necessary to express v in degrees, minutes, and seconds before interpolating in the table of trigonometric functions; the writer used radians for the foregoing calculations. J. J.

PRACTICAL FEATURES OF FACTORY LIGHTING[1]

PRINCIPAL REQUIREMENTS OF ARTIFICIAL LIGHTING

BY C. E. CLEWELL[2]

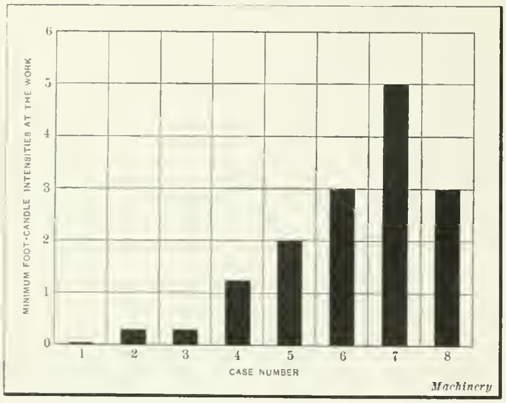


Fig. 1. Minimum Values of Illumination at the Work. The Case Numbers are the Same as those used in Table 2

It is proposed in this article to outline the requirements of proper artificial lighting for factory spaces and to indicate some of the ways in which these requirements can be met with modern lamps. It is well to note at the outset of this discussion that there are two parts to the general problem of factory lighting, one of which relates to the source of light, that is to say, the lamps of the system, and the other to the general question of the effect of the lamps in illuminating the objects to be seen and thereby in fulfilling the conditions for clear vision. These two parts of the lighting problem may be briefly summarized as cause and effect, and, as we shall show, each of these involves careful determination if the net result is to be satisfactory. One of the major objects of this article is to show that the problem of lighting, as it is looked upon today, is a scientific one, and that every factory should make it a point to see that the two fundamental qualities, which may be termed a maximum in the excellence of the system and a minimum in the cost, are realized in the lighting equipment chosen. In other words, it will be shown that the lamps for a factory section should no longer be merely a matter of haphazard selection without regard to their cost and lighting efficiency, nor that the arrangement of the lamps should be determined on the basis of guesswork or random judgment.

Principal Requirements

In the article "Daylight Facilities in Industrial Plants," published in the November number, is shown a greater need for artificial light in the average factory than is commonly supposed. It is not only necessary to have an adequate supply of artificial light for those who comprise the night force, but it is also necessary to provide artificial lighting during a portion of the day, as practically every winter day has two dark intervals, namely, in the early morning and at the close of the working day, and unless artificial light is available these intervals are likely to form a relatively non-productive part of the day's work. To these, there must be added other dark intervals due to cloudy or stormy weather conditions and to fogs or a smoky atmosphere, all of which go to make the artificial lighting problem of more than ordinary importance in the fall and winter, and also of considerable importance in the spring and summer months.

In order to meet these dark conditions, it follows that every factory should have a general system of artificial illumination with a sufficient intensity at all parts of the floor space, first of all, to make it possible for employes to get around their machinery and to use the aisles and passages without risk of accidents, and, second, to enable materials to be handled easily as well as the ordinary operations that confront a workman outside of the actual work in hand. This initial requirement means that a certain fairly well defined degree of general illumination is a necessity without regard to the working operations themselves, but, of course, in addition to this there must also be available a sufficient degree of illumination at the work to make it possible for the operative to see clearly all the details of his work without undue tax on his vision. While the latter intensity is naturally higher than that usually specified for aisles and passages, it is entirely practicable to make the general illumination adequate not only for the prevention of accidents, but also for the work itself, with a somewhat lower intensity for aisles and passages and such spaces as storage and the like.

The foregoing points constitute the principal requirements of the lighting system from the standpoint of its effect in illuminating the work. To these there must be added a number of important points concerned with the lighting equipment. First, and possibly most important, is the use of proper shades or reflectors in connection with the lamps for the purpose of directing the light from the lamps most advantageously to the working surfaces beneath. This statement implies that the lamps are mounted overhead near the ceiling and that they are distributed symmetrically over the ceiling area so that the illumination can be made practically uniform over the entire floor space. However, it may be noted that even where the lamps are located fairly close to the machinery in the form of individual units for each workman, they should likewise be supplied with suitable auxiliaries for directing the light to the space where it is required. There is another important reason for the use of reflectors or shades, namely, to serve as a protection for the eyes of those employes who may have occasion now and then to look into or toward a lamp, thus

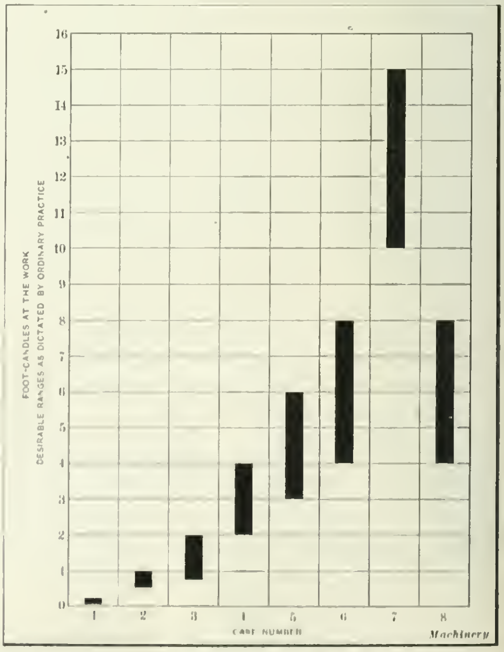


Fig. 2. Ranges in Values of Illumination at the Work. The Case Numbers may be identified by Reference to Table 2

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[1] For other articles on this subject, see "Daylight Facilities in Industrial Plants," in the November number of MACHINERY.

[2] Assistant Professor of Electrical Engineering, University of Pennsylvania, Philadelphia, Pa.

TABLE 1. DESIRABLE AND MINIMUM INTENSITIES OF ILLUMINATION TO BE MAINTAINED AT THE WORK AS STIPULATED IN THE FACTORY LIGHTING CODE ISSUED IN 1915 BY THE ILLUMINATING ENGINEERING SOCIETY AND REVISED IN JUNE 1917

Classification	Foot-candles at the Work	
	Ordinary Practice	Minimum
(a) Roadways and yard thoroughfares	0.05 to 0.25	0.02
(b) Storage spaces	0.50 to 1.00	0.25
(c) Stairways, passageways, aisles	0.75 to 2.00	0.25
(d) Rough manufacturing, such as rough machining, rough assembling, rough bench work	2.00 to 4.00	1.25
(e) Rough manufacturing involving closer discrimination of detail	3.00 to 6.00	2.00
(f) Fine manufacturing, such as fine lathe work, patternmaking and toolmaking, light-colored textiles	4.00 to 8.00	3.00
(g) Special cases of fine work, such as watch-making, engraving, drafting, dark-colored textiles	10.00 to 15.00	5.00
(h) Office work, such as accounting, typewriting, etc.	4.00 to 8.00	3.00

Machinery

receiving the total light in their eyes. If the lamp is very bright, as is the case, for example, with tungsten lamps, when one looks directly at the bare filament of the lamp, the glare not only produces a most unpleasant blinding effect, but if such abuse of the eyes is long continued, that is, day after day, permanent injury may result. A suitable reflector may be used with such lamps not only to increase the downward light and thus raise the efficiency of the system, but also to serve as a medium for softening the light and reducing the objectionable glare and blinding effect otherwise present.

TABLE 2. CLASSIFICATION OF WORK AS OUTLINED IN THE REVISED CODE OF FACTORY LIGHTING OF THE ILLUMINATING ENGINEERING SOCIETY

No.	Classification	Examples
1	Yards	Roadways Thoroughfares
2	Storage	Storage spaces in general
3	Stairs	Stairways Passageways Aisles
4	Rough manufacturing	Rough machining Rough assembling Rough bench work
5	Rough manufacturing	Involving closer discrimination of detail
6	Fine manufacturing	Fine lathe work Patternmaking Toolmaking Light-colored textiles
7	Special cases of fine work	Watch-making Engraving Drafting Dark-colored textiles
8	Office work	Accounting Typewriting

Note: The numbers used in this table correspond with the numbers in Figs. 1 and 2.

The lighting equipment should be supplied from circuits or mains which are so planned out, both as to size and arrangement, that there may be an adequate pressure at the lamps at all times. This follows at once when it is considered that only slight changes in the supply pressure (the voltage in the case of electric lamps) cause considerable changes in the amount of light given off by the lamps. Hence, if such voltage changes are rapid, due possibly to changing loads taken by motors on the same circuits, an unpleasant flicker of the light will result; whereas, at times of heavy load, for example, when all the lamps in the factory are turned on, if there is an undue steady decrease in the supply circuit voltage, then a part or all of the lamps will burn dim and the resulting illumination may prove inadequate and unsatisfactory. The supply circuits, however, should not only be capable of maintaining a steady pressure, but they should also be so protected that an interruption of the service is unlikely. In other words, dependence is placed on the circuits for a steady and reliable supply at all times, and these requirements are also apparently related closely to the machinery in the power plant which, coupled with the circuits, largely determines the reliability of the lighting service.

Rules—Old and New

The average person who is confronted with the problem of deciding on the way in which to light a factory naturally desires to have available rules for his guidance. In earlier practice, one method of specifying the lamps for electric lighting was in terms of watts per square foot of floor space required to produce enough light for the given conditions. Thus we might say that the lamps for a system of a certain type, to be satisfactory for a given floor area, must be installed in such density over the ceiling area as to result in a value of, say, 1.25 watt per square foot of floor space. For a floor area of 800 square feet, then, it would be necessary to install an aggregate of 800 × 1.25, or 1000 watts, so that eight lamps, each consuming 100 watts, would meet the requirements.

A rule of this kind has certain clearly defined disadvantages, and to make these disadvantages understood it is only necessary to point to the kind of errors that can easily be made in attempting to apply it to any given case. One instance that came to the writer's attention about eight years ago will serve as a good example. At that time tungsten lamps were coming into use for factory lighting, and Nernst lamps were also quite generally used for certain purposes. The electrical man in a factory had been told that if a figure of 1.25 watt per square foot of floor was used, good office lighting would result. The same person was later requested by the works department to plan out the lighting for an office where Nernst lamps were to be used. He applied the figure of 1.25 watt per square foot, which had been given him for tungsten lamps, for the determination of the number of Nernst lamps required, and when the system was installed the illumination was found to be inadequate—approximately one-half of what it should have been—and, as a result, an entire rearrangement was necessary. The explanation of the discrepancy in this case is found to be due to the difference in the amount of light given off by the two types of lamps per watt of energy consumed. Thus the Nernst lamps produced only about one-half as much light for each watt as the tungsten units, and, as a result, the total number of watts calculated on the basis of the constant 1.25 (for tungsten lamps) produced an effect only one-half as great as it should have been. In other words, a higher constant of about 2.5 should have been applied for the Nernst lamps for satisfactory illumination. This simple yet

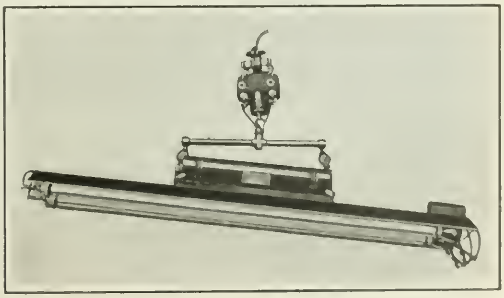

Fig. 3. New PP Lamp of Mercury Vapor Type

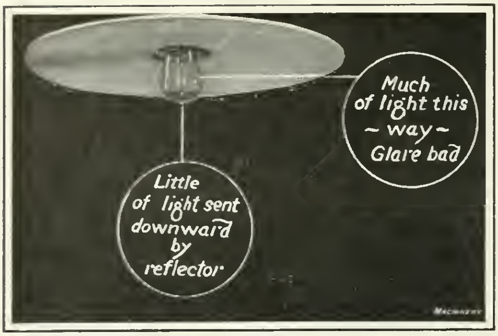
Much of light this ~ way ~ Glare bad
Little of light sent downward by reflector
MACHINERY

Fig. 4. Tungsten Lamp equipped with Flat Glass Reflector. Note that Much of the Light can pass off in Horizontal Directions, thus wasting Light and causing Objectionable Glare

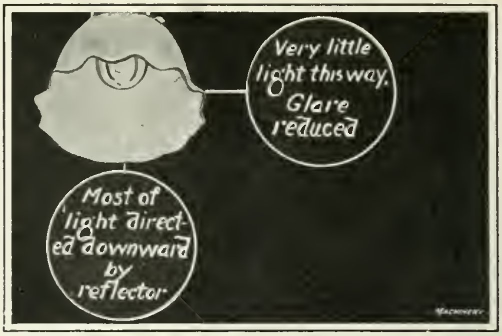
Very little light this way. Glare reduced
Most of light directed downward by reflector
MACHINERY

Fig. 5. Tungsten Lamp with Holophane Bowl-shaped Prismatic Glass Reflector. Note that Most of the Light is directed downward by the Prisms that constitute the Reflector

Fig. 6. Large Tungsten Incandescent Lamp housed in Metal Reflector and suspended by Automatic Disconnecting Hanger

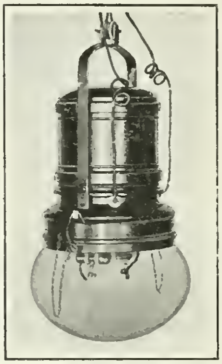

Fig. 7. Quartz Mercury Vapor Lamp for High Interiors and for Exterior Lighting

important illustration will serve to show that a rule of this kind is not satisfactory, primarily because it concerns itself with the power consumed by the lamp rather than with the effect of the light from the lamp in producing illumination on the work. This very weakness of earlier lighting rules has led in more recent years to the beginning of a movement on the part of certain authorities to adopt a form of specification of the quantity of light necessary at the work for various industrial operations and to work back from this specification to find the number and size of the lamps that are required.

Without going into details of the theory involved in this more recent method, it may be outlined briefly by saying that if we multiply the intensity of the illumination at the work by the area of the floor space to be lighted, the product of these two factors gives us a measure of the total light required over the entire working surface. Dividing this product by the efficiency with which the light from the lamps is sent to the work indicates directly the amount of light that all the lamps must generate. The result of this operation is expressed in a unit called the "lumen," which is now commonly used by the lamp manufacturers to indicate the amount of light produced by a given lamp. A simple example of this more recent rule will serve to show the method and will make clear the meaning of the two or three steps in the process. Suppose for a given class of work that an intensity of 5 foot-candles (the unit of illumination intensity was described in the article "Daylight Facilities in Industrial Plants," in the November number) is required at the work, and that the area of the floor or working surface to be lighted is 4000 square feet. Multiplying these two factors, we have: 5 × 4000 = 20,000 lumens, which is the quantity of light that must be incident or at the working surface. If now we divide this total light at the work by an assumed efficiency of, say, 50 per cent, which means merely that of the total light generated by the lamps 50 per cent is effective at the work while the remainder is lost or dissipated in various way, the result indicates the total amount of light that must be produced by all the lamps, or 20,000 ÷ 0.50 = 40,000 lumens. The remainder of the problem is merely to decide on the size of lamp to be used, and if each lamp produces, according to the manufacturer's rating, a value of, say, 1000 lumens, we know at once that 40 lamps distributed over the ceiling area will produce the required result. The application of this rule depends on the proper choice of intensity and on a careful selection of the efficiency constant, as the latter depends on the type of reflector and on the surrounding conditions, whether light colored or dark, and also to some extent on the arrangement of the lamps and the size of the lighting system.

As a guide to this first factor of intensity, Table 1 shows the recent recommendations of the committee on

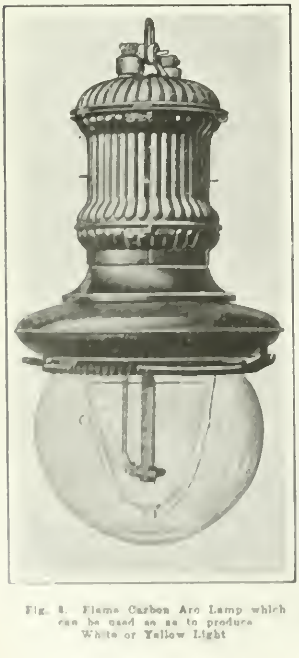

Fig. 8. Flame Carbon Arc Lamp which can be used so as to produce White or Yellow Light

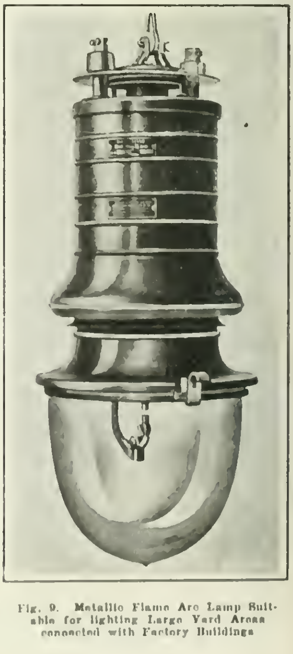

Fig. 9. Metallic Flame Arc Lamp Suitable for lighting Large Yard Areas connected with Factory Buildings

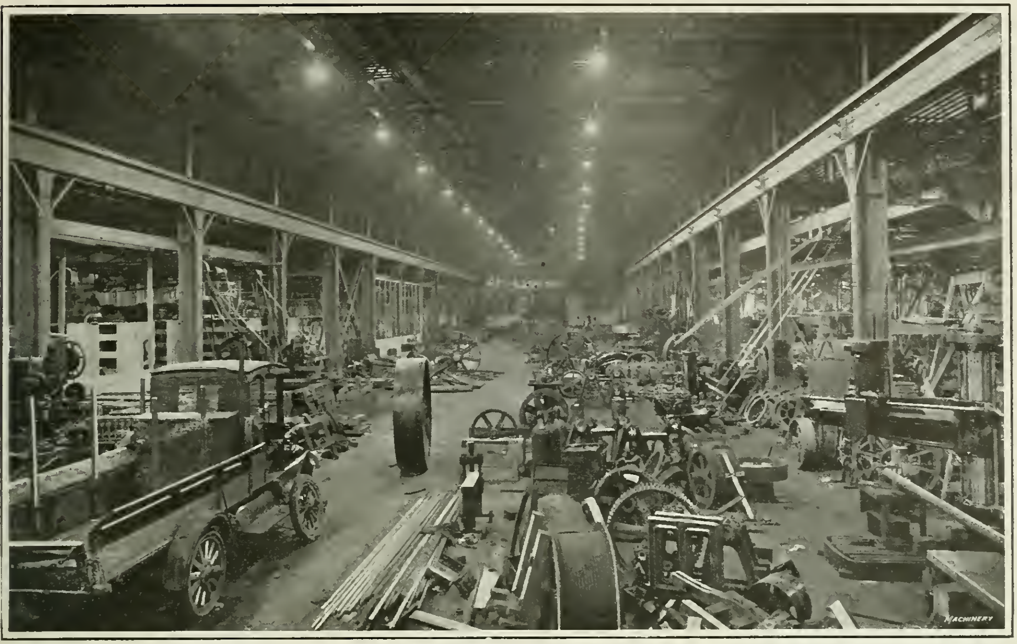

Fig. 10. Interior of Machine Shop Space where Uniform Illumination is produced on Work by Tungsten Lamps and Efficient Reflectors with Lamps well overhead

lighting legislation of the Illuminating Engineering Society for various classes of work, while Table 2 gives the divisions that have been employed in classifying the spaces and operations in a number of typical industries. Figs. 1 and 2 show graphically the minimum values of the illumination intensity and the ranges dictated by ordinary practice for each given class of work. The industrial commissions of several states have adopted tables of this same nature.

The values of the efficiency factor (commonly called the utilization efficiency) used in various practical cases is somewhat more difficult to determine. The writer has found that values of about 30 per cent apply to average industrial conditions with the usual dark surroundings due to dirt on walls and ceilings and where due account is taken of the gradual deterioration of any system due to the unavoidable gathering of dust and dirt on the lamps and reflectors. Certain lamp

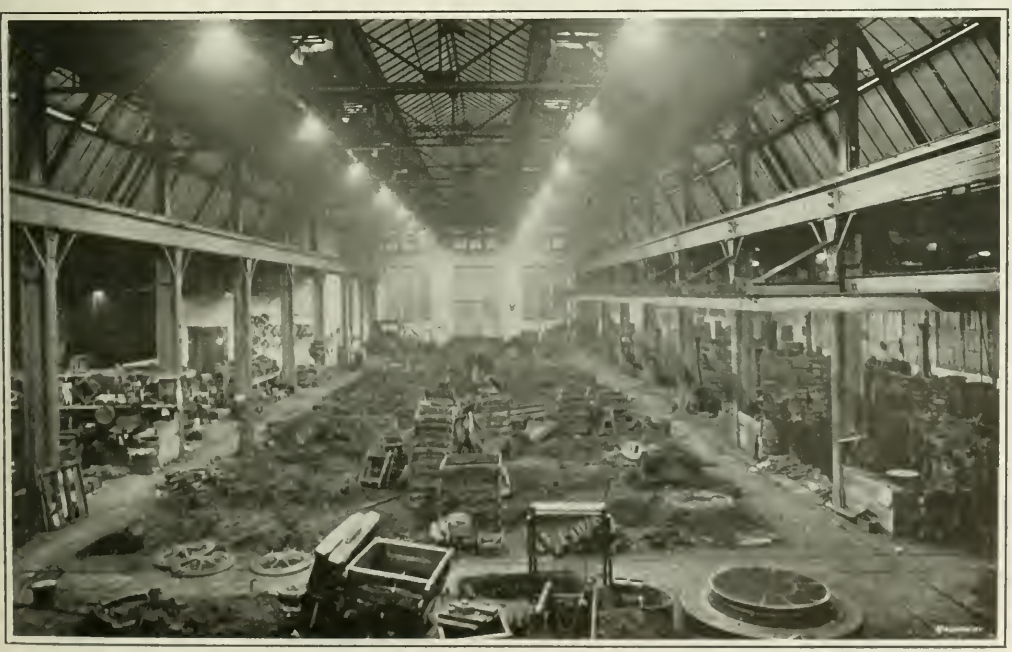

Fig. 11. Large Foundry Space Illuminated by Overhead System of Lamps. Note Excellent Distribution of Light on Working Surfaces, Little Glare being produced on Eyes of Employes in looking up and down Aisles because Lamps are so High

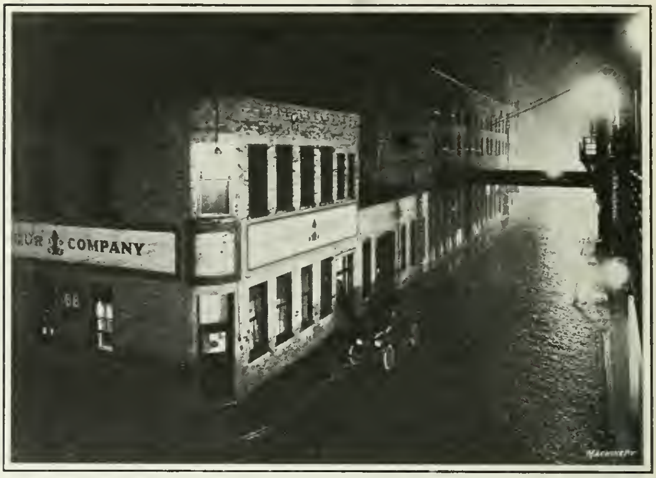

Fig. 13. Example of Flood Lighting by Lamps equipped with Efficient Projectors and mounted on Adjacent Structures

manufacturers publish values ranging from somewhat below 30 per cent for some types of reflectors and small installations up to 71 per cent in large installations and presumably with more or less ideal surroundings. As a general policy it will be found desirable in factory lighting work to be conservative in the selection of this constant and to use smaller rather than too high values, because too high a value means that not enough light will be produced at the work, whereas a conservative value means that some allowance has been made for the accumulation of dirt on the equipment between the times regularly assigned for cleaning.

Lamps Available

The discussion thus far has related mainly to ways for accomplishing given results. This feature is obviously an important one to the practical shop man who may be entrusted with this division of the factory equipment. Of almost equal importance is the question of the kinds of lamps that are available for producing the results. It is not generally recognized, perhaps, that great limitations were imposed in earlier lighting practice by a lack of a suitable range of lamp sizes. For example, until ten or fifteen years ago, practically the only types of electric lamps in use or available for factory lighting were the arc lamps, of rather bulky size and unsuited to many conditions, and the carbon filament glow lamp, which was mostly employed in the form of a hand lamp on an extension cord or possibly as a drop lamp located close to the bench or machine. These two extremes left much to be desired in earlier practice, since many factory spaces could not be effectively illuminated by either type. Today new and improved types of lamps are available.

Lamps are rendered more efficient by the use of properly designed shades or reflectors, and this important feature is well illustrated by Figs. 4 and 5; from Fig. 4 it will be seen that the bare tungsten lamp or the same lamp equipped merely with a flat glass shade makes it possible for much of the light to pass off in horizontal directions from the lamp. Fig. 5, by way of contrast, shows a similar lamp equipped with a superior reflector which has the property of sending the light of the lamp effectively to the work and at the same time of protecting the eyes of workmen from the blinding glare of the bare lamp filament. Figs. 3, 6, 7, 8 and 9 illustrate various types of modern electric lamps, each type being suited, in a general way, to given conditions of service. The two types that are most widely used for shop and factory interiors are the mercury vapor and the tungsten lamps illustrated in Figs. 3 and 6. The lamp shown in Fig. 3 operates on direct-current circuits and is designed mainly for high areas. It consumes 770 watts at 220 volts. Other types for use on alternating-current circuits are also available. The lamp in Fig. 8 gives off 920 mean lower hemispherical candlepower and consumes 500 watts. It is occasionally used for very high interiors. The lamp in Fig. 9 gives off a mean lower hemispherical candlepower of 495 with an energy consumption of 272 watts. The lamp in Fig. 7 produces a very high candlepower with a low energy consumption. This type is not on the market at present, because of the inability of the manufacturers to secure quartz tubing from abroad.

Systems and Special Cases

As a final consideration, brief mention should be made of the general systems of illumination that have come to be looked upon as standard for factory work. It may be stated at the outset that the use of individual lamps close to the work is discouraged as inferior to the scheme of general lighting illustrated in Figs. 10 and 11, where the lamps are shown mounted well overhead according to a symmetrical arrangement. Sometimes a modified form of general lighting is found desirable in which the positions of the lamps, instead of being symmetrical throughout, are determined by the locations of the machines on the floor space. Such a plan embodies some of the features of the local or individual method of lighting along with the advantsges that usually accompany the placing of the lamps well overhead. Other interesting and important schemes involve the use of enclosing bowls for sending some or all of the light of the lamps to the ceiling, from which it is redirected to the working surfaces beneath. Such schemes, one of which is shown in Fig. 12, depend for successful operation on light colored ceilings and surroundings generally, and hence their use is limited largely to the office or drafting room. One feature which is of unusual value at this time is the use of projectors with tungsten lamps for illuminating building fronts or yards at night as a protective feature. Such a case is illustrated in Fig. 13, where it will be noted that the projectors are so mounted that the front and sides of the building are brightly illuminated.

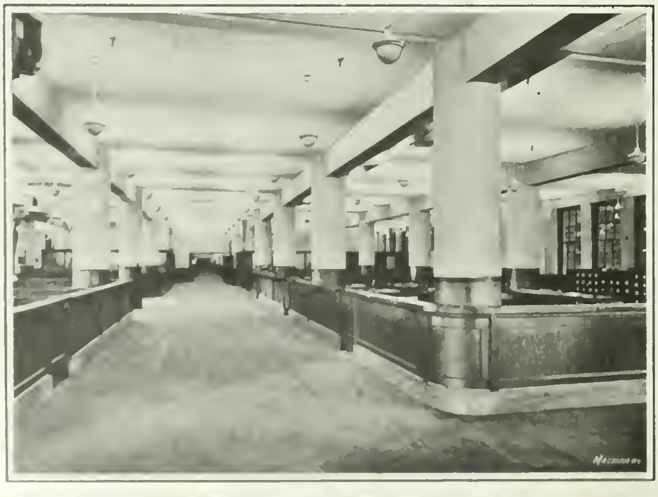

Fig. 12. Interior of Large Office where Indirect System of Illumination with Tungsten Lamps is used. Note Uniform Distribution of Light on Working Surfaces and Freedom from Glare because Lamps are concealed from View

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

IN THIS NUMBER

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CRALEY "MASTER TOOLMAKER"

FOR use in drilling holes in jigs, fixtures and other work where accurate spacing is required, the Craley Mfg. Co., Lancaster, Pa., has developed a machine known as the "master toolmaker," which is illustrated and described herewith. This equipment is clamped to the table of a drilling machine with the drill bushing in line with the axis of the machine spindle, so that holes may be drilled as in the case of an ordinary jig. The "master toolmaker" is equipped with a compound table with slides at right angles, which are operated by the usual screw and ball crank combination. These screws are merely employed for making approximate settings; the actual locations which are depended upon to secure accurate spacing of the holes are made by means of micrometer heads and standard distance bars. The work-table is adjusted until both micrometers read zero against stops on the table which act as the micrometer anvils, and in this position the center of the drill bushing is located over the intersection of the guide strips on the work-table. Work is clamped against these guides, and in starting to locate the first hole, the two table slides are manipulated so that an approximate setting is secured, after which the distance bars and micrometer heads are used to obtain the final location in the manner to which reference has already been made. In this connection, attention is called to the fact that the arm which supports the drill bushing should be set to bring the bushing as close to the work as possible. Obviously it is possible to use this equipment to locate any number of holes in the work in the desired relation to each other, as the table slides may be manipulated and final settings made with the micrometer heads and distance bars, so that each hole is located in the proper relation to the preceding hole. Clamps are provided to lock the table in each position before the drilling operation is started.

It will be apparent from the illustrations that the distance bars are supported by bushings held in V-shaped seats, which support them at the proper height to line up properly between the micrometer spindles and stops on the table which come in contact with the micrometer spindles when the table is set in the zero position. A set of distance bars is provided, so that any desired combination of whole inches may be obtained up to the full capacity of the machine, and thousandths of an inch are then secured with the micrometer heads. Johannson gages may be used in place of the distance bars, if so desired. An important feature is that by the use of this machine there is no danger of introducing a cumulative error, as each measurement is taken from the intersection of the guide strips. The capacity of the machine is for holes up to ⅝ inch in diameter, but should it happen that the necessity arises for drilling a hole of larger size, this can easily be done by drilling and reaming a smaller hole in the desired location; then, after all other holes have been drilled and reamed, a plug is placed in the hole, which marks the position at which the larger hole is to be drilled. The work is next transferred to

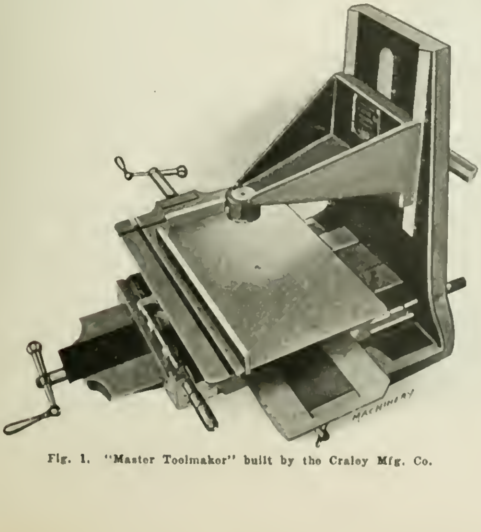


Fig. 1. "Master Toolmaker" built by the Craley Mfg. Co.

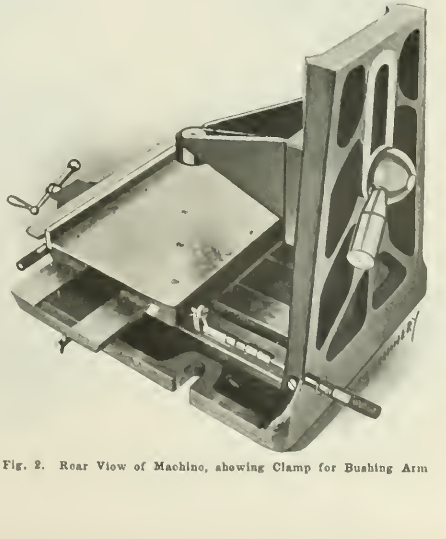
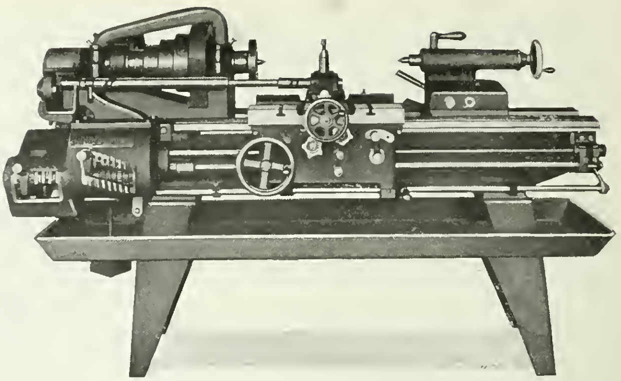


Fig. 2. Rear View of Machine, showing Clamp for Bushing Arm

a lathe and indicated by means of this plug; then, after the desired location has been secured, the hole can be bored and reamed on the lathe. The advantage of using a machine of this type in shops where there is a lot of accurate drilling to be done will be obvious to any experienced mechanic, and it is claimed that in such shops the machine will pay for itself in a relatively short time.

Among the classes of work in which holes may be drilled and reamed with the "master toolmaker," the following may be mentioned: jigs, dies, templets, master plates, models, etc. Its use does away with the necessity of laying out work, and the accuracy of the "master" may be depended upon without requiring a high-priced mechanic to spend a lot of time on inspection. The work-table is 8 by 11 inches in size, and it has a maximum longitudinal movement of 8¼ inches, a maximum transverse movement of 6¼ inches, and the drill bushing arm has a maximum vertical movement of 6 inches. The machine weighs approximately 125 pounds. The regular equipment furnished includes two special Brown & Sharpe micrometer heads, eleven hardened and lapped distance bars 1/4 inch in diameter and varying in length in intervals of 1 inch, eight bushings from 3/16 to 5/8 inch in diameter, inclusive, varying by intervals of 1/16 inch, and four clamps and screws for the T-slots.



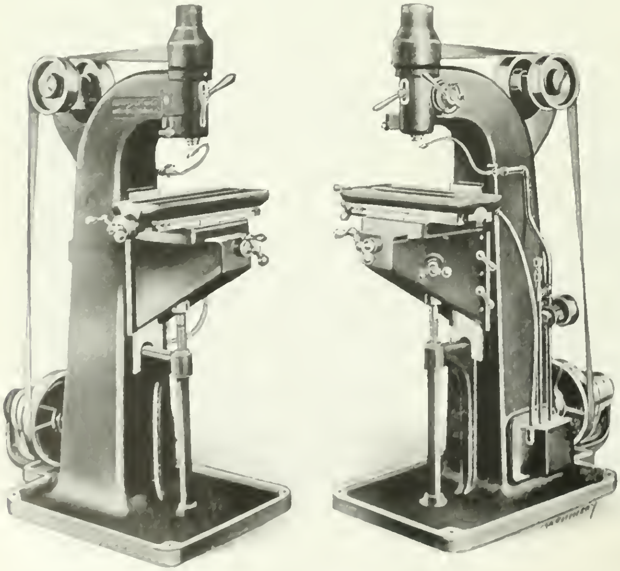
Crawford Fifteen-inch Engine Lathe

CRAWFORD FIFTEEN-INCH ENGINE LATHE

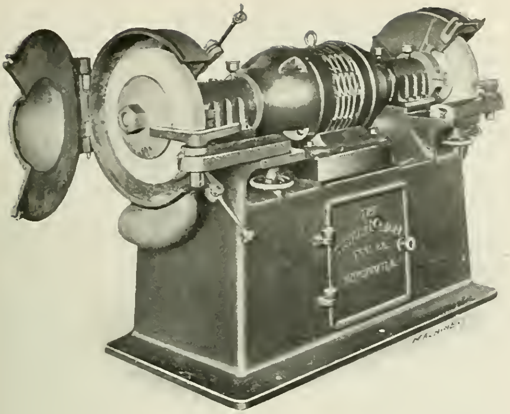
The Joseph Crawford, Jr., Co., Erie, Pa., is manufacturing the improved design of fifteen-inch lathe shown in the illustration. This lathe differs from the design previously built in regard to the arrangement of the gear- and feed-boxes and in the separation of the screw-cutting mechanism from the feeding mechanism. This machine also has an increased range of feeds and a larger thread-cutting capacity. The bed of this lathe has three large vees and one flat way. The spindle is made of high-carbon steel and has a 1¼-inch hole extending through it. The tailstock is so arranged that the compound rest can be set at right angles to the cross-slide. The longitudinal and cross feeds are friction driven and the cross-feed screw is provided with micrometer adjustment. By changing the positions of the two handles (see illustration) forty-eight different speeds can be obtained for threading and feeding. There is an independent feed-rod, so that the lead-screw can be used exclusively for thread cutting. The taper attachment is of simple design and so connected to the back of the carriage that it is within easy reach of the operator. The spiral relieving attachment, which is shown in position in the illustration, may be used for straight or taper parts and for inside or outside relieving on both right- and left-hand work with any number of flutes from 2 to 28, inclusive. A universal joint and a bearing block will be provided when axial relieving is desired. The taper attachment and relieving attachment are part of the special equipment. This lathe swings 16½ inches over the ways and 9½ inches over the carriage. The maximum distance between the centers is 34 inches. The machine has a thread-cutting capacity varying from 2 to 120 threads per inch.

TAYLOR & FENN VERTICAL-SPINDLE MILLING MACHINE

The Taylor & Fenn Co., Hartford, Conn., is now manufacturing a vertical-spindle milling machine designed for light vertical milling operations. This machine, as shown in the accompanying illustrations, is sufficiently rigid and powerful to permit of high cutter speeds and may be adapted for light profiling work. The machine is equipped throughout with double-row self-aligning ball bearings. The unit system of construction is followed throughout, the individual parts being assembled in groups. The spindle is mounted in a steel sleeve in the head, which has a vertical movement of two inches, controlled by a hand-lever at the side of the head. The spindle is locked in position by a clamp ring and handle seen at the front of the head. Positive stops are provided for regulating the depth of the cut, and there are adjustable stops for controlling the longitudinal and cross movements of the table. A four-step cone pulley, in conjunction with a two-step friction countershaft, provides eight spindle speeds, ranging from 246 to 4000 revolutions per minute. The machine table has a longitudinal movement of 11 inches, a cross movement of 6 inches and a vertical movement of 9½ inches. The maximum distance from the end of the spindle to the top of the table is 11½ inches, and the center of the spindle is 10 inches from the column. The table has a working surface 6 by 18 inches. The standard equipment includes a geared pump with tank and piping complete.



Taylor & Fenn Vertical-spindle Milling Machine



Grinder made by United States Electrical Tool Co.

UNITED STATES ELECTRICALLY DRIVEN GRINDER

The electrically driven grinder illustrated herewith is an addition to the line of grinding machines made by the United States Electrical Tool Co., 6th Ave. and Mt. Hope St., Cincinnati, Ohio. This type of grinder may be equipped with either a 5-horsepower motor and two 18- by 3-inch wheels, or with a 7½-horsepower motor and two 24- by 4-inch wheels. These grinders are fitted with ball bearings, instead of using phosphor-bronze or babbitt metal. The grinder of 5-horsepower capacity has a Westinghouse Type CS motor, having a speed of 1120 revolutions per minute. The grinding wheel guards are made of steel and can be furnished with or without exhaust connections. These machines can also be equipped with a push-button switch for starting and stopping the motor, if desired.

"DEMCO" SENSITIVE DRILLING MACHINES

The De Mooy Machine Co., 706 Frankfort Ave., N.W., Cleveland, Ohio, has added to its line of drilling machines three high-speed ball bearing machines, which are known as Nos. 30, 31 and 32. It will be apparent from the illustrations that the Nos. 30 and 31 machines are of essentially the same design, except that one is of the bench type while the other is furnished with a pedestal base, so that it can be set up on the floor. The No. 32 machine is of practically the same design as the No. 31, except that the former is adapted for a maximum speed of 12,000 revolutions per minute, while the latter machine can be run up to 3500 revolutions per minute. On all machines provision is made for adjusting the position of the idler pulley at the back of the machine to provide compensation for the belt when it is shifted from one step on the cone pulley to another. This is done by means of a rack and pinion operated by a capstan wheel, which results in sliding the bracket on which the idler pulley is carried. In addition to the sliding movement, this idler pulley bracket is supported on a pivot, so that a compression spring of the proper strength may be employed to give the desired belt tension. Another distinctive feature of the design is that an independent sleeve is provided which may be clamped in the desired position by tightening the two binding levers seen at the front of the machine. This sleeve affords adequate protection for the spindle bearings, etc., against damage from grit and other foreign matter; and the vertical position of the sleeve may be adjusted so that it affords the maximum amount of support for the spindle at the exact position in which it is working.

On the Nos. 30 and 31 machines, the spindle is 7/16 inch in diameter, and on the No. 32 machine the spindle is 11/16 inch in diameter. The principal dimensions of all the machines are as follows: distance from center of spindle to column in gap of the machine, 8 inches; distance from center of spindle to planed surface of column, 7¼ inches; maximum traverse of spindle, 8 inches; maximum traverse of feed rack, 4 inches; maximum traverse of table, 15 inches; width of belt for spindle drive, 1 inch; number of spindle speeds, 5; width of oil-groove around table, 1¾ inch. In addition to the single-spindle machines shown in the accompanying illustrations, these machines are built in one-, two-, three-, four- and six-spindle gangs.

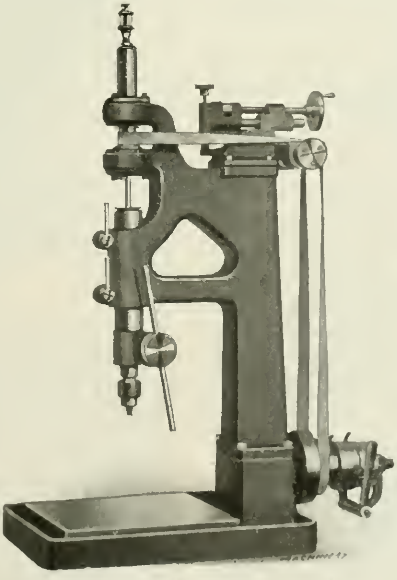


Fig. 1. No. 30 "Demco" Bench Type High-speed Sensitive Drilling Machine

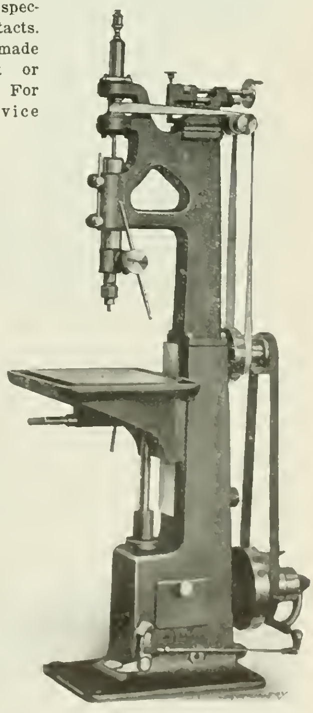


Fig. 2. No. 31 "Demco" Floor Type High-speed Sensitive Drilling Machine

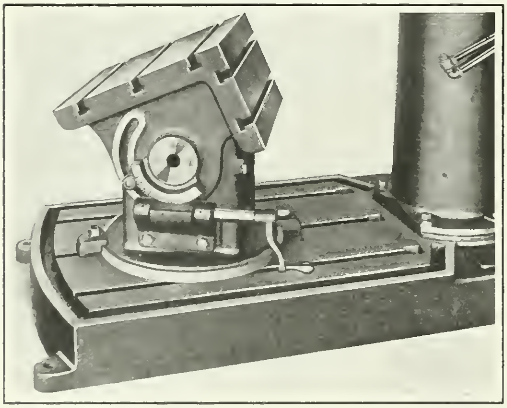
WESTINGHOUSE DRUM REVERSE SWITCH

One of the latest products of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., is a small drum reverse switch for operating motors in machine tool, wood-working and other services requiring reversing of the motors. The small size of this reverse switch makes it especially adapted for mounting directly on the machine. A terminal board of heavy micarta forms the back of the switch, and on the front side of this board are mounted the stationary contacts. The movable contacts are mounted on cast-brass brackets clamped on the shaft, from which they are thoroughly insulated. Good contact is insured by phosphor-bronze springs, on the movable contacts, these being protected by copper shunts. Heavy barriers of asbestos lumber separate adjacent sets of contacts, so that cross-arcing is impossible. All live parts are protected from exposure by an enclosing cover of sheet steel, lined with asbestos, and held in place by two ring latches, which permit easy removal for inspection or renewal of contacts.

These switches are made for alternating-current or direct-current circuits. For alternating-current service and for direct-current service without dynamic braking, they are provided with "Forward," "Off" and "Reverse" positions. For alternating-current service, the motor is connected directly across the line. For direct-current applications with dynamic braking, the switch handles have five positions, as follows: "Forward," "Drift," "Off and Brake," "Drift," and "Reverse." They may be used with automatic starters for shunt- and compound-wound motors. With compound-wound motors having heavy series winding for tailstock and cross-rail service, they may be used to connect the motor directly to the line, either with or without resistors permanently connected in series with the armature. When remote mechanical control is desirable, both alternating-current and direct-current switches can be furnished with extended shaft, permitting either gear or sprocket operation.

MORRIS UNIVERSAL TILTING TABLE

For use in connection with its line of radial drilling machines, the Morris Machine Tool Co., Court and Harriet Sts., Cincinnati, Ohio, is building a universal tilting table, which is illustrated in position on the base of a radial drilling machine. This table can be furnished in place of the regular box table and is so designed that it can be tilted to any angle by means of a worm and worm-wheel segment graduated in degrees. In addition to being tilted to any angle, the table can be swiveled around and clamped in any desired position. When brought to the straight position it rests on positive stops. The working surface of the top of this table is 18 by 18 inches, and the side is 11 by 18 inches. The T-slots are ¾ inch in width.



Universal Tilting Table for Radial Drilling Machines built by Morris Machine Tool Co.

CLEVELAND MILLING MACHINE VISE

A plain milling machine vise made by the Cleveland Milling Machine Co., 18511 Euclid Ave., Cleveland, Ohio, is shown in Figs. 1 and 2. This vise is made as low as possible without sacrificing strength and the facilities for clamping. It has a machine-finished flange extending completely around it, so it can be placed in any position on the machine table. The jaws are of steel and can be removed readily if special jaws are required. The ways of the vise are solid and the block and gibs are so arranged that they wipe the ways free from chips and foreign matter. The tongue slots are milled at right angles to each other, so that the vise can be held either parallel or at right angles to the machine spindle. The tongue slots on all vises are the same distance from the face of the solid jaw. This facilitates using the vise in place of a fixture. The solid jaw and the opposite end, in which the screw bearing is formed, are cored out as shown in Fig. 2. The object of coring out these sections, instead of making them solid, is to secure an even distribution of metal and a stronger construction by eliminating spongy metal at these points and shrinkage strains. The movable jaw is gibbed on the outside, so that there are no slots cut in the base of the vise. These external gibs, however, do not interfere in any way with the clamping of the vise onto the milling machine table.

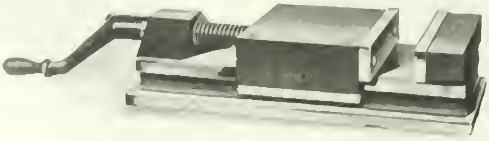


Fig. 1. Cleveland Plain Vise for Milling Machines

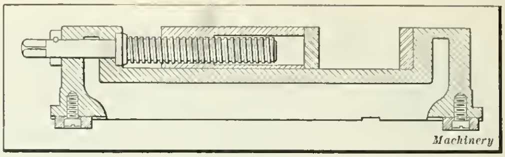
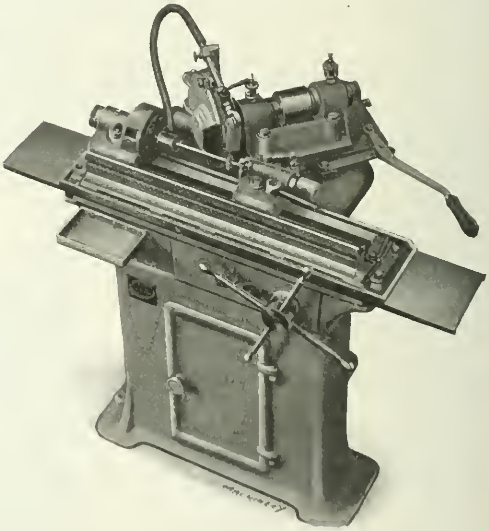


Fig. 2. Sectional View of Cleveland Vise

OTT VALVE SEAT GRINDING MACHINE

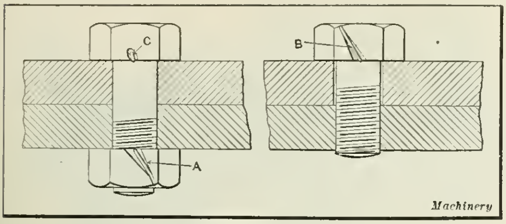
The Ott Grinder Co., Indianapolis, Ind., is now building a machine that is especially adapted for grinding motor valve seats—usually to an angle of 45 degrees. A special wheel-base provided on this machine can be set so that work may be ground to any angle from 15 to 60 degrees. It will be apparent from the illustration that the wheel-slide is operated by a hand-lever to provide for traversing the wheel across the face of the work while it is being ground; the table reverse is also operated by hand turnstile levers. When centers are not provided in the head of the valve stems, a draw-in collet chuck is furnished, which may be operated by a treadle to facilitate handling the work, as a treadle-operated chuck leaves both of the operator's hands free. This provision made for rapid handling of the work, together with means of traversing a straight-faced wheel across the valve seat, insures the rapid production of accurate work.



Valve Seat Grinder built by Ott Grinder Co.

BOLT AND NUT LOCKING DEVICE

The nut and bolt locking device described in the following is intended primarily to provide a simple and inexpensive but effective method of preventing the unscrewing of nuts or bolts. After a nut is placed on a bolt, it is held in position by a spring locking member *A* (see accompanying illustration). One



Zeman Bolt and Nut Locking Device

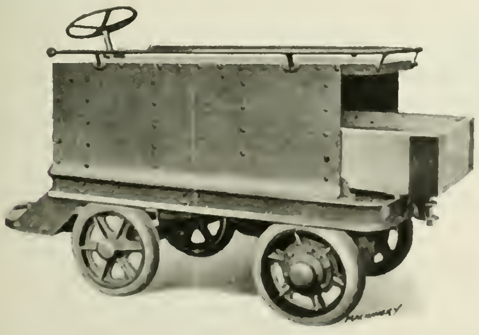
end of this flexible spring is secured in the narrow end of a V-shaped recess formed in one side of the nut. This recess is wide enough on the bearing side of the nut to allow the flexible locking member *A* a certain amount of movement, and this spring is of such a length that it tends to project beyond the surface of the nut; consequently any backward movement of the nut will cause the locking spring to bend in a direction opposite to the rotation of the nut so that it "bites" into whatever part is held by the nut and the latter is prevented from unscrewing. When it is desired to remove the nut it is simply necessary to insert the point of a knife blade or other pointed instrument back of spring *A* and force it outward. The view to the right shows this same locking device applied to a cap-screw or bolt. The spring *B* in this case is inserted in a slot in the bolt-head. When the nut-locking device is employed in connection with a cap-screw or bolt having a round shank, means must be provided to prevent the rotation of the bolt. A small locking pin *C*, which projects from the under face of the bolt-head, is used to bite into the surface beneath the bolt-head, thus preventing rotation in either direction. This locking device has been brought out by Joseph F. Zeman, 15 E. Stonewall St., Charlotte, N. C., and is manufactured by the Inter-State Machine Products Co., of Rochester, N. Y.

LANSING ELECTRIC TRUCKS

Savings to be made through the substitution of power-driven equipment for manual labor in transferring materials and products through a factory are of exceptional importance at the present time, due to the scarcity of labor and the abnormally high wages which are being paid to all classes of factory employes. To facilitate the handling of loads, factory trucks are now being equipped with electric motors which obtain their power from individual storage batteries carried on the trucks. The Lansing Co., Lansing, Mich, builds three types of load carriers, which comprise a truck, a tractor and a trailer. The truck and the tractor are power-driven, the truck being used for ordinary classes of transfer work, while the tractor is employed to pull a train of trailers loaded with materials or products in course of manufacture.

Two types of tractors are made, which have rated trailer load capacities of 5000 and 12,000 pounds, respectively. The tractor carries no load itself, but is essentially a small electric locomotive. Both the tractor and trailers are of sufficiently narrow gage so that they can be run in factory aisles wherever hand trucks may be used. Two types of steering apparatus are used, one of which is controlled by a wheel and the other by a lever. The operator's platform and seat are so placed that the driver may either stand or sit. Where the steering wheel is used, the operator has the wheel and controller handle at his right; and with the lever-controlled steering gear, the lever is at the right and the controller handle at the left of the operator. The brake pedal is operated by the left foot.

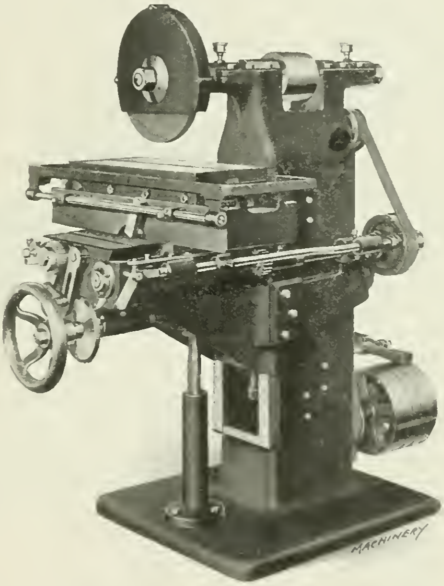
So far as the design of the mechanism is concerned, the Lansing trucks are identical with the tractors, except that the trucks are mounted on springs at the rear as well as at the front, and that the front tires are widened to take care of the increased load they must carry. The point of difference lies in the fact that the truck has a "loading area" on which the raw material or product is carried by the truck, while the tractor is simply employed to haul a load of trailers in the manner to which reference has already been made.



Electric Tractor built by the Lansing Co.

NOBLE & WESTBROOK SURFACE GRINDER

One of the recent products of the Noble & Westbrook Mfg. Co., Hartford, Conn., is the automatic surface grinder which forms the subject of the following description. All working parts of the machine are carefully designed to provide for excluding abrasive dust and other foreign matter which would cause undue wear. A thrust bearing is provided on the table raising and lowering mechanism, which provides for having this mechanism operate easily; and the usual practice is followed of graduating the feed-screw dials to read to 0.001 inch. All slides and spindle bearings are furnished with means of compensating for wear. The cross-slide is equipped with an automatic stop which limits its travel in both directions, and the platen can be instantly started or stopped by use of a hand-lever which engages or disengages the clutch in the driving pulley. This provision for stopping or starting the table without stopping the wheel-spindle or other parts of the machine is an exceptionally convenient feature. It will be apparent from the illustration that this machine is simply designed and particularly well adapted for the requirements of many manufacturing departments where surface grinding operations must be performed on the work.



Surface Grinder built by the Noble & Westbrook Mfg. Co.

At the front of the table there will be seen a horizontal bar on which the reversing stops are carried. These stops may be set in any desired position along the bar, so that they reverse the direction of table travel in the required points. It will be seen that motion for the table traverse is taken direct from the main drive by means of an auxiliary shaft at the right-hand side of the machine, from which power is transmitted to the table through gearing. The large handwheel at the front of the machine provides for raising or lowering the table, and it will be seen that a graduated dial on the same shaft with this handwheel reads to 0.001 inch, which provides for raising the table to take a cut of the desired depth. Transverse adjustment of the table is made by a wrench placed over the end of the squared shaft, which will be seen above the handwheel. The principal dimensions of this machine are as follows: capacity of machine, 8 by 20 inches; distance between bottom of 12-inch grinding wheel and top of platen, 7 1/2 inches; diameter of spindle, 1 9/16 inch; size of grinding wheel, 12 inches in diameter by 3/4 inch face width; and size of tight and loose pulleys, 7 inches diameter by 4 inches face width. This machine can be furnished either with or without a magnetic chuck.

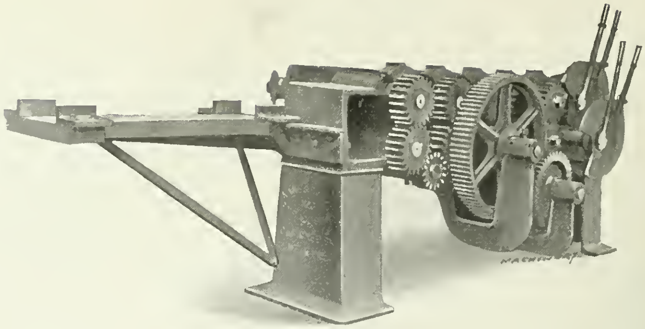


Fig. 2. Opposite Side of Kane & Roach Channeling Machine

KANE & ROACH CHANNELING MACHINE

For the formation of irregular sections of sheet metal of indefinite length for use in the manufacture of metal furniture, automobile rims, show cases, etc., in the small sizes, and for structural steel work, gutters, molds for cement forms, steel car manufacture and kindred uses in the large sizes, the process of rolling or channeling is being largely developed. Sheet stock of any metal may be formed cold by channeling, and any thickness up to ¼ inch may be worked without difficulty. The speed at which this class of work is handled varies from fifty to ninety feet per minute, according to the metal and the shape to be produced.

Generally speaking, a machine for channeling has two or more pairs of steel rolls, although when the shape is particularly intricate the number sometimes runs as high as twelve or fourteen pairs. These rolls are spaced at equal distances along the machine, and each pair gives the metal strip a bend that is slightly more pronounced than that given by the preceding pair. The rolls are geared together and are driven by connecting gears, so that each pair helps to drive the sheet forward as well as to form it. On machines built by Kane & Roach, Niagara and Shonnard Sts., Syracuse, N. Y., the rolls are always of the overhanging type, that is, the forming rolls operate on the outside of the machine housing. This permits changing them without difficulty when it is desired to produce different sections. In addition, the work is more readily reached and controlled than would be possible if the rolls were within the housings. Adjustable outer bearings are fitted to the outer ends of each pair of rolls tying the upper and lower shafts together so they cannot spring apart under the pressure.

In very heavy channeling machines, the outer shaft bearings are connected in the horizontal direction as well. The gears for driving the rolls are made of steel in order that they may have the necessary strength. The driving gear is always located as near the center of the machine as possible in order to distribute the strain on the roll gears. In view of the fact that vertical adjustment of the rolls is often necessary, the gear teeth must be cut fairly long to allow considerable latitude in meshing. The vertical adjustment is made possible by mounting the upper roll bearings in eccentric sleeves. The drive is always to the lower rolls first, in order to keep the gearing as compact and as low down on the machine as possible. In order to start the stock correctly, so that it will not start off center or on a slant, a long table or guide is provided before the first pair of rolls. The design of these parts and their functions will be touched upon later.

Rolls for Channeling

Except for the very smallest and lightest work where there are delicate shapes to be produced, the rolls for channeling machines are made from 80-point carbon steel castings. When the size and shape permit, they are cored out. The rolls are turned to the finished shape, and after hardening, are ground. In case of delicately shaped or small work, tool steel is used, which is hardened and afterward ground and shaped even more carefully than is necessary on the larger size work. The dimensions and proportions of channeling rolls cannot be laid down by any arbitrary rule, but depend on the depth of the bend and the thickness of the stock. In general, the ideal condition is to have the rolls as small as practical, still maintaining the strength necessary for mounting the rolls properly. Kane & Roach channeling machines are made standard, so that rolls for different sections may be used on the same machine.

On these machines the distances between roll centers are arbitrarily fixed; on the machines shown they are 16 to 20 inches, which would make the roll diameter about 8 or 10 inches. It should be borne in mind that the smaller the roll diameter, the less will be the grip of the rolls on the metal for driving purposes. This is an important point, as it is sometimes hard to secure a sufficient grip on the stock for driving it through the rolls, especially when the section is a different one to produce. This is especially true when it is necessary to form metal strips that have been perforated before channeling.

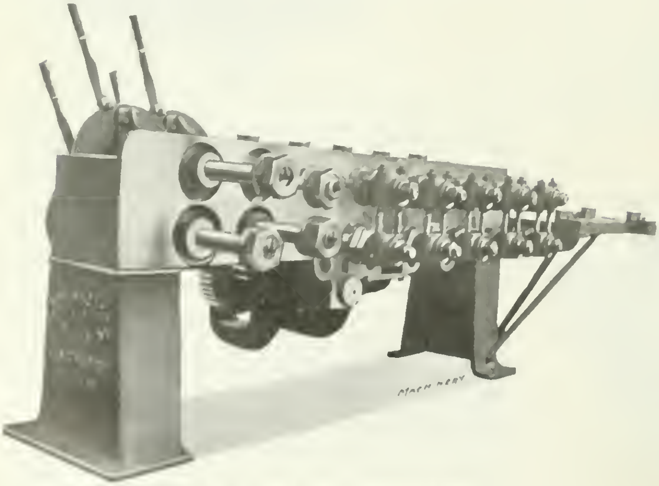


Fig. 1. Kane & Roach Channeling Machine

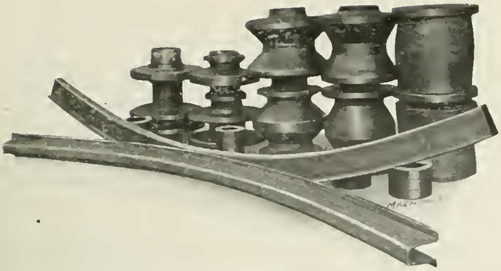


Fig. 3. Rolls used on Kane & Roach Channeling Machine and Examples of Work

In such cases the amount of metal left for the rolls to obtain the grip on is limited, and it is sometimes necessary to throw a fine sand on the stock as it is going through in order to make the rolls "take hold." Under no circumstances is a lubricant used, as it would destroy the driving power of the rolls.

Guiding the Stock

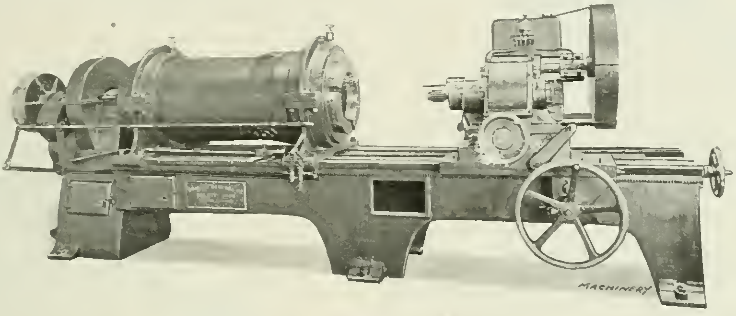
The metal to be formed by channeling must be kept under perfect control by guides before it enters the first pair of rolls and while it passes from one pair of rolls to the next; it must also be guided or straightened after it emerges from the last set of rolls, to counteract the tendency to curl. It is not necessary to have straightening rolls before the first set of rolls, as the latter are sufficient to remove any kind of irregularities from the strips, but whenever the shape to be produced can be secured without the help of the first pair of rolls, they should be used perfectly straight as feed rolls. These assist in straightening and driving the stock into the first part of forming rolls. In fact, this feature is absolutely necessary when the metal is so thick that it cannot be readily started into a pair of rolls that will give it the first slight form. It is essential to start the stock absolutely central and straight, and for this purpose a long table guide is fitted in the front of the machine. This facilitates starting the strip, and when it has once entered correctly between the first rolls, it will retain its alignment unless there is some serious defect in the channeling rolls.

Between each pair of channeling rolls, there must be means for guiding the stock to the next set of rolls, as mentioned. The usual method of doing this is to provide guides in the form of enclosed boxes in which the stock fits fairly close, which gives it the proper direction to enter the next pair of rolls. Sometimes, however, smaller rolls are used for guiding the partly channeled stock in place of the solid guides, and in addition to guiding the stock, these intermediate rolls are made to help in forming the stock as it passes through. At times, the shape of the section is such that it cannot be formed with rolls operating in one plane only; this is especially true when the section is deeply under-cut. In such cases, side rolls are employed that operate in the opposite plane. These are located in the same manner as the intermediate rolls, except that they are turned at right angles and do pressing-in operations on the sides of the stock.

It was also mentioned that, in order to produce accurate work, it is necessary to have a straightening roll at the end of the channeling machine to guide the stock as it leaves the last pair of rolls. On almost every channeling operation there is a tendency for the formed strip to curl either upward or downward, depending on the shape, as it emerges from the machine. To obviate this, a small roll, formed to fit one face of the finished stock, is fitted on the machine, following the last pair of rolls, either above or below the stock, as found necessary. When properly applied, one roll is sufficient to hold the metal straight, delivering the channeled strip in a perfectly straight condition. In the case of channeling stock for hoops or rims of any kind, it is sometimes possible to put a bending attachment on the end of the channeling machines, so that as the stock runs through the last pair of rolls it enters the bending rolls and is formed into the required circle. In this case the stock cannot be run through in indefinite lengths, but each strip must be cut to the proper length for rolling into a ring of the required diameter before it is fed to the machines.

SMALLEY-GENERAL THREAD MILLING MACHINE

The Smalley-General Co., Inc., Bay City, Mich., has added to its line of thread millers the machine which is illustrated and described herewith. This thread miller is motor-driven and equipped with separate motors on both heads with a speed variation of 4 to 1. An air collet chuck is provided which will take 14-inch armor-piercing shells, and liners may be provided for use in this collet to adapt it for holding 12-inch shells. The cutter-spindle head is composed of only two slides, this simple construction providing the exceptional rigidity which is required in a heavy-duty machine of this kind. The machine will cut threads having a pitch of 1/4 inch in openings 9 1/2 inches in diameter by 4 3/4 inches long, and the complete thread-forming operation is finished in one revolution of the work. The armor-piercing shells which are to be milled are made of nickel steel which is exceptionally tough, and to provide for standing up under this service, the cutter-spindle is made of ample size and tapered as in the case of milling machine construction. The cutter-spindle is driven by large steel herringbone gears which eliminate vibration.



Thread Milling Machine built by the Smalley-General Co.

In working out the design of the feed mechanism provision has been made to enable the operator to throw in the feed at any instant without having to wait for a split nut to pick up the thread. In addition, the lead-screw on the machine is 18 inches in length, and as the wear is distributed over this long screw, ample life and accuracy are insured. Cutting compound drips down into a pan cast integral with the bed and from there runs to the tank in the base of the machine under the main head. In this tank, the oil is strained before it can find its way into the pump. All bearings except the chuck bearings are bronze bushed, and the machine is entirely controlled by a push-button control system. Two changes of speed are available, either of which may be instantly obtained. These speeds comprise a milling speed and a turning speed. On the far side of the head there is located a tool with which a finishing cut is taken on the plug seat and recess of the shell, this being done at the same chucking with the milling operation to assure obtaining true alignment and concentricity between the threads and the plug seat and recess, which is a highly important point to observe in shell manufacture.

DRAPER & HALL UNIVERSAL GRINDING MACHINE

To meet the requirements of grinding milling cutters, reamers, counterbores, taps, end-mills, gages, etc., and also for the

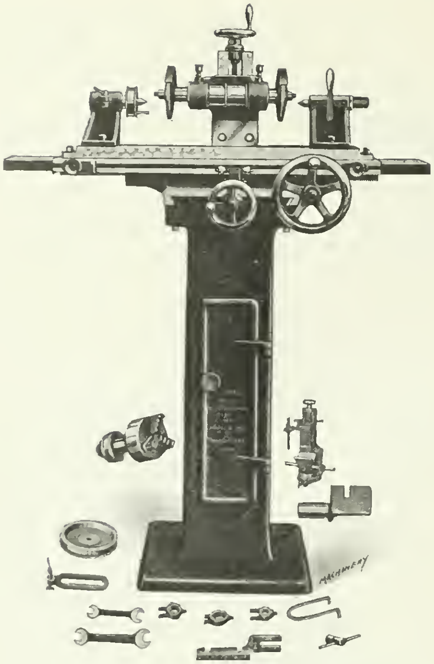


Fig. 1. Universal Grinding Machine built by Draper & Hall Co.

performance of internal and surface grinding operations, the Draper & Hall Co., Middletown, Conn., is now building a universal grinding machine which is shown in the illustrations that accompany this description. Attention is called to the fact that the internal attachment is equipped with ball bearings and is adapted for accurately grinding small work. The table is supported for its entire length by the longitudinal slide, so that there is no overhang. The slide, in turn, rests for its entire length upon the main column. The table is provided with a screw adjustment for accurately aligning the centers; and a scale at one end is graduated to set the table for grinding tapers denoted by inches of taper per foot, while the scale at the other end is graduated to indicate tapers in degrees. Dials graduated to 0.001 inch are furnished on the mechanism for the longitudinal, vertical and cross-feeds. The spindle is made of 60-point carbon steel and is carried by carefully scraped bronze bearings, which are protected against damage from abrasive dust by means of felt washers. All slides on the machine are carefully scraped and fitted with gibs.

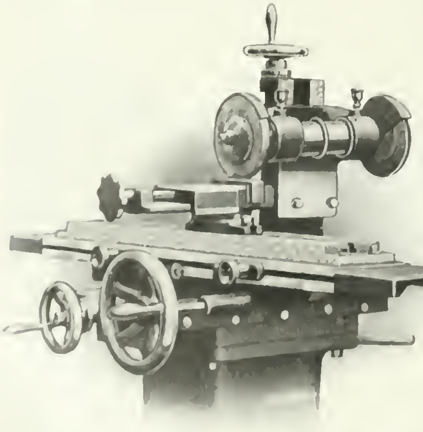


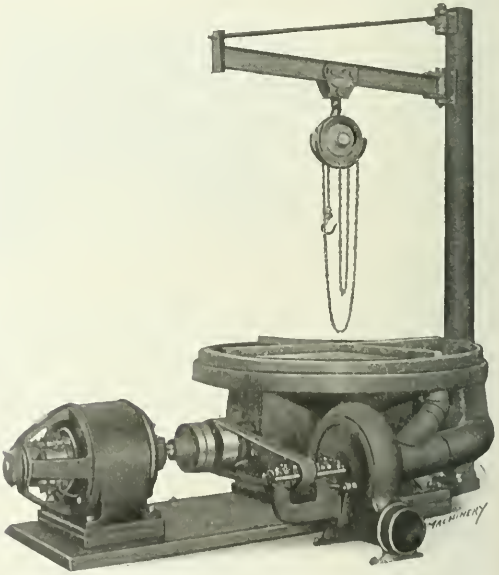
Fig. 2. Close View of Mechanism of Draper & Hall Universal Grinder

The standard equipment furnished with this machine includes a V-combination attachment, a universal vise, a three-inch chuck, an internal grinding attachment, an adjustable tooth-rest, a tooth-rest holder for spiral cutters, dogs, wrenches, etc. The principal dimensions are as follows: swing, 8 inches; maximum distance between centers, 17 inches; maximum longitudinal feed, 18 inches; maximum cross-feed, 7 inches; maximum vertical adjustment, 7 inches; size of top platen, 26 by 4 inches; size of grinding wheels used, up to 6 inches in diameter; and net weight of machine with attachments and countershaft, 700 pounds.

GARDNER VERTICAL DISK GRINDER

The Gardner Machine Co., Beloit, Wis., is now building a new vertical-spindle disk grinder which embodies several interesting features. Most conspicuous of these is the hoisting attachment, designed to handle the heavy pieces which this machine is built to grind, and also to apply and remove pressure weights used in grinding lighter castings. This attachment consists of a hand ¼-ton chain hoist, mounted on a trolley and swinging jib. A crane column, to which this jib is attached, is rigidly fixed on the base of the machine. By means of this arrangement, any heavy parts can easily be lifted from the floor and swung onto the surface of the grinding wheel.

Another feature of this machine is the dust exhaust system, which is claimed by the makers to practically eliminate the dust problem. A channel is cast into the base of the machine just below and around the edge of the disk wheel. Above this and just over the edge of the disk wheel is fixed a detachable guard ring, which permits the occasional removal of any coarse grindings. Attached to four openings in the bottom of the dust channel there is an exhaust manifold which connects with a powerful exhauster. This exhauster is driven from an extra pulley on the driving shaft of the machine, and in this way the grinding surface of the machine is left entirely clear, yet the dust is simply and effectively removed.



Gardner Vertical-spindle Disk Grinder equipped with Individual Motor Drive

A valuable change in the construction of this machine is that by which it is made adaptable to direct connected motor drive. In the belt driven type, the countershaft, or outer portion of the driving shaft which carries the tight and loose pulleys, is connected to the driving shaft proper by a flange coupling. By removing this countershaft and the outer bearing, a motor may be mounted on a plate bolted to the sub-base, as shown in the illustration. The rotor shaft of the motor is connected to the driving shaft by means of a flexible coupling. Thus the necessity of mounting the motor on a side bracket and driving the shaft through sprockets and chain is eliminated. The direct connection with the driving shaft does away with all lost motion and friction incident to the old type, reduces the number of wearing parts, and produces a more compact and efficient machine. Also, the interchangeable feature may appeal to those who contemplate a change to motor-driven machinery at some future time.

The design and construction of this machine have been worked out to make it adaptable for heavy grinding operations. The 53-inch disk wheel is carried on a spindle 3⅝ inches in diameter, and supported by a heavy cast-iron flange 20 inches in diameter by 1⅜ inch thick. The spindle is mounted in two self-aligning radial ball bearings, and the end thrust is taken on an exceptionally heavy thrust bearing, the balls of which are 1⅛ inch in diameter; in fact, this equipment has been made ball bearing throughout, which represents another change from the old type, insuring smooth running qualities and a marked saving in power. The spindle has a speed of 500 revolutions per minute and is driven by means of a pair of hardened steel bevel gears, having a ratio of 2.4 to 1. These gears are enclosed in a dust-protected housing, and provision is made for ample lubrication. The entire weight of this equipment is 4600 pounds.

OAKLEY UNIVERSAL GRINDER

In the July, 1917, number of MACHINERY, a description was published of a No. 2 cutter and tool grinder which had just been placed upon the market at that time by the Oakley Machine Tool Co., Cincinnati, Ohio. Recently, this firm has added to its lines the machines shown in Figs. 1 and 2, which are of similar design except that Fig. 1 shows a machine equipped with longitudinal power feed and a wet grinding attachment, while in Fig. 2 the machine is simply equipped with the longitudinal power feed.

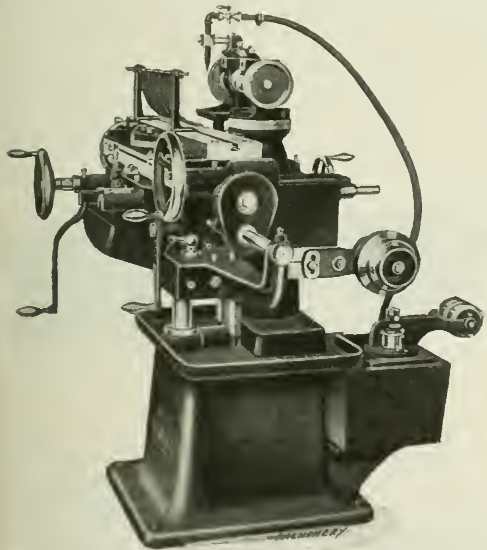


Fig. 1. Oakley No. 2 Universal Grinder with Power Longitudinal Feed and Wet Grinding Attachment

The advantage secured through the use of power feed is a smooth and even travel of the table, which increases the speed at which grinding operations can be performed. A small handle at the front of the machine controls the power feed, and the drive is through the table feed-screw, which provides an exceptionally smooth and uniform table travel. To enable the wheel to grind clean at shoulders on the work, a short "pause" of the table is allowed before reversal takes place. The reverse mechanism is positive and accurate in operation. Provision is made for operating the machine by hand by simply disengaging the clutch. Three rates of power feed are provided, which are 6, 10½ and 18 inches per minute. The stop-dogs are hinged, making it easy for the operator to run the work past the setting to measure both external and internal diameters.

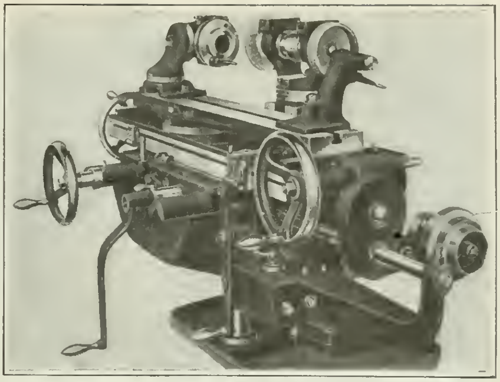


Fig. 2. Oakley No. 2 Universal Grinder with Power Longitudinal Feed

For rapid grinding of tools, and especially carbon tools, it is often desirable to be able to deliver water to the wheel and work. This is indispensable where an exceptionally fine finish is desired; and to meet the requirements of wet grinding operations, the Oakley grinder may be furnished with a wet grinding attachment which may be applied in a few minutes to any machine. The provision of power longitudinal feed and a wet grinding attachment does not alter the capacity of the machine, which is the same as that of the machine with hand feed, namely, longitudinal movement, 17 inches; vertical movement, 10½ inches; and cross movement, 9 inches. All parts are easily accessible and no extra countershaft is required. Machines of this type may be furnished with either plain or universal equipment.

TAYLOR ELECTRIC WELDER

Fig. 1 shows an electric welding machine which has recently been developed by the Taylor Welder Co., Warren, Ohio,

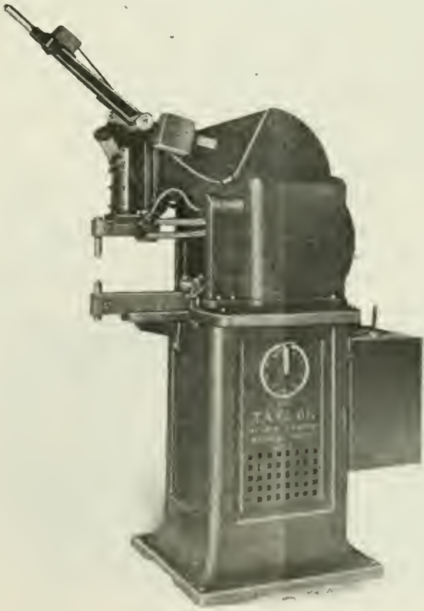


Fig. 1. Electric Spot-welding Machine built by Taylor Welder Co.

and Fig. 2 shows diagrammatically the principle upon which this machine operates. The diagram represents the electrodes or welding dies as seen from the front of the machine. The lower horn and the upper point holder, together with the welding electrodes themselves, are split and a suitable insulating material placed between each piece. The secondary leads from the transformer are likewise separated and cross where the connection is made to the lower horn, causing the current to be crossed over the path on crossed and intersecting lines as illustrated by dotted lines. It is claimed that a weld so produced is stronger and also made in a shorter space of time than has heretofore been possible. The use of the electric welder for welding material above ¼ inch in thickness has heretofore been a comparatively slow and doubtful operation in that the electrode, being of copper, requires frequent dressing due to the fact that the pressure which it is always necessary to apply to set the work together properly, causes these parts to "mushroom" or flatten out, and the time spent to redress them oftens offsets the saving which would have been shown over the old riveting method.

By means of the new process it is possible to spot-weld much heavier material than has been practicable heretofore. This is due to the fact that the electrodes may be separated and steel pressure dies used between them, and two or more separate currents of larger volume may be passed in bias directions through the metal and through each other's path; then when the metal has reached a welding temperature additional pressure may be applied with the steel dies to complete the weld. All this is done without subjecting the copper electrodes to pressure beyond the need of a good electrical contact. In other words, the electrodes are used only to carry the current and not to sustain a heavy pressure required to force the plates together to complete the weld. Another feature which makes this process unique is that it can be arranged to operate on multiphase current without unbalancing the line. This is a very important feature, as all other spot-welding machines are required to be operated on a single-phase current, and when operated on a multiphase current have a tendency to unbalance the line, which is very objectionable when the generator is of small capacity or the lines heavily loaded.

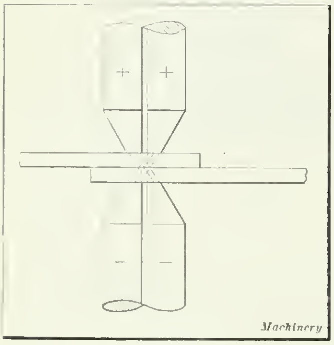


Fig. 2. Diagram Illustrating Principle on which Taylor Welder operates

SIMMONS MAGNETIC CHUCKS

The Taft-Peirce Mfg. Co., Woonsocket, R. I., is now manufacturing and selling a line of rotary and reciprocating or so-called "surface" magnetic chucks, which are shown in the accompanying illustrations. These are known as the "Simmons" magnetic chucks. A feature of all of these chucks is the way in which the faceplate has been designed to provide for holding very small parts at any point on the working surface. There is only a strip of non-magnetic spacing material one-eighth inch in width between poles of opposite polarity, and in addition to extending between the poles, this non-magnetic spacing material runs all the way around the working surface of the chuck. So well has this result been carried out that a piece of work the size of a twenty-five-cent piece can be dropped in any position with assurance that a sufficient part of it will lie over the poles of opposite polarity to be sure of having the work held firmly by the chuck. Both the frame of the faceplate and the body of the chuck are non-polarized, and there are no dead spots in the face.

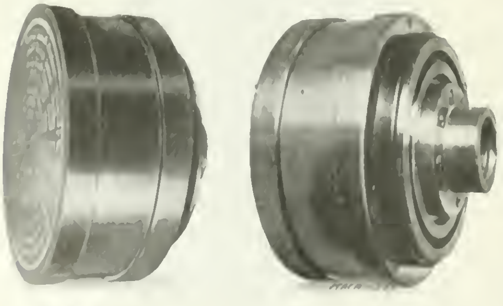


Fig. 1. Two Views of Simmons Rotary Magnetic Chuck made by Taft-Peirce Mfg. Co.

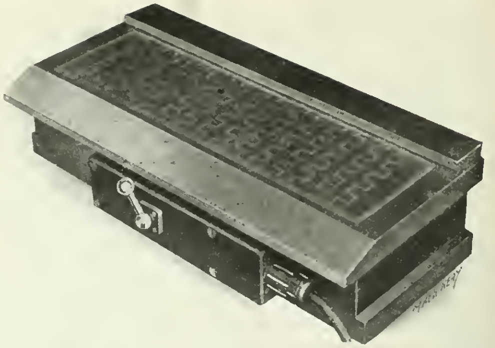


Fig. 2. Simmons Reciprocating or So-called "Surface" Magnetic Chuck made by Taft-Peirce Mfg. Co.

An important feature of the Simmons magnetic chucks is the care which has been taken in designing the switch, which is both watertight and fool-proof. All contact points are enclosed, so that the operator cannot get an electric shock, and having the contacts enclosed also makes it possible to pile up chips level with the top of the chuck without any danger of producing a short circuit. A single movement of the switch lever provides for first reversing the polarity of the chuck and then breaking the electric circuit. This effectually demagnetizes the chuck, so that no trouble is experienced in removing work due to the presence of residual magnetism. The switch covers a terminal bracket in which there are mounted connections which may be instantly adjusted to provide for taking current for the chuck from a 110- or 220-volt circuit. These connections are accessible by merely removing four screws that hold the switch in place. The connections consist of two pairs of short brass levers carried on pivots; by swinging these levers into engagement with the proper contact points, the chuck is ready for connection with either of the electric circuits of the two commonly used voltages.

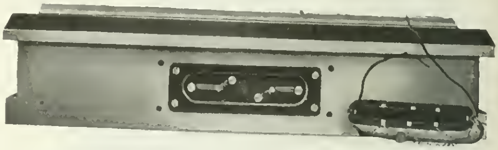
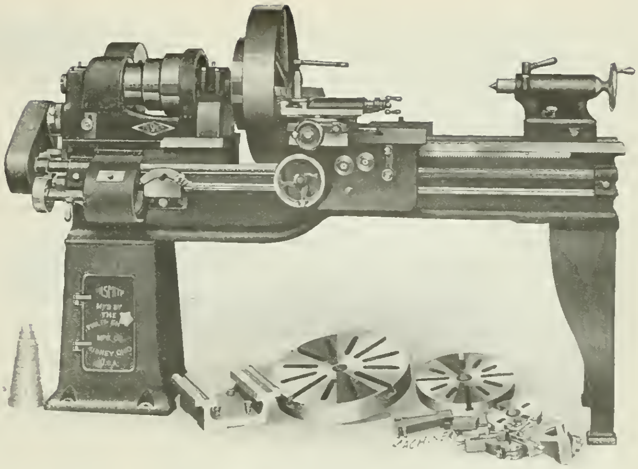


Fig. 3. Chuck with Switch Box removed to reach Terminal Connections, which may be adjusted to adapt Chuck for Use on 110- or 220-volt Circuits

In working out the design of these chucks great care has been taken in the selection of materials that experience has shown to be best suited for the respective parts of magnetic chucks. Swedish iron is used for the poles, because this material has exceptionally high magnetic permeability and may be instantly demagnetized and left free from residual magnetism. These poles are drop forgings. The cores on which the electromagnet coils are mounted are set on non-magnetic washers, which provide for effectually insulating the cores from the chuck body. The coils are wound with single cotton-covered enameled magnet wire; they are wound on collapsible forms on a universal winding machine. A fiber casing is placed inside each coil which serves the double purpose of insulating the coil from the core, and also protecting the insulation on the wire while the coil is being slipped over the steel core. Brass clips are also placed at the center of each coil to prevent its shape being distorted during the performance of manufacturing operations which come between the completion of winding the coil and the time that it is slipped onto the core. The coils are impregnated with "Sterling" extra insulating varnish, after which they are baked. The next step is to give the coils a dipped coat of varnish, after which they are baked a second time; each coil is then given a brush coat of varnish, and baked for the third and last time. All the coils in a chuck have the same number of ampere turns of wire, so that equal holding power is provided on all surfaces of the chuck.

The rotary chucks are made in various standard and special sizes. These chucks are made in two types, one of which has the interlocking arms of opposite poles arranged on concentric circles, as shown in Fig. 1, the object being to bring the poles of opposite polarity so close together that very small pieces of work can be held. The other type of rotary chuck is equally serviceable for all classes of work which are not of extremely small sizes. The so-called "surface" chucks shown in Figs. 2 and 3 are also made in various standard and special sizes to accommodate a wide range of work. These chucks are made in two types, those for use on planers and milling machines having a T-slot at the front in which a work finger is held to provide for holding the work against the back-rest. This additional support is not required in the case of magnetic chucks used on surface grinders.



"Filsmith" Gap Lathe, which swings 22 Inches in Gap and 14 Inches Over Ways

"FILSMITH" GAP LATHE

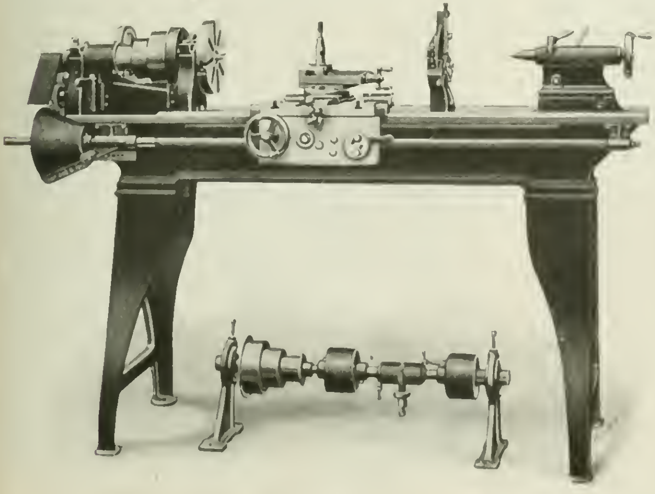
There are many shops where it is occasionally necessary to turn a large pulley or plate, although the amount of work of this kind is not sufficient to justify investment in a lathe of the required swing for handling such operations. To meet the requirements of shops of this kind, a gap-bed lathe is usually selected because it can be used on regular production work, and when the exceptional job comes along, the additional swing provided by the gap bed is found very useful.

The Philip Smith Mfg. Co., Sidney, Ohio, is now building the "Filsmith" gap lathe shown in the accompanying illustration. A 20-inch pulley with a 4-inch face is shown in place on the lathe, and below is shown the section of bed which can be secured in the gap when only the normal swing of the machine is required. To enable the lathe to stand up under the exceptional conditions of service for which it is occasionally employed, in addition to giving satisfactory results on general lines of work, the machine is rigidly constructed. The swing over the ways is 14 inches, while a swing of 22 inches is obtained in the gap. It only takes a few minutes to remove the gap piece or replace it to adapt the machine for handling work that comes within the range of a 14-inch lathe. This machine is built with 5-, 6-, 8-, 10- and 12-foot beds, and it is also furnished with a quick-change gear-box if so desired.

SHEPARD ENGINE LATHE

The 12-inch semi-quick-change engine lathe shown in the accompanying illustration is a recent product of the Shepard Lathe Co., 217 E. 8th St., Cincinnati, Ohio. Attention is called to the following features of design: A reversing clutch in the headstock makes it unnecessary to reverse belts or watch a dial when chasing threads, because this reversing clutch enables the lead-screw nut and change-gears to remain in constant engagement, the feed of the lathe being instantly reversed by operating the small lever which will be seen on the headstock. It will be obvious that this is the means of saving time when chasing threads in addition to simplifying the operation. Another feature is the design of the semi-quick-change feed mechanism which locates and locks all of the change-gears in a cone on the feed-rod. By shifting this cone of gears back and forth, the required gear is swung into mesh. All gears are always in place on the machine, so that no time is lost in finding the desired gears for a given combination. It will be apparent from the illustration that the carriage has a bearing of ample length on the ways and also that the bearing on the compound rest is of ample size to assure freedom from vibration.

The headstock is of the back-geared type and furnished with a hollow spindle made of 50-point carbon steel. This spindle runs in phosphor-bronze bearings and has a hole 1 inch in diameter extending all of the way through. The three-step cone pulley carries a 2-inch belt. The tailstock is of the offset type and provision is made for setting it over to provide for the performance of taper-turning operations. This machine is built in 10- and 12-inch sizes and both machines



Engine Lathe with Semi-quick-change Gear built by Shepard Lathe Co.

may be furnished for drive from an overhead countershaft or by an individual motor. In addition to the cone-pulley driven machine, lathes of this type are built with a geared head. Extra attachments made for use with this machine include a milling attachment, taper-turning attachment, turret attachment, and draw-in collet chuck. A compound rest, steady-rest, faceplate, friction countershaft, gear guards, and the necessary wrenches for making all adjustments are furnished with the lathe as part of the regular equipment.

The principal dimensions of the 12-inch machine are as follows: actual swing over bed, 12¼ inches; diameter of hole through spindle, 1 inch; size of front and rear spindle bearing, 1 9/16 by 2 1/4 inches; cone pulley diameters, 6, 4½, and 3 inches; ratio of back-gears, 7 to 1; diameter of lead-screw, 15/16 inch; length of carriage bearings on bed, 14½ inches; size of lathe tools, ½ by 1 inch; speed of countershaft, 225 R. P. M.; range of spindle speeds, 25 to 425 R. P. M.; length of bed, 4 feet, 3 inches; 5 feet, 3 inches, or 6 feet, 3 inches; and capacity between centers for above lengths of bed, 25, 36, and 48 inches, respectively.

SCUSA SNAP GAGE AND MICROMETER

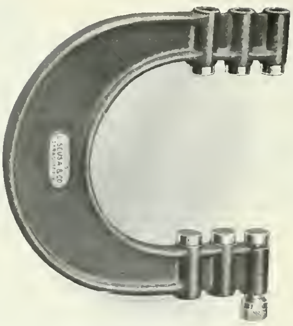
L. Scusa & Co., Syracuse, N. Y., are now making a line of combination limit snap gages and micrometers of the type illustrated and described herewith. These tools are designed to meet the demand for gages which can be used for measuring those classes of work on which ordinary snap gages are employed and also provide means of rapidly determining just the amount of stock which it is necessary to remove in order to enable a piece of work to enter the limit gage without in any way interfering with the usual function of such a gage. An advantage of this combination is that gaging may be accomplished without offering any temptation for the inspector to force the gage onto the work, thus removing the danger of springing the gage open and reducing wear on the "go" surface to a minimum. Hardened tool-steel measuring plugs are forced into accurately reamed seats in the frame and are sealed by the inspector. These plugs are ground and lapped on their measuring faces and various limits may be provided to meet requirements of different shops. No change can take place except as the result of wear, and adjustment is easily effected by means of screws set in the end of the plugs. Similar adjustment is furnished for the micrometer anvil. After making the required adjustment, the screws are sealed.

SIZES IN WHICH SCUSA COMBINATION SNAP GAGES AND MICROMETERS ARE MADE

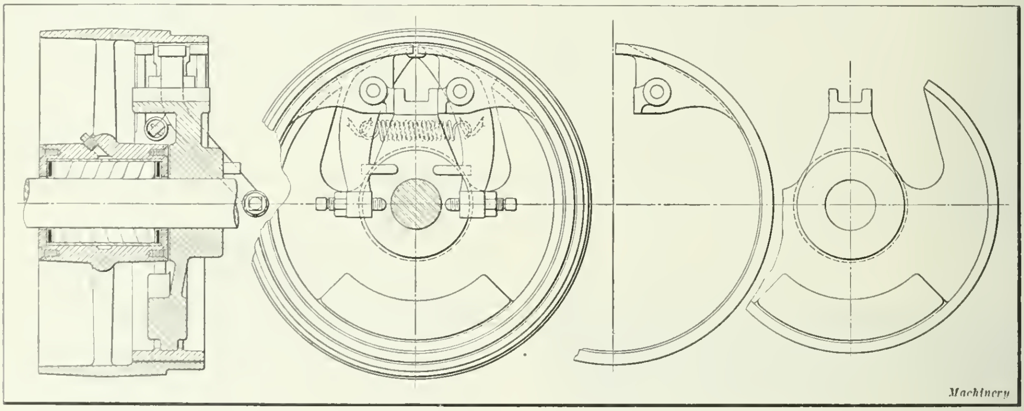
Inch	Inch	Inch
⅜ to ½	3 to 3¼	6 to 6¼
½ to ⅝	3¼ to 3½	6¼ to 6½
⅝ to ¾	3½ to 3¾	6½ to 6¾
¾ to 1	3¾ to 4	6¾ to 7
1 to 1¼	4 to 4¼	7 to 8
1¼ to 1½	4¼ to 4½	8 to 9
1½ to 1¾	4½ to 4¾	9 to 10
1¾ to 2	4¾ to 5	10 to 11
2 to 2¼	5 to 5¼	11 to 12
2¼ to 2½	5¼ to 5½	12 to 13
2½ to 2¾	5½ to 5¾	13 to 14
2¾ to 3	5¾ to 6	....

Machinery

The micrometer screw is essentially the same as that in the standard instrument, being ¼ inch in diameter and 40 pitch, with a head graduated to read to 0.001 inch from 0.0005 to 0.125 inch over size. The object of having a limit of 0.0005 is to serve as a check to prevent the operator making work too small. This screw is provided with positive stops in either direction. It will be seen that the frame is of double ribbed section, which affords stiffness without unduly increasing the weight and also provides a convenient and secure grip on the gage. The frame is finished with baked black enamel and the gage limit sizes are stamped on a polished pad where they are easily seen. The accompanying table shows the series of sizes in which the Scusa combination limit snap gages and micrometers are made.



Scusa Combination Limit Snap Gage and Micrometer



Roller Bearing Friction Clutch built by Accurate Machine Co. and equipped with Hyatt Roller Bearings

ROLLER BEARING FRICTION CLUTCH FOR MACHINE TOOLS

The average machine shop has at times experienced considerable trouble with countershaft clutches, due to slipping of the friction surfaces and worn or hot bearings. This has resulted in the inefficient operation of the machine and involves time and expense in making the necessary repairs. A clutch built by the Accurate Machine Co., Cleveland, Ohio, is designed, under the patents of F. Demuth, to overcome these objections. The distinguishing features of this design are the large area of friction surface, the automatic self-tightening friction ring and the Hyatt roller bearing with which it is equipped. The illustration shows the general construction of the clutch, which consists principally of a pulley, friction ring and spider. The counterbalanced spider supports and drives the friction ring, and the driver fits in the space which is formed between the two lugs cast at each side of the split on the friction ring. This driver bears against either of the lugs, and as the pressure increases a corresponding pressure will be increased between the friction ring and friction surface on the pulley, thereby making an automatic self-tightening clutch.

Slots in the spider on each side of the driver allow sufficient space for the operation of the clutch fingers. Both clutch fingers are supported on pins which are mounted in the lugs on the friction ring. As the thimble forces the fingers apart and the other ends of the fingers act against each other, the pins act as a fulcrum which expands the friction ring out against the friction surface of the pulley. It requires a slight pressure to force the thimble between the clutch fingers, and then the tightening of the clutch is automatic. The use of a roller bearing in the clutch pulley will eliminate wear and hot bearings, due to the self-lubricating and anti-friction qualities of the bearings. A large supply of lubricant is retained in the bearing housing, so that an additional supply of oil is required only at long periods of time. This provision of an oil reservoir carrying a supply of lubricant sufficient to last for several months greatly reduces danger of damage to the mechanism through failure of the attendant to provide oil.

T. P. WALLS MULTIPLE SAW AND BEVELING TABLE

The T. P. Walls Tool Co., Inc., 75 Walker St., New York City, is placing on the market a multiple saw and beveling table, consisting of eleven circular saws and ten bevel cutters placed one inch apart on an arbor 1⅛ inch in diameter and driven by a ½-horsepower motor. The saws are adequately guarded and the work is held in position by ten spring steel fingers operated by a handle behind the finger plate. This machine was originally built for the purpose of cutting player-piano action air-valves into one-inch units and beveling them on one edge. These air-valves are made in strips about eleven inches long, each strip containing ten valves. Heretofore it has been the practice to cut these valve units one at a time, and then to bevel the edge of each valve unit separately. By the use of the multiple saw and beveling table, what formerly consisted of twenty-one operations is done in a single operation. The saws on the multiple table may be adjusted any distance apart down to 1/32 inch, thus making the table adaptable for many purposes, such as making combs, box corners, strips for wood dowels, etc. These machines are furnished in such sizes as may be required for any specified multiple cutting or beveling.

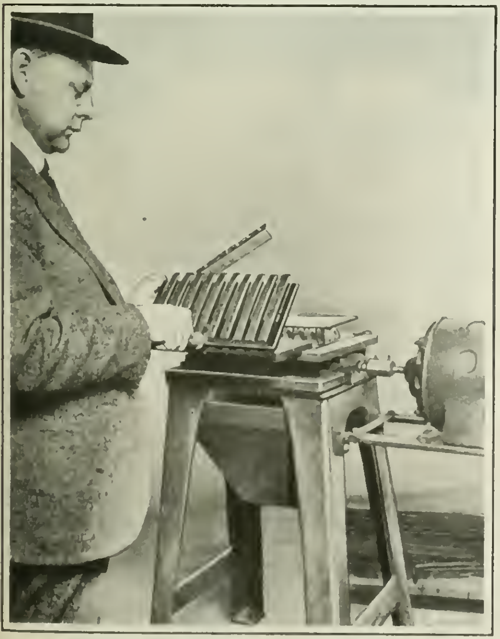


Fig. 1. T. P. Walls Multiple Saw and Beveling Table

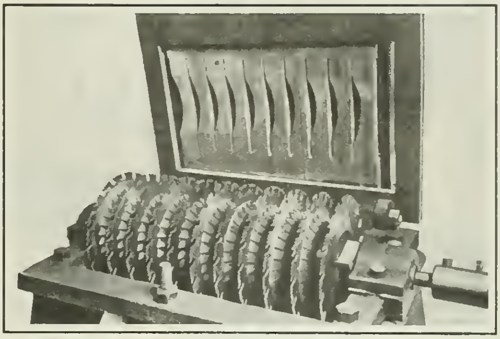


Fig. 2. Close View of Saws and Bevel Cutters

NEW MACHINERY AND TOOLS NOTES

Drilling Machine: Smith Engineering Works, 32nd and Locust Sts., Milwaukee, Wis. A 24-inch high-duty drilling machine on which ten speed changes are obtainable covering a range from 30 to 446 revolutions per minute. Six changes of feed are provided, covering a range from 0.007 to 0.071 inch per spindle revolution.

Demagnetizer: W. F. Davis Machine Tool Co., 549 W. Washington St., Chicago, Ill. A device made in different sizes and claimed to be able to completely demagnetize metal parts as fast as they can be passed through it. This device is particularly adapted for demagnetizing parts that have been machined on magnetic chucks.

Diamond Tool-holder: National Machine Co., 135 Sheldon St., Hartford, Conn. This firm is now making the "Hartford" diamond tool-holder for use in truing the wheels on surface grinders. Provision is made for holding the diamond tool at any angle, and the tool is firmly supported, which is claimed to add to the accuracy that can be obtained in wheel truing.

Plug and Ring Gages: Reliable Machine Works, 48 Lafayette St., Ridgewood, L. I., N. Y. A line of plug and ring gages equipped with revolving grips which are convenient to use. With this arrangement the gages may be used for testing the size of a piece being machined without requiring the machine to be stopped, as the revolving handle may be conveniently held while the gage is revolving with the work.

Grinding and Polishing Stand: St. Louis Machine Tool Co., St. Louis, Mo. A line of grinding and polishing stands which are provided with 0.40 carbon steel arbors that run in dustproof bearings lined with anti-friction metal and provided with automatic lubricators. The work-rests are of improved design and back-rests are furnished for receiving a wheel-guard or other fixture.

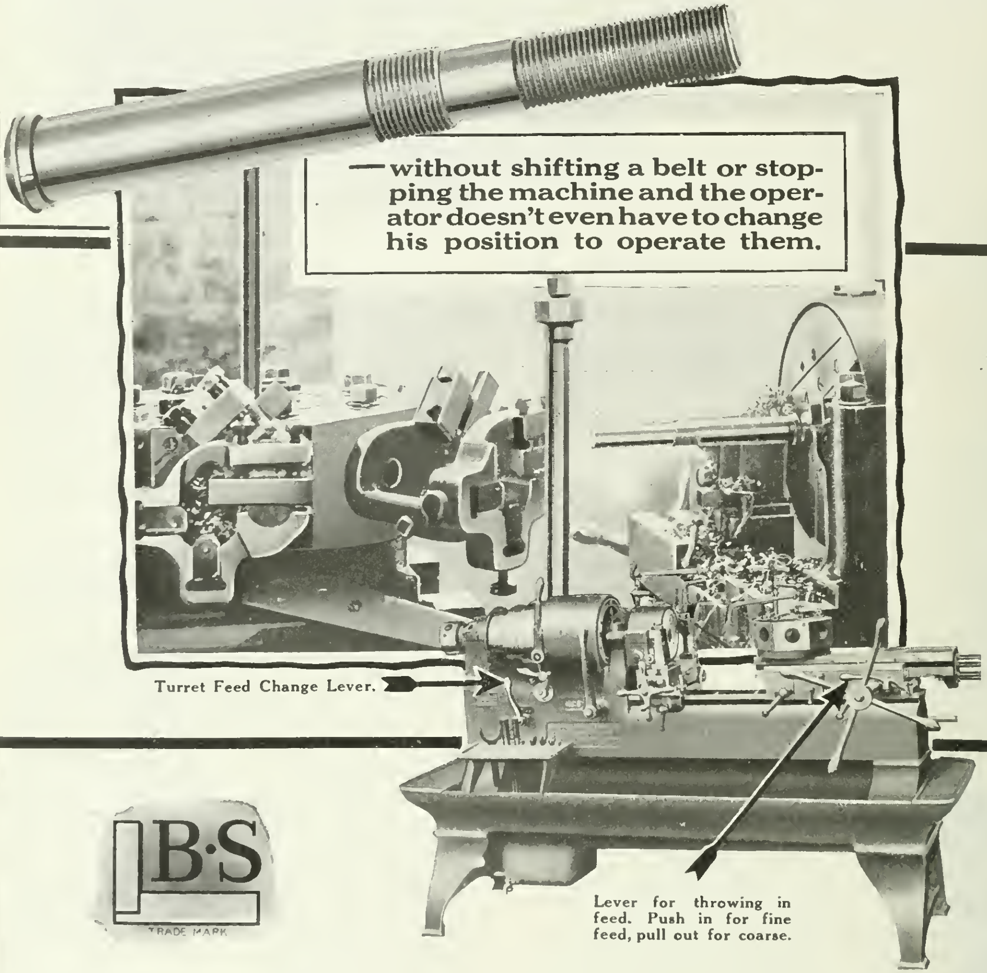
Tapping Machine: Rickert-Shafer Co., 612 W. 12th St., Erie, Pa. A vertical tapping machine for tapping holes from ¼ to ½ inch in steel, and from ¼ to ⅝ inch in cast iron. It is styled a ½-inch Model R tapping machine. Forward and reverse motions are obtained through a patented friction drive in which there is said to be practically no lost motion between the driving and reversing of the tap.

Pyrometer Tube: Charles Engelhard, 30 Church St., New York City. A line of pyrometer protecting tubes which are sold under the trade name of "Impervite." The claim is made for the properties of these tubes that they are practically identical with that of the Marquardt, including the coefficient of expansion, mechanical strength and porosity. The melting point of the tubes is claimed to be above 3500 degrees F.

Thread Gage: Coats Machine Tool Co., 30 Church St., New York City. A special thread gaging fixture which is made by the H. E. Harris Engineering Co., and is sold by the above concern. The stand of this fixture is of new design, but the gage is the standard type of Prestwich fluid gage. Graduations on a vertical scale are ⅛ inch apart and each represents a variation of 0.0001 inch in the work.

Spoticator: Reliance Tool Co., Meriden, Conn. A tool for use on milling machines for spotting holes and for performing lining operations on jig, die and similar work. This instrument will spot holes on the work as accurately as the table of the milling machine may be moved by its screws. The spotting is done by a prick-punch that is normally held out of engagement with the work by a spring.

Two Handy Levers Provide



—without shifting a belt or stopping the machine and the operator doesn't even have to change his position to operate them.

Turret Feed Change Lever.

Lever for throwing in feed. Push in for fine feed, pull out for coarse.

B·S
TRADE MARK

The simple movement of one or both of these levers is all that is required to get the most productive feed for each turret operation, eight feeds in geometrical progression being instantly available for each spindle speed.

Practically no more effort is required to use the correct feed for each operation than to use the same feed for the entire seven tools.

This "self-contained-turret-slide-feed" feature of Nos. 4 and 6 B & S Wire Feed Screw Machines is but one of their many points that make for handiness and consequently FAST PRODUCTION. It will pay you to investigate these efficient machines in detail.

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Wire Feed Screw Machines

Screw Machine Operators

the same as all mechanical workers, demand an accurate, handy, adaptable way of keeping their work to predetermined limits. Accuracy must not be sacrificed for fast production. Both can be maintained by the use of "Brown & Sharpe Equipment." A small but important part of this equipment are the precision tools employed. Brown & Sharpe Tools have supplied, for three generations, the handy, adaptable, sure method of keeping the work of the machine tool operator, the machinist and the toolmaker up to the highest standards of accuracy.

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Not only should shop superintendents and foremen specify B & S Tools for their tool cribs, but they should encourage their men to buy them for their kits. Better work and faster production naturally follow such a course.

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listing the thousand varieties of these world-known and world-endorsed tools

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REPRESENTATIVES: BALTIMORE, MD., Carey Machinery & Supply Co. CINCINNATI, O., INDIANAPOLIS, IND., The E. A. Kinsey Co. SAN FRANCISCO, CAL., Pacific Tool & Supply Co. CLEVELAND, O., DETROIT, MICH., Strong, Carlisle & Hammond Co. ST. LOUIS, MO., Colcord-Wright Machinery & Supply Co. SEATTLE, WASH., Perine Machinery Co. PORTLAND, ORE., Portland Machinery Co.

Electric Riveting Machine: New England Machinery Co., New Haven, Conn. A machine known as the "Kobert" electric riveting and forging machine. It is of the two-unit single-cycle power type, in which the rivets are heated and driven at a single operation. The two units employed are the copper heating electrodes and the steel forging set, both of which are mounted on a swinging frame so that either set can be brought over the work.

Power Hacksaw: Peerless Machine Co., 1611 Racine St., Racine, Wis. A high-speed power-driven hacksaw which is provided with six changes of speed, covering a range from 50 to 150 strokes per minute. These speed changes are obtained by gears. If desired, the machine can be equipped with individual motor drive, with the motor mounted above the machine to economize floor space. The capacity of the machine is for work up to 6 by 6 inches.

Gear-hobbing Machine: Goss Printing Press Co., 1535 S. Paulina St., Chicago, Ill. An automatic gear-hobbing machine which was originally constructed for cutting gears used in printing presses of this company's manufacture. The machine is now being built for the market. It is made in one size with a rated diametral pitch capacity of 2½ in cast iron or steel, a maximum pitch diameter of 36 inches, and a maximum face width of 12 inches.

Surface Grinding Machine: Abrasive Machine Tool Co., Providence, R. I. A machine in which the entire frame is a one-piece casting which is rigidly braced internally to resist distortion, and supported at three points located in a way to insure equilibrium of the machine. The unit system of construction has been adhered to in designing and planning for the manufacture of this grinder, and any unit can be removed from the machine without materially disturbing other parts.

Thread Milling Machine: Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa. A machine used for milling worms and screws up to 6 inches in diameter by 16 feet in length. In operating this machine the work blank is placed on a mandrel, the end of which is inserted into a tapered draw-in chuck carried in the hollow spindle of the machine. The mandrel is not released until the work is entirely completed, as adjustment for successive leads is controlled by a tooth clutch.

Drilling Jig: Lapointe Machine Tool Co., Hudson, Mass. A universal master drilling jig which consists essentially of a movable guide bushing fitted into a bushing carried by a slide. This slide is moved longitudinally by a screw, and the work is held between two stationary and two adjustable gripping jaws. The table is fitted to a circular base and may be rotated through 360 degrees. Graduations are provided indicating movements of 0.5 degree, and both adjusting screws are provided with dials graduated to 0.0005 inch.

Turret Lathe: W. K. Millholland Machine Co., Indianapolis, Ind. A 2½- by 30-inch manufacturing turret lathe which has been especially designed to meet the requirements of factories where unskilled labor has been employed to take the place of skilled mechanics. As far as possible, unnecessary parts have been eliminated, and the operation of the machine has been simplified so that a minimum number of movements are made by the operator. All parts are of substantial design, and this coupled with simplicity of operation, makes the machine practically fool-proof.

Universal and Plain Milling Machines: Ford-Smith Machine Co., Ltd., Hamilton, Ont., Canada. One of these is a No. 3 universal milling machine, with a longitudinal feed of 30 inches, cross-feed of 10 inches, and vertical feed of 19 inches; twelve changes of feed are obtainable, ranging from 0.006 to 0.092 inch per revolution. The other machine is a No. 3 plain milling machine which has a maximum longitudinal feed of 34 inches, vertical feed of 20 inches, and cross-feed of 10 inches; twelve changes of feed are available, covering the same range as given for the universal machine.

Cutting-off Machine: George Gorton Machine Co., Racine, Wis. A No. 2-D cutting-off machine which is equipped with a head carrying ten cutters supported in blocks driven into pockets in the bore of the head. One edge of each block is tapered and fits into a corresponding taper in the pocket. The cutters and blocks are located centrally by means of a tongue and groove construction. An automatic adjustable power feed mechanism is provided, making it unnecessary for the operator to reverse clutches when he is ready to raise the cutter-head after finishing a cut. A handwheel is employed to raise or lower the cutter-head, and it automatically disengages the feed mechanism when raising the cutter-head.

Turbine Grinder: Henry Perkins Co., Bridgewater, Mass. An air-driven turbine grinder of the portable or so-called "hand" type, which is used for grinding intricate castings. Air is supplied to a single row of turbine blades through six nozzles, and after expansion it flows through open ports located at the side of the housing. The axial thrust developed through the use of only a single row of blades, is carried by a thrust bearing. The rotor is 6 inches in diameter and runs at a maximum speed of 12,000 revolutions per minute when operating with air at a pressure of sixty pounds per square inch. The normal operating speed is from 10,000 to 11,000 revolutions per minute, and the machine carries a grinding wheel 2 or 2½ inches in diameter.

Crankpin Forcing Press: Watson-Stillman Co., 192 Fulton St., New York City. A portable press used for forcing crankpins into locomotive and engine wheels and for miscellaneous shop and field work. The press is mounted on a four-wheeled truck so that it may be conveniently pulled around the shop. A power-driven pump is substituted for the hand-pump used on previous equipments of similar type built by this company. Aside from reducing the number of men required by one, it is stated that the increased speed of operation is 300 per cent through the use of a power-driven pump. Presses of this type are built in capacities ranging up to 300 tons, and each is equipped with a gage to indicate the pressure required to sink the pin into place.

Boring Mill: Pawling & Harnischfeger Co., Milwaukee, Wis. A horizontal drilling and boring machine that incorporates a number of unusual features in its design. Dynamic braking is used to control the forward and reverse motions of the spindle, this being especially useful in the performance of tapping operations. The spindle is supported by bronze bearings and a heavy sleeve that runs out to the end of the spindle's travel. The operating switch is mounted at the top of the column and the switch control handle is placed at the front of the carriage. Control of the motor field rheostat is by a lever located near the control switch lever. All other operating levers and handwheels are centralized so that all mechanism may be readily controlled from the operator's position near the carriage.

* * *

THE CRUCIBLE SITUATION[1]

The important and essential ingredients of the plumbago crucible are the plumbago itself and the clay which serves to hold the crucible together in the process of manufacture and in use. Before the war, all the clay for crucible purposes was imported, and probably 95 per cent of the plumbago. The clay came almost exclusively from Germany. Shortly after the war opened, Germany prohibited the shipment of this clay, perhaps foreseeing the large demand of the Allies for ammunition and metals from this country, so that the manufacturer was launched on the sea of experiment at a time of rapidly increasing demand. The chemical and physical laboratories have been called upon in the search for a suitable substitute for the German clay, but the results of such investigations have for the most part been negative; that is, such investigations enabled only the elimination from real test such metals as did not measure up to such standards as have come to be recognized.

A great many clays have been examined, and perhaps a score have given indications of possible successful use. A clay giving favorable indications is mixed in varying proportions with the other ingredients of the crucible, among which may be other clays (for at the present time a blended clay seems to be the solution), and trial lots are made of each mixture. Owing to the long time required to make and burn crucibles, and adding to the time required for transportation and actual use, two months is the least period required to get results from such tests. If the result of such a trial is favorable, another lot is made up, this time of fifty or one hundred, and sent out to different users. If the results obtained by the different users are in practical agreement, the information is of real value; but when the reports are not in agreement, as is often the case, the test must, of course, be repeated.

In order to gain results as quickly as possible, many experiments have to be carried on simultaneously. Under such circumstances, a long time must elapse before information becomes available, but as the information accumulates there is steady progress toward the desired end. The results secured by the early attempts to use domestic clays were very unsatisfactory. In certain cases the average heats secured were four or five, as against twenty-five to thirty previous to the war. At the present time results are much better, from fifteen up to twenty and twenty-five heats being the range of average service. The above figures refer to an average size crucible, say No. 80, used in standard rolling mill practice.

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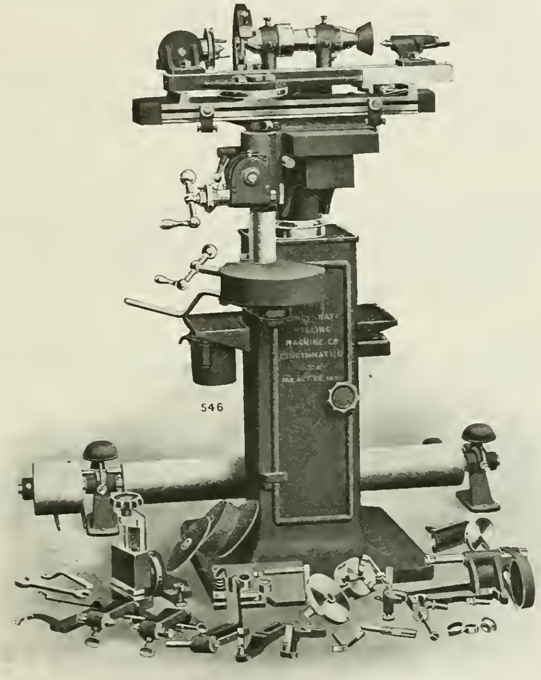
[1] Abstract of an article by M. McNaughton, of the Joseph Dixon Crucible Co., published in the "Journal of the American Institute of Metals," September, 1917.

The Cincinnati Number 1 Cutter Grinder



FOR the medium and smaller sizes of spiral mills, end mills, side mills, angular cutters, etc.—in other words, for the cutters which are used most extensively—this No. 1 Grinder has been popular for many years.

Practically every shop of any consequence has at least one. Many large shops use dozens. They find it just as valuable for sharpening reamers as it is for sharpening cutters.

It is handy. Can be quickly set to any angle. The knee carrying the table swings through a complete circle, and in addition, the table may be set at an angle with the slide. Has graduated dials for all settings, and the lever feed can be operated from any position handiest for the work being done.

We are offering these machines for quick shipment

The Cincinnati Milling Machine Co.
CINCINNATI, OHIO

A REINFORCED CONCRETE BORING MILL

The general use of reinforced concrete for constructing bridges, viaducts, retaining walls, buildings and foundations has become accepted practice within the past decade. When properly mixed, placed and waterproofed, it is the most satisfactory and enduring building material known, but few are yet prepared to regard it as suitable for anything but fixed structures. It is true that reinforced concrete barges and even ships are in successful use, and the number promises to become rapidly greater as their seaworthy quality and comparatively low cost are demonstrated. Notwithstanding this remarkable proof of the value of concrete for purposes fulfilled almost exclusively by iron and steel, there are few machine designers and users who would concede that satisfactory machine tools could be designed and built of this material. But war brings revolutionary changes in social orders and industrial methods, and one of the changes we are likely to see is the use of concrete for the principal members of large special-purpose planers, boring mills and gun lathes.

Lucien I. Yeomans, consulting engineer, 72 W. Adams St., Chicago, who developed a shell lathe that is built without planing or boring the bed, headstock and tailstock, has designed a fifty-foot boring mill for emergency war work that is radical in conception throughout. Metal is used only for the driving parts, pivot, supporting strips or "skates," tool-slides, T-slots, table pan and reinforcing rods. The weight of steel and cast iron is thus reduced to a small percentage of the total weight of the machine.

The foundation and upper part of the bed are built of reinforced concrete following approved methods of mixing and placing in wooden forms, and the table-supporting strips are set with the aid of an engineer's transit by which accurate location is insured. The table foundation is a sheet steel pan filled with concrete reinforced radially and concentrically. The T-slots are formed with rails set as shown in Fig. 3. The ring gear is made in sections which are bolted to the reinforcing bars and two driving pinions are provided on opposite sides. Only one is shown in Fig. 1, which is a diagrammatic sketch only. The housings and cross-rail are a heavy monolithic structure, no provision being made for raising or lowering the rail, as the machine is for single purpose only. The reinforcing bars shown in the housing and coiled in the cross-rail in dotted lines are wrapped in the opposite direction in the other housing in order to oppose the thrust on the tool on that side. The cross-rail is faced with a cast-iron rail which is machined and fitted as usual.

The advantages of reinforced concrete construction for large machine tools are low cost and quick erection. The principal members can be built in less time than is ordinarily required to make the patterns. The pattern work on the metal parts is comparatively insignificant and foundry costs and delays are minimized. The heavy work is done on the ground, and the difficulties of railway transportation are largely eliminated, which is a most important consideration at present. It is estimated that this fifty-foot boring mill could be erected complete in any locality where building materials and ordinary machine shop facilities are available in three months and at a cost of less than one-fifth of that of the common design of mill having equal capacity.

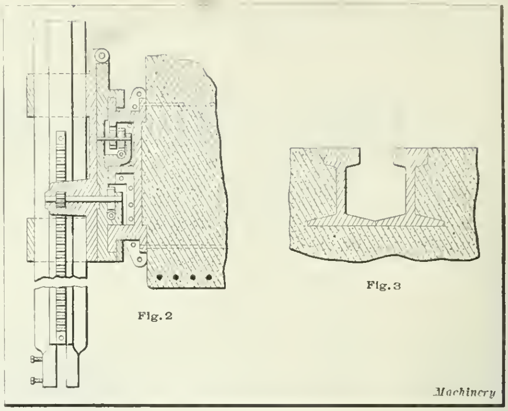


Fig. 2. Section through Cross-rail and Tool-holder. Fig. 3. T-slots formed by Railroad Rails

* * *

COKE FROM PEAT

The Peat, Coal & Oil Syndicate of Doncaster, Yorkshire, England, is developing a new method for treating a special dry black peat and converting it into a hard foundry coke, the by-products being tar and tarry liquids from which automobile oils can be obtained by distillation. It is not claimed that all varieties of peat can be profitably used, but it is said that hundreds of acres containing millions of tons of peat can be commercially utilized by this process. The black layer at the bottom of the bog is most suitable for the manufacture of coke. This material is freed of its excess of water and subjected to a carbonizing process by means of which by-products are recovered, the residue being a soft and friable coke. Notwithstanding that peat coke has a lower sulphur content than any other combustible, up to this time its insufficient hardness has been an obstacle to its application in blast-furnace operation. This fault, it is claimed, is now overcome, and a hard, strong and pure coke is now obtained. A German chemist has proved by analysis that 1000 tons of air-dried peat will produce 400 tons of coke, 40 tons of tar, and 400 tons of tarry liquids. The tar can be further distilled to yield 18 tons of crude oil, 2 tons of creosote, 2 tons of pitch and 8 tons of paraffin. The tarry liquids will yield 4 tons of sulphate of ammonium, 6 tons of acetate of lime and 2 tons of methyl alcohol.

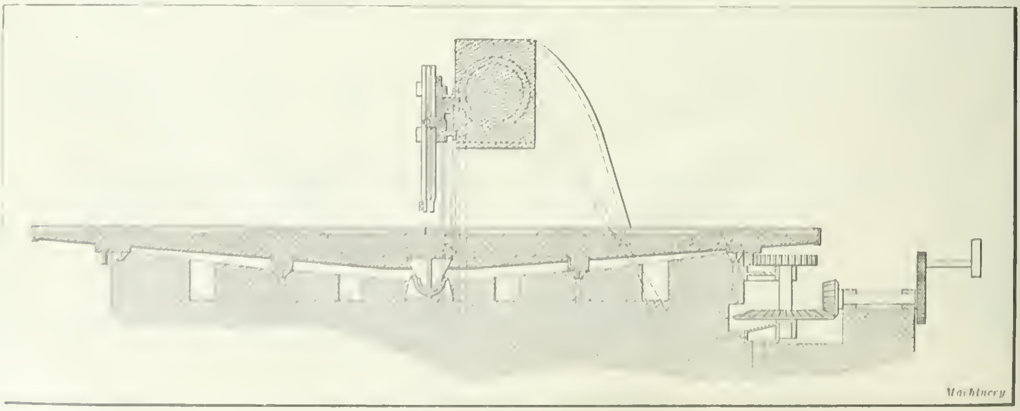


Fig. 1. Diagrammatic Sketch of Boring Mill

The LUCAS

(OF CLEVELAND)

"PRECISION"

BORING, DRILLING AND

MILLING MACHINE

ALWAYS GOOD

and as time goes on

ALWAYS BETTER

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF **CLEVELAND, O., U.S.A.**

DRAFTSMEN BADLY NEEDED FOR ORDNANCE DEPARTMENT

BY DYER SMITH[1]

The Ordnance Department of the United States Army is in great need of a considerable number of mechanical draftsmen. Some, and it is to be hoped many, of the readers of MACHINERY may be able to do a real patriotic service in this connection. There is so much opportunity for profitable employment everywhere these days that the supply of draftsmen for the Ordnance Department has been far behind the demand. So far there has been no conscription of any sort which would include them. Therefore, the recruiting for this service must be accelerated by volunteer work. The National Civil Service Reform League, 79 Wall St., New York City, is aiding the Ordnance Department in this. The lack of designers, detail men and tracers is causing important contracts for shells, guns and other equipment to be held up. Anyone who volunteers for this work aids in winning the war; five hundred more draftsmen in Washington now may considerably lessen the number of Americans who will never come home from France.

There are two grades of draftsmen called for: Grade 1, starting at $800 to $1400 a year, and Grade 2, starting at $1400 to $1800 a year. Applicants will not be required to report for examination at any place, but will be rated on general education, technical training and experience, and practical tests on work submitted. The requirements for the positions are listed in a number of alternative groups, including different amounts of drafting-room experience, graduation from or attendance at mechanical engineering courses, and combinations of both.

All interested are asked to write or call on the secretary of the National Civil Service Reform League, 79 Wall St., New York City, for further information and application forms. Anyone may help by applying himself, or by encouraging men employed by him to apply, or by telling his friends about the matter. The writer knows of no official ruling on the question of exemption under the draft for these men, but it seems evident that they will be "necessary employes of the government," who will be in a deferred class under the draft. Anyone who takes one of these jobs may feel that he is doing his patriotic "bit" in the way he knows best how to do. Many men who are unable to fight have wanted to help the government and have not known what to do. Here is an opportunity for effective service. Appointments will be made promptly on the basis of the training and skill of the applicant.

* * *

A GREAT ENGINEERING WORK COMPLETED

A meeting was held Wednesday evening, November 14, at the United Engineering Societies' Building, New York City, under the auspices of the United Engineering Society, to celebrate the completion of the Catskill water supply for the city of New York. At this meeting were present members of the four national engineering societies—the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. George H. Pegram, president of the American Society of Civil Engineers, presided, and an address was made by the mayor of New York City, John Purroy Mitchell, who gave credit to the engineers who had carried this remarkable engineering work, claimed to be the most difficult engineering feat ever completed, to a successful end. A. D. Flinn, deputy chief engineer of the New York Board of Water Supply, then gave a complete description of the work illustrated with lantern slides.

The water is carried by aqueducts and tunnels 120 miles from the Catskill mountains to New York. One of the most difficult engineering problems in connection with the work was the crossing of the Hudson River which was done by a tunnel 1200 feet below the surface of the river. It is of remarkable interest to note that this work was completed over a year before the estimated time of completion, or in less than nine years instead of in ten years as was expected, and also that the cost was below that estimated, the total cost having been $140,000,000 or $7,000,000 less than the original estimates. Great credit is certainly due those engineers whose ability, integrity and sense of public duty made it possible to complete this tremendous engineering work in so short a time and with such economy.

* * *

RESIGNATION OF FRANK A. SCOTT

The resignation of Frank A. Scott from the chairmanship of the War Industries Board, in which position his unremitting devotion to duty seriously impaired his health, is only one instance of the strain to which such men are subjected. Executives who leave the management of well-organized and smoothly running business concerns to take government positions encounter difficulties in pushing the work forward to their satisfaction on account of the lack of organization and of efficient help. These troubles are inseparable from war conditions, and in most departments are being gradually remedied. The magnitude of the task we have assumed is visible to those behind the scenes, but on the great mass of our people it is only dawning.

* * *

With the help of able and efficient men in the machine tool and other industries, constant progress is being made in the organization of important work connected with the War Industries Board. G. E. Merryweather, of the Motch & Merryweather Machinery Co., Cleveland, whose office is now in the War Industries Building, has collected a large amount of statistical material in regard to the capacity and product of machine tool builders in this country and the condition of their orders, output and deliveries up to date, so that a glance at the card for each shop will show almost exactly what machines the government can count on from that shop and when they can be delivered.

* * *

It is mentioned in a French contemporary that the machine works of Fonderie des Gobelins, in Paris, have recently substituted stellite for high-speed steel for use in turning shells. By the use of stellite, a daily production of 120 six-inch shells was increased to 200. With high-speed steel, twenty minutes was consumed in taking a roughing cut at a speed of 60 feet; for finishing, the same speed was used. With stellite, the roughing speed was increased to 85 feet, and the finishing speed to 125 feet per minute. For completely finishing 1000 six-inch shells, the cost of stellite was found to be six cents per shell.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC. REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

of MACHINERY, published monthly on the 1st at New York, N. Y., for October 1, 1917.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the state and county aforesaid, personally appeared Matthew J. O'Neill, who, having been duly sworn according to law, deposes and says that he is the General Manager of MACHINERY and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, The Industrial Press	140-148 Lafayette St., New York
Editor, Fred E. Rogers	" " " " "
Managing Editor, None	
Business Managers { Alexander Luchars, President	" " " " "
Business Managers { Matthew J. O'Neill, Gen'l Manager	" " " " "

2. That the owners of 1 per cent or more of the total amount of stock are:

The Industrial Press	140-148 Lafayette St., New York
Alexander Luchars	" " " " "
Matthew J. O'Neill	" " " " "
Fred E. Rogers	" " " " "
Louis Pelletier	" " " " "
Erik Oberg	" " " " "

3. That there are no bondholders, mortgagees or other security holders.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 1st day of October, 1917.

THOMAS R. WILLIAMS,
(SEAL) Notary Public, New York County, No. 251.
(My commission expires March 30, 1918.)

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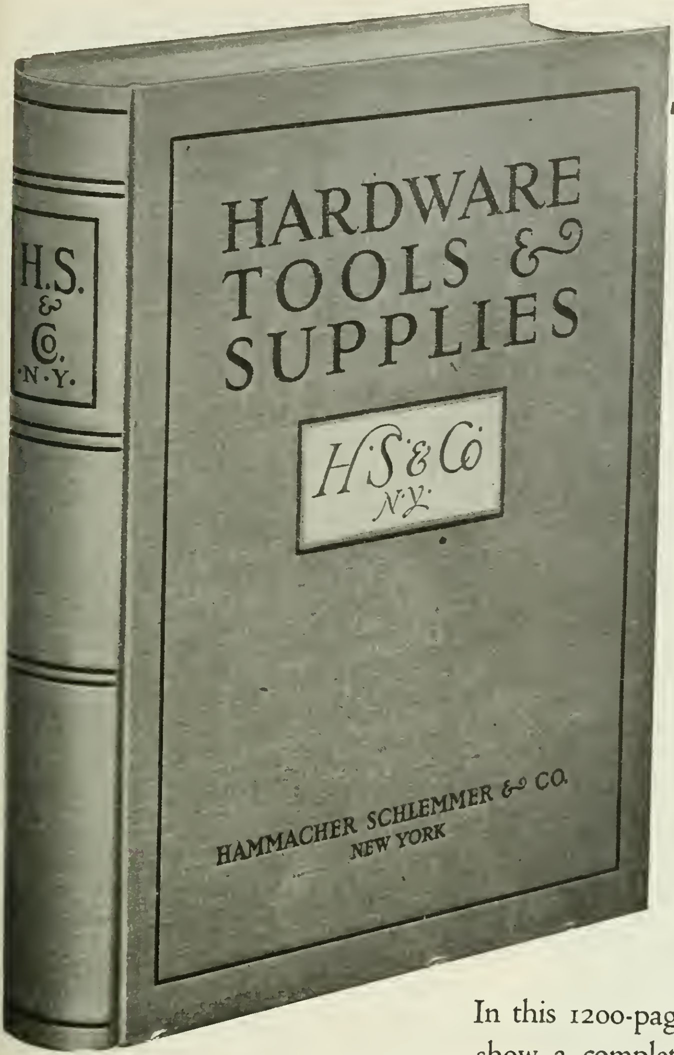
[1] Address 82 Liberty St., New York City



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It is full of items requisitioned every day in every large factory, many of which are sometimes difficult to locate.

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PERSONALS

Fred J. Miller, who for the past nine years has been general manager of the factories of the Remington Typewriter Co., has resigned.

Clarence M. Woolley, president of the American Radiator Co., New York City, has been appointed a member of the War Trade Board.

C. F. Heckman, formerly superintendent of the Russell Motor Car Co., Ltd., Toronto, Canada, is now superintendent of the Russell Motor Car Co., of Buffalo, N. Y.

J. E. MacArthur, formerly factory manager of the Russell Motor Car Co., Ltd., Toronto, Canada, has been made factory manager of the Russell Motor Car Co., Buffalo, N. Y.

L. R. Brink, superintendent of Barnhart Bros. & Spindler, Chicago, Ill., has resigned to become general manager of the Fort Dearborn Mfg. Co., Sterling, Ill., manufacturer of special machinery, gears and metal stampings.

W. C. Webster, who has been secretary and general manager and director of the Nichols Copper Co., 25 Broad St., New York City, for several years, has resigned. Mr. Webster expects to take a rest before assuming further duties.

C. R. Burt, for the past four years assistant general manager of the Russell Motor Car Co., Ltd., Toronto, Canada, has been appointed general manager and a director of the Russell Motor Car Co., of Buffalo, located at 93 Dewey Ave.

W. F. Trenary, Jr., now represents the Harrison Safety Boiler Works, Philadelphia, Pa., manufacturers of the Cochrane heaters and other steam plant appliances, succeeding W. R. Jennison. Mr. Trenary's headquarters will be 419 Brown-Marks Bldg., Birmingham, Ala.

R. J. Morgan has resigned his position with the Midvale Steel & Ordnance Co., and has been appointed supervisor of sales of the American Steel Export Co., Woolworth Bldg., New York City. Prior to his connection with the Midvale Steel & Ordnance Co., Mr. Morgan was with the Carnegie Steel Co. for thirteen years.

Walter C. Voss, formerly in charge of the Detroit office of the rim and tube division of the Standard Parts Co., has been transferred to Washington, D. C., to look after the business of the Standard Parts Co., at that important center. Mr. Voss is being replaced by Art A. Loeffler, formerly of the Jackson-Church-Wilcox Co., of Saginaw, Mich.

J. F. Sells, of the engineering staff of the National X-Ray Reflector Co., Chicago, Ill., has been appointed consulting illuminating engineer for the new business departments of the Henry L. Doherty Co., Central Stations. Mr. Sells is at present located at Mansfield, Ohio, where the Henry L. Doherty Co. operates the Mansfield Electric Light & Power Co.

Roy B. Woolley, formerly sales and advertising manager of the Standard Electric Stove Co., Toledo, Ohio, has returned to America, having served his enlistment in the American Ambulance Field Service at the Verdun front in France. He is now with the Society for Electrical Development, 29 W. 39th St., New York City, as an executive in the advertising department.

J. L. Replogle, vice-president of the American Vanadium Co., has been appointed Director of Steel Supply by the Council of National Defense. He will receive weekly reports from the iron and steel producers, which, in cases of retarded output, will state the reasons therefor. Every effort will be made to remove obstacles that prevent the maximum output of war necessities.

Samuel McRoberts has retired from the board of directors of the Allied Machinery Co., as government work takes all his time, and has been succeeded as chairman by R. P. Tinsley, vice-president of the American International Corporation. R. B. Sheridan has also retired as president of the Allied Machinery Co., but will continue as a member of the executive committee. J. W. Hook succeeds Mr. Sheridan as president.

Arthur C. Rogers, formerly connected with the advertising agency conducted under his name at Cleveland, Ohio, has been appointed a Major in the Ordnance Section of the Officers' Reserve Corps of the United States Army, and will shortly receive orders to active duty. The agency conducted under Mr. Rogers' name has been incorporated under the laws of Ohio as the Rogers-Brett-Baker Co., of which Mr. Rogers will still remain president.

Louis A. Freedman has been elected secretary of the Aeronautical Society of America, 29 W. 39th St., New York City. Mr. Freedman in the past has been engaged in some important aerodynamical research studies, is a member of several of the society's committees, a graduate of the Massachusetts Institute of Technology, and has followed the profession of mechanical engineering for a number of years. His achievements in inventing, designing and building automatic machinery for the production of dry batteries are especially noteworthy.

OBITUARIES

William R. Griswold, mechanical engineer with the Standard Tool Co., Cleveland, Ohio, died October 6, aged forty-nine years. Mr. Griswold had been with the Standard Tool Co. fifteen years.

Albert P. Bowe, formerly advertising manager of the Hydraulic Press Mfg. Co., Mount Gilead, Ohio, was accidentally shot and killed October 27 on the rifle range at Camp Perry. Mr. Bowe was called to the colors in September and had the rank of sergeant. He was not only capable and conscientious in his publicity work, but was representative of the standards that make for good citizenship.

William Thompson Iler, Jr., assistant works manager of the Slocum, Avram & Slocum Laboratories, Inc., New York City, died on October 18 of a complication of typhoid fever and pneumonia, aged twenty-five years. Mr. Iler was a graduate in mechanical engineering of the New York University and a junior member of the American Society of Mechanical Engineers. He contributed a number of articles to MACHINERY.

COMING EVENTS

December 4-7—Annual meeting of the American Society of Mechanical Engineers in New York City; Engineering Societies Bldg., 29 W. 39th St., headquarters. Calvin W. Rice, secretary.

December 27—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. G. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

SOCIETIES, SCHOOLS AND COLLEGES

Michigan College of Mines, Houghton, Mich. Year book for 1916-1917, containing announcement of courses for 1917-1918.

American Society of Mechanical Engineers, 29 W. 39th St., New York City. Condensed catalogues of mechanical equipment for 1917, with mechanical equipment directory, containing 469 pages of catalogue data and a directory of 163 pages. Engineering data from recent publications of the society are included, covering 42 pages. The catalogue is divided into sections as follows: Part I, power plant equipment; Part II, power transmission machinery, elevating and conveying machinery, hoisting and transporting machinery; Part III, metals, alloys and other materials; Part IV, metal working machinery, machine tools and accessories, shop equipment; Part V, compressors, fans, blowers, pumping and hydraulic machinery, drying and crushing machinery, and engineering miscellany; Part VI, testing, measuring and recording apparatus. There are 2200 firms listed in the directory, and catalogue data of 832 manufacturers are given.

NEW BOOKS AND PAMPHLETS

Year Book of the Bureau of Mines, 1916. By Van H. Manning. 174 pages, 6 by 9 inches. Published by the Government Printing Office, Washington, D. C. Price, 30 cents.

Effects of Storage upon the Properties of Coal. By S. W. Parr. 39 pages, 6 by 9 inches; illustrated. Published by the University of Illinois, Urbana, Ill., as Bulletin No. 97 of the Engineering Experiment Station. Price, 20 cents.

German Foreign-trade Organization. By Chauncey Depew Snow. 182 pages, 6 by 9 inches. Published by the Bureau of Foreign and Domestic Commerce of the Department of Commerce, Washington, D. C., as Miscellaneous Series No. 57. Price, 20 cents.

Comparative Basic Costs of Typesetting, by Hand, Linotype and Monotype. 54 pages, 6½ by 8 inches. Published by the Graduate School of Business Administration, Harvard University, Cambridge, Mass., as Student Reports on Business Problems No. 1. Price, 50 cents.

Glossary of Aviation Terms. By Victor W. Page and Paul Montariol. 94 pages, 5 by 7½ inches. Published by Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $1.

The book contains lists of the aeronautical terms in English with the French equivalents, and in French with the corresponding English words. It is arranged in four parts: Flying Field Terms; The Airplane and its Parts; Engine Parts; and Tools and Shop Terms.

Some Unusual Features in the Microstructure of Wrought Iron. By Henry S. Rawdon. 25 pages, 7 by 10 inches. Published by the Government Printing Office, Washington, D. C. Price, 5 cents.

This is Technologic Paper No. 97, issued by the Bureau of Standards. It contains a number of photomicrographs and diagrams of wrought-iron structures, which will prove of interest to any student of metallography and metallurgy.

Experimental General Science. By Willard Nelson Clute. 303 pages, 4¾ by 7¼ inches; 96 illustrations. Published by P. Blakiston's Son & Co., Philadelphia, Pa. Price, $1.25.

This is a general text-book on a number of different scientific subjects written in popular form and intended particularly for school use. It is divided into fifty-two chapters, giving a brief outline of astronomy, chemistry, physics, including the science of heat, light, sound, electricity, and many other subjects.

Mechanical Processes. By G. W. Danforth. 423 pages, 6 by 9 inches; 270 illustrations. Published by the United States Naval Institute, Annapolis, Md.

This book is intended as an elementary course for engineering schools on the processes employed in shaping materials of construction for various mechanical uses, and shows briefly the steps of the manufacture of metal from the ore to the finished product. It contains thirteen chapters dealing with engineering materials; metal-producing processes, fuels; iron and steel; mechanical treatment of metals and heat-treatment of metals; remanufacture of metals; machinery building and repairing plants; drawings for shop use; the pattern shop; the foundry; the blacksmith shop; the machine shop; the boiler shop; and special processes.

Thomas' Register of American Manufacturers. 3000 pages, 9½ by 12 inches. Published by the Thomas Publishing Co., 129 Lafayette St., New York City. Price, $15.

This is the ninth edition of the Thomas' Register, published October, 1917. The work is divided into five sections. The first contains a finding list and index. The second contains a complete list of all manufacturers in the United States classified according to business or product. The third section gives the manufacturers in the United

AJAX

TRADE MARK REG.

FORGING MACHINERY

And The Electrical Industry

At the very forefront of all American progress stands the electrical industry, and in this industry a few names are dominant.

It has been the privilege of the Ajax organization to work with these and other great electrical manufacturers.

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1369 Hudson Terminal
NEW YORK CITY

States arranged alphabetically by name, giving the home offices, branches, and in many cases names of officers, sales managers and purchasing agents. The fourth section gives leading trade names, brands, etc. An appendix or fifth section is included, giving banks, boards of trades or other commercial organizations, leading trade journals, leading manufacturers' representatives, etc. In order to simplify the use of the work, the different sections are printed on paper of different colors, Section 1 being printed on yellow, Section 2 on white, Section 3 on blue, Section 4 on pink, and Section 5 on white paper. This work is claimed to be the largest publication of its kind ever issued. The revisions, new matter and improvements in the new edition have required 400 additional pages. A valuable feature of the work is that successors to firms are given; in cases where there have been business reorganizations, both the new and old firm names are listed in the alphabetical list of manufacturers. The work should be of special value not only to purchasing agents and men directly interested in the purchasing of machinery and supplies, but also to foremen, superintendents and others who have to do, in an indirect way, with the buying or specifying of machinery or supplies.

NEW CATALOGUES AND CIRCULARS

Frank P. Bickow, 83-35 S. DesPlaines St., Chicago, Ill. Circular of 10-inch index universal centers.

Metalwood Mfg. Co., Detroit, Mich. Folder B-40, descriptive of Metalwood single-lever, quick-operating hydraulic valves.

Morris Machine Tool Co., Cincinnati, Ohio. Circular descriptive of Morris lubricating attachment, universal tilting table and constant-speed motor drive.

Ingersoll-Rand Co., 11 Broadway, New York City. Form 3118, descriptive of compressors and vacuum pumps for the extraction of gasoline from natural gas.

Scientific Materials Co., 711 Forbes St., Pittsburg, Pa. Catalogue of improved American model of Brinell hardness testing machine with special depth-measuring gage.

Lovejoy Tool Co., Inc., Springfield, Vt. Catalogue of Lovejoy turning, facing and planing tools, of the positive-lock, inserted-cutter type, giving dimensions and prices.

Ingersoll-Rand Co., 11 Broadway, New York City. Form 859, advertising a convenient pocket oil-flask, weighing 3½ ounces and having a capacity for one-third pint of lubricant.

Draper & Hall Co., Middletown, Conn. Circular illustrating and describing the D. & H. universal grinder, which is adapted for external, internal, surface and cutter grinding.

National Machinery Co., Tiffin, Ohio. National Forging Machine Talk 29, descriptive of the dies for forging the nose piece for a 4.5-inch shell on National heavy-pattern forging machines.

Hall Gas Engine Co., Inc., Bridesburg, Philadelphia, Pa. Booklet descriptive of the Hall thread milling fixture for cutting external or internal threads of any form or pitch, straight or taper.

Worthington Pump & Machinery Corporation, 115 Broadway, New York City. Bulletin D-1301 treating of steam and electric automatic pumps and receivers, of the single, duplex and triplex types.

Oliver Machinery Co., Grand Rapids, Mich. Circular descriptive of the Oliver No. 74 universal vertical and horizontal wood-boring machine, belt- or motor-driven. The machine is equipped with ball bearings throughout.

American Petroleum Products Co., Williamson Bldg., Cleveland, Ohio. Pamphlet entitled, "Use of Oil as a Fuel," comprising a reprint of an article that appeared in MACHINERY treating of economy of fuel, storage and feeding systems, and types of burners.

Charles H. Besly & Co., 120-B N. Clinton St., Chicago, Ill. Catalogue containing illustrations of the Besly flat surface grinder in use on various classes of work, showing how production can be speeded up and manufacturing costs reduced with this machine

U. S. Gutta Percha Paint Co., 19 Dudley St., Providence, R. I. Circular advertising Rice's "Mill-White" paint "Barreled Sunlight," for the interior of plants, which, it is claimed, will materially increase the amount of daylight and decrease the cost of artificial lighting.

Cleveland Milling Machine Co., Cleveland, Ohio. Stock list of cutters, giving the dimensions of Cleveland standard cutters which are in stock and from which immediate shipment can be made. This booklet is published on the 15th of each month and will be sent free upon request

Chelten Electric Co., Philadelphia, Pa. Catalogue of Chelten electrical specialties, giving list prices of switches, plates, receptacles, attachment plugs, cord-connectors, indicating heater receptacles, indicating switch receptacles, fuses, ground clamps, switch boxes, cast iron conduit boxes, etc.

Standard Pressed Steel Co., Philadelphia, Pa. Catalogue of the complete line of milled screws manufactured by this company, which includes hollow safety set screws, cup and oval point set screws, hexagon and square head cap screws, fillister and round head cap screws, flat head and button head screws.

Esterline Co., Indianapolis, Ind., is issuing a publication entitled "The Esterline Graphic," which treats of the uses of the Esterline graphic meter, an instrument for making a continuous survey of the operation of electrical equipment. By means of this instrument the causes of trouble are detected, and shut-downs avoided.

National Machine Co., Hartford, Conn. Circular descriptive of the Hartford improved automatic surface grinder, with a capacity for grinding work 8 inches wide, 30 inches long and 12 inches high. The circular gives specifications for the grinder, details of installation and operation, and a detailed description of the various parts.

American Pulley Co., 4208-60 Wissahickon Ave., Philadelphia, Pa. Booklet entitled "Getting Maximum Pulley Efficiency," describing the mechanical construction of American steel split pulleys, giving the results of tests for belt slip made by engineers, and pointing out the advantages that can be expected through the use of American steel split pulleys.

S K F Ball Bearing Co., Hartford, Conn. Catalogue entitled "Wood-working Precision at High Speed," containing information on the application of S K F ball bearings in wood-working machinery, including band saws, circular saws, planers, surfacers and jointers, shapers, dowelers, lathes, veneer machinery, borers and wood milling machines and special machinery.

Borden Co., Warren, Ohio. 1918 catalogue of "Beaver" die-stocks and square-end pipe cutters, illustrating the complete line of cutting and threading tools made by the company. Several new "Beaver" tools are shown for the first time, one of these being the No. 3 "Beaver Junior" ratchet die-stock, which is built on the unit plan to thread pipe from ⅛ to 1 inch diameter, inclusive.

Simonds Mfg. Co., Fitchburg, Mass. Catalogue entitled "Saws Sammy Showme Saw," containing reproductions of twelve advertisements that were published in MACHINERY. This series of advertisements shows the quest of Sammy Showme for the best metal selling practice throughout the country. The work done by Simonds semi-high-speed steel saws, hacksaws, high-speed steel inserted-tooth saws, screw-slotting saws and slitting saws, as seen by Sammy Showme, is strikingly illustrated.

Fellows Gear Shaper Co., Springfield, Vt. Handbook for operators of Fellows gear shapers, comprising a treatise on commercial gear cutting of spur, helical and internal gears. The principle of tooth generation by the gear shaper is clearly described, as is also the method of generating the cutters. The three kinds of cutters—form, hob and gear shaper cutter—are compared. A complete description of the generated cutter at work is given, and its various advantages are pointed out. The book concludes with descriptions of the No. 6 Fellows gear shaper, No. 65 helical gear shaper, and other sizes of gear shapers. Examples of work cut on the gear shaper are shown, including shoulder gears, cluster gears, helical gears, internal helical gears, herringbone gears, silent chain sprockets, ratchets, cams, irregular shaped work, keys and splined shafts. The descriptive matter is made very clear by the use of numerous halftone and line illustrations.

Merchants National Bank, 28 State St., Boston, Mass., has issued a pamphlet entitled "Women's Work in War Time," for the purpose of assisting manufacturers in this country to meet the shortage of labor. Much of the information has been obtained direct from the British government and other authoritative sources. The operations of the leading industries in England wherein women have replaced men are outlined, and modifications have been suggested to meet industrial conditions in this country. The industries covered are wool industry, cotton industry, printing, bleaching and dyeing, hosiery and knitting, clothing manufacture, leather tanning and currying, boot and shoe manufacture, glove industry, soap and candle trades, paper making, glass bottle trade, woodworking trades, pottery and brick trade, china and earthenware trade, silver and electroplate trades, chemical industries, color, paint and varnish trade, and sugar refineries. The book also includes a compilation of the state labor laws relating to female and child labor, and a chapter on welfare work in war time.

TRADE NOTES

Keller Pneumatic Tool Co. has moved from Fond du Lac, Wis., to Grand Haven, Mich.

Precision Die Casting Co., Inc., Syracuse, N. Y., has changed its name to Precision Castings Co., Inc.

A. L. Ryder, Inc., 160 E. Colorado St., Pasadena, Cal., has changed its firm name to Pioneer Motor Co.

Brown & Sharpe Mfg. Co., Providence, R. I., has removed its Philadelphia office to 1103-1105 Liberty Bldg.

Burton, Griffiths & Co., formerly at 110 W. 40th St., New York City, are now located in the Metropolitan Building.

Excelsior Needle Co., Torrington, Conn., manufacturer of Dayton swaging machines, has changed its name to Torrington Co.

A/S National Industri, Christiania, Norway, has moved its New York office, in charge of Bjarne Holm Hansen, from 309 Broadway to 90 West St.

Wagner Electric Mfg. Co., St. Louis, Mo., has opened a sales office at 118 Auburn Ave., Atlanta, Ga., in charge of Charles M. Welch, formerly office manager of the Indianapolis branch.

Nutter & Barnes Co. has moved its plant to Greenfield, Mass., forming a part of the machinery division of the Greenfield Tap & Die Corporation. All correspondence should be addressed, Greenfield Tap & Die Corporation, Machinery Division, Greenfield, Mass.

Chicago Rawhide Mfg. Co., 1301 Elston Ave., Chicago, Ill., is just completing an addition to its plant of 30,000 square feet. The company manufactures a complete line of mechanical leather goods—rawhide pinions, gear blanks, belting, lace leather and packings.

General Electric Co.'s Atlanta repair shop is fully equipped to give its customers repair service on all classes of direct- and alternating-current apparatus. Correspondence in regard to repair work should be addressed to the engineering department, General Electric Co., Third National Bank Bldg., Atlanta, Ga.

W. B. Knight Machinery Co., St. Louis, Mo., manufacturer of the Knight milling and drilling machine, has erected a new factory at Vandeventer and Pine Sts., which it expects to occupy about December 15. The shop is a one-story brick building, 100 by 150 feet. All the machines will be electrically driven.

Alfred Herbert, Ltd., has removed its New York offices from 30 Church St. to 54 Dey St., where much larger quarters have been secured by W. J. Fuller, the manager. This move has been made necessary by the great increase in the work of this office, which made it impossible to get along in the former quarters.

Russell Motor Car Co., 93 Dewey Ave., Buffalo, N. Y., has been incorporated. The company has purchased a large factory and is now equipping it with machinery for undertaking a large contract for the United States Navy Department. Manufacturers of machine tools are requested to send copies of their catalogues to the company.

J. T. Slocomb Co., Providence, R. I., manufacturer of machinists' tools, announces that improvements in the company's building have been completed and that in the past year the floor area has been almost trebled, the new space being almost entirely equipped with new machinery. One of the departments is now running night and day with three shifts of men.

Haynes Stellite Co., Kokomo, Ind., is sending to customers an announcement of the exchange value of "Stellite" scrap. All "Stellite" scrap except that on electric welded tools is now rated at $4 a pound in exchange. For example: if ten pounds of "Stellite" scrap are sent to the company, the sender will be credited $40 on "Stellite" standard bar stock, which will be billed at the current price.

Niles-Bement-Pond Co., 111 Broadway New York City, has purchased fifty acres of land in the Kearney section of the Newark meadows. The acreage has frontages on the Lincoln Highway and the Hackensack River directly opposite the site of the United States Steel Co.'s federal shipbuilding plant. There are no immediate plans for the improvement of this property, although it is understood that in the future it will be used for an extensive manufacturing plant.

Cincinnati Lubricant Pump Co., Cincinnati, Ohio, manufacturer of the "Fulflo" pump for machine tools, is building a new factory and foundry at Blanchester, Ohio, about thirty miles from Cincinnati on the B. & O. Railroad. The company will erect a two-story brick building, 50 by 100 feet, for manufacturing purposes, and a foundry, 30 by 75 feet, which it expects to occupy about January 15. It is the intention to extend the line of lubricating pumps to include those used in airplanes and automobiles.

Bond Foundry & Machine Co., Manheim, Pa., has purchased the property, plant and good will of the Queen City Foundry Co., Toronto, Canada. The plant will be operated as the Bond Engineering Works, Ltd.; it will continue to manufacture gray iron castings for the trade, and in addition will make a line of power transmitting specialties consisting of shaft hangers, couplings, collars, etc. Additional buildings will be erected to take care of the increased business. The works will be under the management of H. M. Lee.

Seneca Falls Mfg. Co., 330 Fall St., Seneca Falls, N. Y., has been reorganized as a result of the purchase of the interests of Messrs. Davis and others. The board of directors comprises Patrick Sweeney, William H. Foxall, L. Sherman Adams and Levi S. Chapman. The officers are Marcus A. Coolidge, president; Alton F. Tupper, vice-president; and Marshall J. Root, secretary and treasurer. The general management of the business will be under the charge of Mr. Root. Additional equipment will be installed and the output will soon be doubled.

Standard Aero Corporation of New York, organized in June, 1916, has found it necessary, due to business expansion, to organize an additional company under the name of the Standard Aircraft Corporation. These two organizations, under practically the same management, will divide their activities as follows: The Standard Aero Corporation of New York will continue as an engineering and experimental organization, while the Standard Aircraft Corporation will devote itself to the manufacturing of airplanes, with plants at Plainfield and Elizabeth, N. J. Both corporations have their offices at Elizabeth, N. J.

Betts Machine Co., Wilmington, Del., has sold its real estate, buildings and equipment to E. I. du Pont de Nemours & Co., Wilmington, Del., who also took over the accounts receivable and assumed all outstanding obligations, and will complete all unfilled orders on the books of the company at the time the sale was made. The du Pont Co. will also use the plant for the construction of machine tools required in their various machine shops. The Betts Machine Co., now of Philadelphia, Pa., has retained the patents, patterns, drawings, jigs, fixtures, etc., and has negotiations under way for a continuation of the manufacture of its line of machine tools. M. A. Sherritt is now president and C. H. Stoer is secretary and treasurer of the Betts Machine Co.

JANUARY MACHINERY 1918

Modern Drilling Practice[1]

by Edward K. Hammond[2]

Many users of drilling machines fail to appreciate the full possibilities of this type of machine tool; and it is probably safe to say that the average user of drilling machines gives more thought to planning methods for the operation of practically every other type of mechanical equipment used in his factory. In this series of articles it is the intention to explain the basic principles which must be observed in designing jigs and work-holding fixtures, handling the work, selecting suitable speeds and feeds, grinding drills, etc., in order to secure the maximum efficiency in performing drilling operations. The examples of shop practice that are illustrated and described have been selected with the view of showing the great improvement in average results that could be obtained on the different types of drilling machines if they were always operated under favorable conditions. In every case the machines selected for the purpose of illustration have been chosen because the work performed on them is representative of modern factory practice and not because the machines themselves are superior to other machines of similar type which are built in this country.

In those shops where the most remarkable improvement has been made in rates of production secured on drilling machines, the increase has been largely due to constantly higher speeds and rates of feed which are employed in the performance of drilling operations, but more particularly as a result of increasing the speed. There are many noteworthy advantages secured through drilling at high speed, and these will receive detailed consideration in a later section of this article. The remarkable increases in the speed at which drilling operations are performed has created a condition which was formerly unimportant, *i. e.*, in regard to the relation between the time actually consumed in the performance of a drilling operation and the time required for setting up the work. Obviously, increasing the speed and rate of feed cuts down the time required to drill a hole, and so jigs and work-holding fixtures must be so constructed that the setting-up time does not become the limiting factor in performing the drilling operation. The steps which must be taken to secure this result will vary according to the depth of the hole, and consequently according to the time required to complete the drilling operation. In any case, the two chief points which require consideration are to design jigs and fixtures with clamping devices which may be quickly operated, so that the minimum amount of time is required to secure the work in place ready to be drilled, or to provide jigs or fixtures of the so-called indexing type, so that the operator may be setting up a piece in the fixture while the machine is engaged in drilling work held in other sections of the fixture. This point will receive detailed consideration in connection with a description of examples of drilling machine equipment which will be illustrated and described.

Object of Using Drilling Jigs and Fixtures

A jig or work-holding fixture may be used on a drilling machine to provide for interchangeability of the drilled pieces, or it may be used for the sole purpose of holding the work and preventing it from turning while the drilling operation is being performed. By far the most important object of using a jig or fixture for drilling parts that are to be assembled together is to provide for accurately locating holes in all duplicate parts produced on the drilling machine, so that bolts, screws, etc., will enter holes in all of these parts without the necessity of subsequent hand fitting. Obviously, the use of jigs and fixtures provides means of greatly reducing the ultimate cost of producing such parts. A further economy is secured through their use, owing to the fact that both the jig or fixture and the drilling machine can be made so simple to operate that unskilled labor may be employed with assurance that the work will possess the desired degree of accuracy. Aside from the actual saving in the cost of performing drilling operations, it is obvious that an even greater saving will usually be effected through the production of interchangeable parts which may be sent directly to the assembling department, where they are ready to be assembled into the finished product without requiring any hand work. Still another claim in favor of the use of jigs and fixtures is that the production of interchangeable parts makes it a very simple matter for broken pieces to be replaced, with perfect assurance that such pieces will fit properly when received by the customer.

In practically all up-to-date manufacturing establishments interchangeable manufacture is now in vogue, and one of the great advantages of this system is that where a complete equipment of jigs and fixtures is employed for the performance of all machining operations, work may continue on the production of all different parts of the product, which are machined in different departments of the factory, with assurance that these parts will assemble together properly. This saves the necessity of waiting for one part to be finished so that other parts may be fitted to it, as was the case under the old method of "building" a machine, which stands out in strong contradistinction to the modern methods of "manufacturing" which are now employed. Necessarily, the attainment of this result calls for the use of a set of jigs and fixtures which have been very carefully designed so that the relation of all machined holes and surfaces are not only accurate in a given piece, but are also accurate in relation to each other.

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[1] For previous articles on drilling practice, see "Doing Lathe Work on All-geared Drills," May, 1915; "Drilling Cotter-pin Holes," April, 1915; "How the Chisel Point of a Drill Wears," March, 1915; "A Speed Record in Drilling," December, 1914; "Cutting Speeds and Feeds for Twist Drills," May, 1912; "Twist Drill Grinding," June, 1909; "Experiments on Twist Drills," May, 1909, and June, 1909; "Drilling Adding Machine Side Frames by Plate Method," September, 1910; "Minimizing the Time of Drilling Operations," July, 1909, and August, 1909, "Data on High-speed Drilling," May, 1909; "Deep Drilling," January, 1904; "Deep Hole Drilling in Gun Construction," May, 1902; and "Deep Hole Drilling," December, 1901.

[2] Associate Editor of MACHINERY

Definition of Terms "Jig" and "Fixture"

The terms "jig" and "fixture" are loosely used as if they could be properly applied to the same class of equipment, although this is not the case. Jigs and fixtures are made in such a great variety of types that it is hard to cover the subject comprehensively without going into a great deal of detail. Probably the best general distinction to make is that a jig is furnished with hardened steel bushings, through which the drills are guided into the work, while in the case of a fixture the desired location is secured through the provision of gage points on the fixture or by some other means. A combination of gage points and bushings is often employed in working out the design of a jig. In both jigs and fixtures, provision is commonly made for holding the work to prevent it from turning, although there are special cases where jigs are clamped to the work or dropped over a machined surface which affords the desired location for the jig. In the majority of cases, however, both jigs and fixtures are furnished with means of securing them to the table of the drilling machine, common methods of obtaining this result being to provide a tongue on the bottom of the fixture which enters a T-slot in the table, or to employ some similar method.

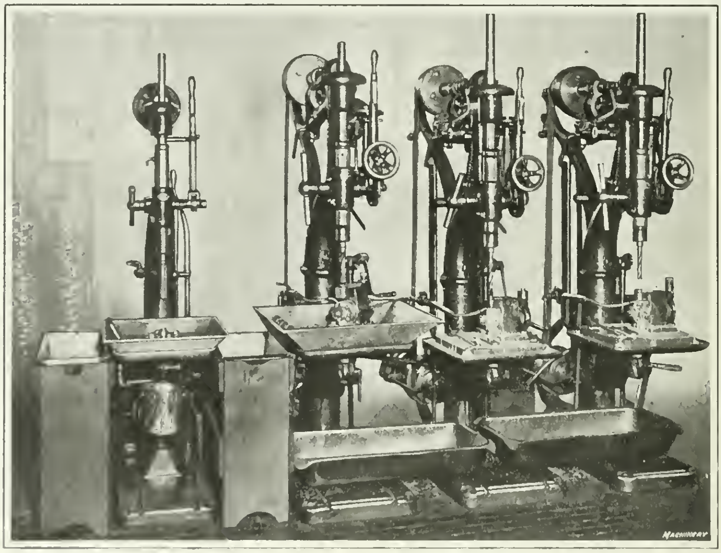

Fig. 1. Vertical Drilling Machines built by the Rockford Drilling Machine Co., equipped with Indexing Fixtures for drilling Universal Joint Rings

In working out the design of either jigs or fixtures, there are a number of points which must receive careful consideration if the most satisfactory results are to be obtained. Among these there is none of greater importance than to be sure that the design of clamping devices which are furnished to secure the work in place, and the form of the fixture, are both such that the work may be put in and taken out after the drilling operation has been completed without entailing an unnecessary loss of time. This point has assumed exceptional importance on account of the steadily increasing rates of speed and feed employed in the performance of drilling operations, because the consequent reduction in drilling time means that the ratio of setting-up time to drilling time will become constantly less favorable unless great care is taken to eliminate all unnecessary loss in setting up the work. Generally speaking, it is necessary to provide a jig or fixture for use in drilling the hole in a part which is to be assembled with a second part that has been drilled with the use of similar equipment. There are certain cases, however, where this is not advisable, as it may be impossible to properly locate a jig on one of the parts to be drilled, or if the attempt were made to design a jig, it would be so complicated as to prove impractical. In such cases the part drilled in a jig is used as the jig for drilling the second part on which it is to be assembled, and where this method is followed, satisfactory results are secured, although the production time is likely to appear somewhat high.

One of the most important questions that should be decided before making a jig is the amount of money that can be profitably spent on special tools for the operation under consideration. In many cases greater efficiency could be secured by making a complicated and expensive tool, but this additional investment would not be warranted by the slight saving in production cost that would be effected through its use. In all cases where the question of jig and fixture design comes up, a careful comparison should be made of the cost of drilling under the present method and the estimated cost of performing the same operation in the new jig or fixture; and unless the saving is sufficient to warrant adoption of the new method, it is obvious that further work should be done by the tool designer to see if a greater reduction in production cost is not possible. While discussing the question of cost, attention is called to the fairly obvious fact that the number of parts to be machined will determine the expenditure that is warranted for jigs and fixtures, as it would be obviously impractical to spend a lot of money for special work-holding equipment — regardless of the efficient results that could be secured through its use — unless the number of parts to be drilled were great enough to return a satisfactory income on the tool investment.

Selection of Locating Points

In choosing the locating surface of gage points on the work to be drilled, consideration must be given to the facilities for locating the corresponding part with which it is to be assembled. This is a highly important point, because, although jigs may be alike as far as their provision for locating the holes is concerned, there may be no facility for locating holes in the corresponding part in the same manner that was used in the one for which a satisfactory selection of locating points was made. In such cases, while the drilled holes may coincide, other surfaces which are required to come into coincidence may be considerably out of line. Therefore, one of the main principles of location is to have the two component parts located from corresponding points or surfaces on the castings. This naturally draws attention to the importance of designing patterns for use in the foundry with suitable provision for holding the castings while they are being drilled. It is sometimes apparent that lack of cooperation between the drafting-room and machine shop, which results in failure to provide efficient means for holding the work, is responsible for adding greatly to the cost of performing machining operations.

Wherever it is possible, special arrangements should be made in designing jigs and fixtures so that it is impossible to insert the piece in any but the correct way. This is especially important in developing tools for use in those shops where a great deal of unskilled labor is employed, as care taken by the tool designers will often be the means of saving a great deal of money which would be lost through spoiling work. The use of fool-proof jigs and fixtures in which it is impossible to insert the work upside down, etc., will also be the means of making important savings in plants where the labor is fairly well trained in the performance of the different classes of work, but where the use of a piece-work system may be responsible for some slight carelessness on the part of machine operators. Another important point is that where the work may vary in size, as in the case of rough castings, etc., it is necessary to have at least some of the locating points made adjustable and placed so that they can be easily reached to make the necessary adjustment, and then fastened so that they are reasonably positive in their function of locating the work.

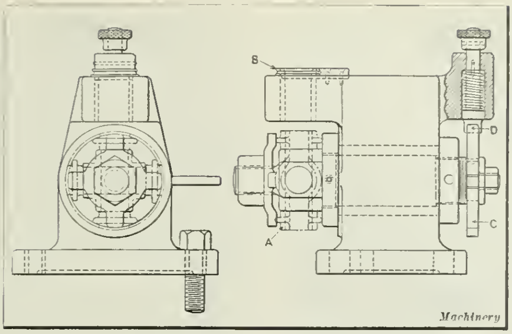

Fig. 2. Indexing Fixture used on Drilling Machine shown in Fig. 1 for drilling Four Holes in Universal Joint Rings

Clamping Devices

In designing clamping devices, care should be taken to arrange each clamp so that the direction in which the strain of the tool or cutter acts upon the work is such that the clamp will possess the maximum strength to resist the pressure of the cut. Another important point is to design the clamps so that they may not readily be detached from the fixture and require a lot of time to be spent in finding clamps which have been mislaid. In all cases, clamping devices should be made as simple as possible and they should be made to operate quickly for reasons that have already been mentioned. In addition to designing clamps so that they are strong enough to resist the pressure of the cut, it is highly important to see that such pressure will not result in springing the work out of place and cause inaccuracy in the location of holes and machined surfaces. This point can best be taken care of by paying attention to the selection of locating and bearing points for the work and clamps, respectively, so that the probability of springing the work is reduced as far as possible. One point to observe in providing for rigidity is to locate clamps or straps so that they are exactly opposite some bearing point on the surface of the work, whenever such a location is found feasible. Another point of importance, in so far as it may affect the accuracy of work produced in a jig or fixture, is to work out the design in such a way that chips may be readily cleared out of the fixture to avoid danger of inaccuracy resulting from chips accumulating on the locating points.

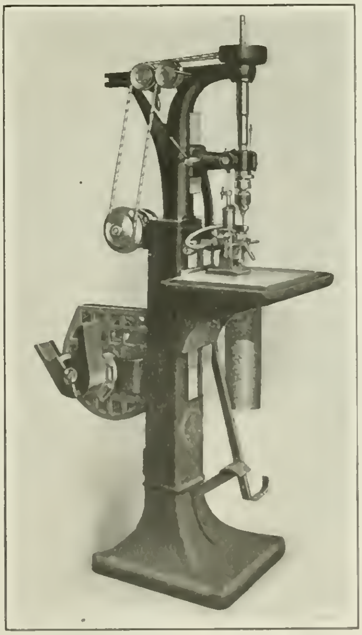

Fig. 3. Leland-Gifford Sensitive Drilling Machine with Special Jig for drilling Cross-holes in Pins

Jigs and fixtures should be made as light as possible in order that they may be easily handled. One way of securing this result is to design the castings with cored holes wherever metal may be eliminated without unduly affecting the strength of the tool. Where jigs are provided with feet, some designers favor the use of three feet, because with such an arrangement they are always sure of the jig taking a firm bearing on the machine table. As a matter of fact, this is an undesirable form of design, because there is nothing to show the presence of chips or other foreign matter under one of the feet of the jig or fixture, which would cause inaccuracy in the setting of the work. With a design in which four feet are provided, the presence of anything under one of the feet will immediately be shown by the fact that an improper bearing is provided and the jig will tend to rock in an unsteady manner until the trouble has been corrected.

Materials Used in Making Jigs and Fixtures

Opinion differs as to the relative merits of cast iron and steel for use in making the bodies of jigs and fixtures. In deciding this point, attention should be given to the use to which the tool is to be put and the character of the work which it is to handle. It is difficult to make a general statement, but the best opinion seems to be that for small and medium sized work, such as parts of sewing machines, typewriters, adding machines, cash registers, phonographs, guns, etc., the steel jig offers decided advantages; but in the case of large work of the kind that has to be machined in factories engaged in the manufacture of machine tools, engines and automobiles, cast iron is undoubtedly the cheaper and more satisfactory material from which to make the castings.

Summary of Desirable Features to Include in Design of Jigs and Fixtures

In presenting the following summary of the features which should be provided in designing jigs and fixtures, the idea is to furnish data which the tool designer may run over in checking up his design. Experienced men will not find it necessary to take such precautions, but in the case of designers who have not had an opportunity to gain the necessary experience to make their judgment absolutely reliable, checking over a design to see that it meets the following requirements will often be the means of saving costly mistakes. These requirements may be briefly summarized as follows:

(A) Does the estimated production cost of drilling work in the new jigs and fixtures show sufficient saving over the cost with existing tool equipment to warrant ordering new tools? (B) Were locating points selected and the method of clamping decided upon before laying out the jig or fixture? (C) Have all clamping devices been made as quick-acting as possible? (D) Were locating points for use in machining component parts selected on corresponding surfaces on these parts? (E) Has the jig or fixture been made fool-proof, *i. e.*, is it arranged so that work cannot be inserted except in the correct way? (F) If the jig is used for holding rough castings, has adjustment been provided for the locating points to compensate for variations in the size of the castings? (G) Are all clamps located in the best position to resist pressure of cutting tool? (H) Have all clamps been made integral parts of the jig or fixture where possible? (I) Has the design of the clamping mechanism been simplified as far as possible? (J) Has provision to avoid springing the work been made by placing all clamps as nearly as possible opposite to bearing points on the work? (K) Has the jig or fixture been made as light as is consistent with rigidity and stiffness by coring out unnecessary metal? (L) Have all corners been made round? (M) Have handles been provided where these will make handling of the jig or fixture more easily accomplished? (N) Has adequate support been provided by placing feet, etc., directly beneath all points where the pressure of cut will come? (O) Has ample clearance been provided in jigs or fixtures used for drilling rough castings? (P) Have all locating points been made visible to the operator while placing work in position in the jig or fixture? (Q) Have holes been provided for the removal of chips from the jig or fixture? (R) Have clamping lugs been located in such a way as to prevent springing the fixture in cases where the fixture must be secured to the drilling machine table? (S) Have instructions been given for the jig or fixture to be tested before it is sent to the shop to be used?

Types of Jigs and Fixtures

The variety of different jigs and fixtures which are in use at the present time is so great that the scope of an article of this kind does not include complete discussion. At the same time, the principles which have just been enunciated apply to all of these different types, and if carefully followed will be the means of greatly improving the efficiency of results secured with the auxiliary equipment designed for use on the drilling machines. Briefly stated, there are three different types of jigs and fixtures used on drilling machines, and mentioned in the order in which they are most generally employed, these are as follows: (1) Jigs or fixtures in which work is held to have one or more holes drilled in its top face. (2) Indexing jigs or fixtures used to provide for the performance of a sequence of operations; such fixtures are furnished with a loading station at which finished pieces may be removed and new parts substituted while pieces held in other sections of the fixture are being drilled. (3) Box jigs in which the work is secured; such jigs are furnished with feet on two or more surfaces, so that the jig may be turned over to provide for drilling one or more holes in two or more surfaces on the work.

Types of Drilling Machines

Drilling machines which find the most general application in American manufacturing plants may be roughly divided into three general classes, as follows:

1. Vertical drilling machines.
2. Radial drilling machines.
3. Multiple-spindle drilling machines.

Each of these general classes is capable of further subdivision, so that drilling machines are finally classified under the following headings:

1. Vertical or "upright" drilling machines.
2. Vertical sensitive drilling machines.
3. Vertical high-duty drilling machines.
4. Radial drilling machines.
5. Multiple-spindle drilling machines of straight line type.
6. Multiple-spindle drilling machines of cluster type.
7. Automatic drilling machines.
8. Turret type drilling machines.

In addition to the eight preceding types of machines a great deal of useful work is done by special machines built to meet the requirements of individual cases. Such machines are generally of the multiple-spindle type, but they are especially designed for specific classes of work.

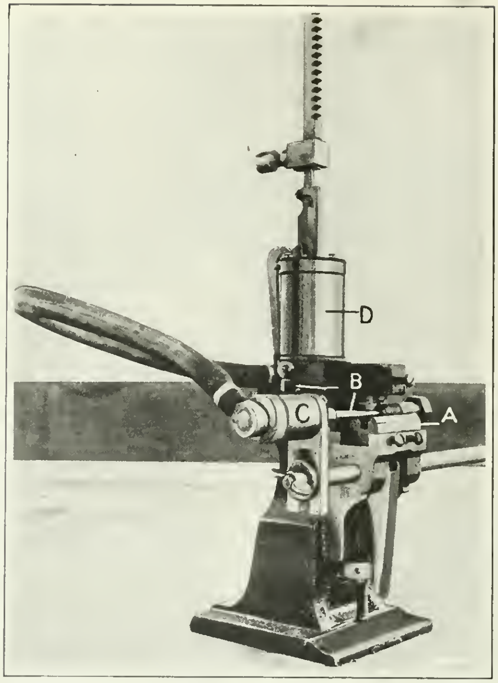

Fig. 4. Quick-acting Jig made by Caulkins & Carpenter for drilling Cross-holes in Pins

Vertical or Upright Drilling Machines

This is the most commonly used type of "drill press" used in the machine shop. It is usually equipped with power feed, and a tapping attachment is often provided, which may be engaged to provide for handling work in which holes have to be tapped.

Vertical Sensitive Drilling Machines—The term "sensitive" is applied to those types of light drilling machines which are equipped with hand feed, so that the operator is able to judge the amount of feed pressure with which the drill is being driven into the work. These machines are usually adapted for drills from the smallest sizes up to from ⅜ to ⅞ inch in diameter. They are used on a great variety of work, and for handling small parts in quick-acting jigs or fixtures they are capable of giving very satisfactory results. One advantage of the hand feed is that an experienced operator may use his judgment in releasing the feed pressure, if he finds the drill has struck a hard spot in the work. This is the means of saving the breaking of drills. Machines of this type are now being built for operation at speeds which were unheard of a few years ago. For instance, some types of sensitive drilling machines are built for operation at speeds ranging from 10,000 to 15,000 revolutions per minute.

Vertical High-duty Drilling Machines—As their name implies, high-duty drilling machines are adapted for the performance of heavy work, and they are commonly employed for using a range of drill sizes running from the maximum capacity of sensitive drilling machines up to the largest sizes in which drills are made. In addition to the performance of drilling operations, high-duty drilling machines are used for a great variety of other classes of work, including such operations as hollow-milling, spot-facing, facing, counterboring, threading, tapping, etc. In general, machines of this character may be employed to advantage wherever it is desired to use a rotating tool on stationary work under conditions where heavy cuts are to be taken. To meet the requirements of such severe service, the high-duty drilling machine is equipped with power-driven feed, and the rates of feed are commonly much greater than that employed on sensitive drilling machines, while the speed at which the drill is operated is correspondingly reduced owing to the greater diameter of the drill. There are various forms of mechanisms used on these machines, but in all cases provision is made for obtaining any of a range of speed and feed changes suitable for the work on which the machine is engaged.

Radial Drilling Machines—On the familiar type of radial drilling machine the spindle head is carried on an arm, which may be swung around the column of the machine, and the spindle head may also be moved back and forth along the arm. This combination of movements makes it possible to locate the spindle of a radial drilling machine at any desired point over work which comes within this range of movement. Radial drilling machines are commonly classified according to the length of arm, *i. e.*, a 6-foot radial drill has an arm 6 feet in length. Sizes in which these machines are generally built run from about $2\frac{1}{2}$ to 6 feet. Obviously, the size of the work which can be handled with a machine of this type is governed by the length of arm and vertical adjustment of the arm on the

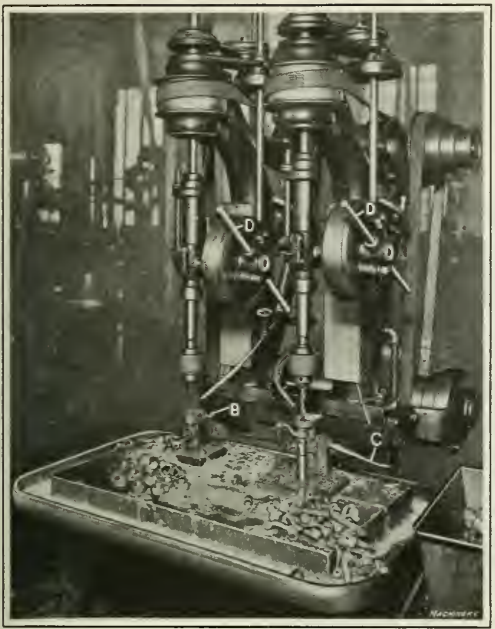

Fig. 5. Leland-Gifford Sensitive Drilling Machine equipped with Power Feed which enables One Operator to keep Two Spindles constantly in Operation

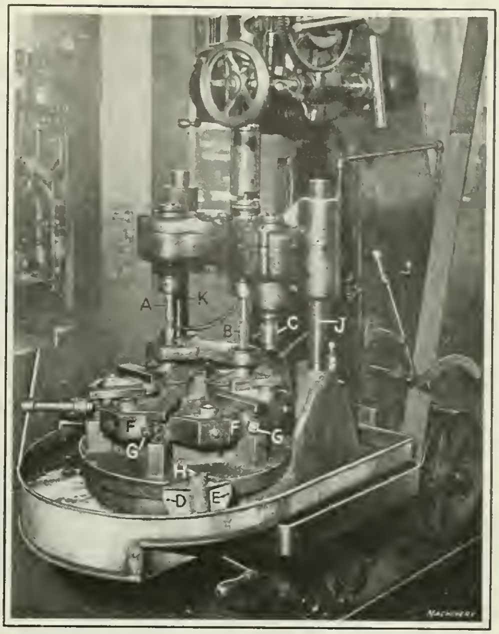

Fig. 6. Baker Bros. High-duty Drilling Machine equipped with Indexing Fixture and Special Three-spindle Head for drilling, reaming and facing

machine column. Radial drilling machines are generally employed for handling those classes of work where there are a number of holes to be drilled and where the work is either too heavy or too large to be conveniently set up on multiple-spindle drilling machines.

Multiple-spindle Drilling Machines of the Straight-line Type—The familiar vertical drilling machine is commonly built with from one to six spindles, and the terms "multiple spindle" and "gang" are used somewhat indiscriminately in referring to machines of this type. Probably the best opinion favors the use of the term "gang" in cases where separate drilling machine units with individual drive are bolted to a common bed casting, while the term "multiple spindle" is understood to designate machines of this type on which all of the spindles are carried in a machine frame of unit construction and are driven by a common driving shaft. In any case, the use made of both gang and multiple-spindle machines covers two general classes of work. In one of these the machine is employed for the performance of a sequence of operations on a piece of work which is passed along from spindle to spindle. On work of this type one or more operators are employed, according to the length of time required to perform the various drilling, counterboring and tapping operations. The other general class of work handled on straight-line multiple-spindle or gang drilling machines is where it is required to drill a number of holes in a piece, a case in point being where a line of holes are to be drilled in a pipe. For operations of this kind the machines are so equipped that all of the spindles feed down and return together.

Multiple-spindle Drilling Machines of the Cluster Type—To obtain efficient results in the performance of drilling operations, the keynote of success in securing a satisfactory rate of production is often found in a satisfactory solution of the problem of properly balancing the ratio of drilling time to setting-up time. If proper means are not provided to reduce setting-up time, this will often become so excessive that the production of the machine is far below the normal rate which ought to be secured. For work where there are a large number of holes to be drilled, profitable use may be made of multiple-spindle drilling machines. These are built with different numbers of spindles, arranged in a "cluster," and furnished with the necessary adjustment to enable the spindles to be set in the desired positions for drilling different groups of holes. The possibility of drilling a number of holes simultaneously, after setting up the work once, is obviously the means of greatly increasing the productivity of the machine.

Automatic Drilling Machines—For drilling holes in small parts, and particularly in those cases where the diameter and depth of the holes are not great, profitable use may often be made of automatic drilling machines. These are built in various types, which will be illustrated and described, but in each case the aim is to provide means of keeping the drilling spindle or spindles constantly employed while the operator is removing drilled pieces from the work-holding fixtures and loading fresh blanks into these fixtures, so that the parts may be drilled when they have been carried around under the drilling spindles. Surprisingly high rates of production can be obtained from machines of this type.

Turret Type of Drilling Machines—Drilling machines of the turret type fill the same general place among drilling machines that is taken by the turret lathe among machines of that type. In other words, turret drilling machines are used in those cases where there is a sequence of such operations as drilling, counterboring and tapping to be performed on a piece of work. Machines of this type are equipped with a turret carried on a horizontal axis about which the turret may be revolved to bring the sequence of tools into the operating position. In general, turret type drilling machines are used as an alternate method of handling those classes of work which are commonly handled on multiple-spindle drilling machines of the straight-line type, where work is passed along from spindle to spindle.

Having made a brief statement concerning the different types of drilling machines and classes of work for which each is adapted, we are ready to enter into a detailed discussion of installations of the different types of machines, showing examples of work for which each type is well adapted, and explaining the methods of setting up the work and giving rates of production that are obtained under favorable conditions. The same order will be followed in discussing the use of these machines as that which was followed in mentioning the different types.

Operation of Vertical or Upright Drilling Machine

Fig. 1 shows a group of three upright drilling machines built by the Rockford Drilling Machine Co., engaged in drilling universal joint rings; and a fourth machine to the left is employed for reaming the holes. It will be seen that the three drilling machines are equipped with indexing jigs to provide for bringing the work into the required positions for successively drilling each of the four holes. A detailed view of the indexing jig is shown in Fig. 2. Referring to this illustration, it will be seen that work *A* is clamped in place under bushing *B* and that provision for locating the work in the four drilling positions is made by means of index plate *C* and spring plunger *D*. The work to be drilled is a drop-forging containing from 0.15 to 0.25 per cent carbon, from 0.30 to 0.60 per cent manganese, sulphur below 0.045 per cent, and phosphorus below 0.05 per cent. The holes to be drilled are 1 inch in diameter by 9/16 inch in depth. The production is approximately 600 completed rings on the three right-hand drilling machines in a ten-hour working day, *i. e.*, 2400 holes are drilled per day in these forgings.

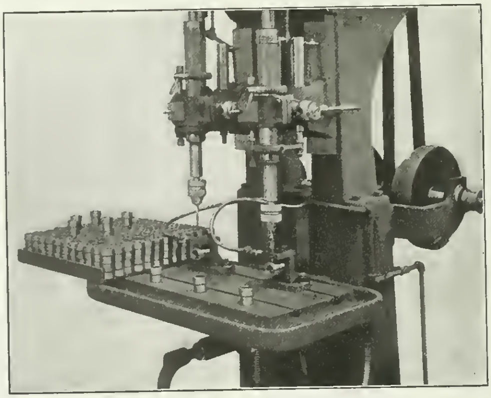

Fig. 7. No. 2½ "Avey" Ball Bearing Sensitive Drilling Machine set up for Use in drilling Steel Bushings. On this Operation the Production is 10,000 Bushings in a Ten-hour Day

High-speed Ball Bearing Sensitive Drilling Machines

To take advantage of the benefits which are secured through the performance of drilling operations at high speed, the Leland-Gifford Co. builds a line of ball bearing sensitive drilling machines which are adapted for operation at speeds ranging from 10,000 to 15,000 R.P.M. These machines are built in a bench type or with a pedestal base so that they may be set up on the floor. Fig. 3 shows one of the pedestal type machines equipped with a special drilling jig built by Caulkins & Carpenter, and a better idea of the way in which this outfit operates will be gathered from Fig. 4. This jig is especially suited for use in drilling cross-holes in pins and similar shaped parts, and to meet the requirements of such work it is furnished with a V-block *A* to hold the work and an end-stop *B* to locate the work in the desired position in the jig. End-stop *B* is connected to a piston in air cylinder *C*, and this cylinder is connected by a rubber hose with cylinder *D*. A rack, which meshes with the feed pinion on the machine, is carried at the upper end of a rod connected with the piston in cylinder *D*, and it will be apparent that during the time that the drill is being fed into the work, the rack carried at the back of the feed pinion is raised, thus raising the piston in cylinder *D*.

After the drilling operation has been completed and the drill spindle starts to rise, the reverse movement of the feed pinion results in driving down the piston in cylinder *D*, and this results in driving air through the flexible tube into cylinder *C*. The result is that end-stop *B* is driven forward and ejects the drilled piece from the V-block. During this time the operator has picked up another piece of work which he can immediately place in position ready to be drilled, so that the operation of the machine may be practically continuous. When the work has been placed in the V-block, and the drill starts to feed down, raising of the piston in cylinder *D* results in actuating a link mechanism at the back of the jig, which is responsible for clamping the work in place. It will also be apparent from the illustration that the V-block which supports the work is carried on a knee which may be adjusted vertically to provide for holding pieces of various diameters; the rod which carries end-stop *B* and cylinder *C* may also be adjusted in its bearing in the knee to provide for drilling pins of different lengths, and it is obviously an easy matter to substitute drill bushings of the correct size for handling different operations. Drilling holes through pins made of screw stock 3/16 inch in diameter with a No. 51 drill, the machine was operated at 6700 R.P.M. and produced 2200 pieces an hour. Such a high rate of production would not be possible were it not for the provision made in designing this jig for rapid handling.

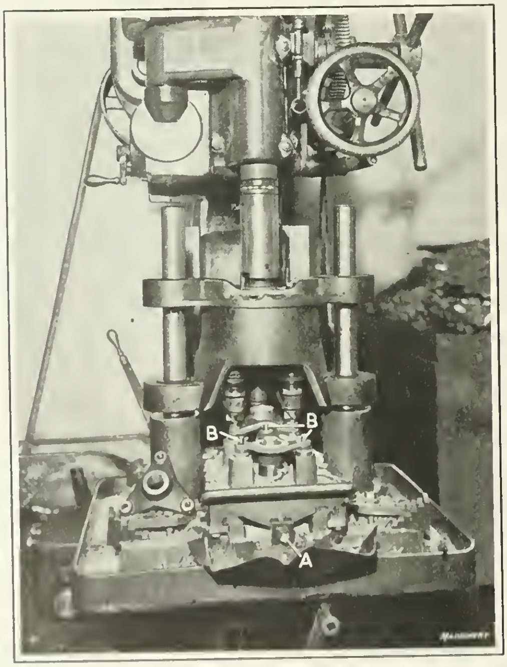

Fig. 8. Baker Bros. High-duty Drilling Machine equipped with a Two-station Work-holding Fixture and Special Three-spindle Head for spot-facing

Fig. 5 shows a high-speed, ball-bearing sensitive drilling machine built by the Leland-Gifford Co. The spindles are mounted in ball bearings, so that it is adapted for running at speeds up to 3500 revolutions per minute. It is known as a semi-automatic machine, and in this respect deviates from what is generally understood to constitute a sensitive drilling machine, because the spindles are equipped with power feed. In operating the machine one man attends to both spindles; he sets a piece of work up in one fixture and engages the power feed, then reaches over to the second fixture, removes the drilled piece of work, sets up a fresh piece in the fixture, and engages the power feed. By this time the drilling operation on the piece under the first spindle has been completed, at which time the feed is automatically tripped and the spindle returned to the starting point, so that the operator merely has to remove the drilled piece and substitute a fresh blank. In this way both spindles of the drilling machine and the man employed to operate them are kept busy almost all of the time, so that an unusually high rate of efficiency is secured. The lever which engages the power feed clutch may also be used to feed the drill by hand; and by simply pushing up this lever, the power feed may be instantly disengaged in any position, without waiting for the full downward movement to be completed. This last-named feature is often of great convenience.

Particular attention is called to the design of the jigs used on this machine. In the case of the 7/8-inch set-collar shown under the left-hand spindle, the operation consists of drilling a 1/4-inch tap-hole which is 3/8 inch deep in a malleable iron part. The work is slipped over pilot *A* and secured by a bell-mouthed bushing operated by lever *B*. In the case of the malleable iron cranks which are being drilled under the right-hand spindle, a bell-mouthed bushing is also employed to secure the work, this bushing being operated by lever *C*. In this case a stronger spring is required to hold the work, and so it was necessary to make the lever longer. The hole being drilled in these cranks is 3/8 inch in diameter by 3/4 inch deep. It will be apparent that in both cases work may be set up and removed with a minimum expenditure of time, which is important, because the operations are soon finished. In drilling the set-collars the operation is performed at 1100 R.P.M. with a feed of 0.005 inch per revolution and the production is 4800 pieces per eight-hour day. In drilling the small cranks, the drill runs at the same speed and feed and 2400 pieces are produced in eight hours. The power feed used in this machine is so designed that when the operator grasps either of the feed levers *D* and pulls it forward, feed is engaged and the drill is advanced into the work by power until an automatic trip throws out the feed clutch, at which time the spindle is automatically returned to the starting position. Graduated circles which are furnished on each of these feed clutches provide for setting the feed to be tripped after a hole has been drilled to a predetermined depth.

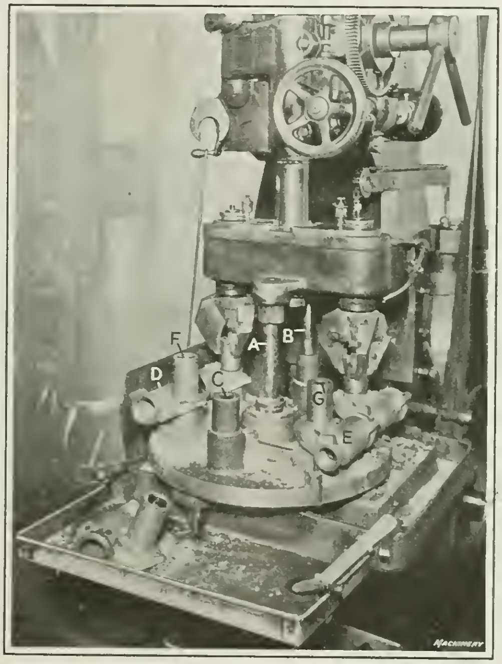

Fig. 9. Baker Bros. High-duty Drilling Machine equipped with Indexing Fixture and Two-spindle Head for hollow-milling Steering-gear Housings

Fig. 7 shows a No. 2½ high-duty, ball-bearing sensitive drilling machine built by the Cincinnati Pulley Machinery Co. This machine is illustrated in use drilling steel bushings where it is required to drill a 17/64-inch hole through a wall 9/32 inch in thickness. These pieces are turned out by an unskilled operator at the rate of 1186 pieces per hour, or approximately 10,000 pieces in a ten-hour day. The daily figure allows time for changing drills and for further unavoidable losses. Machines of this type are built with either plain hand feed or with power feed, and means are provided for automatically reversing the travel of the spindle in one or both directions. The machine equipped with automatic feed mechanism is quite flexible, it being possible to operate it as a fully automatic or semi-automatic machine, or the automatic mechanism may be entirely disconnected and the machine fed by hand. In shops which have pieces that are manufactured in large quantities, and where the nature of the work is such that it may be rapidly set up and removed from fixtures, the fully automatic mechanism is usually employed. On the other hand, where the work is comparatively difficult to handle, more time will be required between successive strokes of the drill, and for such work the automatic trip for the down-feed of the drill is thrown out. In this case the return of the spindle is automatic, but the power feed clutch must be engaged by hand. For still other classes of work all of the automatic movements are disconnected. The trips for the automatic movements may be set so that the time between strokes is just enough to allow the operator to remove the drilled piece and substitute a fresh casting.

Vertical High-duty Drilling Machines

For drilling, reaming and facing the 0.998-inch hole in rear spring center brackets used in the construction of automobiles of its manufacture, the Willys-Overland Co. employs high-duty drilling machines built by Baker Bros., one of these machines being shown in operation in Fig. 6. On this job the nature of the work is such that a considerable amount of time must necessarily be employed in setting the work up in the fixture, but as the depth of the hole to be drilled, reamed and faced is also considerable, this need not constitute an unsurmountable barrier against the attainment of efficient production. The problem has been adequately solved through adoption of the use of an indexing work-holding fixture. The pieces have to be drilled, reamed and faced, and these operations are performed by tools shown at *A*, *B* and *C*, respectively. The drilling operation naturally consumes the greatest amount of time, and while the drill is in operation the workman has ample time to remove one drilled piece from the loading station at the front of the fixture and substitute a fresh blank; then, when the machine spindle lifts the multiple head which drives the three tools, the operator pushes the fixture around until the index pin locates it at the next station. For each traverse of the drilling machine spindle it will be apparent that one finished piece is produced, as the drilling, reaming and spot-facing operations are performed simultaneously.

The work is malleable iron, and referring to the piece shown leaning against the fixture at the front, attention is called to the fact that two locating pins enter holes *D* and *E*, which were drilled in a previous operation. Swinging clamp *F* is then brought up against the front of the work and secured by nut *G* that is tightened with a wrench. The hole *H* to be drilled is 0.998 inch in diameter by 3 1/16 inches deep, and the rate of production is 600 pieces per eight-hour day. The operation is performed at a speed of 300 R.P.M. with a feed of 0.024 inch per revolution. The machine is equipped with a three-spindle auxiliary head built in the Willys-Overland factory, and attention is called to the pilots *J* and *K*, which extend up from the work-holding fixture into bushings in the drill head, thus assuring permanent alignment.

In connection with the general discussion of high-duty drilling machines, mention was made of the fact that machines of this type are well adapted for the performance of many other operations besides drilling. In Fig. 8, one of the Baker high-duty drilling machines is shown set up to provide for simultaneously spot-facing three pads on a universal joint spider. The machine used for this purpose is equipped with a three-spindle multiple head, and this head is piloted from the fixture, as in the preceding case. The pads on these spiders have to be spot-faced on both sides, and to provide for turning over the work or for removing a finished piece from the fixture and substituting a fresh malleable iron casting, so that idle time of the machine may be reduced as far as possible, use is made of a sliding fixture of the type shown. This fixture is furnished with two stops, one of which is shown at *A*, which limit the travel of the fixture in either direction to provide for locating the work supported at one or the other of the two stations on the fixture under the spot-facing tools. The
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holes in these spiders have already been drilled, and these are employed as locating points; in addition, the pins *B* which locate the work from these holes extend up sufficiently through the work so that the spot-facing tools may be piloted over them to assure rigidity. Owing to the clever way in which the design of this fixture has been worked out and applied, these malleable iron spiders may have three pads spot-faced on both sides with a production of 288 parts per eight-hour day from each machine. The machine is run at 200 R.P.M. with hand feed.

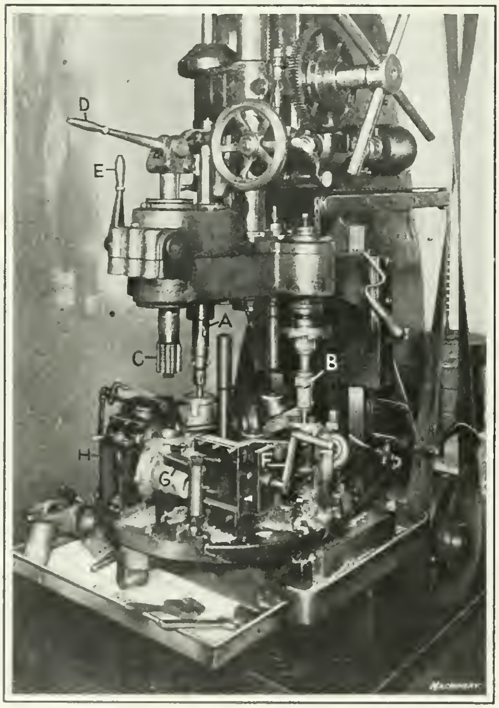

Fig. 10. Baker Bros. High-duty Drilling Machine with Indexing Fixture and Three-spindle Head for boring and reaming Three Holes, facing Two Surfaces and tapping One Hole

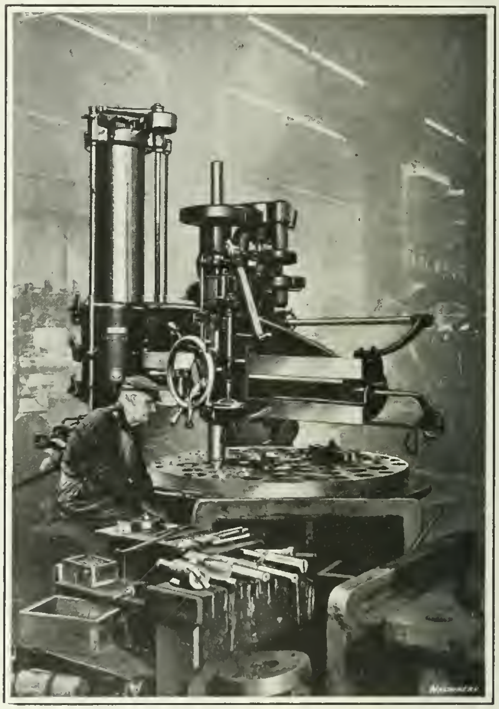

Fig. 11. Radial Drilling Machine built by American Tool Works Co. engaged in Operation of machining Air-head of Mesta Blowing Engine

Another example which tends to show the range of work that may be efficiently handled on high-duty drilling machines is illustrated in Fig. 9, which shows the operation of hollow-milling steering-gear housings for the Willys-Overland car. Here, again, use is made of an indexing work-holding fixture, and the machine is equipped with a special two-spindle auxiliary head. To provide the degree of rigidity that is required under severe service of this kind, however, the system of piloting is somewhat different from that shown on preceding machines of this type. In this case two pilots are employed; the central pilot *A* is carried by the fixture and runs in a bushing in the drill head, while pilot *B* is carried by the head and runs in sockets carried by the fixture. This fixture is indexed through 180 degrees, and in this position pilot *B* will run in socket *C*. In performing this hollow-milling operation, the two pieces of work *D* and *E* are dropped over pilots on the fixture and the ends of these pieces simply bear against lugs on the fixture which prevent them from turning. Where this method of securing work can be employed, it is extremely satisfactory, because the length of time required to set up the work in place for machining is reduced very close to a minimum. The holes have been machined by a previous operation and are employed as the locating points. After setting up the work the fixture is indexed through 180 degrees, as previously mentioned, and this brings the blanks into the position shown in the illustration where two pieces may be milled simultaneously. The hollow-milling cutters used on this machine are provided with pilots which enter bushings *F* and *G* in the studs on which the work is carried, so that further provision is made to guard against vibration. The length of time consumed by this hollow-milling operation is ample to allow the finished pieces to be removed from the fixture and new blanks to be set up. The material is malleable iron; and the surface finished during this operation is 3¼ inches in length by 2¼ inches in diameter; the rate of production is 160 pieces per eight-hour working day. This operation is performed at 70 R.P.M. with a feed of 0.010 inch per revolution.

By employing a carefully worked out design for tools and work-holding fixtures, there are many classes of work on which a considerable sequence of operations may be performed through the use of high-duty drilling machines. An excellent example of this kind is shown in Fig. 10, which illustrates one of the Baker high-duty drilling machines equipped with tools and an indexing fixture to provide for boring and reaming holes of three diameters in the Willys-Overland steering-gear housing, facing the surface at the top of this housing, facing off a seat for the ball bearing, and tapping one of the bored holes. As in the preceding case, a double system of pilots is employed, one of which is secured to the work-holding fixture and enters a bushing in the three-spindle auxiliary head provided on the machine, while the other pilot is carried by this special auxiliary head and runs in a sequence of bushings provided for that purpose in the work-holding fixture. Rough-boring of the holes of different diameters is performed by bits carried in bar *A*. Then, when the work is indexed to the next position, the combination reaming and facing tool *B* reams the three bored holes and faces both the top of the steering-gear housing and the ball bearing seat. After this has been accomplished, the work is indexed once more and the tap *C* cuts the thread in the large hole. To provide for this last operation, the tapping spindle is furnished with a hand-feed lever *D*, and after the tap has penetrated to the desired depth, it is reversed and backed out of the hole by gearing operated by lever *E*.

In this connection attention is called to the fact that all the auxiliary heads employed on these heavy-duty Baker Bros.

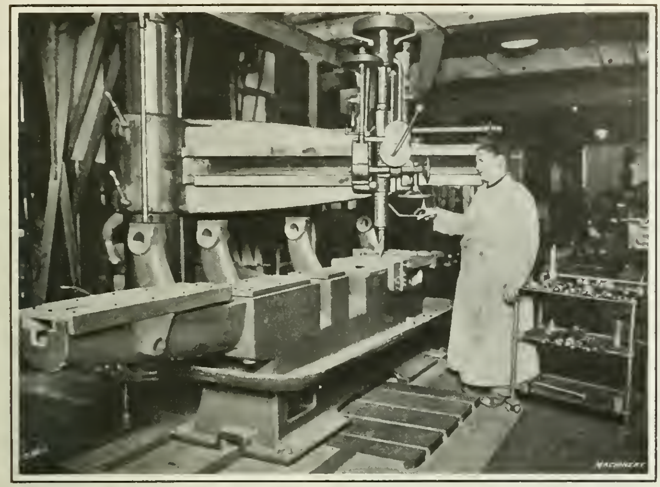

Fig. 12. Radial Drilling Machine built by Cincinnati Bickford Tool Co. engaged in drilling Bed of Cleveland Automatic

drilling machines are counterweighted, the arrangement being clearly shown at the right-hand side of the machine shown in Fig. 10. The fixture used to support the work for performing the preceding operations is quite interesting. The work is placed over a pilot that enters a hole bored by a preceding operation, and is then clamped at either end by jaws actuated by a screw threaded right- and left-hand at opposite ends, which is turned by crank *F*. The work is further secured in place by clamp *G*, and in this connection attention is called to the second clamp *H*, which is not in use. The reason for this is interesting, as it shows an economy effected in the design of work-holding fixtures. Cars built for American use are generally equipped with the steering-wheel at the left, while those exported to Europe have the steering-wheel at the right. This makes it necessary to machine steering-gear housings for both types of design, but to avoid the necessity of an additional investment in jig and fixture equipment, or the loss of time and incidental expense which would be involved in changing from one type of work-holding fixture to another, the fixture shown in Fig. 10 is made "universal," in that it will hold either type of steering-gear housings. The only change is that for holding a housing of the opposite hand, the piece will rest in the fixture in the opposite direction, and in that case clamp *H* will be employed and clamp *G* will remain idle. The holes bored and reamed during this series of operations are 2 3/8 by 13/16, 2 1/16 by 11/16, and 1 1/2 by 1 3/4 inch in diameter and depth, respectively; the first of these three holes is the one to be tapped. These pieces are made of malleable iron and the rate of production is 120 pieces per eight-hour day.

Radial Drilling Machines

Where there are a number of holes to be drilled over the area of a piece of work that is too large or too heavy to enable all of the holes to be conveniently reached by a multiple-spindle drilling machine, use is generally made of a radial drilling machine on which the combined movement secured by swinging the radial arm and adjusting the position of the drill spindle head on this arm will enable all of the holes to be reached with a single setting of the work. Radial drilling machines are also employed in some cases where the size of the holes to be drilled and the material is such that the service would be too severe for many classes of multiple-spindle machines. Fig. 11 shows a typical example of radial drilling machine work, which consists of drilling holes in the air-head of a blowing engine. The view shown is in the shops of the Mesta Machine Co., and the radial drilling machine is a product of the American Tool Works Co. In the Mesta Machine Co.'s shops radial drilling machines are also used to a considerable extent for the performance of machining operations on castings of such size and weight that they sometimes exceed the maximum capacity of the 75-ton electric cranes in the shop, and in any case would be far too heavy to enable them to be set up on any drilling machine. For this class of work the radial drills are furnished with eyes so that they can be picked up by the crane hook and carried to the work instead of following the general practice of taking work to the machine. For handling these exceptionally large pieces which are constantly going through the Mesta shops, the use of portable machines is practically a matter of necessity; at the same time, their application has been found beneficial in that it is possible to have a number of machines working simultaneously on one of these large castings, so that the time required to complete the various machining operations is substantially reduced.

Fig. 12 shows a radial drilling machine built by the Cincinnati Bickford Tool Co. This machine is shown engaged on a typical radial drilling operation, namely, drilling all of the holes in a machine bed casting. This machine is used in the plant of the Cleveland Automatic Machine Co., where it is engaged in drilling fifty-two holes in the bed of a Cleveland automatic. The operations comprise drilling, reaming, counterboring and tapping holes varying from 2¼ down to ¼ inch in diameter; the largest counterbore is 4 inches in diameter. The spindle of the machine is equipped with a quick-change chuck, and, located conveniently for the operator, there will be seen a portable stand on which are carried the different drills, counterbores, reamers, etc., which are required in carrying out the work.

Multiple Drilling Machines of Straight-line Type

In connection with the introductory statement concerning the classes of work handled on multiple-spindle drilling

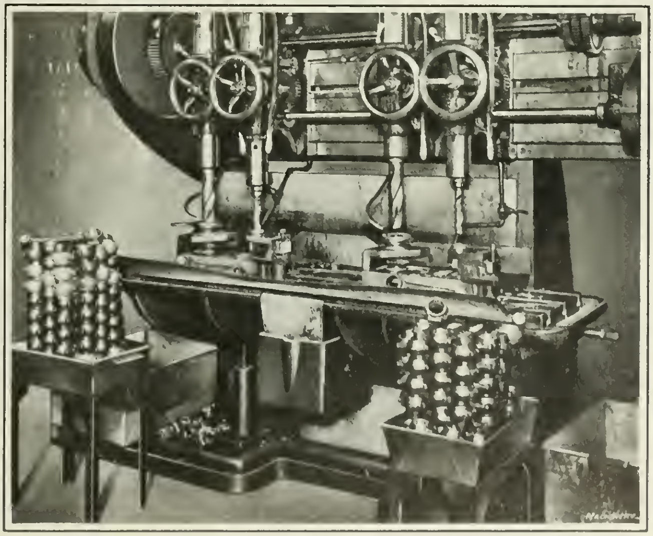

Fig. 13. Four-spindle Drilling Machine built by Foote-Burt Co. engaged in simultaneously drilling Both Holes in Two Connecting-rods

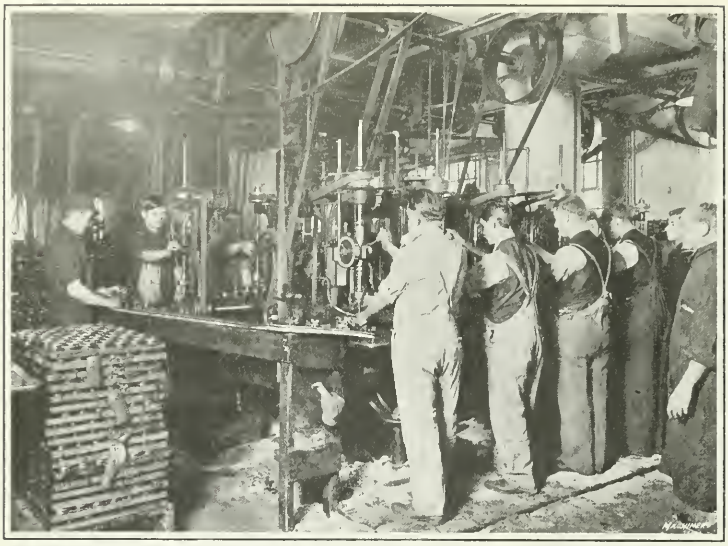

Fig. 14. Battery of Two Four-spindle Washburn Drilling Machines operated by "Team" of Ten Men for drilling and tapping Two Holes in Fuse Parts

machines of the straight-line type, mention was made of the fact that such machines are commonly employed for either simultaneously drilling a number of holes located in a straight line in a piece of work, or else that the machines are arranged to perform a sequence of operations on parts which are set up successively under the different spindles of the machine. In the latter case the operator moves progressively from spindle to spindle, removing drilled pieces and substituting blanks in their place ready to be drilled. Fig. 13 shows a special multiple-spindle machine of the straight-line type built for the Willys-Overland Co. by the Foote-Burt Co., which is engaged in the performance of drilling operations on connecting-rods. Here the work is of such character that two spindles are required for drilling each piece, but the length of these operations is sufficient so that a four-spindle machine may be employed to allow the operator to busy himself setting up work under one pair of spindles, while the other pair is engaged on the drilling operation on another part. In this way the operator is kept constantly employed. The work-holding fixtures used on this machine employ two principles which are often used in jig and fixture design for locating and securing the work in place. The small end of the connecting-rod is pushed into a V-block, which locates it under the drill, and after this has been done, a bell-mouthed bushing, through which the other drill operates, is screwed down onto the large end of the connecting-rod, thus locating this end in place to be drilled and also clamping the work in the fixture. With an arrangement of this kind the time involved in setting up the work is reduced to a point where lost time becomes unimportant. The material to be drilled is drop-forgings, the large hole being 2.188 by 1.688 inch deep; and the small hole is 1.123 by 1 5/16 inch deep. The operation is performed at a speed of 325 R.P.M. and a feed of 0.005 inch per revolution; the production is 720 crankshafts per eight-hour day from each machine.

For use in drilling and tapping nose adapters for shrapnel cases, excellent results have been obtained with an equipment consisting of two four-spindle drilling machines built by the Washburn Shops. These machines are of the power feed type and are placed back to back, as shown in Fig. 14, with metal covered shelves extending across the ends of the machines to provide for sliding jigs from one machine to the other. The work consists of drilling two holes, each of which must subsequently be tapped, the sizes being 3/8- and 3/16-inch tap holes. The interesting feature of this installation is the careful way in which plans were made to increase production as far as possible. About three dozen jigs were supplied and the "team" which operates this pair of machines consists of ten operatives, one at each of the spindles and one stationed at each end shelf, whose duty it is to remove finished pieces from the jigs and substitute fresh blanks. A piece is placed in a jig by one of the men stationed in the loading position, and this piece is passed along from spindle to spindle, so that the two holes are drilled and tapped by the four spindles of one machine unit. This piece is then removed from the jig and a fresh blank substituted, after which the jig is pushed across the shelf to the four men operating the machine at the opposite side of the group. In this way each jig goes round and round in a continuous circuit, and there is practically no loss of time. The order in which the operations are performed is as follows: drill 3/8-inch hole, drill 3/16-inch hole; tap 3/8-inch hole and tap 3/16-inch hole. These men work ten hours a day on a piece-work basis, and the normal rate of production is about 5500 pieces per working day for each gang. At times the production was increased to a considerable extent, but this is regarded more in the light of a "spurt" than normal operating conditions.

In the plant of the Hupp Motor Car Co. heavy-duty drilling machines, built by the Colburn Machine Tool Co., are used for drilling and reaming connecting-rods. A gang of four machines are used, which are equipped with a special combination table or track on which the jigs are slid along from one spindle to another, the arrangement being clearly shown in Fig. 15. Looking at the spindles from right to left, the first spindle at the right drills out the hole at the large end of the connecting-rod and the second spindle reams this hole; the third is a reserve spindle, the use of which will be explained later, and the fourth spindle drills the hole in the small end of the connecting-rod. One operator attends to the

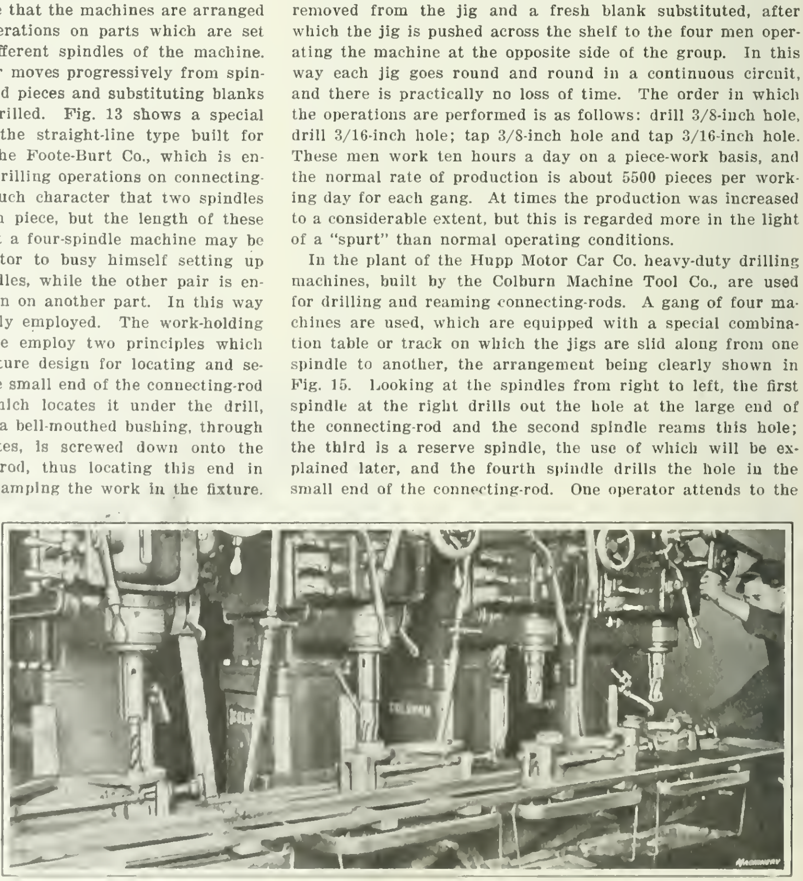

Fig. 15. Gang of Four Colburn High-duty Drilling Machines equipped with Sliding Jigs for drilling Hupp Connecting-rods. One Spindle is held in reserve to substitute as required

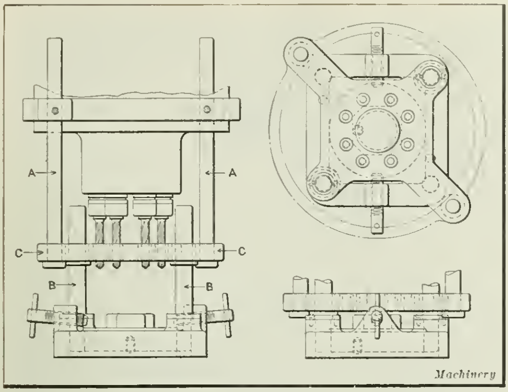

Fig. 16. Multiple-spindle Drill Head provided with Jig-plate that is lifted with Head when Spindle of Drilling Machine rises in order to facilitate Removal of Work from Fixture

whole battery of machines, and after he has started a drill working on one hole, he goes along to the next jig and gets it ready for operation. The jigs are never lifted, it being merely necessary for the operator to remove the drilled connecting-rod and insert a new forging after each operation. By having the drilling machines independently belted, it is possible to obtain any speed for any particular requirement, and should a breakdown occur on any spindle the other three spindles are not affected, as would be the case with a multiple-spindle machine of the straight-line type. In case of emergency, the reserve spindle can be quickly changed over to either tool that requires this spindle, so that production is not held up. The way in which the connecting-rods are held in the jigs is fairly apparent from the illustration. Both ends of the rod rest on finished pads in the jig, and by tightening the clamping screw the large end of the rod is forced between the ends of two converging studs that form the equivalent of a V-block. It will be seen that the clamping screw is inclined slightly downward so that it holds the work down on the supporting surfaces of the jig. The drop-forgings to be drilled contain from 0.035 to 0.045 per cent carbon. The hole to be drilled in the large end of the rod is 2 1/16 inches in diameter by 1 3/8 inch deep; and the hole in the small end of the rod is 0.864 inch in diameter by 7/8 inch deep. The rate of production secured on this job is 400 connecting-rods in a nine-hour working day.

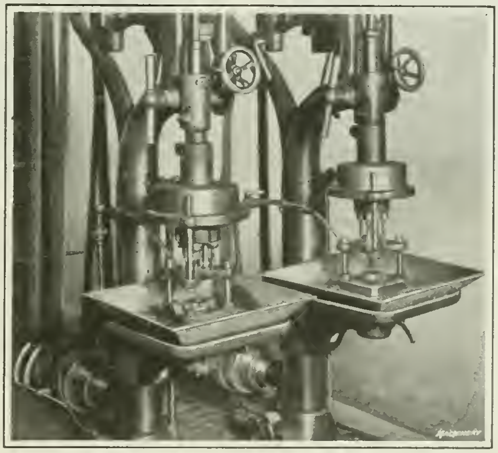

Fig. 17. Rockford Vertical Drilling Machines with Multiple Heads

Fig. 17 shows an interesting installation of vertical drilling machines built by the Rockford Drilling Machine Co., and equipped with multiple-spindle drill heads. The feature of this equipment is the provision of a jig-plate carried by the drill head, the idea being more clearly shown in Fig. 16, which gives a detailed view of the jig construction. It will be seen that this jig-plate comes down to the points of the drills, so that adequate support is provided during the intervals at which the drills are being started into the work; then the jig-plate remains on the work while the drills are fed in to the desired depth. While the drilling machine spindle is raised, the head carries the jig-plate up with it, so that there is no obstruction to hinder the operator in removing work from the fixture. The way in which this result is secured is as follows: When the drilling machine spindle is raised, heads at the lower ends of rods *A*, carried by the multiple head, lift the jig-plate. These arms are so adjusted that the jig-plate is held with its lower surface just above the drill points, as shown in Fig. 17. When the drills are fed down to the work, the jig-plate drops until further movement is retarded by flanges on rods *B* carried by the work-holding fixture. In this position the jig continues to support the drills, but the drills may be fed through to the desired depth. It will, of course, be apparent that jig-plate *C* is furnished with the usual arrangement of hardened steel bushings; and the work is held in the fixture by an arrangement of clamps which is quite apparent in the illustration. It will be seen that the drill heads shown on the machines in Fig. 17 are of four- and eight-spindle types, respectively, and the work to be drilled is two types of universal joint rings. The holes drilled by the four-spindle head are 5/16 inch in diameter by 3/8 inch deep, and the holes drilled on the eight-spindle head are 5/16 inch in diameter by 1/2 inch deep. The material is drop-forgings containing 0.025 to 0.035 per cent of carbon. The rate of production is from 1400 to 1500 rings in a ten-hour working day.

Compressed Air for Ejecting Work from Fixtures

Mention has already been made of the increased importance of designing fixtures to provide for the rapid handling of work on account of the reduction in drilling time which has been made possible through the design of high-speed machines. Fig. 18 shows the fixture used on a machine equipped with a two-spindle head which is used for drilling holes 0.107 inch in diameter in disks shown at *A*. A feature of this equipment is the provision for rapid handling of the work. A supply of disks is kept in feed-trough *B*, and as soon as one piece has been engaged by the drills, the operator lays his thumb on a second piece and starts to advance it to the drilling position. Location of the work is very simple, as it is merely necessary to slide the work into the notch *C*, which locates it under the drill spindles. When the drilling operation has been completed, the operator removes his thumb from the piece of work and reaches for another piece. As the spindle on the machine rises, a blast of compressed air through tube *D* blows the drilled work off the fixture and it drops through opening *E* into a receiver. At the back of the

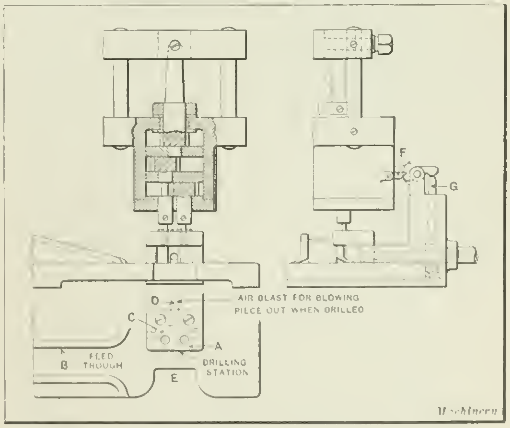

Fig. 18. Work-holding Fixture provided with automatically operated Air Ejector to discharge Work through Chute into Receiver placed under Drilling Machine

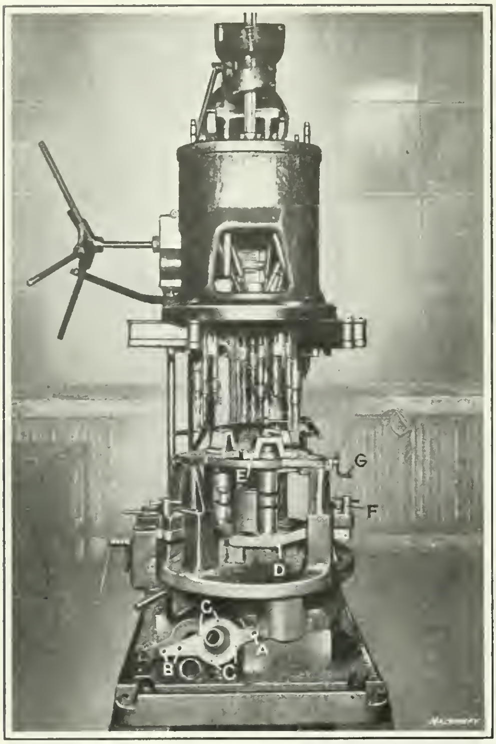

Fig. 19. Ten-spindle Drilling Machine built by National Automatic Tool Co. engaged in drilling and reaming Rear Axle Spiders

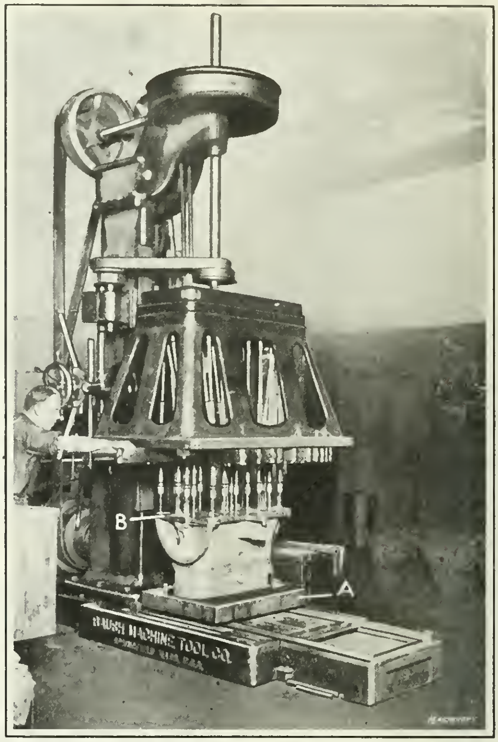

Fig. 20. Baush Multiple-spindle Drilling Machine equipped with Sliding Fixture to facilitate loading Casting in Fixture and removing Drilled Work

drill head it will be seen that there is a stud *F* that engages a trip which actuates air-valve *G* to provide for the admission of air into tube *D* at the proper time to eject the work. Such an apparatus can be worked very rapidly.

Multiple-spindle Drilling Machines of Cluster Type

Machines which will be discussed under this heading may be roughly sub-divided into standard and special equipments. Standard multiple-spindle drilling machines are built by several firms and are practically universal in their application, in so far as drilling holes over an area within their range is concerned. The only limitation in the use of these machines is in regard to the minimum distance between centers of different holes that must be drilled. As compared with this condition, we have the special-purpose multiple-spindle drilling machine, which is adapted for the performance of one specific manufacturing operation; machines of this type are being used to extremely good advantage in the performance of drilling operations on automobile crankcases, etc., but it necessarily follows that a plant that can afford to buy a single-purpose multiple-spindle drilling machine must have a large volume of work in order to be able to earn a fair return upon the investment. After reading the following description of operations performed on machines of each type, the reader will have a good idea of the scope of work that comes within the province of the cluster type multiple-spindle drilling machine.

Fig. 19 shows one of the No. 14 "Natco" multiple-spindle drilling machines built by the National Automatic Tool Co.; this machine is used at the plant of the Willys-Overland Co. for drilling and reaming one hole 3/4 inch in diameter by 1 3/8 inch deep and two holes 5/8 inch in diameter by 1 inch deep. In addition, four 17/64-inch holes, 7/32 inch deep, are drilled in the flange of the rear axle spiders, but these holes are not reamed. This installation is somewhat exceptional in that it involves the use of an indexing fixture on a multiple-spindle drilling machine. This fixture is furnished with three stations, one of which is a loading station; at one station the three large holes are drilled and two of the 17/64-inch holes are also drilled, and at the third station the three large holes are reamed while the other two 17/64-inch holes are drilled. Evidently this calls for the use of a ten-spindle drilling machine with the spindles arranged in two groups of five spindles each. In the first group there are one 3/4-inch drill, two 5/8-inch drills and two 17/64-inch drills; in the second group there are one 3/4-inch reamer, two 5/8-inch reamers and two 17/64-inch drills. The arrangement of these holes in the work will be apparent after studying the piece shown lying at the base of the machine just under the fixture. The 3/4-inch hole is shown at *A*, the two 5/8-inch holes at *B* and the four 17/64-inch holes at *C*.

The preceding description has explained the manner in which the indexing fixture carries the work under the two groups of spindles in order to provide for drilling and reaming three holes, and drilling four other small holes. The arrangement of this work-holding fixture is quite interesting. A pilot carried on pivoted bar *D* enters the hole in the lower end of the work and raises the work so that a pilot carried by frame *E* enters the upper end. After the pivoted bar *D* has been clamped by T-screw *F*, the work is secured in the fixture, as regards its vertical position. It is still necessary, however, to locate the work about its vertical axis so that all seven holes *A*, *B* and *C* will be properly positioned in the spider. This is accomplished by a sliding V-block, which is pushed over the end of the work adjacent to the 3/4-inch hole *A* by means of screw *G*. Of course, there are three complete sets of mechanism corresponding to each of the three stations on the work-holding fixture, and for each traverse of the multiple-spindle drill head, one spider is finished, so that the operator may remove one piece at the loading station and substitute a fresh blank. These spiders are made of malleable iron and the rate of production is 960 pieces per eight-hour working day. Owing to the length of time required to load pieces into this fixture, the speed and feed at which the operation is performed is less than would ordinarily be employed

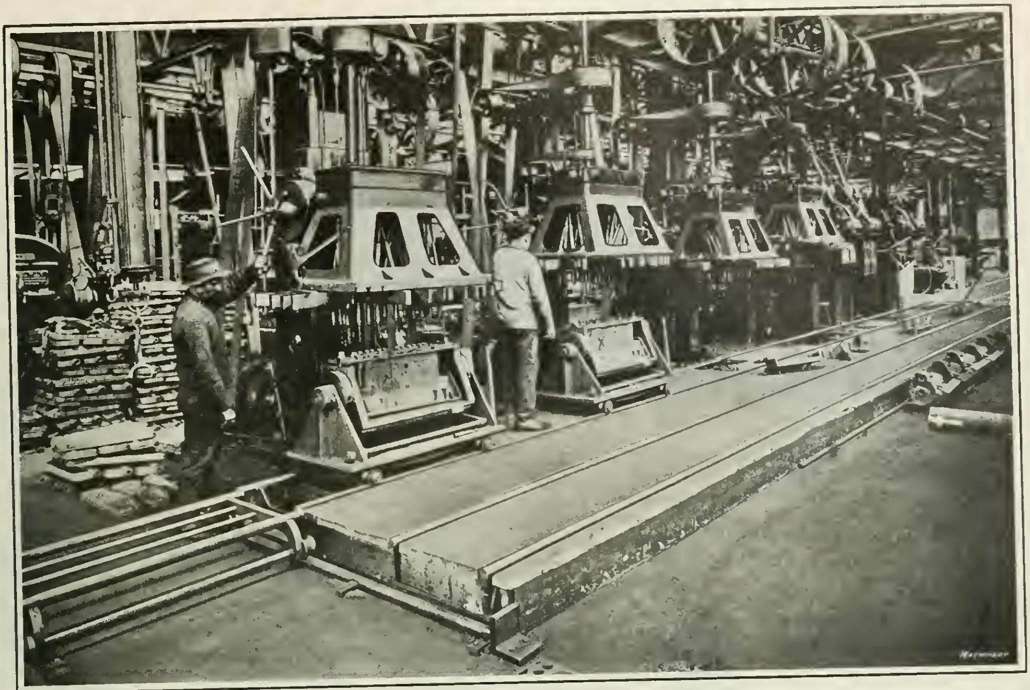

Fig. 21. Traveling Jigs used in Connection with Multiple-spindle Drilling Machines built by Baush Machine Tool Co. for machining Automobile Engine Cylinder Blocks

for drills and reamers of these sizes. This loss is partially offset by the fact that more parts are obtained for each grinding of the tools.

At the plant of the Continental Motors Co. there is an extremely interesting equipment of multiple-spindle drilling machines built by the Baush Machine Tool Co. These machines are used for the performance of drilling operations on the engine cylinder blocks, and to facilitate handling of the work as far as possible, an interesting arrangement of traveling jigs has been developed. Reference to Fig. 21 will show that each of these fixtures is carried on a truck running on tracks that pass along under the heads of the multiple-spindle drilling machines. The jigs are supported on trunnions in the truck frames, which make it possible to swing the work around to provide for the performance of drilling operations in different planes on the work. Each drilling machine is equipped with a cluster head in which the spindles are grouped to provide for simultaneously drilling all of the holes in one face of the cylinder block. After the groups of small holes have been drilled, the work goes on under straight-line multiple-spindle drilling machines which provide for drilling the valve-stem holes, valve push-rod holes, etc. The work is then removed from the jig and the empty truck is run onto a section of track, which, in turn, is supported on truck wheels so that the track may be moved over into alignment with the return track rails, which will be seen in the foreground of the picture. As the truck jig moves down this track a new casting is put in place, after which the jig is moved along onto a second transfer truck on which it is moved over to the rails which will carry it under the drilling machines for the performance of successive operations. With this arrangement it is possible to employ a sufficient number of reserve jigs, so that work may be constantly available for the machines as fast as they complete operations on a given cylinder block. Consequently idle time of the machines and operators is reduced very close to the absolute minimum.

Fig. 20 shows another application of a Baush multiple-spindle drilling machine on cylinder block work. In this case the machine is employed in the plant of the Lozier Motor Co., and the arrangement of work-holding fixture and jig-plate bring out two principles which are of interest. In the first place, the base *A*, on which the work is supported, is mounted on ways which enable it to be slid out from under the multiple-spindle drill head to provide for the convenient removal of drilled work and substitution of a fresh casting. The other point of interest in connection with this job is the use of a jig-plate *B*, which is secured to the work to provide for maintaining a positive relation of the drills to one another. This idea of employing a jig-plate which is secured to the work, instead of having the jig part of a work-holding fixture which carries the piece to be drilled, may be employed in many cases with very satisfactory results.

The next installment will take up single-purpose cluster-type multiple-spindle drilling machines, station-type machines, applications of inverted drilling principle for deep-hole work, machining shells on drilling machines, auxiliary drilling heads and speeders, automatic and semi-automatic drilling machines, etc.

* * *

MEN REQUIRED FOR MECHANICAL WORK ON AIRPLANES

In order to further extend the aviation branch of the U. S. Navy, Secretary Daniels has authorized the enlistment of 8000 men for mechanical work on airplanes. These men will not be enlisted for pilot's duties, but, coming into the service as mechanics, will receive a special and unusual training in the building, handling, repairing and overhauling of aircraft, and will be the ground personnel of the flying corps. The requirements for enrollment will be the same as for the regular service in the U. S. Navy, the enlistment being as machinist's mate. The training will last about three months, and on the completion of the training course, those who pass the examination will be rated as first- or second-class petty officers, and will be eligible for promotion to the next higher grade if they show fitness, the promotion in the aviation field being unusually fast. The age limit for enlistment is from 21 to 35 years. Besides machinists, coppersmiths, blacksmiths, acetylene welders, gas-engine repair men, instrument makers and electricians are wanted. Machinists who have had previous experience in gasoline engines or in any similar skilled trade will have preference. Applications should be sent to the U. S. Navy Recruiting Bureau, 318 W. 39th St., New York City.

GRINDING MACHINE TOOL PLANE SURFACES

Milling machine tables may be finished at low cost by grinding the top on a surface grinding machine after the slide has been scraped and finished. The resulting surface is true, hard and smooth, and well fitted for long wear. Not only is the finishing by grinding an economical practice, but it gives a pleasing effect of material advantage in selling the machine.

The grinding of plane surfaces on machine tools is being developed still further, and it would not be at all surprising to find some enterprising machine tool builder who has developed a method of grinding lathe ways and thus eliminated the slow, laborious and costly job of fitting and scraping. A ground lathe bed should be superior to a scraped bed both as regards accuracy and durability. No one questions the accuracy of a ground surface. It is easy to produce plane surfaces true within limits of ± 0.00025 in a length of 18 inches, and, in fact, closer limits can be worked in actual practice. Another advantage of great importance on a lathe bed is that the ground surface is hard and dense, and in first-class condition to resist long wear. Any fitter who has tried to scrape a ground cast-iron surface knows how hard and dense the surface is when ground. Unfortunately, lathe designers have not yet been able to design an engine lathe in which the ways—the vital working surfaces—are fully protected from cast-iron dust and its abrading action. The ground chilled vee is a partial solution of the problem.

LOCK KNOB DIES

BY W. B. GREENLEAF[1]

In Fig. 1 are shown the four stages in the process of transforming the stamping *A* into the lock knob *D*, which is invariably taken to be a drop-forging. As the ball is stamped from ⅛-inch stock and the outside diameter is ½ inch, the inside diameter is, approximately, only ¼ inch; consequently the area of the outside of the ball is four times as great as the inside, and as these two sides are about the same in the blank *A*, it is necessary to compress one face and stretch the other. This stretching and compressing of the metal must be done in the second operation. If any of it is done in the third, the punch, which is only ¼ inch in diameter, will push through the metal; if any of it is done in the fourth operation, a fin will be squeezed out between the upper and lower dies. On the other hand, it can easily be done in the second operation, because the piece is flat and can be worked on both sides by the punch and die; besides, it can be enclosed and kept from flowing out of bounds. The process of making this knob was developed only by spending considerable time experimenting, for a slight variation in the blank changes the result. For working purposes, the finished ball is considered as being divided into five sections. The largest of these is approximately a half ball and handle, or shank, as shown at *B*, Fig. 2; the other four are triangular sections, shown at *B* and *C*, Fig. 1, each of

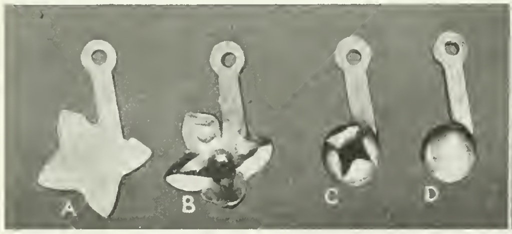

Fig. 1. Four Stages in Manufacture of Lock Knob

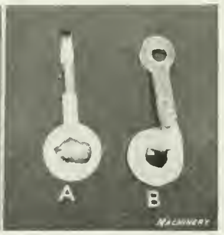

Fig. 2. Sections through Finished Knob

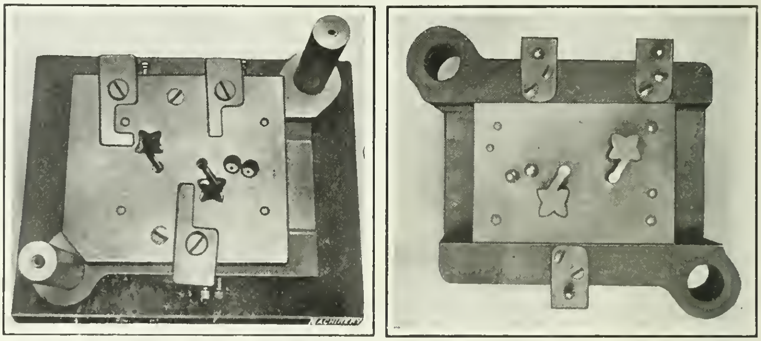

Fig. 3. Die and Punch for making Stamping

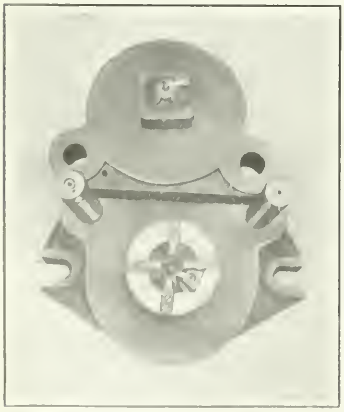

Fig. 4. Swaging Die for compressing and stretching Blank

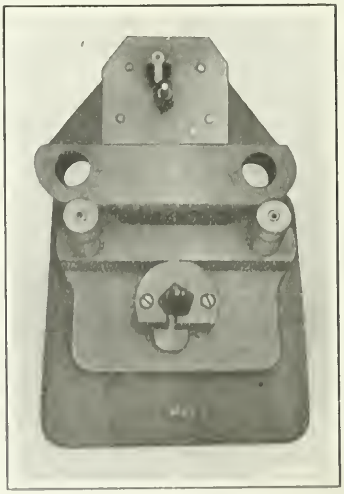

Fig. 5. Die for bringing Knob into a partly Spherical Shape

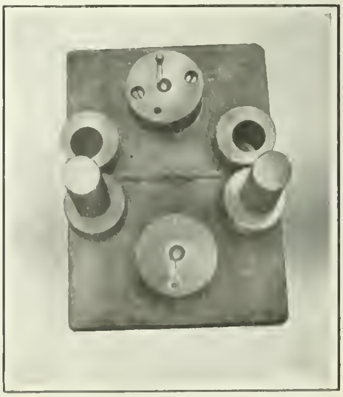

Fig. 6. Finishing Die for performing Fourth Operation

which forms about one-eighth of the finished ball. At *A*, Fig. 2, is shown a section through the ball at right angles to the section shown at *B*.

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[1] Address: Plymouth, Mich.

The success of the whole process depends on the results obtained in the second operation, in which the flat blank *A*, Fig. 1, is swaged into such a shape *B* that it may be transformed into a ball in the following operations without much pressure. In this operation, each of the five sections of the ball is correctly formed, but the sections are left spread out, as shown. However, as the metal still has a tendency to back up in the final rounding, in the third operation, the diameter is reduced 1/32 inch to allow for this and prevent a fin.

The dies used are shown in Figs. 3, 4, 5 and 6. The blanking is done on a gang follow die, shown in Fig. 3, the two pieces interlocking to save metal; as shown by Fig. 7, there is little waste. No pilots are necessary, as a large variation is allowable in the position of the small hole. In a follow die of this kind, there is likely to be considerable waste from bad pieces at the beginning of each strip, unless some sort of positive stop is used at the first, second and third stages. Of course, any of several styles of temporary stops may be used, but they all have disadvantages. In this die, three automatic trigger stops are hinged about flush with the top of the stripper; this increased the first cost, but the plan worked so well that the same scheme has been used on several similar dies. The operator is thus relieved of all trouble, and can run the strip against the first stop and, after the press is tripped, the strip will go right through without stopping to the end, and all the blanks possible will be made from this strip.

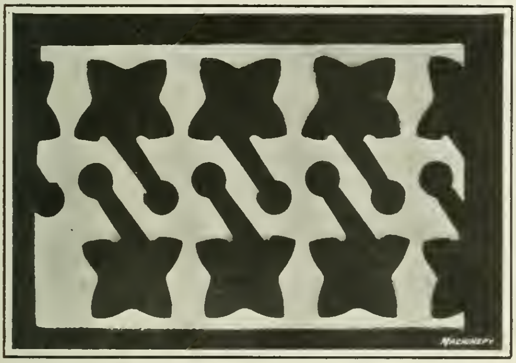

Fig. 7. Strip showing Waste left by Stamping

The punch in the third operation, shown in Fig. 5, enters a seat made in the piece in the second operation, which locates it exactly and keeps it central during the bending. The face of the die is worked out to fit the piece, and the opening has a long gradual taper at the mouth to make the bend as easy as possible. A positive ejecting pad, not shown, is joined to the punch-holder by a yoke and rods. In the fourth, and final, operation, the piece is located by the shank, and a spring pin in the punch shown in Fig. 6 strikes the end of the shank first and keeps the points upright so that they will enter the upper form. *A* and *B*, Fig. 2, show how effective is the closing.

MILLING RELIEF IN KNURLS

At the Frankford Arsenal use is made of the type of knurl shown at *B* in Fig. 1. These knurls are made of high-speed steel, and the first operation consists of setting the blanks up on a gear-cutting machine to provide for cutting the teeth. After this operation has been completed, the condition of the work is that shown at *A* in Fig. 1. A concern which had a contract to furnish the government with a large number of knurls of this type experienced trouble in milling the relief. This matter was mentioned to the management of the T. C. M. Mfg. Co., Hunterdon and First Sts., Harrison, N. J., with the result that this firm undertook to mill the relief on a contract basis. For this purpose a T. C. M. thread milling machine was set up as shown in Fig. 2. Here it will be seen that the work *A* is mounted on an arbor in the spindle which is driven by pulley *B*, power being transmitted through a worm on the pulley shaft to worm-wheel *C*, which is keyed to the spindle. It will be seen that milling cutter *D* is driven by an independent belt on pulley *E*, from which power is transmitted by a silent chain drive to sprocket wheel *F*, keyed to the rear end of the cutter-spindle.

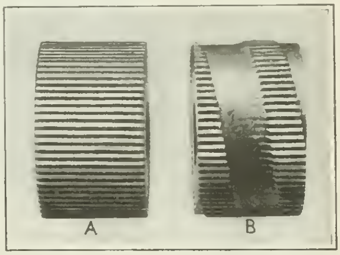

Fig. 1. Knurl before and after milling Relief

In handling this milling operation, the cutter-head is set at such an angle to the work-spindle that the helical relief will be milled as the work is fed past the cutter. In order to obtain this result, provision is made for setting the cutter-spindle at the required angle to the work-spindle, and also to feed the work past the cutter. This feed motion is obtained by having the work-spindle designed to move longitudinally in its bearings as feed motion is imparted to the spindle by worm *G*, which runs in a half-nut carried in a bracket bolted to the bed of the machine.

Attention is called to the half-nut engaging worm *G* and the head carrying the cutter-spindle, which are arranged on slides, so that the half-nut and cutter may be dropped out of engagement with the worm and work, respectively. This result is obtained by having a trip arranged on the work-spindle in such a way that when this spindle has been advanced to a point where the milling operation has been completed, the trip engages a dog carried on horizontal shaft *H*. Engagement between this trip and dog results in turning shaft *H*; and this shaft carries two cams which hold the nut in contact with worm *G* and the cutter-spindle head in its upper position. Hence, turning shaft *H* allows disengagement of the half-nut and cutter, respectively. The work is then removed from the machine and the work-spindle pushed back to the starting point, after which a hand-lever is used to swing shaft *H* back so that the cams carried by this shaft will raise the half-nut and cutter into their working positions. After a fresh piece of work has been set up, the machine is ready to be started. Eighteen knurls are milled per hour, the rate of production being kept down by the hardness of the steel and by the small size of the hole, which is only 5/16 inch in diameter. E. K. H.

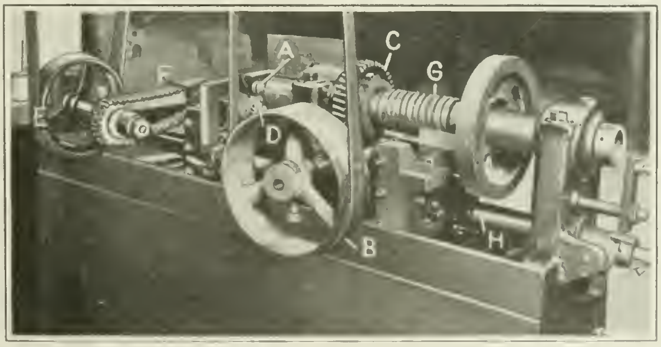

Fig. 2. T. C. M. Thread Milling Machine set up to mill Relief in Knurls

MACHINERY

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

DRILLING PRACTICE

Drilling holes is the most common machine shop operation, and the drilling machine the most common of machine tools. Even a blacksmith shop has some sort of drilling machine, and in hundreds of small shops the drilling machine is the only machine tool provided. Drilling or boring a hole in wood and stone is essentially a primitive operation that was practiced by the human race before the dawn of history. In this age of manufacture the production of holes runs into millions daily.

The development of high-speed steel has made a great change in drilling practice as in other metal working with machine tools. High-speed drilling machines have been greatly improved as regards dynamic balance, those capable of driving a 1/32-inch drill at a cutting speed of 80 feet per minute being dynamically balanced and provided with bearings offering a minimum of frictional resistance.

War needs must be supplied quickly, and rapid drilling of motor parts is necessary for the rapid production of the great number of engines needed for motor trucks and airplanes. The multiple-spindle drilling machine is a most important factor, and so highly are these machines developed that all the holes in a crankcase numbering more than one hundred are drilled in a minute, thus making the drilling production on crankcase work to exceed five hundred in a nine-hour day. This remarkable result is obtained on a high-grade machine tool, strictly interchangeable throughout, the parts being standardized in units, and the gears and shafts being hardened and ground. The time when a drilling machine was a cheaply made tool is past, especially for rapid production work. Only the best design and construction will stand the strain of such intensive work.

In drilling practice everything depends on the drill point, and more trouble is due to improper drill grinding than to any other cause. Because of its simple character, the drilling machine is commonly operated by men of little or no mechanical training, who have but a moderate comprehension of the principle of metal cutting, and if required to keep their drills sharp, they are likely to produce some harrowing examples of drill grinding. The result is broken drills, inaccurate holes, slow production, broken feed gears and many other troubles that are caused solely by dull and improperly shaped points. It is hardly possible to exaggerate the importance of correct drill grinding. It means longer life for the drill and the machine, better work, less lubricant consumption and greater efficiency all along the line. Drill grinding is too important a tool-sharpening operation to be entrusted to the ordinary run of operators. That practice is uneconomic and wasteful. Drills should be ground by experts and furnished to the operators ready for use. This is an established fact, but, unfortunately, one not generally practiced.

* * *

MACHINERY FOR CRIPPLED SOLDIERS

Although machinery is designed for operation by normal men and not by cripples, and much has been done to simplify its operation, the designer has always had in mind operators with both hands and feet. The war is making an enormous number of cripples who must be provided with ways and means of earning a living. A percentage of those cripples who before enlisting were working in machine shops, because of their disability, will be unable to continue their vocations unless means are provided that will enable them to produce at least an average day's output. We suggest that machinery be designed with simple auxiliary control devices which will enable men who have lost their hands to work the levers by their feet. Electrical control probably offers the best solution, as push-buttons that may be worked by either foot or by an arm stump could be readily adjusted to suit the convenience of almost any cripple who is able to move himself about. The development of electrical control along these lines would be a step toward making machinery more efficiently operated by normal workmen generally.

The problem of designing machinery for the use of cripples will never be of greater importance than now; and it should receive immediate attention from designers, because the number of industrial cripples created each year is great, and the number created by the war will be enormous. Machinery should be so designed that the industrial as well as the war cripples will be able to continue earning an honorable and self-respecting livelihood.

* * *

GAGING AND INSPECTION OF MUNITIONS

There was considerable discussion on the subject of gaging and inspection of munitions at the last annual meeting of the American Society of Mechanical Engineers, but except for the resolution which was passed recommending that the Bureau of Standards be designated as a central bureau for verifying and certifying all gages used in the carrying out of government contracts requiring accurate measurements, the discussion brought out but few definite and conclusive ideas. There are two general and fundamental principles which, if suitably recognized and applied, would eliminate much confusion and most of the criticism to which the Ordnance departments have been subjected on account of the methods they have pursued and the inspectors they have employed. The first of these principles is that as great tolerances as possible should be permitted in every case, the only limiting condition being that the parts should properly fill the function for which they are designed. The widest permissible limits in dimensions make for economical manufacture and rapidity of production—two factors of the highest importance in the making of war materials. It is the general belief that the Ordnance departments demand too close limits, and in many cases it is well known that the drawings call for an excessive degree of accuracy where it is of no practical importance and only increases the expense of manufacture.

When the widest possible tolerances have been allowed, the second principle that of providing gages so designed and having themselves such limits of accuracy as to make their manufacture a simple commercial proposition is comparatively easy to apply. The degree of accuracy of limit gages, for example, need not be as great where large limits are allowed on the work and where the tolerances are small. The tolerances on the gages themselves should be a certain percentage of the total tolerance in the work, and, furthermore, the working gages should be so designed that any part that is correct according to the working gage passes the inspection gages without question. In other words, the working gages should allow slightly smaller tolerances than the inspection gages.

These two main principles having been correctly worked out, all other questions connected with the inspection of machine parts become merely a matter of detail and routine. Of course, the inspector requires a certain amount of judgment, but by the use of proper gages the need for the exercise of this faculty may be reduced to a minimum. It is, however, highly desirable that when close limits are required on work that may seem of little importance to the mechanic not familiar with the construction or purpose of the product, the specifications should state the reasons for requiring a highly accurate finish, as this would help to create a proper attitude of mind toward the work on the part of all concerned. As an example, it may be mentioned that shell manufacturers thought the high finish required on the inside of the shells a mere fad, when, in practice, it has been found that rough shell interiors may cause premature explosion, due to the friction set up in the revolving shell between the bursting charge and the walls, which may, with rough walls, create enough heat to ignite the charge. The Russian shell specifications sent to this country in the early part of the war contained explicit directions and explanations, making it possible for the manufacturer not only to understand the mechanism, but also to see the reasons for many of the peculiar requirements.

* * *

COST PLUS TEN PER CENT

In order to avoid paying exorbitant prices for war materials ordered by the government, a policy was adopted almost immediately after the United States entered the war to pay manufacturers undertaking contracts for the government on the basis of cost plus a percentage. The percentage differs according to the trade and conditions, being adjusted in each case to what is assumed as a fair profit.

Theoretically, this is a very good arrangement, and was entered into by the government officials with the best of intentions; but, unfortunately, it has not worked out as satisfactorily in practice as was at first expected. As the contractor's profits are based upon his costs, it is not to his interest to keep costs down, for in so doing he also keeps his profits down. It has been observed by people who have seen this principle in practice that it does not work to the advantage of the government, and that enormous amounts are wasted, because it is not to anybody's direct advantage to keep costs down. It has been stated, for instance, that workmen engaged in building cantonments took life very easy, and the contractors did not interfere for the simple reason that their profits rose with the rising costs to the government. It has been rumored that similar conditions exist in other industries.

MACHINERY ventures to suggest to the earnest men who place government contracts that it should be practicable for them to so arrange the cost-plus-percentage plan that it would be to the interest of the contractor as well as the government for him to keep his costs down. Assume, for example, that at the outset a maximum fair price be determined as nearly as possible, the contractor to be allowed, say, 10 per cent for profit (or whatever percentage is deemed fair); now stipulate that for every 5 per cent the contractor saves the government on this estimated cost, he be allowed, say, 2 per cent extra profits. On the other hand, for every 5 per cent that he exceeds the stipulated cost, he loses 2 per cent; in other words, if the actual cost of a contract were estimated at, say, one million dollars, the contractor's profits would be 10 per cent, or $100,000. If the contractor could cut the cost 20 per cent, or to $800,000, his profits would be 18 per cent of $800,000, or $144,000. But if his costs went up to $1,100,000, his profits would be cut to 6 per cent of this amount, or to $66,000.

It is quite evident that under such an arrangement it would be to the interest of the contracting manufacturer to keep his costs down, because the lower the costs the greater his profits. On the other hand, if he could not keep his costs within the predetermined fair figure, it is quite equitable that he should share some of the loss with the government in the form of decreased profits, as the government would have to pay the lion's share of the increased cost.

Of course, the foregoing figures and percentages are stated as examples only, to illustrate the principle, which, if adopted, would doubtless overcome the evil tendencies of the straight cost-plus-percentage principle. With business men acting on so many of the advisory boards at Washington, we believe that some such arrangement will soon be adopted to meet the criticisms directed against the straight cost-plus-percentage method of letting contracts.

The straight cost-plus-percentage plan gives an undue profit to the inefficient, careless or unscrupulous contractor, while it penalizes the efficient, honest and painstaking concern. The proposed differential cost-plus-percentage plan would place a premium on ability and integrity. It would encourage contractors and manufacturers to develop efficient organizations, to employ labor-saving methods, and to work under the conditions of high-pressure efficiency that are necessary to win the war, and to win it without needless cost in men and wealth.

* * *

GAGE COMMITTEE OF A. S. M. E.

A committee was appointed at the spring meeting of the American Society of Mechanical Engineers held in Cincinnati, Ohio, in May, 1917, to take up the question of securing uniformity in gages used in the manufacture of all kinds of war material ordered by the government from private manufacturers. This committee presented a report at the annual meeting of the society in New York, and a public hearing was held by the committee on December 4 at the Engineering Societies' Building. At the meeting a resolution was passed embodying the principle that the American Society of Mechanical Engineers recommends that all master and reference gages and standards of measurements used in the manufacture of war materials be certified by the Bureau of Standards, as in this way there would be one central bureau or place where all gages could be compared with accurate standards. It was recommended that a clause to this effect be inserted in all contracts placed by the Ordnance Departments, and incorporated in all specifications for work that requires accurate gages, and that all the gages used by the various government bureaus also be certified in the same manner. It is not the intention to make the Bureau of Standards responsible for the limits set, but merely to have the Bureau certify that the gages submitted are made according to the limits prescribed in the specifications.

It was evident that considerable interest and importance is attached to this method by both the government and manufacturers of gages and war materials. The hearing was well attended, there being present, in addition to many members of the society, a number of officers representing the government and the Ordnance Department, members of the British Ministry of Munitions in the United States, representatives from the Canadian Munition Board, and a number of the leading manufacturers of gages, munitions and other war materials in the United States. An interesting point brought out by one of the speakers familiar with the manufacture of rifles and ammunition was that the cost of inspecting small arms, ammunition and rifles was about equal to the actual cost of manufacture. The great importance of proper gages and gaging methods was emphasized, and it was suggested that no greater service could be rendered at this time than the spreading of information relating to proper gaging methods, properly constructed gages and the principles generally involved in gaging and inspection.

* * *

Sheet lead may be used for making a small pattern in a hurry when a casting is wanted for experimental purposes. The lead can be easily cut and formed by hand to any required shape and soldered at the joints to hold the pieces together. By the judicious use of iron rods or pipe to reinforce and hold the shape, long slender patterns can be made in this manner and pressed sheet tin pans and other hollow metalware may be used also to build up a fairly complex form of considerable size. The result may not be pretty, but it often serves the purpose when time and cost are important considerations.

WELDING TRANSFORMER TANKS BY THE ELECTRIC ARC PROCESS

METHODS DEVELOPED BY THE PITTSFIELD WORKS OF THE GENERAL ELECTRIC CO. IN THE MANUFACTURE OF ELECTRIC TRANSFORMER TANKS

BY ERIK OBERG[1]

THE electric arc-welding process, the general principles of which were outlined in an article in the December, 1917, number of MACHINERY, has been developed and applied to a great extent in the welding of seams in transformer tanks at the Pittsfield Works of the General Electric Co. The method has been found superior for this work to all other methods used or investigated by the company. At one time, many of the transformer tanks were riveted; this was more expensive and less satisfactory than the welding on account of the fact that it was difficult to obtain absolutely leakproof tanks by the riveting process, oil having a tendency to seep through even the most minute openings. In its efforts to obtain a better method than riveting, the company used the oxy-acetylene method to a large extent for several years. This method had the advantage of producing satisfactory oil-tight welds, but was found to be quite costly. In an effort to reduce the manufacturing cost, electric arc welding was tried and found to meet the requirements, producing a satisfactory weld at a decreased cost; hence practically all the sheet-metal transformer tanks made at the Pittsfield Works are now welded by the electric-arc method. In addition, the electric arc is used on miscellaneous welding about the plant.

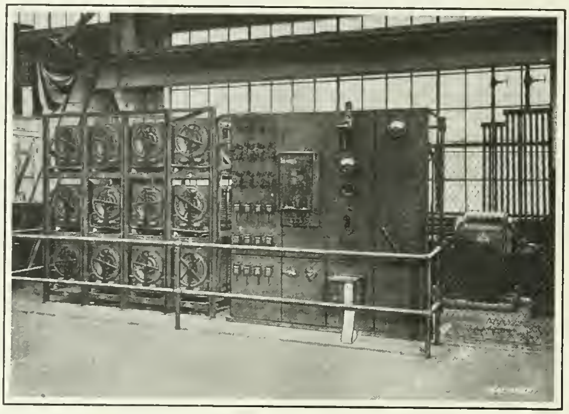

Fig. 1. Welding Equipment, showing Part of Generator Set and Switchboard

Welds are made in metal varying all the way from 1/16 to 3/4 inch in thickness. Steel plate as thin as 1/16 inch is lap-welded, and butt-welds may be made in metal as thin as 1/8 inch. Thin metal like this requires no beveling at the edges of the sheet preparatory to welding. If metal thinner than 1/16 inch is to be welded, the arc process is found unsuitable, because the arc will burn the metal. When metal from 1/4 to 5/8 inch in thickness is welded, it is beveled on one side, and steel plate 3/4 inch or more thick is beveled on both sides when seams are made. When used against the transformer shell for a bottom, it is beveled on only one side. Transformer tanks from the smallest size up to those 10 feet in diameter and 14 feet high (the latter being made from 5/8-inch boiler plate) have all their longitudinal seams welded in this manner, and the sheet-steel rim at the bottom is also welded to the tank by the electric arc. Cast-iron bands at the top of some transformers cannot be welded to the cylindrical steel shell, but must be riveted or joined by bolts; but the arc welding process is used for welding around the heads of the rivets or bolts on the inside of the tank in order to insure that there will be no leakage at those points.

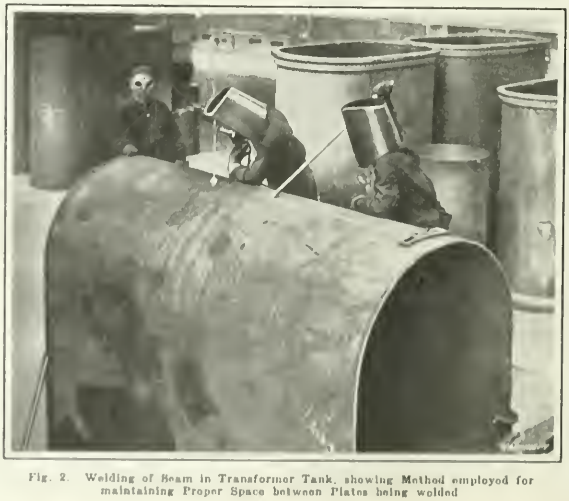

Fig. 2. Welding of Seam in Transformer Tank, showing Method employed for maintaining Proper Space between Plates being welded

Equipment Used for Welding

The equipment used for welding in the Pittsfield plant consists of a motor-generator set which generates 75 volts direct current. The capacity of the generator is 150 kilowatts; it is driven by a 225-horsepower induction motor supplied with 60-cycle alternating current. The direct current from the generator passes to direct-current busses on which a constant voltage is maintained by a voltage regulator. Attached to the busses are twelve separate welding circuits, so that each welder can work independently. On the switchboard panel, shown in Fig. 1, twelve rheostats are mounted together with the remote-control switches in series with each welding circuit, so that the welder does not need to leave the place where he works in order to control the current. In series with the rheostats is a reactance coil, the object of which is to maintain the arc if drawn out too far, and also to reduce the rush of current when striking the arc. All this apparatus is mounted on or adjacent to the main switchboard and the generator set.

On the floor where the welding is done, separate stations are provided, with one panel for each welder. These are placed adjacent to the spot where the work will be done. From these panels the welder adjusts the current, as indicated by the ammeter mounted on the panel. A plug is provided which is pulled out when the operator is not working. On the holder for the electrode, a switch is also provided which may be snapped to open or close the circuit.

Electrodes

The electrodes for welding sheet steel and boiler plate, used in the construction of transformer tanks, are bought in the form of wire coils or rolls, from which the electrodes are cut off in lengths of about 18 inches, and straightened. Swedish iron wire is used for this purpose, when obtainable, but similar wire, known as "Toncan wire," is also obtainable in the United States, the Pittsfield Works obtaining their supply from the Washburn Wire Co., Phillipsdale, R. I. The wire comes in sizes of from 1/16 to 3/16 inch in diameter. The carbon electrodes used for certain work are tapered in shape, being about 1/8 inch in diameter at the small end, and 3/8 inch at the large end. The length is about

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[1] Associate Editor of MACHINERY

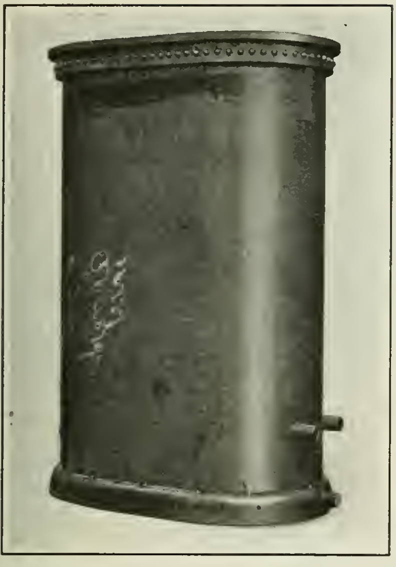

Fig. 3. Base of Tank with Space between Base and Shell and Spot-welds holding Base and Shell together

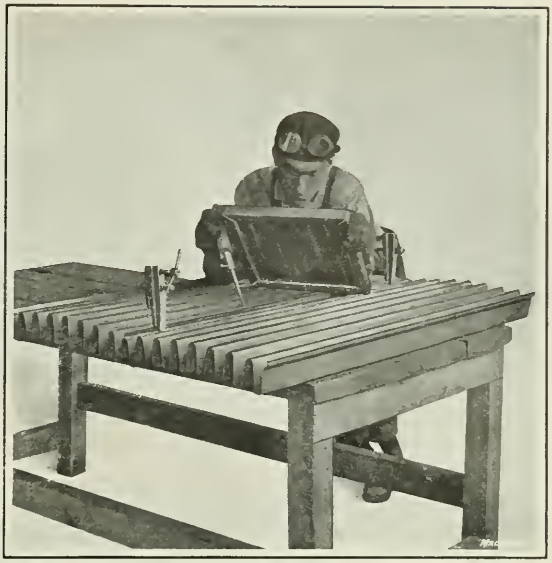

Fig. 4. Arc Welding of Corrugated Sheet Steel for Small Transformer Tanks, using Carbon Electrode

5 inches, when new. When used, the carbon electrode gradually burns away, but, being tapered, it maintains practically the same diameter at the point as it diminishes in length. The carbon electrodes are made from a composition similar to that from which arc-lamp carbons are made. Graphite electrodes may also be used, but they do not last such a long time as do the carbon electrodes.

DATA FOR BUTT-WELDING OF SHEET METAL BY THE ELECTRIC ARC (METALLIC ELECTRODE)

Thickness of Metal, Inches	Diameter of Electrode, Inches	Speed per Hour, Feet	Amperes			Mean K.W. at 60 Volts	Mean K.W. at 70 per Cent Efficiency	Electrode Used per Hour, Pounds	Cost of Power per Hour, Cents	Cost of Electrode per Hour, Cents	Total Cost per Hour, Cents[1]	Total Cost per Foot, Cents
			Low	Mean	High							
1/16	1/16	20.0	25	30	40	1.8	2.6	0.9	7.8	4.5	42.3	2.12
1/8	1/8	16.0	30	50	75	3.0	4.3	1.4	12.9	7.0	49.9	3.12
1/4	1/8 or 3/16	10.0	70	100	125	6.0	8.6	3.1	25.8	15.5	71.3	7.13
3/8	3/16 or 1/4	6.5	100	125	150	7.5	10.7	3.6	32.1	18.0	80.1	12.30
1/2	1/4	4.3	120	140	175	8.4	12.0	3.8	36.0	19.0	85.0	19.80
5/8	1/4	2.8	125	155	195	9.3	13.4	3.4	40.2	17.0	87.6	31.30
3/4	1/4	2.0	125	160	200	9.6	13.8	2.4	41.4	12.0	83.4	41.70
1	1/4	1.4	125	160	200	9.6	13.8	2.7	41.4	13.5	85.9	61.30

Machinery

[1] Labor estimated at 30 cents per hour

Protection of Welders

The welders wear a hood, as shown in Fig. 2, to protect their heads from the rays from the arc and their eyes from the intense light, and also gloves to protect their hands from burns. The glass in the welding hood consists of three thicknesses: one medium green glass, one dark red glass, and one plain white window glass. The latter is placed outside of the colored glass, the object being to protect the colored glass from the deposit of atomized metal which, during welding, gradually settles on the glass. The piece of plain glass, when useless on account of these metal deposits from the arc, can be replaced at a low cost.

Preparation for Welding

Comparatively little preparation is required for the welding of sheet metals. In the case of thin metals, the pieces are merely held together by suitable clamps and lightly tapped with a hammer so that they will fit properly. In the case of long welds, it is necessary to separate the plates slightly, previous to welding, because of the expansion that takes place during the welding operation. The usual method is to separate the plates 1/8 inch at the end where the weld is to begin, and to increase the space between the edges of the plates at the rate

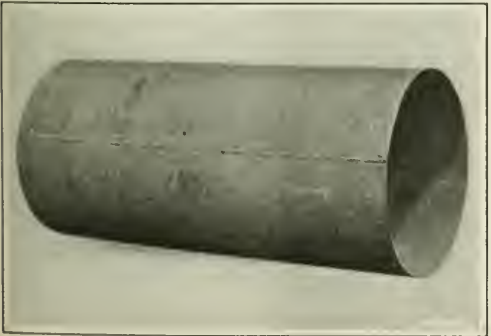

Fig. 5. Tank with Six Seams that were welded by Electric Arc-welding Process

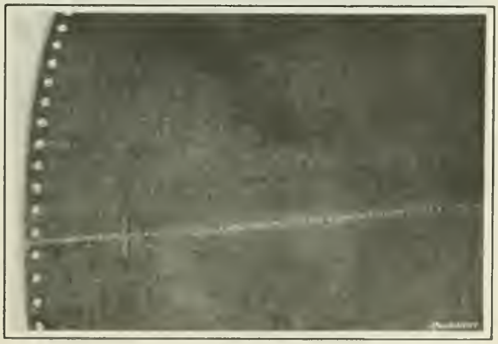

Fig. 6. Inside View, showing Metal forced through Seam and Reinforcement at End of Seam

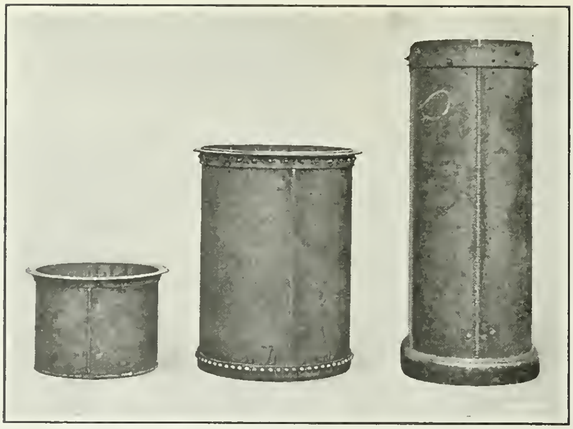

Fig. 7. Tanks welded by Electric Arc, using Metallic Electrode

of 2 per cent of the length. It has been found that, by placing the plates in this position, they will come together as the weld proceeds along the seam. As already mentioned, thin work is not beveled or prepared in any way, while thick plates are beveled on one or on both sides.

In Fig. 2 is shown a longitudinal seam of a tank being welded. As indicated, the plates are held apart by a clamp and bolts at one end of the seam, while the welder works from the other end. An assistant holds the plates apart a short distance from the weld with a bar as shown. In Fig. 3 is illustrated the base of a tank prepared for electric arc welding. A space is left between the tank itself and its base, but spot-welds are provided along the edge of the shell for holding the base and shell together during the arc welding.

Welding Operation

The welding operation is comparatively simple, and operators can be taught to become proficient in a comparatively short time. The best welders are those who have had previous experience with oxy-acetylene welding. They will learn to do good arc welding in about four weeks, but a "green" man will require from eight to ten weeks to become proficient. It is somewhat easier to manipulate the carbon arc than the metallic arc, on account of the fact that the former is longer and does not break as easily if the operator does not hold his hand steady. The arc, while welding by the metallic electrode, is not more than 1/8 inch long, and it requires considerable practice to move the electrode steadily along the weld without either touching the work or bringing the electrode so far away from the work that the arc is broken. The metallic arc is used for welding practically all the sheet-metal work that is butt-welded, and most of that which is lap-welded. The carbon arc is used only in the case of welding thin sheets of corrugated metal used for smaller transformer tanks. In that case, sheets from 1/16 to 3/32 inch in thickness are fitted together, side by side, so that the edges of both sheets face upward, as shown in Fig. 4. The carbon electrode is then moved along the joint, melting the metal at the edges and welding or fusing together the two sheets without using a welding rod or supplying any additional metal. The reason for using the carbon arc is that the metal is melted much more rapidly in this way than by the metallic arc, but, for general welding, the metallic arc is preferred, because it produces a neater job, the seam being much more uniform in thickness and the metal deposited more evenly. Most of the welding is done by hand, but special welding machines have been developed, in which the electrode is guided along the seam at a rate of advance that has been determined to be correct for each kind of work.

In Fig. 7 are shown three examples of tank welding. In the small tank to the left, the longitudinal seam, as well as the bottom, is arc-welded. In the tank in the middle, the longitudinal seam is welded, and in the tank to the right, the longitudinal seam and the seam between the shell and the base have been welded. Fig. 5 shows an interesting example of a shell welded together from six separate pieces or segments. Fig. 6 shows the upper end of the inside of an electrically arc-welded seam in a tank. This view indicates how the metal from the electrode is forced clear through the seam, as indicated to the right, and also shows, to the left, the reinforcement at the end of the seam, where the seam is also welded from the inside. Fig. 8 indicates what can be done in the

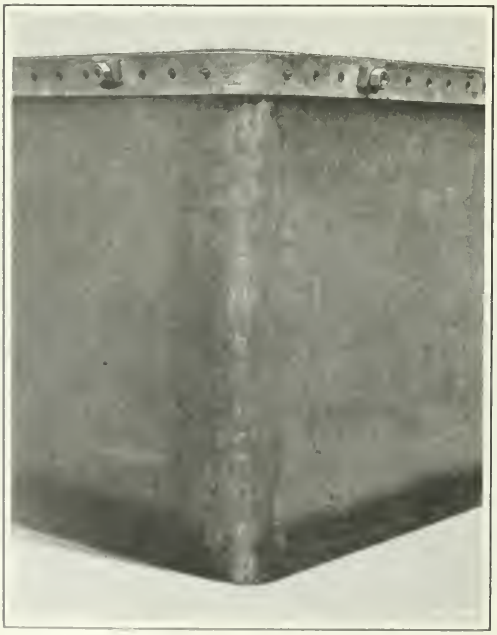

Fig. 8. Tank with Welded Seam, which has been ground Smooth

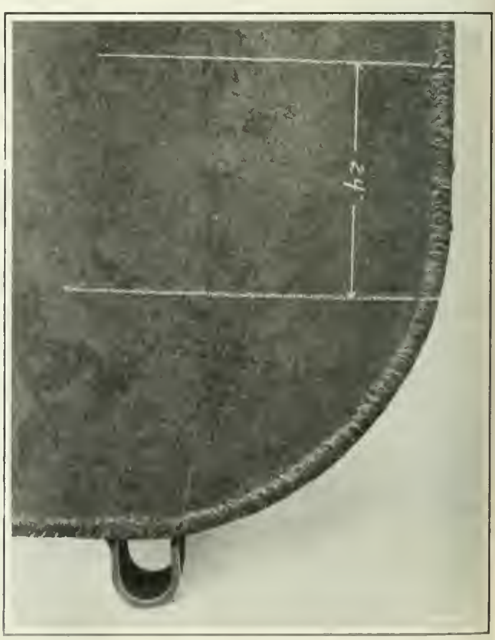

Fig. 9. View of Seam in Tank where Bottom is welded to Shell

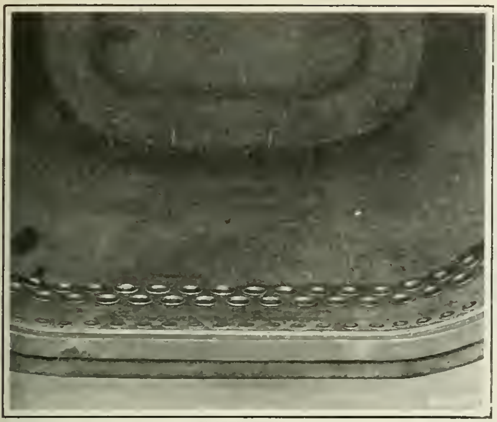

Fig. 10. Tubular Transformer Tank, showing Tubes expanded preparatory to Welding

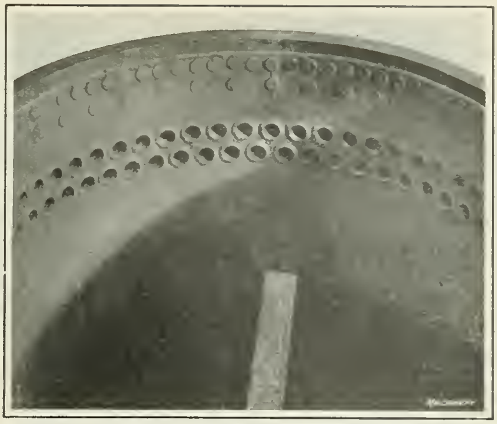

Fig. 11. Tubular Transformer Tank, showing Tubes after having been welded to Shell

way of finishing welded tanks so that the joint is practically imperceptible. The tank shown has welded seams at the corners and the surface of the weld has been ground off to present a smooth appearance, the weld being reinforced on the inside. If a tank made in this manner were painted, it would be impossible to find any joints whatever on the outside. In Fig. 9 is shown a view of the bottom of a large tank where a 3/4-inch base is welded to a 3/8-inch shell. The size of the tank is about 6 by 12 by 14 feet high. The illustration shows clearly the character of the weld.

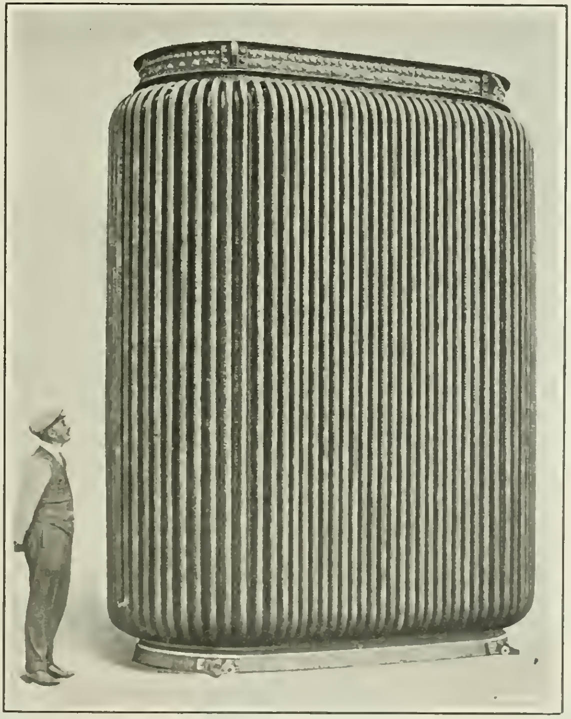

Fig. 12. Tubular Transformer Tank, Base, and Tubes welded by Electric Arc

Examples of the Application of Arc Welding

In addition to the welding of the longitudinal seams of the transformer tanks, the electric arc is used for a number of other welding operations in connection with the manufacture of transformers. The tubes are welded into oil-cooled transformers by the electric arc. The tubes are bent, inserted, expanded, and then welded. It has been found that this process is far superior to using oxy-acetylene for welding. In the past, out of 100 tubes welded by the oxy-acetylene process, about 10 per cent developed leaks. When welded with the arc-welding process, however, out of 100 tubes, only an average of one tube is found to leak. Fig. 10 shows the tubes in one of these tanks expanded preparatory to electric arc welding. Fig. 11 shows the tubes welded to the transformer shell, while Fig. 12 shows the completed tubular transformer tank in which the base and tubes are welded by the arc-welding process.

Bolt heads and rivets are welded around the heads in order to insure oil-tightness. Fig. 13 shows a section of a riveted joint indicating the probability of leakage between the rivets and the plates, were it not for the welding at *A*, which provides for an oil-tight joint. Fig. 14 shows the appearance of the weld around the rivet heads. Welding around the rivet heads by means of the oxy-acetylene flame was tried, but was not found successful, because the heat from the flame when welding successive rivets caused the weld already made to crack.

Malleable-iron bosses are welded to sheet-steel tanks instead of being fastened by riveting. In this case, carbon electrodes with a soft metal feeding rod are used. The cast-iron heads, however, cannot be welded to the sheet-steel tanks, mainly because of the different expansions

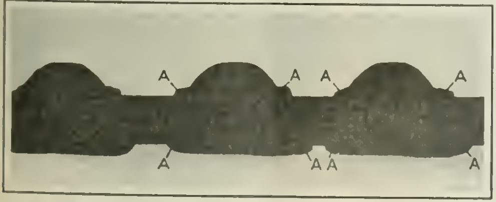

Fig. 13. Boiler Plate riveted together, showing Space between Rivets and Plate, and how Rivet is made Oil-tight by welding Head to Plate

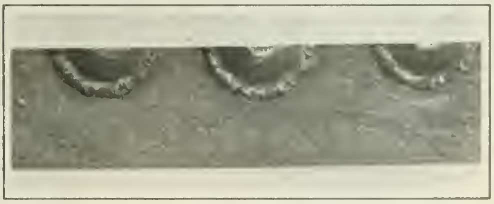

Fig. 14. Appearance of Welds when Rivet Heads have been welded to Plate by Electric Arc Welding

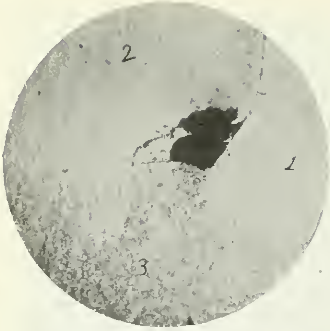

Fig. 15. Photomicrograph of Steel Tubing welded to Boiler Plate, taken at A in Fig. 18

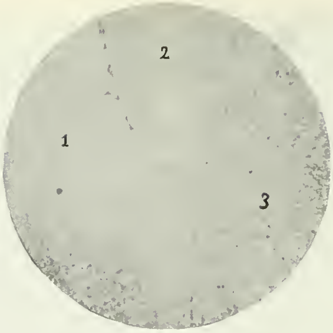

Fig. 16. Photomicrograph of Steel Tubing welded to Boiler Plate, taken at B in Fig. 18

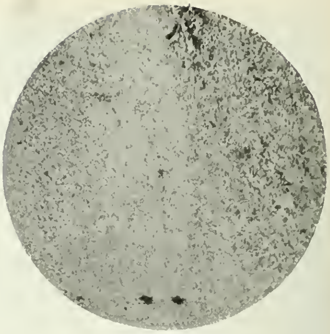

Fig. 17. Photomicrograph of Rivet Head welded to Boiler Plate

in the two metals when welding; hence the cast-iron heads are riveted to the shells and the rivet heads welded as previously explained. Small corrugated tanks have the sheet-steel shell cast directly into the cast-iron flange.

The work is always the positive electrode, and the carbon or metallic electrode the negative terminal. The positive electrode may be clamped to the work anywhere.

Strength of Seams

The arc-welded butt-joint, if properly made, has been found to be quite as strong as a lap-welded single-riveted joint. A lap-welded joint will be found to be stronger than a single-riveted lap-joint, and as the joints required for the transformer tanks are sufficiently strong when single-riveted, it follows that either butt-welded or lap-welded seams made by the electric arc are amply strong.

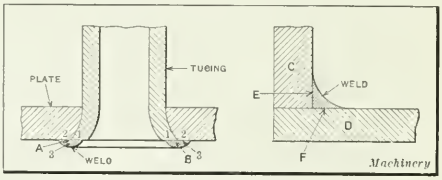

Fig. 18. Diagrammatical View of Welds illustrated by Photomicrographs

Data for Sheet-metal Welding

The accompanying table gives the thickness of metal, diameter of electrode used, speed per hour, current required, and cost of power and electrode for sheet-metal welding. This table is based on carefully made records, and represents actual experience in manufacturing work. Power is assumed to be available at 3 cents per kilowatt-hour, and the electrode metal is assumed to cost 5 cents per pound. The total cost per hour includes labor cost at the rate of 30 cents per hour, but, at the present time, with the high rate of wages, this is not sufficient.

Photomicrographs of Arc-welded Joints

Figs. 15 to 21, inclusive, show the appearance of arc-welded joints as seen under the microscope. At the left in Fig. 18 is shown a diagrammatical illustration of a tube welded to a flat plate. The photomicrograph in Fig. 15 is taken at *A*. The figures 1, 2 and 3 in Fig. 18 correspond to the figures 1, 2 and 3 in Fig. 15, the area indicated by 1 being the tubing; that indicated by 2 being the boiler plate; and that indicated by 3 being the weld, which is of Swedish iron. The black spot is a cavity at point *A* where the tube and the plate did not come together perfectly, there being a minute flaw or cavity at the edge of the plate. This cavity is not in the weld itself, and does not indicate any defect in the weld. In Fig. 16 is shown a photomicrograph of the same weld taken at *B*, where the figures 1, 2 and 3 indicate the tubing, the boiler plate, and the Swedish iron welding material, respectively, the same as in Fig. 15. The line between 1 and 2 shows the junction between the tubing and the plate. The homogeneity of the weld is quite apparent. Fig. 17 shows a photomicrograph of a weld between a rivet head and boiler plate, the welds themselves being shown in Figs. 13 and 14. The line of the weld runs vertically through the center of the photomicrograph between two areas that are slightly different in color. Fig. 19 shows the central part of the same weld as illustrated in Fig. 16, but at a higher magnification. Fig. 20 shows a photomicrograph of the joint at *E* between plate *C* and the welding material in the case of two boiler plates being welded together, as shown to the right in Fig. 18. The figure 1 is Swedish iron welding material, and 2 is the boiler plate. Fig. 21 illustrates the joint at *F* and is made with a slightly higher magnification. Here 1 is again the Swedish iron welding material, and 2 the boiler plate.

Cutting Metal by the Arc or Oxy-hydrogen Flame

The ends of the shells for the transformer tanks must often be trimmed, and this trimming or cutting of the metal is performed by the oxy-hydrogen flame rather than by the electric arc, on account of the clean, smooth cut that the hydrogen

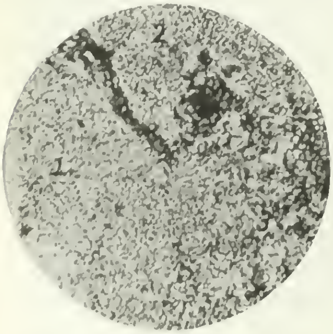

Fig. 19. Enlarged View, showing Center of Weld in Fig. 16

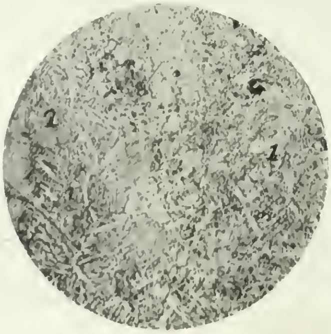

Fig. 20. Photomicrograph showing Joint between Welding Metal and Boiler Plate

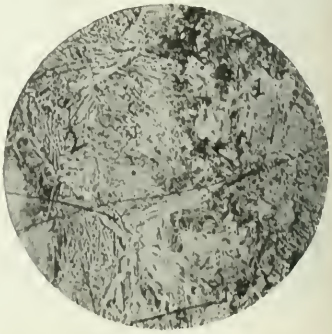

Fig. 21. Another Photomicrograph showing Joint between Welding Metal and Plate

flame will produce. While the arc could be used for this purpose, it has not been found advantageous, on account of the length of time that would be required in the effort to obtain a smooth cut, and, furthermore, the result would not be as satisfactory as that obtained by the hydrogen flame; hence, in the manufacture of transformer tanks, it has been found that there is a distinct field for the electric arc and for the gas flame. The electric arc is used for all welding operations, while the gas flame is used for the trimming or cutting operations. In welding, the electric-arc method has also one other great advantage over the oxy-acetylene method, in that, when using the metallic electrode, the position of the seam or weld is of no importance. It may be overhead, vertical or horizontal. The weld can be properly made in every case. The metal from the feeding rod is actually carried over with considerable force by the arc, and is driven against the welded surfaces, even when the electrode is held underneath the seam to be welded. Work of this kind, of course, cannot be accomplished by the oxy-acetylene flame, as in that case the molten metal from the feeding rod drops, by gravity, into the weld, and hence the weld must always be in a horizontal or nearly horizontal position.

The author wishes to express his indebtedness to R. E. Wagner, of the General Electric Co., for assistance rendered in obtaining the information on which this article is based. Mr. Wagner is responsible for the development of the arc-welding process as applied to the welding of large transformer tanks at the Pittsfield Works.

* * *

GRINDING FACTS AND SUGGESTIONS

Truing of grinding wheels is always accomplished by the use of diamonds, never with so-called "wheel dressers." The dressing is done with wheel dressers. Truing is not a sharpening operation, but just what its name implies. Dressing can never true a wheel, but it can and does break up the surface of the wheel and cause it to cut more roughly and more rapidly. Only a part of its cutting points are true or perfectly concentric, and not all are the same radius. Therefore, the wheel is not true, although it is a fact that the wheel dresser can make a wheel approximately concentric by its use. One should never attempt to grind precision work with a wheel that is dressed, although some rough grinding is best done with wheels that are dressed. This is especially true in the case of grinding from the rough stock, or forgings, like crankshafts of automobiles.

There is a popular notion that water and lubricant of various kinds is used to keep work cool. It is not at all necessary that the work should be kept cool when grinding, but it is necessary that it be kept at a nearly uniform temperature during the passage of the wheel over the entire length of the work being ground, although no particular temperature need be maintained. It may be cold or it may be very hot. The work does not have to be of the same temperature for different passes over the same piece of work; it is only necessary that with each pass the temperature shall remain nearly constant from one end to the other, so that the work may remain straight. Increasing the temperature from the end to the center will cause the work to spring and the wheel to cut on one side of the work deeper than on the other side; then when the work returns it will cut on the opposite side; and at the next pass it will cut at right angles, and so on, as long as grinding continues with insufficient lubricant or with a wheel too hard for the work, or both. Any liquid can be used, but clear water will rust both the machine and the work. Carbonate of soda added in sufficient quantity will prevent rusting, and many use this mixture. A better mixture is one containing oil. There are compounds made for grinding machines that are rich in oil, and these are no doubt better than water and soda. The life of the grinding wheel and the production are both increased by increasing the lubricating feature of the liquid.

There is a popular belief that oil will prevent grinding wheels from cutting. This belief is so strongly fixed in the minds of some that when they discover there is oil in the lubricant furnished with their machine they report that the compound causes the wheel to glaze and prevents cutting. Such persons should know that the best cutting wheels are used with compound, and that many thousand machines are producing the best quality and a phenomenal amount of work by the use of compound, and that the wheel maintains its shape and sharp cut as by no other known method. The lubricant should never be allowed to become thick. Keep it mixed as directed by the maker. Never assume to know better than the maker about mixing the lubricant. If the lubricant is too thick, the work will not grind true. If it is too thin, the machine and work will rust.

Wheels give service according to the conditions surrounding their use. A series of experiments was made with a view to using a wheel under ideal conditions. These experiments showed that when the conditions were ideal the wheel would give a service of 20 cubic inches of steel removed for 1 cubic inch of wear from the wheel. With careless or ignorant use, not more than 2 cubic inches of steel may be removed to 1 cubic inch of wheel wear. In everyday practice in some places the wheel removes 3 cubic inches of steel to 1 cubic inch of wheel wear. In the grinding of very large chilled iron rolls, 16 cubic inches of chilled iron to 1 cubic inch of wheel wear is obtained. In some places where steel work is ground, 10 cubic inches of steel is removed to 1 cubic inch of wheel wear.

The causes of wheel waste are: wheel not in balance; wheel too soft for the work; work speed too fast for the wheel grade; insufficient steadyrest support; wheel-spindle too loose in the bearing; very careless hand feeding, *i. e.*, feeding too much at one time and too little at another; any vibration of the machine or work. To increase the wheel service, use the automatic cross-feed at all times. Sharp corners of wheels may be preserved and yet the work may be produced rapidly by using the automatic cross-feed. When the same amount of work is done with hand feed the corners of the same wheel will probably be destroyed.

Support the work rigidly with plenty of solid non-yielding steadyrests (no spring).

See that the wheel is well balanced.

See that there are no heavy lacings or knots in the belt that drives the work and the wheel.

Look after all things that cause vibration.—*Grits and Grinds*

* * *

WEAR IN LARGE GUNS

In an article in *Arms and Explosives*, the subject of wear in large guns, which has a most important influence on the cost of the war, is dealt with. The increased cost due to wear depends on two factors: first, the expense of making repairs, and, second, the increase in the amount of ammunition expended to attain a definite object on account of the inaccuracy of firing due to the wear of the gun. The author, Major Tulloch, of the British Army, says, "If a few thousandths of an inch of steel at the beginning of the rifling of guns could be prevented from wearing away in so short a time as at present, the reduction in the cost of the war, so far as guns, ammunition, transport, etc., are concerned, would be almost incalculable." The damage to the bore near the breech is known as "corrosion," while that near the muzzle is termed by the author "erosion," as it is due purely to mechanical causes. Corrosion in big guns is caused by high temperatures, chemical and physical qualities of the powder, weight of charge and rapidity of firing, escape of gas past projectile, and composition and physical properties of steel used for the inner tubes of the gun. It is pointed out that the methods of making the inner tubes and their heat-treatment are still capable of much improvement. As an indication of the erosion that takes place when a projectile is fired, it is mentioned that, by electrolytic methods, in one case over fifteen pounds of copper was removed from the bore of an eight-inch gun that had fired slightly over one hundred rounds, this copper having been torn from the copper bands on the projectiles.

* * *

Because of gasoline restrictions, bicycles are again becoming popular in England, replacing automobiles and motorcycles.

SPUR GEARING PRODUCED BY THE ROTARY CUTTER PROCESS[1]

The present highly developed state of the gear-cutting art is not an over-night growth. What we know as an accurate gear today is not the result of the automobile, the trolley car, or any other particular demand. It is the product of a slow, steady growth until practically every class of machinery requires cut gears, whereas years ago the cast-tooth gear was the rule and the cut-tooth gear the exception. But in those days, when lathes, shapers and planers had cast-tooth gears throughout, the gears were made with greater nicety than the rough cast gears seen today in so-called "rough mill work." Even the change-gears on screw-cutting lathes had cast teeth, and they ran much better than some of the rough-cut work obtained nowadays from concerns that know very little about cutting an accurate gear and employ incompetent workmen. It does not matter by what process a gear is cut; if the arbor runs out, or the gear is otherwise not properly mounted, bad work is the result and the gear will be noisy.

In 1867, exactly fifty years ago, the writer entered the machine and gear industry, by being bound to serve six and one-half years as an apprentice in the building of gear-cutting engines, as they were called at that time. His master, Ezra Gould, was a master of the now lost art of working with a hammer and chisel, shoulder and hand tools, also with hand chasers for cutting threads. Few of the lathes had lead-screws in those days. Mr. Gould designed a gear-cutting engine, about 1848, that used a disk cutter and had the dividing worm-wheel made in two parts, so that it could be corrected. The machine was fed and indexed by hand. In 1852, at the Crystal Palace Fair, New York City, he received a silver medal for this machine.

The writer's first experience in cutting gears was on a machine of this type, and at that time there were very few gear-cutting engines in his state and none at all west of Pennsylvania, so far as he knows, because the demand for cut gears was very small. Most gears coarser than ten or twelve diametral pitch were generally made with cast teeth, and many wooden, iron and brass patterns were cut. Coarse-pitch gears with cut teeth were only made on special order for what was considered very nice, accurate work.

The cutters were not the form cutters of today, which can be purchased right out of stock and sharpened without trouble. They were all homemade, of the fine-tooth type, nearly like a circular file, and had practically no chip room. A cutter, say, of six diametral pitch and three inches in diameter would nowadays have about twelve cutting teeth; in those days it had about forty-eight teeth, on the supposition that the more teeth it had the faster it would cut. However, when the cutter became so dull that it would not cut but would practically push the metal out of the back of the wheel, nearly ruining it, the operator would stop, anneal the cutter, remill the cutting teeth, and harden the cutter again. Sometimes he was fortunate enough to maintain the previous tooth form, but generally each cutting produced a new form. In fact, to show how far we have advanced from those early days, where we nowadays have eight cutters in each pitch and special cutters for more refined work, in those days we had only two cutters. One was marked with the letter L and the other with the letter S. The L stood for large gears and the S for small gears. When the gears were medium sized, the operator could decide which cutter to take. The writer remembers, when a boy, turning up about a dozen of these cutters in the lathe and milling the teeth on them for a customer who had purchased a gear-cutting machine, yet when it was time to mark these cutters, just before hardening them, he could not tell which cutters should have the L and which the S. The gages used for obtaining the tooth form were made from actual gears that showed up especially good in practice. Some of these gears ran smoother and with less noise than gears cut with cutters made from templets laid out with the theoretical involute curve, because such early gears had teeth with practically modified tooth form, whereas the gear-tooth designer or draftsman usually laid out a gear tooth without any modification whatever.

You can imagine the writer's interest in the cutters that were being introduced by Brown & Sharpe, which could be sharpened without changing their form. These cutters impressed him as being good, but his efforts to introduce them in the shop were vigorously opposed by his superiors. A demonstration, however, caused the new cutters to be adopted. Then new troubles arose. The cutters had more chip room and fewer teeth, and therefore took a heavier chip. This gave the operator quite a jerk when he was operating the hand-lever feed with which many of the machines were then provided. The cutting edges were so far apart that each time the cutter touched the work it gave the operator a regular hammer blow. It was hard on the cutters also. It was only a few steps from this improvement to making the machine entirely automatic, which was a little before 1883.

After the first machine proved a success, the firm soon had several machines running night and day because the demand for cut gears was continually growing. Electric trolley cars were becoming commercially successful, and cut gears were just as important as the motors. Each car had a four-gear reduction: a rawhide pinion on the motor driving a large gear and a steel pinion on the intermediate shaft driving a large gear on the axle. The wear and tear were great, for the gears and motor were not encased, so that dirt and grit destroyed the gear teeth rapidly. The cost of the gears, therefore, became the important factor. Even though one man could attend to from five to eight automatic machines, the production was not enough to reduce the cost to the low point demanded.

It seemed to the writer that one disk cutter per machine was not enough, so, about 1892, he made a triplex, automatic gear-cutting machine, having three separate cutter-spindles. These cutters were arranged in tandem, one behind the other, so that stock cutters could be used. Three gear blanks were mounted on the work-arbor, with spacing collars between. Thus the cutter carriage traveled only the width of the face of one gear to cut the three gears. This was very fast, but was not the maximum production desired, so the radial duplex cutter, using two or more cutters on the same spindle at one time, and thus cutting more than one tooth at one time, was devised. By putting three of these gang cutters on each of the three spindles of the triplex gear-cutting machine, it was possible to finish nine teeth at one passage of the cutter carriage. The machine was good in every respect, but was too light for the heavy duty demanded of it.

The cast-iron motor gears in general use in those days, which had sixty-seven teeth and were three diametral pitch, were falling behind the pinions; so it was decided to rough out all the teeth of the gear at once. Therefore a machine was made that had a cutter for each tooth, or sixty-seven cutters, all acting at once. The cutters were made of 5/8-inch square steel and were ground to 14½ degrees. The gear blank was moved up and down by a powerful crank motion, while the cutters were fed toward the center, simultaneously, by means of a circular rack. The tools released themselves on the return stroke. The machine worked well and would stock out the sixty-seven teeth in about sixteen to eighteen minutes. The gear was then placed in the triplex gear-cutting machine and finished, using a gang of three cutters and feeding about six inches per minute.

It might be of interest also to mention that the writer designed and built at that time a vertical boring machine to turn the diameter, face off both sides of the rim, turn the diameter of both the hubs, and bore, rough-ream and finish-ream these motor gears in one operation or setting. The boring-bars were driven independently, thus maintaining the best cutting speeds and permitting nearly all operations to take place simultaneously. The complete time was about eighteen minutes per gear. In fact, the work was going very nicely when the order came to make all the gears of steel. New troubles arose, because the entire equipment was altogether too light to make steel gears on a manufacturing basis. This brings us to the present-day practice, with high-speed steel cutters, high-duty machines and high wages.

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[1] Paper read before the American Gear Manufacturers' Association at Chicago, September, 1917, by Henry E. Eberhardt, of the Newark Gear Cutting Machine Co., Newark, N. J.

Through all these fifty years the disk cutter has held its own. It has a range from as fine as sixty-four diametral pitch up to six inches circular pitch. The work can be forced or it can be done carefully to produce accurate work; the disk cutter can also be depended upon where low cost and a fair degree of accuracy are required. As to the form of tooth now used—the modified involute—it must be borne in mind that it was easy to change the previous forms, after practice had indicated what was wanted. In other words, where the form needed modification, the disk cutter readily lent itself to such changes, because it could be seen in advance just what form would be produced. In December, 1908, the American Society of Mechanical Engineers appointed a committee to investigate and report upon the subject of interchangeable involute gearing and to make recommendations. A report, made by a majority of the members, in 1913, touched upon some of the technical points relative to the addendum, also to the pressure angles in use. It also stated that the gears cut by the Brown & Sharpe Mfg. Co. with disk cutters ran more quietly than those cut by any other method. Still each method was evolved by necessity and has its individual field. No one method has driven the others out of the field as yet, because no one method covers the entire range of requirements.

* * *

WORKMEN'S COMPENSATION IN MUNITION PLANTS

BY CHESLA C. SHERLOCK [1]

The effect of the war upon the workmen's compensation acts in this country cannot be ascertained at this time. We may, however, surmise the general attitude the courts and commissions will take where injuries are received through conditions due to the war by examining the decisions handed down by the English courts. One decision that is particularly interesting is the case where an engineer was engaged in his usual occupation in an English town on the east coast of that country. German warships appeared in the harbor and commenced to shell the town, and the claimant sought refuge under a truck where he remained for some time. It then occurred to him that the injector should be opened or the steam pipes on the engine would be burned, so he went to perform this service and while returning to his place of refuge was struck by a fragment of a shell which smashed his left arm. Lord Cozens-Hardy, perhaps the foremost compensation authority in the British Isles, handed down the decision of the court. His Lordship held that no compensation was allowable for the reason that the claimant was subjected to no greater risk than others in the vicinity; that the hazard was common to all and for that reason the injury did not arise out of and in the course of the employment.

There are other cases of general interest that have been decided since the war broke out, but our chief attention is directed to those accidents that have occurred in munition works. The English courts put a great deal of stress upon the subject of notice. If the employer is not promptly notified of an injury by the injured employe or someone on his behalf, it is customary to absolve the employer from all liability under the law for the payment of compensation. That rule is not usually followed in this country. In one English case a young woman received an injury to her left eye while working in a munition plant. The evidence was such as to justify a finding that she received her injury "by accident arising out of and in the course of" her employment. Upon appeal, the court set aside the award upon a technical question of notice.

In another case a workman was injured prior to the declaration of war and received compensation to the amount of one-half his weekly wages. When war broke out his employers posted a notice that they would pay their employes, who volunteered or were sent to the front, full wages after deducting what they received from the government. The workman continued to draw his half-pay until the following year when he recovered his normal physical strength and commenced to draw full pay. A short time later he enlisted in the army and being killed his widow brought action for compensation. The court found that the workman came within the terms of the offer posted by his employers and that as he was drawing full pay at the time he enlisted, he was entitled to receive the benefits of the compensation offered by the employers according to the restrictions before mentioned. The question has frequently arisen in England as to whether or not compensation should be cut off, where paid for physical incapacity, when the so-called injured man has been accepted in the army. Justice would seem to indicate that such a rule should obtain and indeed the courts have so decided.

Where compensation is based upon the difference between the wages that the workman earned at the time of injury and those that he is able to earn after injury in the same employment, the question has come up that if he enlists in the army he is not earning wages in the sense intended by the act and, in fact, is not employed in an industrial employment at all. The point was also brought out that the employer has no means of ascertaining the amount of compensation due and for that reason no compensation is payable. This case came up and the arbitrator held that the employer was relieved from liability, but the court on appeal reversed the decision, stating that the estimate could be made upon the soldier's present physical condition and what he was able to earn in such condition if employed in an industrial occupation.

The tendency in compensation practice in England seems to be to preserve the compensation rights of workmen in every case where it is possible. In fact, the integrity of the compensation service demands that it should be preserved as nearly as consistent with the ends of justice against the inroads of war. If compensation is to survive these times of trial and suffering, much depends upon the attitude that the employers of this country take toward it. The mere fact that a man is called to the colors should not encourage employers to take advantage of his absence and seek to relieve themselves of the payment of the compensation due to his dependents or representatives. The English courts have, as a rule, blazed a wide, liberal path for our courts and commissions to follow, and it is hoped that American employers will be as open-minded as English employers.

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AN AFTER-THE-WAR MACHINERY PROBLEM

The demand for scrap metal for use in the production of munitions has brought out of various branches of industry considerable machinery that up to the beginning of the war had been used, but has now become obsolete. The high prices of scrap metal of all kinds have been a strong inducement to owners to sell everything that can be spared and then arrange to re-equip their works as soon as possible. There are two main causes of this clearing-out process: most of the industries that were diverted to war purposes found a proportion of the machinery unsuitable; if it were old or badly worn, it could not profitably be installed again, and so was put on the scrap heap. Capital has been gradually withdrawn from the industries seriously affected by war conditions, and new industries have been fostered. In Great Britain, vehicle and furniture factories, builders' plants, etc., have been almost idle so long that some of the unused machinery is worth only the weight of the metal. Then, too, considerable metal has been obtained from farms where the motor tractor has thrown into disuse old types of plows and other implements.

Not the least of the difficulties of industrial reconstruction on a normal basis after the war will be the problem of unsuitable machinery, no inconsiderable proportion of which will probably find its way to dealers in scrap metals. Manufacturers of machinery will require time to construct new equipments, in whole or in part, and therefore to owners of plants now devoted exclusively to war work the question of readiness to take up old or new lines of production immediately on the cessation of hostilities is an urgent one. At best, the adaptation of present plants to old or new uses will, it is thought, be a slow process, and for some time alert manufacturing firms have been thinking and acting ahead.—*United States Commerce Reports*

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PIN MEASUREMENT OF SPUR GEARS

PRINCIPLES GOVERNING PIN MEASUREMENT AND DERIVATION OF FORMULAS USED

BY REGINALD TRAUTSCHOLD [1]

SPUR gearing enters into the operation of many intricate and accurate mechanisms, and, quite obviously, the efficiency of such transmission and its satisfactory operation must largely depend upon the accuracy with which the gears and their teeth are finished. Yet when it comes to checking up spur gears, the unusual condition is encountered of having nothing definite from which to measure. Gears are proportioned from what may be termed an imaginary line or circumference—the pitch circle. The teeth may have long or short addenda, the pressure angle may vary, etc. Of course, the pressure angle is now pretty well standardized, but this does not materially affect the problem, for measuring the diameter of gears from the top of the teeth or from the base of the tooth spaces cannot establish their accuracy on the pitch circumference. The latter is governed by one dimension—the pitch diameter—which must not vary and which must be accurately established for satisfactory operation and exact ratios.

In order to ascertain accurately the measurement of this elusive dimension, pin measurement of spur gears has been developed. This system consists simply in measuring the distance between suitably proportioned pairs of pins that bear on the profile pitch lines of pairs of adjacent teeth. In gears with an even number of teeth, the pins are inserted between pairs of diametrically opposite tooth spaces; in gears with an odd number of teeth in which a tooth is diametrically opposite a tooth space, the second pin has to be placed in a tooth space most nearly opposite the first pin. The measurement in this instance is not one of diameter, but of a chord as nearly the length of what would be the corresponding diameter of a gear with an even number of teeth as can be secured.

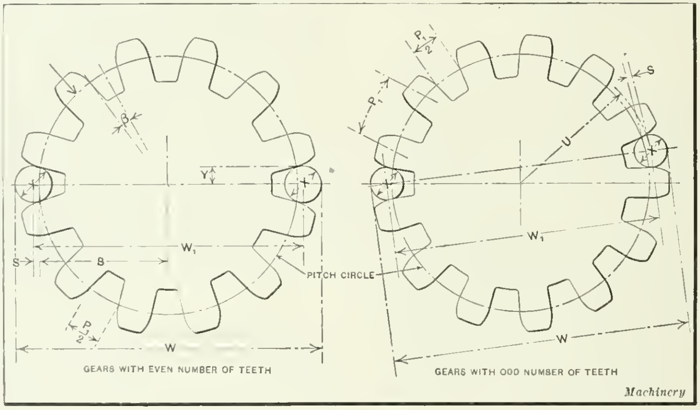

Fig. 1. Methods of taking Measurements of Spur Gears

The method of making pin measurements of gears with even and odd numbers of teeth is shown in Fig. 1, from which it is evident that the distance between pin centers or, what is customarily taken, the distance over the pins must accurately measure the pitch diameter of the gears—directly in one case and in the other by a chord that bears a definite relationship to the diameter of the gear. The diameter of the pin employed is an important factor and is naturally controlled by the width of the tooth spaces. The logical size of pin would appear to be that which, when resting in the tooth space, will bear on the pitch points of the respective tooth profiles in such a way that radii of the pin to such points will be normal to the tooth profiles.

Such a proportioned pin is shown in Fig. 2, the diameter of which can be readily calculated for use with teeth of any specific pressure angle. The angle subtended on the pitch circle by the tooth space is easily calculated, for one-half this angle is equal to 360 divided by four times the number of teeth in the gear, or $\beta = \frac{360}{4N} = \frac{90}{N}$. The chordal width of the tooth space is likewise easily calculated and the pressure angle is known. Then the distance H_1 between the chordal plane of the tooth space and the point where planes tangent to the tooth profiles on the pitch circle intersect is equal to half the chordal width of the tooth space multiplied by the cotangent of the pressure angle. This establishes the location of point Z, Fig. 2. The distance H_2 between the point Z and the center of the pin is equal to the distance between this point of intersection and the chordal plane of the tooth space multiplied by the square of the secant of the pressure angle. The distance between the center of the gear and the chordal plane of the tooth space is then equal to the pitch radius of the gear multiplied by the cosine of the angle subtended by one-half a tooth space. With such dimensions established, the distance between the center of the pin and the center of the gear is readily obtained, and also the diameter of the pin. For convenience, this pin diameter may be designated as the "standard"; that is, it is the diameter of a pin that will be tangent to adjacent tooth profiles at points on the pitch circle.

Finding Size of Pin

For a given pitch, the standard diameter of a pin is obviously dependent upon the number of teeth in the gear, and it must increase with the number of teeth. In other words, as the curvature of the pitch circle is decreased the chordal width of the tooth spaces increases, while the width measured on the pitch circle remains constant. For instance, the standard diameter of a pin for a gear of five diametral pitch having six teeth—about the smallest number of teeth that will be encountered in practice—will be 0.320802 inch, while for a similar gear with fifty teeth the diameter of the standard pin will be 0.324434 inch, an increase in diameter of 0.00363 inch.

Notation for Formulas

Pitch diameter	D
Pitch radius	R
Number of teeth	N
Diametral pitch	P
Circular pitch	P_1
Pressure angle	a
Half angle subtended by tooth space	β
Half chordal width of tooth space	Y
Chordal ordinate	B
Pin center amplitude	S
Offset of pin center (gears with an odd number of teeth)	O
Pin center gear ordinate (gears with an odd number of teeth)	H
Diameter of pin	X
Pin center spacing	W_1
Pin center radius	U
Width over pins	W
Backlash	L
Half angle subtended by tooth space plus backlash	β_1
Half chordal width of tooth space with backlash	Y_1
Pin center amplitude with backlash	S_1

Formulas Used in Pin Measurements

$$D = \frac{N}{P} \quad (1) \qquad R = \frac{D}{2} \quad (2) \qquad P_1 = \frac{3.1416}{P} \quad (3)$$

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$$\beta = \frac{90}{N} \quad (4) \qquad \beta_1 = \frac{45(P_1 + L)}{1.5708D} \quad (5) \qquad Y = R \sin \beta \quad (6)$$

$$Y_1 = R \sin \beta_1 \quad (7) \qquad B = R \cos \beta \quad (8) \qquad S = \sqrt{0.25X^2 - Y^2} \quad (9)$$

$$S_1 = \sqrt{0.25X^2 - Y_1^2} \quad (10) \qquad U = B + S \quad (11)$$

$$O = U \sin 2\beta \quad (12) \qquad H = O \cot 2\beta \quad (13)$$

$$W_1 = 2U \quad \text{Gears with even number of teeth} \quad (14)$$

$$W_2 = \sqrt{O^2 + (H + U)^2} \quad \text{Gears with odd number of teeth} \quad (15)$$

$$W = W_2 + X \quad (16) \qquad X = 2R \sin \beta \sec \alpha \quad (17)$$

$$X > 2Y \text{ but not } > 2Y \sec \alpha \quad (18)$$

Discussion of Formulas

A different size of pin for measuring each gear that differs in the number of teeth or in pitch will result in such a multiplicity of gages, however, as to detract seriously from the method of measurement, particularly if the number of pins is to be also increased by the number of different pressure angles employed. Fortunately, this can be avoided without sacrifice in accuracy. In the first place, the pressure angle factor does not affect the diameter of the pin as much as may be imagined. For instance, take two 6-tooth gears of 3 diametral pitch, one having a pressure angle of 14.5 degrees and the other one of 20 degrees, the hypothesis for Example 1. The standard diameter of the pin will vary about 0.015 inch for the two gears.

Example 1—Required the pin diameter X for 6-tooth gears, 3 diametral pitch, with 14.5- and 20-degree pressure angles.

$$D = \frac{6}{3} = 2 \text{ inches} \quad (1) \qquad R = 1 \text{ inch} \quad (2)$$

$$\beta = \frac{90}{6} = 15 \text{ degrees} \quad (4)$$

For gears having a pressure angle of 14.5 degrees:

$$X = 2 \times 0.25882 \times 1.0329 = 0.53466 \text{ inch} \quad (17)$$

For gears having a pressure angle of 20 degrees:

$$X = 2 \times 0.25882 \times 1.0642 = 0.55006 \text{ inch} \quad (17)$$

Fig. 4 illustrates how a pin of slightly smaller diameter than that which has been referred to as standard can be employed for the accurate measurement of gears, thus materially reducing the number of pin diameters required. The broken-line circle depicts a pin of standard diameter and the full-line circle a slightly smaller pin. Both circles are, however, of greater diameter than the chordal width of the tooth space, and the contacts of both circles are at the pitch point of the respective tooth profiles. In the case of the pin of standard diameter, radii to the points of contact are normal to the tooth profiles, while in the case of the smaller circle such radii are not normal to the tooth profiles. Below, or within, the pitch circle, the curvature of the tooth profiles and the curvature of the pins are opposed and the contact between the pins and the teeth must take place at the extremities of the common line that depicts the chordal width of the tooth space and joins the pitch points on the adjacent tooth profiles. The measurement of the pitch diameter, therefore, may be as accurately obtained with the smaller pin as with the one of standard diameter. The only requirement is that the diameter of the pin is greater than the chordal width of the tooth space.

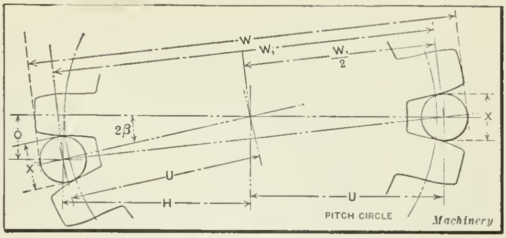

Fig. 3. Pin Measurement of Spur Gears with Odd Number of Teeth

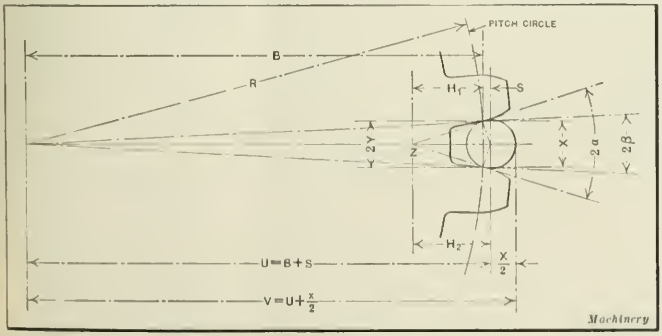

Fig. 2. Pin Measurement of Spur Gears

Though the diameter of the pin used may be slightly less than that of the standard diameter for the particular gear, it must not be greater, for, immediately above the pitch circle, the curvatures of the pin and of the tooth profiles are in the same direction and that of the pin is the greater. The effect of this, with a pin of greater diameter than the particular standard, would be to cause the pin to rest on the tooth profiles at a point above, or without, the pitch circle. The diameter of the pin must, therefore, be between that of the standard for the particular gear and the chordal width of the tooth space. This latitude permits the same size pin to be employed for measuring a number of gears of the same pitch, but differing considerably in the number of teeth. Within the range of the smallest and the largest gears of the same pitch cut in any particular shop, several diameters of pins may be required, but in all cases the diameter of the pin must fall within the aforesaid limits.

The amplitude of the pin center, or the distance it lies above the chordal plane of the tooth space, is equal to the square root of the square of half the pin diameter minus the square of half the chordal width of the tooth space. This relationship exists for any pin of suitable diameter.

Allowance for Backlash

The foregoing deductions are based on the assumption that the width of the teeth and the tooth spaces are equal. Cases frequently arise, however, in which a certain backlash is permissible and sometimes it is essential. The effect of this backlash is equivalent to increasing the arc of the pitch circle confined within the tooth space; that is, one-quarter the backlash may be considered as being removed from the profiles of each of the bounding teeth, as shown in Fig. 5. The effect of this is to cause the pin to sink farther down between the teeth, but the contact points between the pin and the respective tooth profiles remain on the pitch circle, for the diameter of the pin must remain greater than the increased chordal width of the tooth space.

The angle subtended by a tooth space permitting backlash is equal to the angle of an arc on the pitch circle that is equal to one-half the circular pitch plus one-half the total amount of backlash. The chordal width of the tooth space is then equal to twice the product of the pitch radius by the sine of the increased subtended angle, and the radius amplitude of the pin center is found, as before, from the diameter of the pin and one-half the chordal width of the tooth space.

Example 2—Required pin measurements for 30- and 33-tooth gears, 3 diametral pitch, 20-degree pressure angle; first, without backlash; second, with 0.001 inch backlash, and third, with 0.005 inch backlash.

For a 30-tooth gear:

$$D = \frac{30}{3} = 10 \text{ inches} \quad (1)$$

For a 33-tooth gear:

$$D = \frac{33}{3} = 11 \text{ inches} \quad (1)$$

$$P_1 = \frac{3.1416}{3} = 1.0472 \text{ inch} \quad (3)$$

With no backlash, for the 30-tooth gear:

$$\beta = \frac{90}{30} = 3 \text{ degrees} \quad (4)$$

and for the 33-tooth gear:

$$\beta = \frac{90}{33} = 2.7273 \text{ degrees} \qquad (4)$$

With 0.001 inch backlash, for the 30-tooth gear:

$$\beta_1 = \frac{45 \times 1.0482}{1.5708 \times 10} = 3.0029 \text{ degrees} \qquad (5)$$

and for the 33-tooth gear:

$$\beta_1 = \frac{45 \times 1.0482}{1.5708 \times 11} = 2.7299 \text{ degrees} \qquad (5)$$

With 0.005 inch backlash, for the 30-tooth gear:

$$\beta_1 = \frac{45 \times 1.0522}{1.5708 \times 10} = 3.0143 \text{ degrees} \qquad (5)$$

and for the 33-tooth gear:

$$\beta_1 = \frac{45 \times 1.0522}{1.5708 \times 11} = 2.7403 \text{ degrees} \qquad (5)$$

With no backlash, for the 30-tooth gear:

$$Y = 5.0 \times 0.05234 = 0.26170 \text{ inch} \qquad (6)$$

and for the 33-tooth gear:

$$Y = 5.5 \times 0.04758 = 0.26169 \text{ inch} \qquad (6)$$

With 0.001 inch backlash, for the 30-tooth gear:

$$Y_1 = 5.0 \times 0.05239 = 0.26195 \text{ inch} \qquad (7)$$

and for the 33-tooth gear:

$$Y_1 = 5.5 \times 0.04763 = 0.26197 \text{ inch} \qquad (7)$$

With 0.005 inch backlash, for the 30-tooth gear:

$$Y_1 = 5.0 \times 0.05259 = 0.26295 \text{ inch} \qquad (7)$$

and for the 33-tooth gear:

$$Y_1 = 5.5 \times 0.04781 = 0.26296 \text{ inch} \qquad (7)$$

With no backlash, for the 30-tooth gear:

$$B = 5.0 \times 0.99863 = 4.99315 \text{ inches} \qquad (8)$$

and for the 33-tooth gear:

$$B = 5.5 \times 0.99887 = 5.49379 \text{ inches} \qquad (8)$$

With 0.001 inch backlash, for the 30-tooth gear:

$$B = 5.0 \times 0.99862 = 4.99310 \text{ inches} \qquad (8)$$

and for the 33-tooth gear:

$$B = 5.5 \times 0.99886 = 5.49373 \text{ inches} \qquad (8)$$

With 0.005 inch backlash, for the 30-tooth gear:

$$B = 5.0 \times 0.99861 = 4.99305 \text{ inches} \qquad (8)$$

and for the 33-tooth gear:

$$B = 5.5 \times 0.99886 = 5.49373 \text{ inches} \qquad (8)$$

Maximum $2Y = 0.5259$ inch; therefore, from Formula (18), make $X = 0.55$ inch.

With no backlash, for the 30-tooth gear:

$$S = \sqrt{0.075625 - 0.068487} = 0.08449 \text{ inch} \qquad (9)$$

and for the 33-tooth gear:

$$S = \sqrt{0.075625 - 0.068482} = 0.08452 \text{ inch} \qquad (9)$$

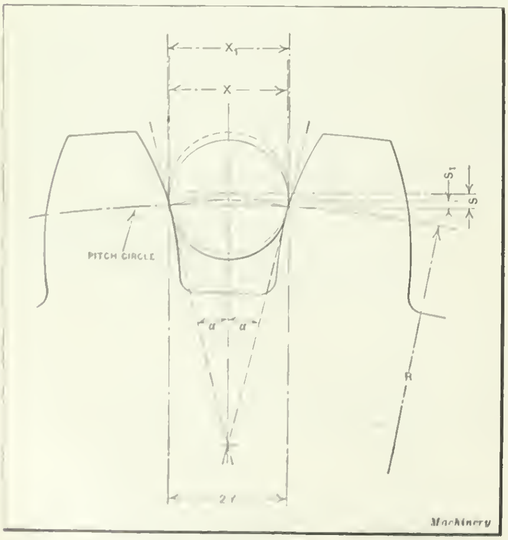

Fig. 4. Measurement with Pins proportioned for Smaller Gear

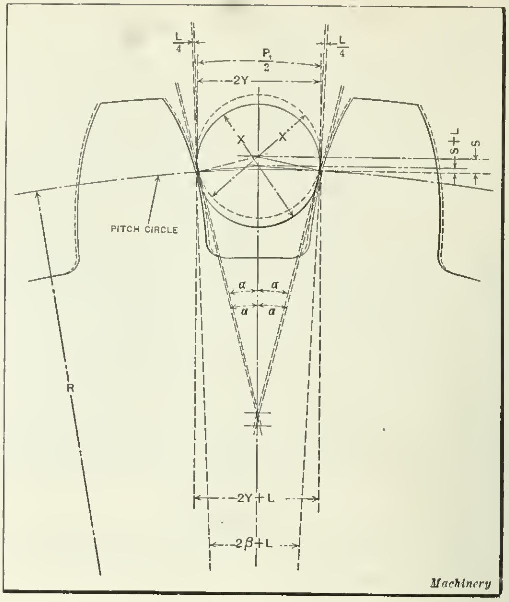

Fig. 5. Pin Measurement for Backlash

With 0.001 inch backlash, for the 30-tooth gear:

$$S_1 = \sqrt{0.075625 - 0.068618} = 0.08370 \text{ inch} \qquad (10)$$

and for the 33-tooth gear:

$$S_1 = \sqrt{0.075625 - 0.068628} = 0.08365 \text{ inch} \qquad (10)$$

With 0.005 inch backlash, for the 30-tooth gear:

$$S_1 = \sqrt{0.075625 - 0.069143} = 0.08051 \text{ inch} \qquad (10)$$

and for the 33-tooth gear:

$$S_1 = \sqrt{0.075625 - 0.069147} = 0.08048 \text{ inch} \qquad (10)$$

With no backlash, for the 30-tooth gear:

$$U = 4.99315 + 0.08449 = 5.07764 \text{ inches} \qquad (11)$$

and for the 33-tooth gear:

$$U = 5.49379 + 0.08452 = 5.57831 \text{ inches} \qquad (11)$$

With 0.001 inch backlash, for the 30-tooth gear:

$$U = 4.99310 + 0.08370 = 5.07680 \text{ inches} \qquad (11)$$

and for the 33-tooth gear:

$$U = 5.49373 + 0.08365 = 5.57738 \text{ inches} \qquad (11)$$

With 0.005 inch backlash, for the 30-tooth gear:

$$U = 4.99305 + 0.08051 = 5.07356 \text{ inches} \qquad (11)$$

and for the 33-tooth gear:

$$U = 5.49373 + 0.08048 = 5.57421 \text{ inches} \qquad (11)$$

For the 33-tooth gear, with no backlash:

$$O = 5.57831 \times 0.09506 = 0.530274 \text{ inch} \qquad (12)$$

For the 33-tooth gear, with 0.001 inch backlash:

$$O = 5.57738 \times 0.09506 = 0.530196 \text{ inch} \qquad (12)$$

and with 0.005 inch backlash:

$$O = 5.57421 \times 0.09506 = 0.529884 \text{ inch} \qquad (12)$$

For the 33-tooth gear, with no backlash:

$$H = 0.530274 \times 10.472 = 5.553029 \text{ inches} \qquad (13)$$

For the 33-tooth gear, with 0.001 inch backlash:

$$H = 0.530196 \times 10.472 = 5.552213 \text{ inches} \qquad (13)$$

and with 0.005 inch backlash:

$$H = 0.529884 \times 10.472 = 5.548945 \text{ inches} \qquad (13)$$

With no backlash, for the 30-tooth gear:

$$W_1 = 2 \times 5.07764 = 10.15528 \text{ inches} \qquad (14)$$

and for the 33-tooth gear:

$$W_1 = \sqrt{0.28119052 + 123.906708} = 11.14396 \text{ inches} \qquad (15)$$

With 0.001 inch backlash, for the 30 tooth gear:

$$W_1 = 2 \times 5.0768 = 10.1536 \text{ inches} \qquad (14)$$

and for the 33 tooth gear:

$$W_1 = \sqrt{0.28110780 + 123.867804} = 11.14221 \text{ inches} \qquad (15)$$

With 0.005 inch backlash, for the 30 tooth gear:

$$W_1 = 2 \times 5.07356 = 10.14712 \text{ inches} \qquad (14)$$

and for the 33 tooth gear:

$$W_1 = \sqrt{0.28077705 + 123.724577} = 11.13576 \text{ inches} \qquad (15)$$

SIZES OF PINS USED IN MEASUREMENT OF 1 D. P. GEARS

Number of Teeth	Pressure Angle 14 Degrees, 30 Minutes		Pressure Angle 20 Degrees		Number of Teeth	Pressure Angle 14 Degrees, 30 Minutes		Pressure Angle 20 Degrees	
	Pin Diameter	Over-all Diameter	Pin Diameter	Over-all Diameter		Pin Diameter	Over-all Diameter	Pin Diameter	Over-all Diameter
12	1.6179	13.9199	1.6668	14.1339	57	1.6222	58.9805	1.6713	59.1986
13	1.6183	14.8341	1.6673	15.0431	58	1.6222	60.0066	1.6713	60.2212
14	1.6189	15.9359	1.6679	16.1502	59	1.6221	60.9834	1.6713	61.1973
15	1.6195	16.8594	1.6686	17.0725	60	1.6223	62.0074	1.6714	62.2221
16	1.6199	17.9486	1.6689	18.1628	61	1.6222	62.9920	1.6713	63.2110
17	1.6203	18.8798	1.6693	19.0938	62	1.6224	64.0063	1.6715	64.2241
18	1.6204	19.9576	1.6695	20.1718	63	1.6224	64.9669	1.6715	65.1801
19	1.6204	20.8894	1.6695	21.1081	64	1.6225	66.0104	1.6716	66.2246
20	1.6208	21.9649	1.6699	22.1794	65	1.6224	66.9701	1.6716	67.1863
21	1.6211	22.9147	1.6702	23.1282	66	1.6223	68.0093	1.6714	68.2240
22	1.6211	23.9710	1.6704	24.1854	67	1.6224	69.0205	1.6715	69.2325
23	1.6212	24.9164	1.6707	23.1324	68	1.6224	70.0269	1.6716	70.2255
24	1.6213	25.9754	1.6704	26.1900	69	1.6225	70.9672	1.6716	71.1837
25	1.6214	26.9230	1.6705	27.1376	70	1.6225	72.0113	1.6716	72.2258
26	1.6214	27.9800	1.6704	28.1949	71	1.6222	72.9784	1.6713	73.1909
27	1.6215	28.9369	1.6705	29.1507	72	1.6223	74.0120	1.6715	74.2267
28	1.6216	29.9831	1.6705	30.1977	73	1.6222	74.9844	1.6713	75.1973
29	1.6216	30.9423	1.6704	31.1557	74	1.6222	76.0126	1.6713	76.2278
30	1.6217	31.9862	1.6708	32.2008	75	1.6224	77.0302	1.6715	77.2422
31	1.6218	32.9573	1.6710	33.1704	76	1.6223	78.0142	1.6714	78.2282
32	1.6219	33.9897	1.6709	34.2038	77	1.6224	79.0069	1.6716	79.2187
33	1.6219	34.9592	1.6709	35.1743	78	1.6224	80.0083	1.6716	80.2271
34	1.6218	35.9913	1.6709	36.2059	79	1.6224	81.0389	1.6714	81.2613
35	1.6221	36.9434	1.6712	37.1596	80	1.6224	82.0109	1.6715	82.2291
36	1.6220	37.9935	1.6711	38.2082	81	1.6224	83.0203	1.6715	83.2350
37	1.6220	39.0097	1.6712	39.1885	82	1.6223	84.0114	1.6714	84.2267
38	1.6220	39.9963	1.6711	40.2107	83	1.6225	85.0660	1.6717	85.2788
39	1.6221	40.9669	1.6712	41.1825	84	1.6223	86.0135	1.6715	86.2286
40	1.6221	41.9974	1.6712	42.2119	85	1.6225	87.0445	1.6716	87.2608
41	1.6220	42.9823	1.6711	43.2014	86	1.6222	88.0143	1.6713	88.2286
42	1.6220	43.9985	1.6712	44.2134	87	1.6223	88.9796	1.6715	89.1987
43	1.6221	44.9727	1.6713	45.1880	88	1.6225	90.0147	1.6716	90.2292
44	1.6220	45.9997	1.6712	46.2146	89	1.6222	91.0297	1.6713	91.2389
45	1.6222	46.9872	1.6713	47.2022	90	1.6224	92.0119	1.6715	92.2300
46	1.6221	48.0016	1.6712	48.2161	91	1.6222	92.9743	1.6713	93.1955
47	1.6223	48.9776	1.6714	49.1915	92	1.6225	94.0166	1.6717	94.2309
48	1.6222	50.0050	1.6713	50.2189	93	1.6225	95.0353	1.6716	95.2535
49	1.6221	51.0005	1.6713	51.2123	94	1.6225	96.0156	1.6716	96.2301
50	1.6222	52.0031	1.6713	52.2174	95	1.6226	97.0651	1.6718	97.2769
51	1.6222	52.9937	1.6714	53.2087	96	1.6224	98.0129	1.6715	98.2310
52	1.6223	54.0055	1.6714	54.2199	97	1.6223	99.0448	1.6714	99.2494
53	1.6222	54.9732	1.6713	55.1849	98	1.6223	100.0143	1.6715	100.2296
54	1.6223	56.0066	1.6713	56.2206	99	1.6225	100.9448	1.6717	101.1635
55	1.6223	56.9804	1.6714	57.1977	100	1.6224	102.0118	1.6716	102.2304
56	1.6223	58.0083	1.6715	58.2227	...	......	....	......	....

Machinery

With no backlash, for the 30-tooth gear:

$W = 10.15528 + 0.55 = 10.70528$ inches (16)

and for the 33-tooth gear:

$W = 11.14396 + 0.55 = 11.69396$ inches (16)

With 0.001 inch backlash, for the 30-tooth gear:

$W = 10.15360 + 0.55 = 10.70360$ inches (16)

and for the 33-tooth gear:

$W = 11.14221 + 0.55 = 11.69221$ inches (16)

With 0.005 inch backlash, for the 30-tooth gear:

$W = 10.14712 + 0.55 = 10.69712$ inches (16)

and for the 33-tooth gear:

$W = 11.13576 + 0.55 = 11.68576$ inches (16)

The general formulas governing the pin measurement of spur gears are, with the exception of the pin diameter, quite independent of the pressure angle and scarcely require further explanation, for the general formulas and those applying to specific instances can be readily followed by reference to the illustrations. The principal consideration is the accuracy of the method, and this is best illustrated by the consideration of a concrete example; Example 2 is quite typical and gives the calculations required for ascertaining the distance between centers and over pins for 30- and 33-tooth gears, of 3 diametral pitch, with 20-degree teeth; first, without backlash; second, with 0.001 inch backlash, and, third, with 0.005 inch backlash. The greater backlash is not excessive and is frequently found necessary for gears of ordinary pitch.

In explanation of the choice of pin diameter, the fact that the maximum chordal width of tooth space with 0.005 inch backlash equals 0.5259 inch must be taken into consideration in selecting the diameter of the measuring pin. The diameter of the pin selected is 0.55 inch, which is greater than the chordal width of the tooth space, but less than the product of half the chordal width multiplied by the secant of the pressure angle.

The presence of 0.001 inch backlash in a 30-tooth, 3-diametral pitch gear is quite apparent by the pin method of measurement, although it could not very well be measured in any other way. It is shown by a difference in measurement of about 0.0016 inch, while a 0.005 inch backlash, an amount which is frequently allowed, makes a difference of approximately 0.0078 inch. A backlash of 0.01 inch would be apparent by a reduction in diameter of 0.0156 inch. This multiplication of backlash in pin-measurement readings is one of the chief advantages of the system, for it eliminates the necessity of the careful micrometric readings, which would be about the only other way in which such small variations between the thickness of the teeth and the width of the tooth spaces could be measured.

In the case of the 33-tooth gear, or any gear with an odd number of teeth, the variation in measurement is not quite so proportionately pronounced, as the measurement is made on a chord slightly shorter than a diameter, so that the variations are proportionately reduced. Owing to the fact that all teeth may not be quite uniformly proportioned in a gear, more than one pin measurement is always advisable, particularly in the case of gears with an odd number of teeth. The various measurements should also be made from or between different sets of teeth, so as to obtain a reliable average.

The accompanying table gives the pin diameter of gears of 1 diametral pitch having from 12 to 100 teeth, with 14.5- and 20-degree pressure angles. It also gives the diameter of the gears when measured over the pins.

TOOLING A FOREIGN CAR IN AMERICA

THE REAR AXLE HOUSING

BY THOMAS ORCHARD[1]

Oper. No.	Operation	Type of Machine	Tools
1	Clean casting	Sand blast	
2	Anneal and pickle	Annealing furnace	
3	Mill surface of joint (rough and finish) and burr	Beaman & Smith continuous milling machine	Fixture for holding four pieces
4	Face-mill eight bolt bosses	Becker vertical milling machine	Plate with locating pins and clamps
5	Drill eight bolt holes in flange and ream two holes for locating	No. 14 "Natco" multiple-spindle drilling machine	Trunnion jig
6	Rough straddle-mill inside and outside of main bearings and bosses surrounding. Allow for finish cut	Le Blond milling machine	Fixture, cutters and arbor
7	Assemble the two halves	Bench	Bolts
8	Bore (rough and finish) and size 133-millimeter diameter bearing holes; finish face, inside and outside (except bosses); index work 90 degrees and bore (rough and finish) and size 130-millimeter diameter hole; rough- and finish-face flange at same end	Universal boring machine	Indexing table. Boring fixture, bars and cutters
9	Turn out and size recess for rear axle tube on one side; reverse and recess other side	No. 7A Potter & Johnston turret lathe	Fixture
10	Drill ten holes in each side of case; drill six holes in end	No. 14 "Natco" multiple-spindle drilling machine	Trunnion jig
11	Tap twenty 12-millimeter holes	No. 30 "Natco" multiple-spindle drilling machine	
12	Tap six 10-millimeter holes	No. 30 "Natco" multiple-spindle drilling machine	
13	Drill hole, counterbore end of boss and tap 22-millimeter hole	Rockford horizontal drilling machine	Fixture
14	Drill hole, face boss and tap 30-millimeter hole	Rockford horizontal drilling machine	Same fixture as used for Operation 13
15	Wash in soda solution		
16	Inspection		

Machinery

In this and following articles will be described some interesting jigs and fixtures used in tooling an automobile of foreign design. This car was originally built by Russian engineers, who employed hand methods, and it became evident that in order to increase the production a change would have to be made in their methods of manufacture. Accordingly contracts were made with concerns in America to provide them with jigs and fixtures for interchangeable manufacture, which were designed by American engineers in accordance with modern practice. The tooling of the rear axle housing, crankcase, piston ring and connecting-rod will be explained. The present article takes up the machining of the rear axle housing.

By glancing through the various operations necessary to machine the rear axle housing, it can readily be seen that most of the jigs and fixtures are very simple affairs which do not involve any points of special interest. However, the designing of the jig for Operation 10 brought out some interesting methods of tooling. This operation is performed in a trunnion jig and involves the drilling of twenty holes, half of which are located on opposite sides of the housing, and six holes located at right angles to the twenty holes.

The rear axle housing, Fig. 1, is loaded in a trunnion jig *A*, Figs. 2 and 5, in the position shown. Part *A* is revolved in two bearings, or supports, *B* and *C*, at each end, which are set on the base *D*. These parts are all of cast iron, while the pins *E* on which the revolving takes place are of steel, pressed into *A*, and having a running fit in *B* and *C*. The supports *B* and *C* are tongued in the base by means of the keys *F*, to insure proper alignment. Support *B* is bolted permanently to the base, while support *C* may be adjusted in either direction, should the revolving part *A* turn too hard, or should there be any wear at *G* and *H*. The adjustment is made by the set-screws *J* and *K* after loosening the nuts *L* and *M*, elongated slots being provided to permit this adjustment. The base *D* is equipped with six steel wheels *N* and runs on a track under the spindles of two "Natco" multiple-spindle drilling machines; one of the machines is set up for drilling the ten holes on opposite sides of the work, and the other for the six holes on the end.

The revolving part *A* has a disk A_1 on each end, these disks being a part of the casting itself. They revolve with part *A*, their purpose being to relieve the pins *E* of the entire weight when revolving. The outside diameters of these wheels are finished and they ride on cast-iron shoes *P*, which rest on supports *B* and *C*, and are held in place by means of the screws and dowels *Q* and *R*. The friction of the disks A_1 on the shoes *P* also serves, to a certain extent, as a brake while revolving the jig, and prevents the operator from losing control of it when the indexing plunger is not in place.

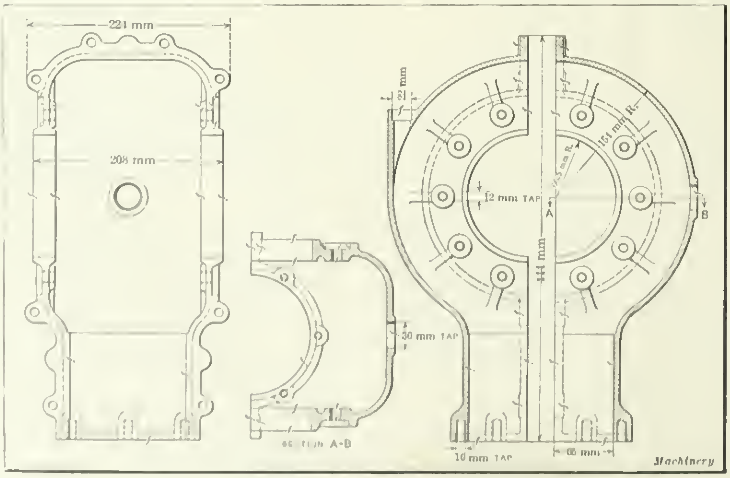

Fig. 1. Rear Axle Housing

Loading the Jig

As previously stated, Figs. 2 and 5 show the jig in the loading position. To load, the clamping arrangement contained in strap *S* is removed, and plug *T* is pulled back into the counterbored hole *U*, by means of handle *V*. The locating plug *W* is drawn back until pin *X* clears the top of boss *Y*. It is then given a quarter turn, spring *Z* bringing the pin in contact with boss *Y*, thus keeping plug *W* in the clear. The work may now be inserted from the top in the position shown in Fig. 1, and the 133-millimeter hole slipped over the locating plug B_1, which is pressed into the wall of the jig *A*.

The plug *T* is then pushed inward, fitting into the corresponding hole on the opposite side of the work, until the shoulder on the plug rests against the finished boss on the work. In order to allow ample loading and unloading clearance between the side walls of the jig, it was found necessary to devise a quick clamping device to be used in conjunction with plug *T*, in order to save time in pulling this plug back out of the way and moving it forward to clamp the work. The following method was used. A plate C_1, with a slot D_1 cut in it to allow the pin E_1 to pass through it, was screwed in position on top of the boss F_1.

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[1] Address: New Britain Machine Co., New Britain, Conn.

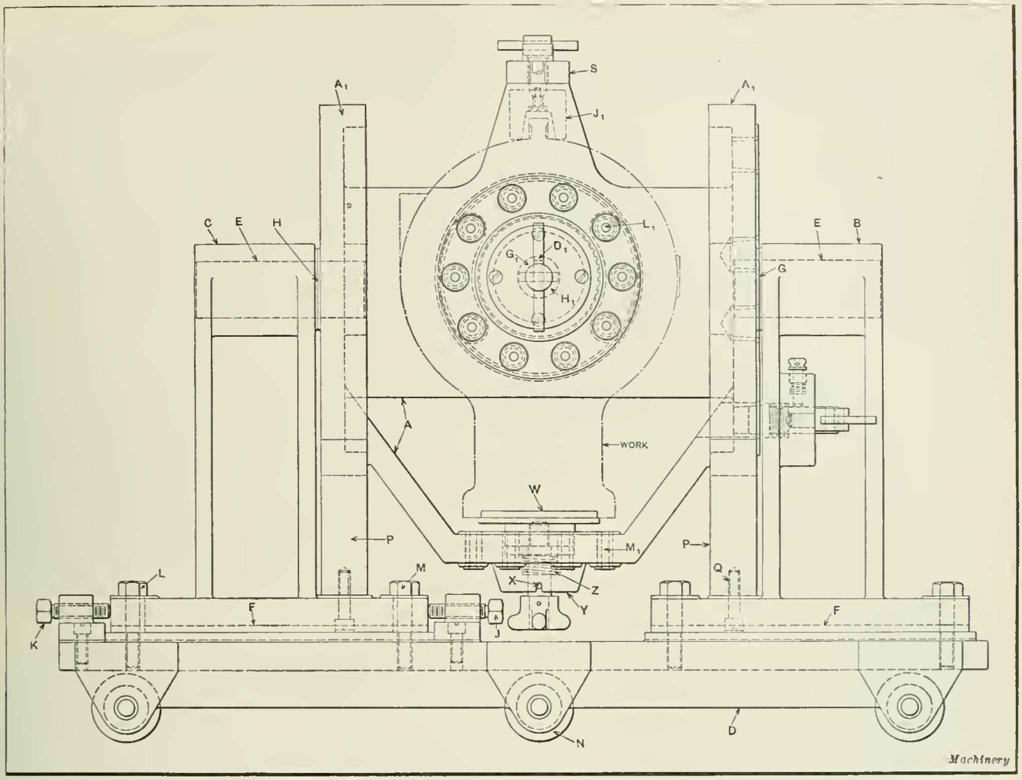

Fig. 2. Side Elevation of Trunnion Jig

Two plates G_1 and H_1 were set in a counterbored hole in the bottom of C_1, these plates being cut at an angle. To pull plug *T* back from the work, handle *V* is turned 90 degrees, thus allowing pin E_1 to pass up between the two plates G_1 and H_1 and through the slot D_1 in the plate C_1. Handle *V* is again turned 90 degrees and plug *T* is held back in the counterbored hole *U* by pin E_1 resting on top of plate C_1. When loading, a reverse method is employed to get plug *T* into the 133-millimeter hole in the work, after which the work is clamped by the cam action of pin E_1 against G_1 and H_1 as handle *V* is turned. This not only gives the work horizontal alignment, but clamps it in place as well. As soon as the work has been slipped over plug B_1, *W* may be allowed to spring upward, and as *T* is inserted in the work, *W* will find

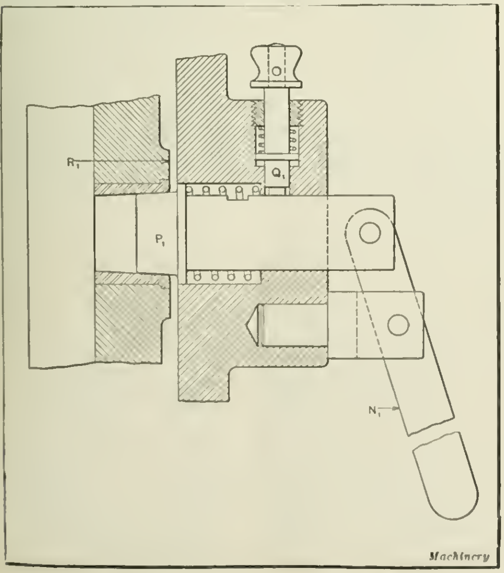

Fig. 3. Indexing Plunger engaged with Trunnion Jig

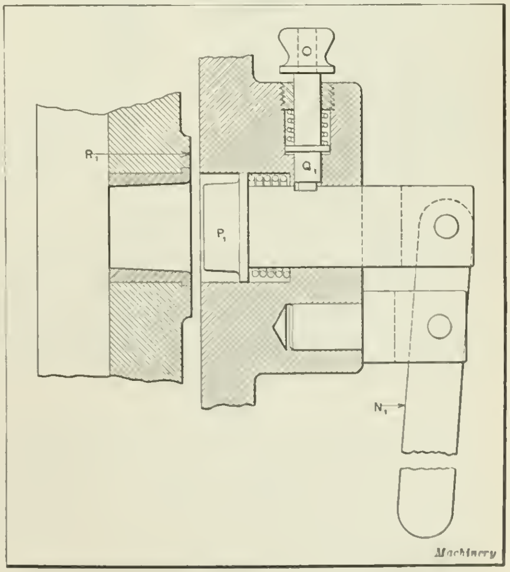

Fig. 4. Indexing Plunger withdrawn from Trunnion Jig

its place in the 130-millimeter hole, thus taking care of the vertical alignment. Strap S is then locked on the jig by means of quarter-turn screws and the equalizing clamp J_1 brought down against the work. This clamp is free to rock in any direction and adjusts itself to any irregularities there may be on the rough casting. The method of obtaining this result is clearly shown in Fig. 6.

The jig may now be revolved or indexed 90 degrees and run along the track under a "Natco" drilling machine, in which the ten holes are drilled at once by a bank of drills arranged for this particular operation. The fixture may then be indexed 180 degrees and the ten holes L_1, Fig. 2, drilled under the same machine, as their location is identical with the corresponding holes on the opposite side of the housing. The fixture is then run along the track and under another "Natco" drilling machine, which is set up for drilling the six holes M_1.

Indexing the Jig

The method of indexing is very simple and is shown in Figs. 3 and 4. When the work is to be revolved, the lever N_1 raises the indexing plunger P_1 until it assumes the position shown in Fig. 4 The pin Q_1 drops into the slot as shown, thus holding the indexing plunger in the clear, so that the operator is free to use both hands in revolving the fixture. As soon as the fixture starts to revolve, pin Q_1 may be raised, allowing plunger P_1 to spring forward and ride against the finished surface R_1. As the next hole is indexed around, the plunger will automatically drop into place.

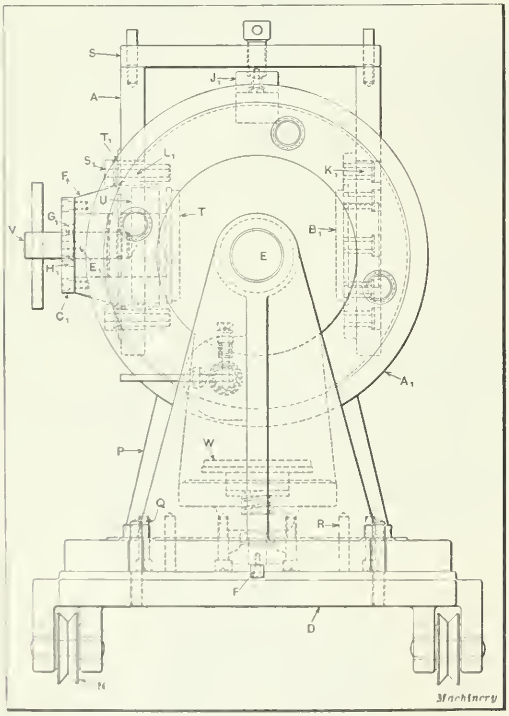

Fig. 5. End Elevation of Trunnion Jig

Slip Bushings

The most important feature of this jig was the discovery of a method whereby a slip bushing could be made a permanent part of the jig rather than a loose piece. This method can be applied to slip bushings in almost any jig to great advantage, due to the fact that loose pieces in a jig are often mislaid and sometimes lost. It was necessary in this particular case to draw the slip bushings S_1, Fig. 5, back, in order to get clearance for loading and unloading, which would mean the disengaging each time of whatever locking device was used in order to keep the bushings from falling out as the jig was revolved. This difficulty was overcome by a method that is shown in Fig. 7. A hole was drilled in the liner bushings T_1 and a steel ball U_1 inserted, with a spring V_1 behind it. A slot W_1 was cut in the slip bushings to receive the steel ball. Owing to the location of the hole to be drilled in the work, the slip bushing must be in the position shown at B when the work is removed or placed in the jig. However, the ball and spring in the liner bushing prevent the slip bushing from falling out or being removed. After the work has been clamped in the jig, the slip bushing being in the position shown at B, the drill will, on entering the bushing, carry it down until it assumes the position shown at A. After the hole has been drilled, the slip bushing will be carried back by the friction of the drill to the position shown at B, thus automatically leaving clearance for loading and unloading the jig. The spring pressure behind the ball in the liner bushing holds the slip bushing in this position until the drill again carries it down when the holes are being drilled in the next piece. The travel required for clearance in removing the work from the jig should correspond to the length of the slot in the slip bushing. Taking into consideration the amount of work accomplished in this jig, it should not be considered an expensive arrangement.

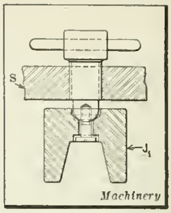

Fig. 6. Detail of Equalizing Clamp

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AMERICAN GRAPHITE DEPOSITS

According to a pamphlet published by the United States Geological Survey, the largest graphite mines in the world producing the best quality of mineral graphite are in Ceylon, though there are great deposits in Mexico and Korea. Before the war, the clay with which the graphite must be combined in the making of crucibles came from Bavaria, where there are also extensive graphite mines. Cut off from Ceylon, the Germans have made Bavarian graphite serve them, but, on the other hand, cut off from Bavaria, American manufacturers have succeeded in developing clay beds at home that furnish the material for making as good crucibles as those made of Bavarian clay.

The largest American graphite mines are in Alabama, Alaska, California, Colorado, Michigan, Montana, Nevada, Texas, Washington, New York, Pennsylvania, North Carolina and Rhode Island. At Niagara Falls, graphite is also made in the electric furnaces. In 1915, the total American mine production of amorphous (finely divided) graphite was 1181 tons; and of crystalline graphite, 3500 tons. In 1916, the total of amorphous graphite was 2622 tons, and of crystalline, 5465 tons. To this must be added 2542 tons of artificial graphite in 1915 and 4199 tons in 1916. But it will be some time before we become independent of the mines in Ceylon and elsewhere, for while home production has been doubled, the demand for graphite has also increased so that imports in 1916 amounted to 42,930 tons.

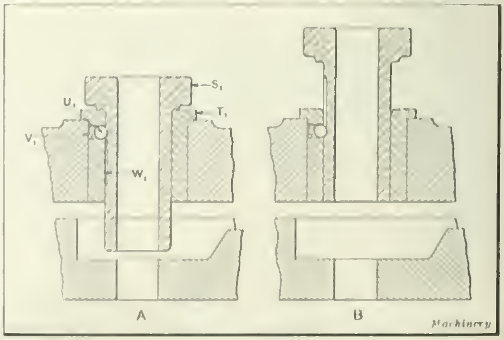

Fig. 7. Method of securing Slip Bushings to Jig

THREAD MILLING[1]

GENERAL APPLICATION AND ADVANTAGES OF MILLING PROCESS—DIFFERENT METHODS OF FORMING SCREW THREADS BY MILLING—VARIOUS TYPES AND DESIGNS OF THREAD MILLING MACHINES AND ATTACHMENTS

BY FRANKLIN D. JONES[2]

THE formation of screw threads by means of a rotating cutter or by the milling process has been practiced for nearly half a century, but the real development of thread milling is relatively modern as marked by the introduction of efficient machines constructed especially for doing this work on a manufacturing basis. A great many screw threads that formerly were cut with a single-pointed tool in an engine lathe are now milled. Thread milling has also proved superior to the use of dies or taps for certain external and internal screw-cutting operations. Before considering the relative advantages of the thread-milling process as compared with other screw-cutting methods and the particular classes of work for which thread milling is especially adapted, the different methods of forming screw threads by milling and various types of thread milling machines and attachments will be described.

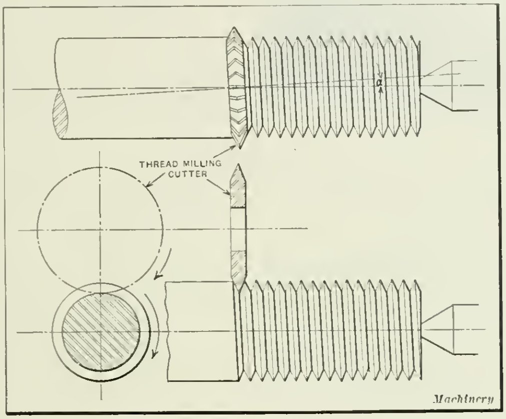

Fig. 1. Diagram illustrating Method of milling Screw Thread with a Single Cutter

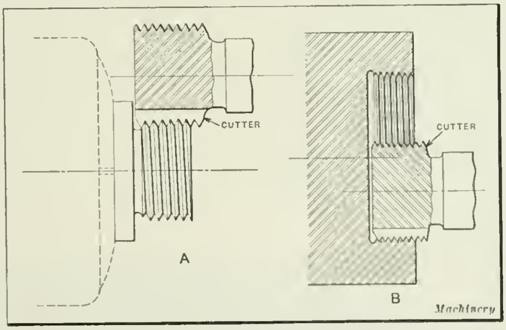

Fig. 2. Examples of External and Internal Thread Milling with a Multiple Type of Cutter

Milling Threads with Single Cutter

There are two general methods of forming screw threads by milling, which may be designated as the single-cutter and the multiple-cutter methods. The way a single cutter is used is indicated by the diagram Fig. 1. The profile of the cutter or the shape of its cutting edge conforms to the sectional shape of the thread groove. This cutter should revolve as fast as possible without dulling the cutting edges excessively, in order to mill a smooth thread and prevent unevenness such as would result with a slow-moving cutter on account of the tooth spaces. As the cutter rotates, the part on which a thread is to be milled is also revolved, but at a very slow rate (a few inches per minute), since this rotation of the work is practically a feeding movement. The cutter is ordinarily set to the full depth of the thread groove and finishes a single thread in one passage, although deep threads of coarse pitch may need two or even three cuts. For work of this kind a roughing cut is sometimes taken with a special cutter which is somewhat narrower than the finishing cutter.

Whenever a single cutter is used, the axis of the cutter is inclined to some angle a instead of being parallel to the axis of the screw, in order to locate the cutter in line with the thread groove at the point where the cutting action takes place. (Tangent of angle a = lead of screw thread ÷ pitch circumference of screw.) The helical or "spiral" thread groove is generated in practically the same way as when an engine lathe is used. In the case of a thread milling machine, however, the lengthwise traversing movement is applied to the cutter on some machines and to the screw being milled on other machines. For instance, the revolving cutter may be traversed in a direction parallel to the axis of the work a distance equal to the lead of the thread for each revolution of the screw blank, or this order may be reversed, the cutter revolving in one position while the screw blank moves in a lengthwise direction as it slowly rotates. These variations in the design of different thread milling machines will be considered later. The single cutter process is especially applicable to the milling of large screw threads of coarse pitch, multiple threads, and the heavier classes of work. For fine pitches and short threads the multiple-cutter method to be described is preferable, because it is more rapid.

Milling Threads with Multiple Cutter

The second thread milling method referred to, which requires the use of a multiple cutter, is illustrated by the diagrams *A* and *B*, Fig. 2. This multiple cutter is practically a series of single cutters, although formed of one solid piece of steel, at least so far as the cutter proper is concerned. The annular rows of teeth do not lie in a helical or spiral path, like the teeth of a hob or tap, but coincide with planes which are perpendicular to the axis of the cutter. If the cutter had helical teeth the same as a hob, it would have to be geared to revolve in a certain fixed ratio with the screw being milled, but a cutter having annular teeth may rotate at any desired speed, while the screw blank is rotated slowly to provide a suitable rate of feed. (The multiple cutters used for thread milling are frequently called "hobs," but in this article the term hob will be applied only to cutters having helical teeth.)

The object of using a multiple cutter instead of a single cutter is to finish a screw thread complete in approximately one revolution of the work, a slight amount of over-travel being allowed to insure milling the thread to the full depth where the cut joins the starting point. In order to finish the thread complete in one revolution (plus the over-travel referred to), it is necessary to use a cutter which is at least one or two threads or pitches wider than the thread to be milled. When using a multiple cutter it is simply fed in to the full thread depth and then either the cutter or screw blank is moved in a lengthwise direction a distance equal to the pitch of the thread. Since there is an annular row of cutting teeth for each thread groove, this movement equal to the pitch is sufficient to finish the entire thread in one revolution of the work, plus whatever additional movement there might be due to the over-travel. If an exceptionally smooth thread were required, the work might be revolved two revolutions and the cutter be traversed a distance equal to twice the pitch of the thread. During the first revolution the

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[1] For information previously published on this subject, see "Tapping Machines and Attachments," in the December, 1917, number of MACHINERY, and articles there referred to.

[2] Associate Editor of MACHINERY

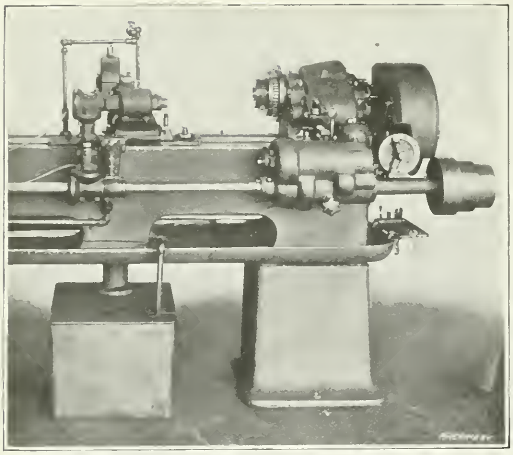

Fig. 3. Rear View of Pratt & Whitney Thread Milling Machine

thread would be rough-milled and a light finishing cut would then be taken while the work made a second revolution. Sketch *B*, Fig. 2, illustrates the application of a multiple cutter to internal thread milling.

It is apparent that the length of the thread that can be milled by the multiple-cutter method is limited, because the cutter is supported at one end only and it would be deflected considerably if the length of the cutting end and the "overhang" were increased to any great extent. As the cutter is milling along the entire screw thread at the same time, the lateral thrust is relatively large as compared with a single cutter operating on a thread of corresponding pitch; therefore, the multiple cutter is used for milling comparatively short threads and usually for medium or fine pitches.

Position of Multiple Cutter Relative to Work

When using multiple cutters either for internal or external thread milling, the axis of the cutter is set parallel with the axis of the work, instead of inclining the cutter to suit the helix angle of the thread, as when using a single cutter. Theoretically, this is not the correct position for a cutter, since each cutting edge is revolving in a plane at right angles to the screw thread while milling a thread groove of helical form. It might be supposed that there would be serious interference between the cutter and the thread, and as a result a decided change in the standard thread form. In practice, however, the defect is very slight and may be disregarded except when milling threads which incline considerably relative to the axis, as when the pitch is large in proportion to the diameter or the thread is of the multiple form and has a large helix angle. Threads which have steeper sides than the U. S. standard or Whitworth forms should ordinarily be milled with a single cutter, assuming that the milling process is preferable to other methods. For instance, when cutting an Acme thread which has an included angle between the sides of 29 degrees, there might be considerable interference if a multiple cutter were used, and for this reason the single cutter is preferable. If an attempt were made to mill a square thread with a multiple cutter, the results would be very unsatisfactory owing to the interference. If a multiple cutter, in any case, were inclined to align it with the thread groove, the same as is done when the single form of cutter is employed, the advantage of the multiple type would be lost, and instead of finishing the thread in one revolution of the screw blank, it would be necessary to traverse the cutter along the entire length of the thread.

Interference between the cutter and work is more pronounced when milling internal threads, because the cutter does not clear itself so well. Experiments have shown that multiple cutters for internal work should preferably not exceed one-third the diameter of the hole to be threaded. A cutter that is one-quarter the diameter of the thread will do very satisfactory work. It is preferable to use as small a cutter as practicable, either for internal or external work, not only to avoid interference, but to reduce the strain on the driving mechanism.

Direction of Cutter Rotation

It is the general practice when milling threads in steel, cast iron and brass to revolve the cutter and screw blank so that they are moving in opposite directions on the cutting side. For some thread milling operations, however, it is preferable to rotate the work and the cutter so that they travel in the same direction on the cutting side. For instance, when milling threads in aluminum castings, celluloid and parts made of fiber, smoother and better threads will be obtained if the cutter and work revolve together, the same as two gears in mesh, except that the cutter revolves quite rapidly, while the part being milled has a slow feeding movement.

Milling Multiple Threads with Single and Multiple Cutters

If a multiple thread is to be milled with a single cutter, the method followed is practically the same as when using a single-point tool in the lathe. The machine is arranged to give a lengthwise traversing movement equal to the lead of the thread (not the pitch), and then, after a single thread groove is milled, the screw blank is indexed a half revolution for milling the second thread groove, assuming that a double thread is required. Thread milling machines and attachments are commonly provided with means for indexing when cutting multiple screw threads.

Multiple threads can readily be milled with the multiple style of cutter, although in some cases difficulty may be experienced due to interference between the cutter and the sides of the thread. Such interference is more likely to occur in the case of a multiple thread on account of the increased helix angle. In order to mill a multiple thread, it is simply necessary to arrange the machine so that the work is advanced a distance equal to the lead of the thread instead of the pitch, the same as when using a single cutter for milling a multiple thread. In other words, the advance movement of the cutter or work, as the case may be, should be equivalent to the distance that one of the single threads advances in a complete

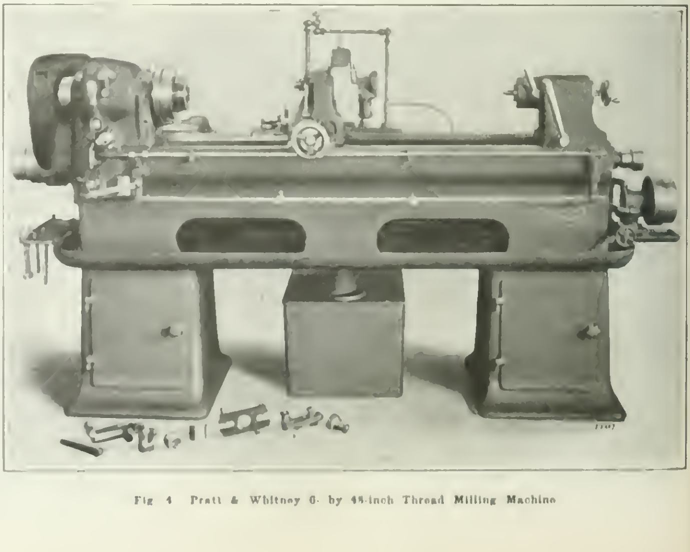

Fig. 4. Pratt & Whitney 6- by 48-inch Thread Milling Machine

turn. Another way to cut a multiple thread would be to use a cutter having a pitch equal to one-half the pitch of the lead-screw, assuming that the machine was of a type controlled by the direct action of the lead-screw on the spindle.

Types of Thread Milling Machines

Thread milling machines may be classified according to the kind of cutter used, that is, whether single or multiple, and also with reference to the method of obtaining a lengthwise feeding movement for generating the thread. Some machines are so designed that the cutter-slide or carriage is traversed along a horizontal bed by a lead-screw which is connected to the work-spindle through change-gears, the arrangement being practically the same as on an engine lathe. With this general type of machine, the cutter (which may be single or multiple) moves along one side of the work, while the latter rotates but remains in one position. This order is reversed in another general type of milling machine which is designed to move the part on which a thread is to be milled, in an axial or lengthwise direction, while the cutter-slide remains stationary, except when it is traversed laterally or at right angles to the screw thread for moving the cutter in or out of the working position. A machine of this kind may have a work-table which is traversed by a gear-driven lead-screw, or the traversing motion may be imparted to the work-holding spindle either by the direct action of a lead-screw or by a lead-screw and gearing combined. When a lead-screw is applied directly to the work-spindle, the lead of its thread is the same as the lead of the thread to be milled, and different lead-screws are used for milling threads of different pitches. Some of these "duplicating" machines are designed especially for milling threads on large numbers of duplicate parts, and they are less complicated and cheaper than a machine equipped with change-gears and arranged for milling threads of different pitches. Other machines which derive the traversing motion directly from a lead-screw are so constructed that one lead-screw may easily be replaced with another of different pitch. Such machines are intended for general application, but lead-screws are changed for milling threads of different pitch, instead of change-gears, as in the case of the other general type of machine mentioned. Thread milling machines embodying the general principles of operation outlined differ, of course, in regard to the arrangement, as well as to the details of construction, as shown by the following descriptions.

Pratt & Whitney Thread Milling Machine

One design of thread milling machine having a gear-driven lead-screw and a traversing cutter-slide is shown in Fig. 4, which illustrates a 6- by 48-inch machine manufactured by Pratt & Whitney Co., Hartford, Conn. This machine is driven by a belt connecting with a cone pulley carried by a horizontal shaft extending along the rear side of the bed, as shown in Fig. 3. This shaft drives the work-spindle through a gear-box which provides for the necessary speed changes. The lead-screw for traversing the cutter-slide is connected to the work-spindle by change-gears selected with reference to the pitch or lead of the thread to be milled. The rear view illustrates how motion is transmitted from the driving shaft to the cutter-spindle through bevel gearing and suitable connecting shafts. The main driving shaft at the rear is splined to permit the cutter-slide to move along the bed. The cutter-slide has a rapid traversing movement and automatic stops for controlling the length to which a thread is milled.

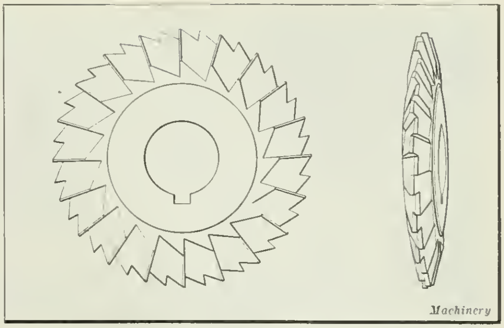

Fig. 6. Kind of Cutter used on Pratt & Whitney Thread Milling Machine

The work-spindle is indexed when cutting multiple screw threads by a notched ring attached to the inner section of the compound work-spindle. The outer section of this spindle is normally locked to the inner part by a pawl which engages a notch in the ring referred to. In order to index a screw requiring a multiple thread, the pawl is disengaged and the inner part of the spindle is turned whatever fractional part of a revolution may be required. For instance, if a double thread were being milled, the indexing movement would equal one-half revolution, whereas for a triple thread it would be necessary to index one-third revolution, and so on. As a machine of this type is used for many other helical milling operations other than screw threads, the index ring is provided with forty-eight notches for accommodating other classes of work.

When it is necessary to mill helical grooves of exceptionally long lead, it might not always be practicable to drive the lead-screw from the work-spindle in the usual manner because of the excessive stresses to which the change-gears would be subjected. One method of avoiding this difficulty in connection with lathe practice has been to drive the work-spindle from the lead-screw. The drive can be changed in this same way when using the thread milling machine shown in Fig. 4, by simply shifting clutches which, for work of the class mentioned, make the lead-screw the driver and the work-spindle the driven member. These machines are sometimes provided with what is known as a "backing out attachment." This is simply an arrangement for gradually withdrawing the cutter at the end of a thread so that the thread groove will gradually taper from the full depth out to zero, instead of abruptly rising from the bottom to the top of the thread groove. When this attachment is in use the cutter withdraws while the work is making three turns. This method of finishing the end of a screw thread is desirable when screws are subject to severe shocks, as, for example, the screws of rock drills.

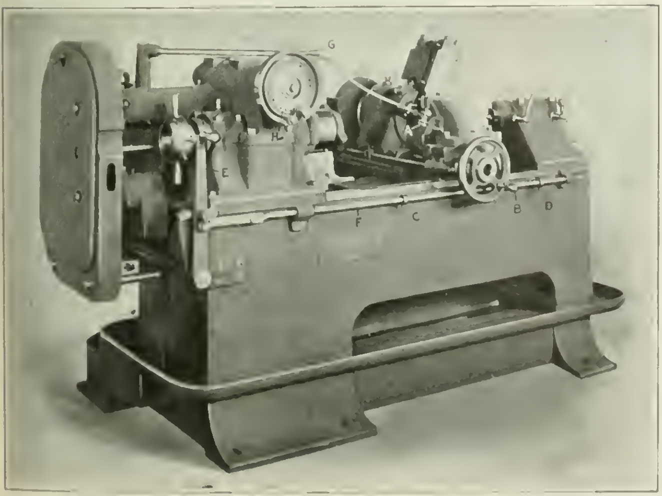

Fig. 5. Lees-Bradner Thread Milling Machine

The style of milling cutter used on the Pratt & Whitney thread milling machine is shown in Fig. 6. This is a special form of cutter having staggered teeth. The teeth

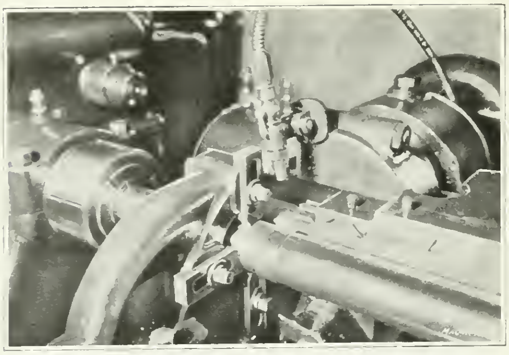

Fig. 7. Detail View of Lees-Bradner Machine milling Screw Thread with a Multiple Type of Cutter

do not extend across the cutter, but are arranged to cut only on one side, each cutting edge being midway between the adjacent edges on the other side. One tooth is left full for the purpose of gaging. The cutter is made in this way so that the oil or cutting compound has free access to the cutting edges and the chips readily escape or are washed away by the lubricant. A special automatic grinder is used for sharpening these cutters. This grinder has three wheels, two of which are for grinding the angular sides; after the sides are finished, the third wheel is used for sharpening the points of the teeth.

Lees-Bradner Thread Milling Machine

The thread milling machine shown in Fig. 5 is another example of the type which mills a screw thread by traversing a cutter along the work while the latter revolves but remains in the same lengthwise position. The change-gear mechanisms for controlling the lead of the thread to be milled, the speed of the work-spindle or the feeding movement, and the cutter speed are incorporated in the design of the headstock. All movable parts are driven from a single belt pulley at the rear. Motion is transmitted to the cutter-spindle *A* by means of a splined shaft which extends along the rear side of the bed and is connected to the cutter-spindle through suitable gearing. The cutter-head is of cylindrical design and can be swiveled 180 degrees for aligning the cutter with a thread groove or any other helical groove. The angular position of the cutter-spindle is indicated by graduations and a vernier scale. The lateral position of the cutter is controlled by handwheel *B*. The depth of the cut is indicated by a micrometer dial and it may be regulated positively by an automatic adjustable stop which is used either when milling duplicate screw threads or multiple threads.

The traversing movement of the cutter carriage along the bed may be controlled automatically by stops *C* and *D* and also by hand lever *E*, with which the trip-rod *F* is connected. The machine is idle when clutch lever *E* is in the neutral position shown in the illustration. When this lever is shifted to the right, thus engaging the positive feed clutch, the carriage travels to the left until it engages stop collar *C*, which is set in accordance with the length of thread to be milled. After the cutter is withdrawn from the work, the carriage may be rapidly returned to the starting position by throwing lever *E* to the left, which engages a friction clutch. The return movement of the carriage is arrested by collar *D*, which swings lever *E* to the neutral position again. The operating parts of the machine are started or stopped by lever *G*.

The work may be held between centers or in a collet chuck at the headstock end and on a center at the tailstock end, if this additional support is necessary. The collet chuck should be used if possible. The work may be turned independently by means of the indexing mechanism at *H*, which is used when cutting multiple screw threads or for relocating the cutter with a previously milled thread groove.

When threads of fine pitch are to be milled, a multiple form of cutter is used, instead of a single cutter, in order to finish a thread complete in practically one revolution of the spindle. The detailed view, Fig. 7, shows a multiple cutter milling a thread on one section of a spindle. The steadyrest shown in this illustration and in Fig. 5 is used for supporting all flexible parts. While this machine is designed primarily for milling such parts as lead-screws, worms, etc., it may also be employed for milling either spiral or spur gears. It is manufactured by the Lees-Bradner Co., Cleveland, Ohio.

Moline Thread Milling Machine

The machine shown in Fig. 8 differs from the designs previously described in that it has a traversing work-table and a cutter which revolves in one position when milling a thread. The work-table carries the headstock and tailstock spindles for holding the work between centers, and it is traversed at the proper rate for generating a thread of the required lead by means of change-gears, seen at the end of the machine, which connect the main or headstock spindle with the lead-screw. This machine is adapted for milling threads of coarse pitch or large worms. The cutter, of course, can be adjusted to the helix angle of the thread as well as laterally for feeding it in to the depth of the thread or away from the work. This machine has an indexing mechanism for use when cutting multiple threads. This device consists of an index plate attached to the driving gear of the main spindle and having suitable holes which are engaged by a plunger. The work may either be held between the centers, as shown in the illustration, or in a collet chuck or jaw chuck screwed onto the spindle. When parts are held between centers a steadyrest block, provided with bushings, may be used for supporting the work. This machine has a maximum swing of 8 inches and will hold parts 30 inches long between the centers. The spindle is hollow and a 3½-inch shaft may be passed through it. This machine is made by the Moline Tool Co., Moline, Ill.

Waltham Thread Milling Machine

The thread milling machine illustrated in Fig. 9 is intended for small precision work. The cutter-slide of this machine is traversed along the bed by a lead-screw connecting with the work-spindle through change-gearing. The machine is driven from a constant-speed shaft mounted in brackets on the rear side. This shaft drives the work-spindle through the cone pulleys shown and worm-gearing. The four-step cone pulleys are interchangeable and provide the necessary speed changes. The milling cutter-spindle is set at the helix angle of the thread as shown by graduations on the circular base of the swiveling member. When a thread has been milled to the required length, the machine is stopped automatically by the disengagement of a clutch on the work-spindle. Oil or some

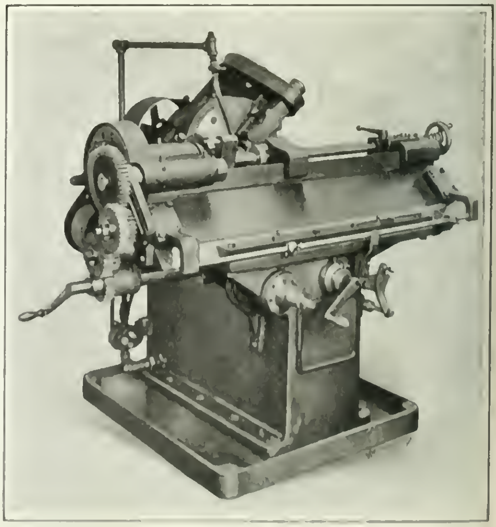

Fig. 8. Moline Thread Milling Machine

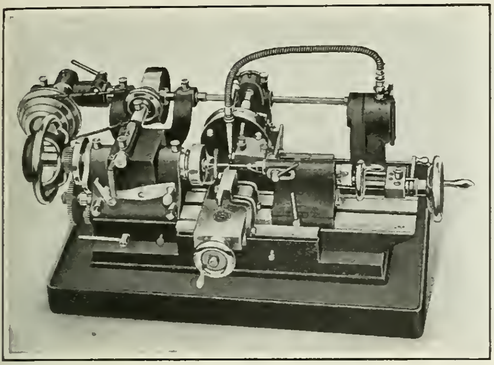

Fig. 9. Waltham Thread Milling Machine

cutting compound is supplied to the cutter by means of a pump driven from the constant-speed shaft at the rear of the machine. Tapering threads may be milled by using a taper attachment which is similar in principle to the attachment found on engine lathes. This machine also has a compensating bar for obtaining slight variations in the lead of a screw thread to compensate for shrinkage in hardening, as when making thread gages or taps. A pointer attached to the swiveling bar extends through to a graduated index at the front of the machine and shows the amount of increased lead that can be obtained. The angular position of the compensating bar can be changed by means of two thumb-screws at the front of the machine. The right-hand bearing of the lead-screw is threaded, and this bearing can be rotated by a lever to change the location of the cutter carriage in relation to the thread groove. This fine longitudinal adjustment may be used for setting the cutter to match a thread groove that has previously been milled. This machine is made by the Waltham Machine Works, Waltham, Mass., and it is intended for toolrooms and experimental laboratories, as well as for universal use on work within its range.

Internal Thread Milling Machine of Single-cutter Type

The Pratt & Whitney internal thread milling machine shown in Fig. 10 is adapted particularly for milling threads of moderate pitch in holes varying from 1¼ inch in diameter up to about 6 inches. The work-spindle and cutter-spindle are both driven from a horizontal shaft at the rear carrying a three-step cone pulley. The speed of the work-spindle is varied by means of a gear-box at the rear of the machine, eighteen speed changes being obtained for each of the three positions of the belt on the cone pulley. The cutter-spindle is driven through gearing from the shaft referred to, and in order to eliminate any tendency on the part of the cutter to chatter owing to lost motion in the driving gears, use has been made of a flywheel which is mounted in bearings that are independent of the spindle. The cutter-spindle head is so constructed that the angular adjustment of the cutter for aligning it with the helical thread groove does not disturb the central relation between the cutter and the thread being milled. The lateral position of the cutter may be regulated by means of a micrometer dial and a positive adjustable stop. The latter enables the cutter to be withdrawn from the screw thread and returned for cutting a thread groove of the same depth. The spindle of this machine is provided with a notched index ring and a pawl which holds the inner and outer spindle sections together, as described in connection with the machine illustrated in Fig. 4. When cutting a multiple thread the work is indexed by simply releasing the pawl and turning the inner spindle whatever fractional part of a revolution may be required.

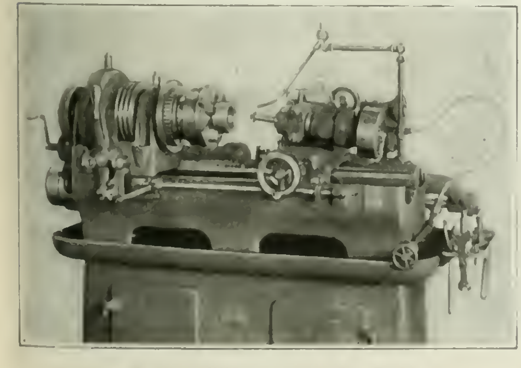

Fig. 10. Pratt & Whitney Internal Thread Milling Machine

Taft-Peirce Thread Milling Machine

A thread milling machine of the multiple-cutter type which completes a thread in practically one revolution of the work is shown in Fig. 11. This machine is manufactured by the Taft-Peirce Mfg. Co., Woonsocket, R. I. The cutter-spindle and work-spindle are driven by separate belts leading from the same countershaft. The work is held in some form of chuck or fixture at *A*, and the cutter, which is partly enclosed by a guard for the protection of the operator, is located at *B*. When a thread is being milled the cutter is set transversely for milling the thread to the proper depth, and the work-spindle then advances a distance equal to the pitch or lead of the thread as it turns one revolution plus a slight amount of overtravel. The work is held either in a self-centering chuck or a special fixture which may be fitted to the counterbore *A*, Fig. 12, on the front end of the work-spindle. This spindle is of the open yoke design and it is driven from a cone pulley at the rear of the machine, from which motion is transmitted through bevel gears to worm-shaft *E* and a worm to a worm-wheel on the work-spindle. This drive is controlled by the engagement of a sliding clutch operated by a rod *F* extending through the hollow worm-shaft. On the front end of this rod there is a knob *S*, Fig. 11, used for engaging or disengaging the clutch. The teeth in the worm-wheel are not of the usual concave or curved form, but extend in a straight path diagonally across the face of the worm-wheel, so that the work-spindle will be free to move longitudinally when milling a thread. This longitudinal movement is derived from a master nut *D* and a lead-screw *C*, Fig. 12. The lead-screw is made in two parts, and when assembled in the master nut there is a space between the two sections which provide a means for compensating for wear. The lead-screw and work-spindle rotate together and the master nut *D* and handwheel *M* are held stationary, when milling a thread, by lock-pin *N*, so that the work-

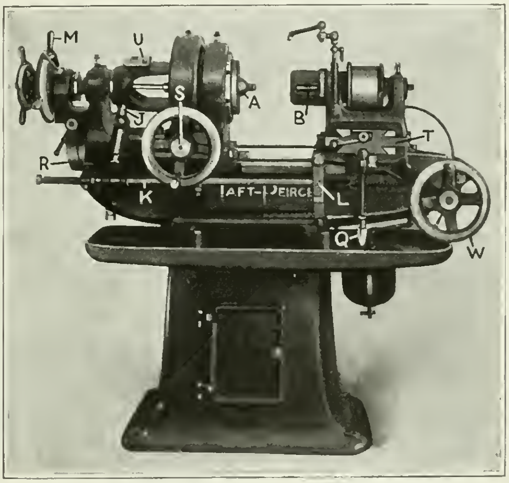

Fig. 11. Taft-Peirce Thread Milling Machine of Multiple-cutter Type

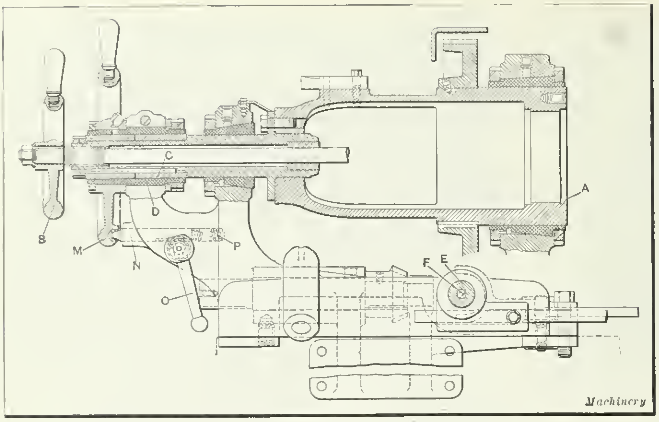

Fig. 12. Sectional View of Headstock of Machine shown in Fig. 11

spindle moves longitudinally. The pitch of the thread in the lead-screw and master nut must correspond with the pitch of the thread to be cut.

The cutter-spindle slide is mounted on an intermediate slide *T*, Fig. 11, which rests upon the lower slide. The upper cutter-slide is adjusted transversely by a screw. A positive stop is provided to insure returning the cutter-slide to the same position. The intermediate slide also has a transverse movement for withdrawing the cutter at the completion of a cut or for returning it to the working position. After the work-spindle completes one revolution, a cam *U* on the work-spindle engages a trip pin *J* and through a bell-crank mechanism operates the horizontal shaft *K* which releases the knock-off lever *L*. When this lever *L* is withdrawn, a spring throws the cutter-slide back so that the cutter is removed from the work; the work-spindle and feed motion are also stopped at the same time. The cutter-slide and cutter are returned to the working position by pulling up lever *Q*. After the cutter-slide has advanced to the right location, the lever *L* drops into place and holds the slide until another thread has been milled.

The saddle which rests on the bed and carries the cutter-slide may be adjusted longitudinally along the bed by turning handwheel *W*, the shaft of which carries a pinion meshing with a rack. For most external thread milling operations this saddle is locked in position and is seldom adjusted, but for most internal work it is necessary to move the cutter-slide along the bed for withdrawing the cutter from the work so that the piece can be removed from the chuck or holding fixture. A stop is provided on the bed against which the saddle is located in the operating position in order to maintain the same relation between the position of the cutter and the face of the fixture or work. When the parts to be threaded are inserted through the opening in the work-spindle at the rear of the front bearing for internal thread milling, it is not necessary to move the saddle when a part is completed.

Parts 3 1/4 inches in diameter by 10 inches long may be held in a spring chuck, and if a regular lathe chuck is used, it is possible to hold work up to 4 7/16 inches in diameter by approximately 18 inches long. When a lathe chuck is applied to this machine it is fitted to the counterbore *A*, Fig. 12, at the front end of the work-spindle. Special chucks or fixtures for holding flanges, etc., may be as large as 18 inches in diameter, which represents the full swinging capacity of the machine. Pneumatically operated chucks are recommended for use in this machine, as it is possible to increase the production from 20 to 50 per cent as compared with hand-operated chucks. The handwheel shown at *R* is used for operating chucks of the spring or collet type. This type of machine is especially designed for milling comparatively short internal or external threads located at or near the ends of parts. Fig. 13 illustrates a typical example of external work. The length of thread which can be milled depends, of course, upon the pitch of the thread and the kind of material that is to be cut.

Some examples of work milled on the Taft-Peirce machine are shown in Fig. 14. The internal threading operation on the small brass parts shown at *A* was done at the rate of 90 pieces per hour; the thread in this case is 1 3/16 inch diameter and 20 pitch. The internal threading operation on the part shown at *B* was done at the rate of 55 pieces per hour, the threads being 1 3/8 inch diameter and 6 pitch. The brass part illustrated at *C* has a thread 2 inches in diameter and 14 pitch, and was milled at the rate of 60 per hour. The pressed aluminum piece shown at *D* has an external thread 1 3/8 inch in diameter and 6 pitch; the thread is the Whitworth form and these parts were milled at the rate of 70 per hour. The clutch housing shown at *E* has a 3-inch thread of 16 pitch, and 26 housings were milled per hour. The internal threading operation on the part shown at *F* was performed at the rate of 30 pieces per hour, the thread being 3 1/4 inches in diameter and 16 pitch; the external thread on this same part is 4 1/2 inches in diameter and 16 pitch, and was milled at the rate of 25 pieces per hour. The different rates of production referred to are not given as representing the maximum, but the output under normal conditions in regular manufacturing practice.

Lees-Bradner Multiple-cutter Type of Thread Milling Machine

The Lees-Bradner special or "collet type" thread milling machine shown in Fig. 15 is the type having a multiple cutter and a lead-screw driven through change-gears selected with reference to the pitch of the thread to be milled. The work-spindle is driven through suitable gearing from a single constant-speed belt pulley at the rear, and the cutter-spindle is revolved by a belt operating on pulley *C*. The rotation of the work-spindle as well as the feeding movement of the cutter-slide may be started or stopped by operating hand-lever *D*, which serves to engage or disengage a friction clutch.

The cutter-spindle is carried by a slide *E* (see also the sectional view, Fig. 16), which, in turn, is mounted on an intermediate slide *N*, supported by a bottom slide or main saddle *J*, which rests upon the ways of the machine bed. The main saddle *J* may be adjusted along the bed by handwheel *K* for locating the cutter in the right lengthwise position relative to the work, and this saddle may be locked to the bed. The intermediate slide *N* connects with a short lead-screw *R*, Fig. 16. This lead-screw is driven through gearing by a splined shaft *S*, which is revolved by means of change-gears selected according to the pitch of thread to be milled. The upper slide which carries the cutter-spindle may be adjusted in a crosswise direction by means of handwheel *F*, Fig. 15, to suit the diameter of the work and depth of thread to be milled. When the feed lever *M* is pulled over to the place marked "feed" on the quadrant, the cutter-slide *N* operates, assuming that lever *D*

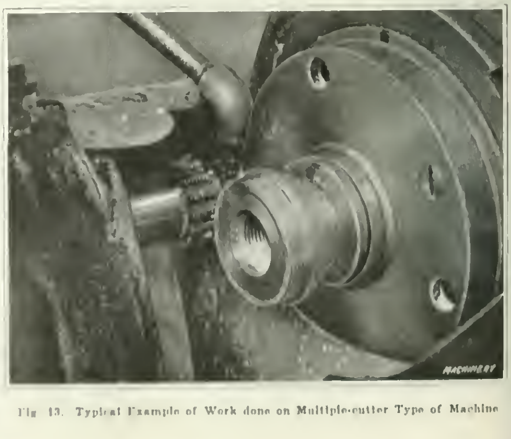

Fig. 13. Typical Example of Work done on Multiple-cutter Type of Machine

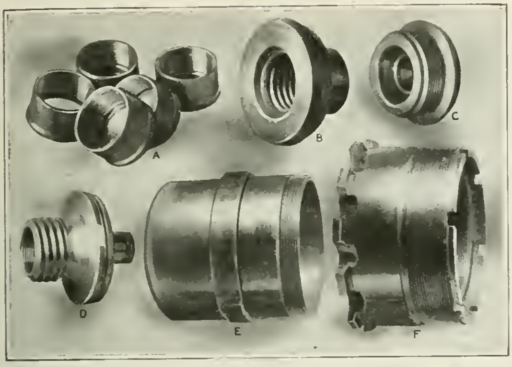

Fig. 14. Miscellaneous Examples of Thread Milling performed on Machine shown in Fig. 11

is in the right position. When lever *M* is thrown in the opposite direction as far as it will go, the work-spindle may be revolved with a rapid reverse motion.

Motion is transmitted to the intermediate cutter-slide by the splined shaft and lead-screw referred to, in order to avoid a reversal of the rotating parts each time a thread is milled and the resulting loss of time which would occur while waiting for any backlash or lost motion in the transmission to be taken up. When milling a thread, the intermediate and upper slides with the cutter-spindle are traversed along the bottom slide or main saddle *J* a distance equal to the pitch of the thread plus a slight amount of over-travel. This traversing movement is away from the chuck for internal milling and toward the chuck for some external milling operations. If ten threads to the inch were being milled, the traversing movement of the intermediate slide on the bottom slide would equal approximately 1/10 inch for each thread milling operation. As the intermediate slide has a total travel on the main saddle of about five inches, obviously threads could be milled on about fifty pieces before it would be necessary to return the intermediate slide to the starting point. The number of parts that could be milled before it becomes necessary to reverse the lead-screw and return the slide depends, of course, upon the pitch of the thread. When the intermediate slide has reached the limit of its travel, the clutch at *T*, through which the lead-screw *R* is driven, is disengaged by pin *V*. The operator then revolves the lead-screw in the opposite direction by means of handwheel *W*, or by means of the quick-return lever *M*, thus returning the slide to the other end of its travel preparatory to milling another lot of parts. Any movement of the main slide on the bed which may be necessary for inserting the work in the chuck or removing it does not necessitate disengaging the lead-screw clutch or reversing its driving mechanism.

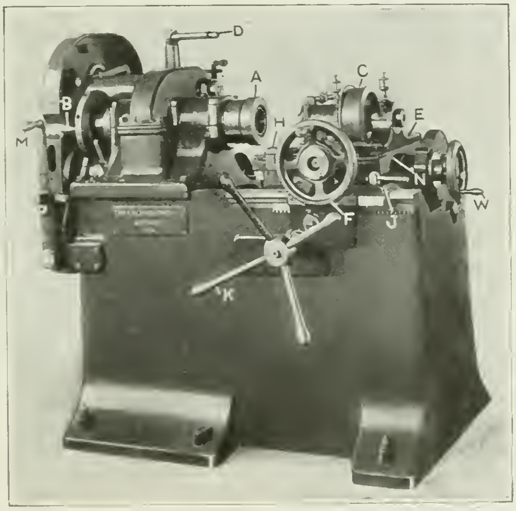

Fig. 15. Lees-Bradner Collet or Multiple-cutter Type of Thread Milling Machine

The crosswise position of the cutter is indicated by an adjustable micrometer dial reading to thousandths of an inch which is located just back of handwheel *F*. This dial is set at the zero position when the cutter just touches the part to be milled. The micrometer dial is then locked in position and the handwheel turned far enough to move cutter-slide *E* an amount depending upon the depth of the thread to be milled. When the cutter has been fed in to the right depth, a stop on the handwheel should be adjusted so that it is in contact with stop *H*. The latter may be adjusted by means of a binder screw operating in cutter-slide *E*, so that stop *H* will intercept the stop on the handwheel *F* when slide *E* is in position for milling a thread. The engagement between the two stops referred to is such that stop *H* moves far enough during one revolution of handwheel *F* to clear the stop on the wheel. When the cutter-slide is returned to the milling or working position, stop *H* will again engage the handwheel stop automatically and locate the cutter at whatever depth it was previously set to.

The collet chuck *A* in which the work is held is opened or closed by handwheel *B*. This collet chuck (see sectional view, Fig. 16) is an ingenious design so arranged that the collet is positively actuated both when opening and closing. This collet is made of machine steel and the jaws are casehardened, but the flexible part is left unhardened. When the collet is drawn back against the tapering seat *X* in the spindle, it grips the work, and when moved in the opposite direction one side of a V-shaped groove on the outer end engages another tapering seat in ring *Y*, thus positively forcing the collet jaws outward. The amount of this expansion is regulated by the distance the ring *Y* is screwed on or off the end of the spindle. With this arrangement it is unnecessary to have a spring temper in the flexible part back of the jaws. The detailed view, Fig. 17, shows one of these machines milling external threads on shell fuses.

Thomson Thread Milling Machine

The multiple-cutter type of thread milling machine shown in Fig. 18 is designed for milling threads on such parts as rifle barrels, rifle receivers, bronze primers, fuse bodies, the nose pieces for the smaller shells, automobile parts, watch cases, or whenever a short thread of a pitch not greater than 12 threads per inch (in steel) is required. When a thread is being milled, the work-spindle of the machine is advanced as it revolves by a short lead-screw which is mounted on the spindle and engages an adjustable nut *A*. The work-spindle and the cutter-spindle each have a separate driving belt. The large pulley *B* back of the headstock is for driving the work-spindle and transmits motion to it through worm-gearing. The belt pulley *C* drives the cutter-spindle by means of a silent chain. The cutter-spindle is carried by a vertical sliding head, which, in turn, is mounted on a carriage that can be moved along the horizontal ways of the machine bed by the handwheel *D*. The cutter is adjusted for the right depth of cut by means of handle *E* attached to the adjusting screw and equipped with a micrometer dial reading to thousandths of an inch. After the

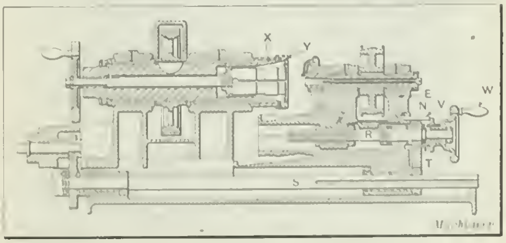

Fig. 16. Sectional View, showing Important Features of Machine illustrated in Fig. 15

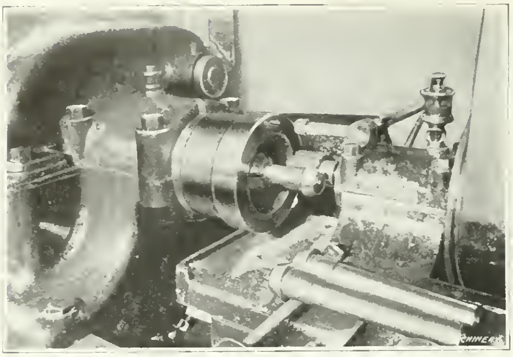

Fig. 17. External Thread Milling on Multiple-cutter Type of Machine

cutter is once set in the right position, it is advanced and withdrawn from the work by the action of a cam on the horizontal shaft *F*, which is turned by hand-lever *G*. One movement of this lever moves the cutter up to the cutting position and, at the same time, engages a clutch with the worm-wheel *W*, which revolves loosely on the work-spindle except when a thread is actually being milled. As the work-spindle revolves, it also advances at a rate depending upon the pitch of the lead-screw thread, which must correspond to the pitch of the thread to be milled. Attached to a drum on the work-spindle there is a wire cable *H* which connects with a spring drum located inside of the machine base. This cable is slowly wound upon the work-spindle drum as the spindle revolves, until a sleeve attached to cable *H* comes into contact with trip lever *J*. When this lever is raised, shaft *F* is released and is turned backward by the tension spring *K*, thus withdrawing the cutter from the work and stopping the spindle. The mechanism is so arranged that this tripping action occurs after the work has made a little over one revolution and the thread is completed. When milling internal threads, the cutter-slide is withdrawn by means of handwheel *D* after each operation, in order to remove the work from the chuck. An adjustable stop-rod *L* on the cutter-slide comes into engagement with stop *M* and serves to relocate the cutter after it has been withdrawn for removing work having internal threads. The cutter-slide is locked to the machine bed when a thread is being milled. This machine is made by the T. C. M. Mfg. Co., Harrison, N. J.

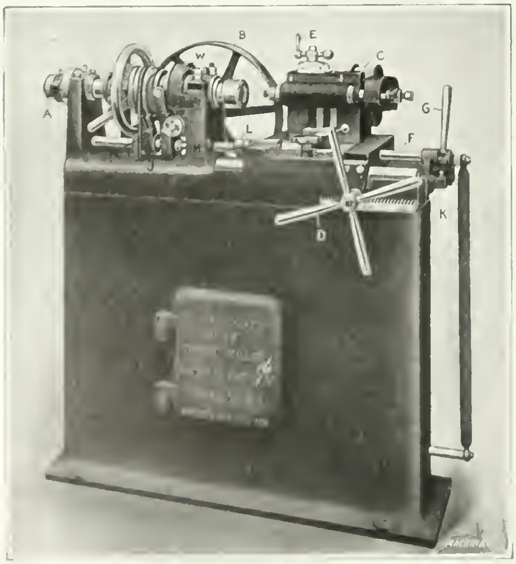

Fig. 18. Thomson Thread Milling Machine of Multiple-cutter Type

Smalley-General Thread Milling Machine

The thread milling machine illustrated in Fig. 19 is arranged especially for shell work, although it can be equipped for general thread milling by removing the special shell-holding chuck and attaching some other form of chuck. This machine (manufactured by the Smalley-General Co., Bay City, Mich.) has a multiple cutter for finishing a thread in practically one revolution, and the particular machine illustrated is equipped for milling threads in the bases of 9.2-inch high-explosive shells. The chuck for holding these shells is pneumatically operated, and by the use of liners the adapter and plugs for these shells may also be threaded in this machine. The cutter-spindle is mounted on a carriage which is traversed along the bed by a gear-driven lead-screw when milling a thread. The carriage can also be traversed by turning the large handwheel seen at the front of the machine. The cutter-spindle and the work-spindle are driven independently by separate belts. The drive to the spindle is so arranged that the comparatively slow speed required for thread milling can be increased sufficiently for turning operations. In order to perform operations of this kind where a surface or shoulder must be absolutely true with a milled thread, the machine is equipped with a turning tool. This tool is located near the hob and it is used on the 9.2-inch shells referred to for finishing a recess at the end of the shell.

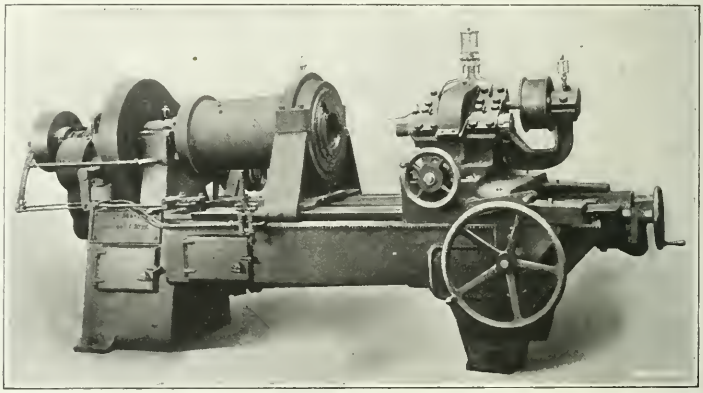

Fig. 19. Smalley-General Thread Milling Machine

The tool is so located that the thread milling cutter can be used without moving the turning tool, or the latter can be used without removing the cutter. The normal feed for thread milling, which is about six inches per minute, is increased to twenty-five feet per minute for turning. The single belt pulley which drives the main spindle transmits motion to it through a worm-gear and spur-gear. The high speed for turning is obtained by driving direct through the spur-gearing, and the speed is reduced for thread milling by driving through the worm-gearing. This change of speed is obtained by shifting a lever located on the main head, which operates a clutch. This lever is held in either the high-speed, low-speed or neutral position by a notched quadrant. The gear on the main spindle which drives the train of change-gears is free to slide in or out of mesh for disengaging the lead-screw drive.

One of the special features of this machine is the method of engaging the lead-screw nut with the cutter-slide or carriage. On the lead-screw there is a nut which is attached rigidly to a wedge bar which moves along with the nut whenever the lead-screw is in motion. On the bottom of the cutter-slide

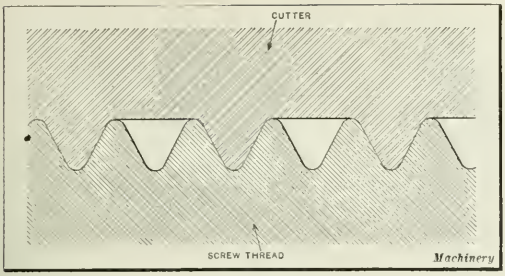

Fig. 21. Enlarged Sectional View, showing Multiple Cutter with Alternate Rows of Teeth removed for milling Comparatively Long Screw Threads

there are two wedge blocks. One block is fixed and the other is controlled by means of a lever which is located just above and back of the large handwheel for traversing the cutter-slide or carriage along the machine bed. These two wedge blocks engage grooves on each side of the wedge bar for transmitting motion from the lead-screw to the cutter-slide. The advantage claimed for this arrangement is that the operator does not have to wait for the lead-screw to engage a split nut. By introducing an extra idler gear in the train of change-gears, the lead-screw is made to rotate in the right direction for milling either right- or left-hand threads and the cutter-spindle moves outward in either case. The cutter-spindle of the machine illustrated is driven through herringbone gears from the belt-pulley shaft. Machines used for comparatively light work have the belt pulley mounted directly on the cutter-spindle.

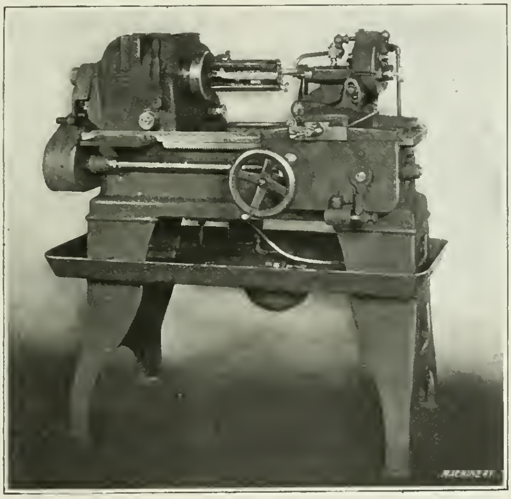

Fig. 20. Reed-Prentice Thread Milling Machine arranged for Internal Work

To illustrate the method of using this machine, we shall assume that an internal thread is to be milled and a shoulder faced off true with the thread. After the work is chucked, the cutter-slide is traversed along the bed by the large handwheel until the hob or thread milling cutter is properly located in a lengthwise direction, the feed lever for engaging the lead-screw being released. The cutter is usually located by means of a depth gage or by moving it in against a shoulder which serves as a locating point. The main spindle should, of course, be revolving at the slow speed of five or six inches per minute and the cutter-spindle is also revolving. The cutter-slide is now connected to the lead-screw by means of the feed-lever and as soon as the cutter is fed into the work. The proper depth of cut is indicated by a micrometer dial on the cross-feed screw and the work should revolve until the cutter passes the point at which it started to cut to the full depth of the thread. When the thread is completed the cutter is withdrawn and the drive to the lead-screw is disengaged by means of a control lever provided for this purpose. The main spindle is now revolved at the higher speed for turning, and the turning tool is used for facing the shoulder true.

A larger machine designed along the same general lines as the one illustrated in Fig. 19 has been used for milling threads having a pitch of ¼ inch, a length of 4¾ inches, and a diameter of 9½ inches. Threads of this size were milled in nickel steel armor-piercing shells.

Reed-Prentice Thread Milling Machine

Fig. 20 shows a single-purpose thread milling machine designed especially for milling external threads on rifle barrels and the internal threads in rifle receivers. The machine, as illustrated, is arranged for the thread-milling operation on the receivers. The special work-holding fixture is designed to hold each receiver in the same position so that the thread will start at a predetermined point, thus making all the receivers interchangeable. When the machine is used for milling the external threads on rifle barrels, the receiver fixture shown in the illustration is removed and a special collet chuck is used which grips the barrel at the breech end close to the part that is to be threaded. The barrel extends through the hollow spindle of the machine and provision is made for accurately locating each barrel so that the threads start at a fixed point and are interchangeable with the receivers. The muzzle end of the barrel is supported by a special cam-action closer which holds the muzzle end concentric with the breech end. When a thread is being milled, the carriage upon which the cutter-spindle is mounted is traversed along the bed by a lead-screw, which is driven through change-gears. This lead-screw is engaged by a split nut, the arrangement being similar to an engine lathe. The bearing or bracket carrying the cutter-spindle is pivoted at one end, so that the cutters can be set in line with the angle of the thread, an adjustment of 5 degrees each side of the perpendicular being provided for. This machine is made by the Reed-Prentice Co., Worcester, Mass.

Classes of Work for which Thread Milling Machines are Adapted

Determining when the thread-milling process is superior to other thread-cutting methods may be very easy in some cases and very difficult in others. Each standard method of cutting threads, whether by milling, by means of taps and dies, or by using a single-point tool in the lathe, has its own advantages when applied under favorable conditions. The chief competitors of the thread milling machine are the engine lathe, dies for external threads, and taps for internal thread cutting. A thread milling machine may be used (1) because the pitch of the thread is too coarse for cutting with a die, (2) because the milling process is more efficient than using a single-point tool in a lathe, (3) in order to secure a thread which is smoother and more accurate as to lead than would be obtained with a tap or die, (4) or because the thread is so located relative to a shoulder or other surface that milling is superior to any other method if not the only practicable way of doing the work.

When making comparison between thread-cutting processes,

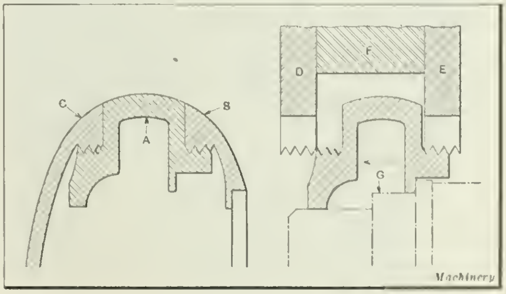

Fig. 22. Use of Duplex Cutter for milling Very Short Threads close to a Shoulder

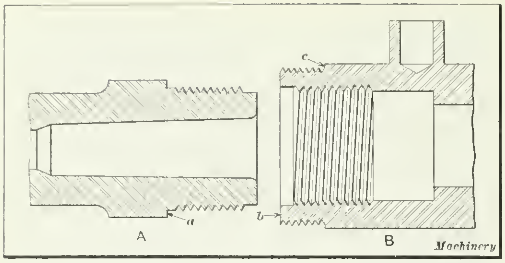

Fig. 23. Screw Threads on Rifle Barrel and Receiver which must qualify or register accurately with Other Surfaces

it is also essential to consider the relation that may exist between the thread cutting operation and other operations which may precede it. To illustrate this point, a lathe may be inferior to a thread milling machine for cutting a thread of a certain size and pitch, and yet the lathe may be preferable because cutting the thread is only one of a series of operations and by doing this work in the lathe the piece is finished at one setting and the thread is accurately located with reference to other machined surfaces. Similar conditions may exist in connection with work done in turret lathes or screw machines. For example, when a part requiring an internal thread is turned and bored in a turret lathe there is a decided advantage, in most cases, in finishing the part without removing it from the chuck and, ordinarily, some form of tap would be used, or a die in the case of external threads. In view of this close relationship between the method of cutting the thread and the work as a whole, it is apparent that any comparison between thread milling and other thread-cutting processes must be general and subject to modification. The classes of work for which the different thread-cutting methods are particularly adapted also merge into one another and there is no well-defined dividing line to serve as a guide.

Determining the relative merits of different thread-cutting processes is further complicated by the fact that a comparison between thread milling and the use of a lathe, die or tap, might be based either on the rate of production, accuracy of thread as to diameter and lead, smoothness of thread, or its location relative to other surfaces. The importance of these different features may, of course, vary considerably on different classes of work. It might be possible to obtain a much higher rate of production with a die than with a thread milling machine of the single-cutter type, but milling might be preferred in order to secure screw threads having a higher degree of accuracy as to lead than is usually obtained with a die.

Effect of Diameter, Pitch and Torsional Strain on Method of Cutting Thread

As the diameter and pitch of threads increase beyond the ordinary sizes, the use of dies for external work and taps for internal work becomes less practicable. If the screw is of large diameter, a die or tap must also be large and cumbersome, and the cost of these tools for cutting one size and pitch of thread may be prohibitive in view of the amount of work to be done. If a large number of duplicate threads are required, dies or taps may be used in preference to any other method even though the diameter is large, especially if the pitch of the thread is not so coarse as to cause distortion of the work as the result of torsional strain when cutting. Some parts such as sleeves, collar-nuts, etc., are difficult to hold firmly enough for tapping without distortion, but work of this kind can easily be handled on a thread milling machine. As a general rule the best method of cutting large screw threads of coarse pitch, multiple-threaded screws, or any form or size of thread requiring the removal of a relatively large amount of metal is by means of a thread milling machine equipped with a single cutter. The milling process is particularly desirable if the pitch of the thread and size of the thread groove is large in proportion to the diameter of the screw, because the metal removed by each cutting edge around the circumference of the cutter during one revolution is small and the screw being milled is not subjected to any great torsional strain. When a die is used for work of this kind, the accuracy of the screw may be seriously affected by the torsional strain or the twisting of the screw blank when cutting the thread. In some cases, duplicate screws large enough as to diameter and pitch to come well within the range of the single-cutter type of thread milling machine are cut by dies, because a greater production is obtained and the finish and accuracy of the threads are within the allowable limits.

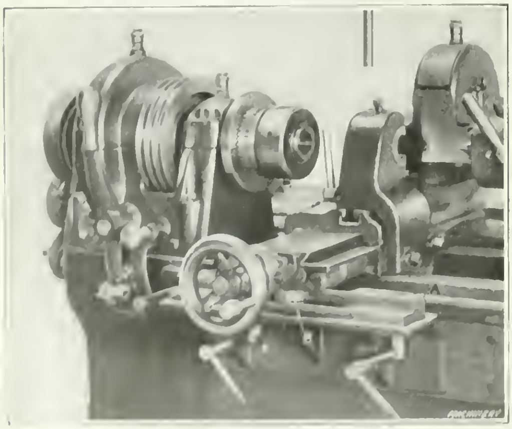

Fig. 24. Taper Attachment applied to a Pratt & Whitney Thread Milling Machine

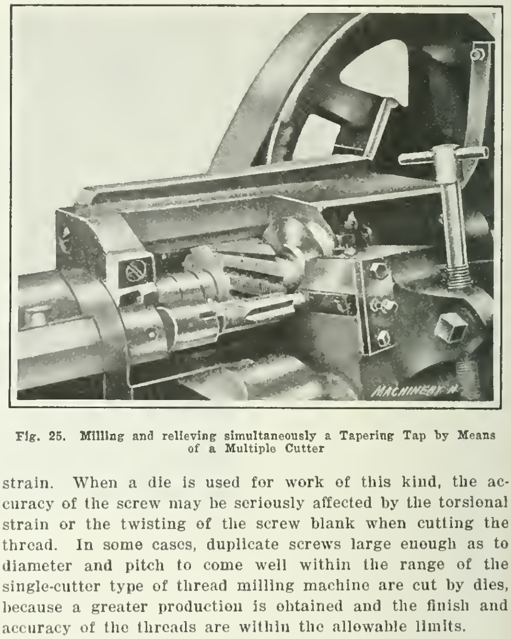

Fig. 25. Milling and relieving simultaneously a Tapering Tap by Means of a Multiple Cutter

Advantages of Thread Milling Machine as Compared with Lathe

The single-cutter type of thread milling machine is superior to the lathe for cutting threads on lead-screws, worms, etc., because it gives a higher rate of production due to the fact that the action of the milling cutter is continuous and a single cut usually finishes the thread complete. The thread milling machine has little if any advantage over the lathe in regard to accuracy of lead since both machines duplicate the controlling lead-screw. The heat generated when cutting the thread may, however, affect a screw cut in the lathe more than one that is milled. When milling a screw the blank revolves very slowly and the small amount of heat generated by the cutter is localized, so that it can readily be dissipated by using sufficient oil or cutting compound. As the single-point tool moves along more rapidly there is liable to be a greater expansion of the screw, which, when cold, may not be as accurate in regard to lead as a screw that has been milled. The rotating milling cutter is also more durable than a single-point tool and it can be used for cutting longer screw threads without sharpening and relocating the tool; moreover, the cutter is superior in maintaining a given diameter

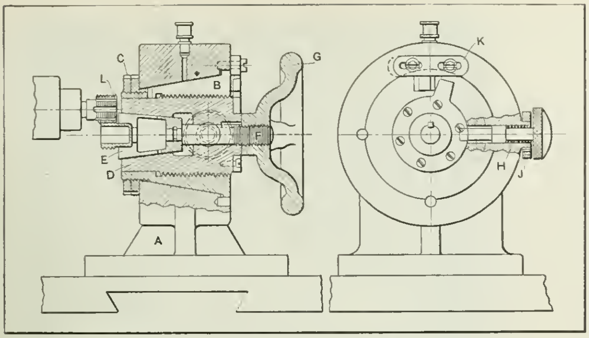

Fig. 26. Hand-operated Type of Thread Milling Fixture

The accuracy of a milled screw may depend upon several factors, such as the accuracy of the lead-screw on the machine, the condition of the cutter, the quality of the material of which the screw is made, the amount of oil or other cooling medium that is supplied, the accuracy of diameter of the screw blank, and the rate of feed. According to the Pratt & Whitney Co., lead-screws, when milled under favorable conditions, in most cases will not show an error of over 0.001 inch in any foot of their length. For accurate work of this kind, it is very important to use stock that is uniform in diameter and a good fit in the follow-rest bushing of the machine; in fact, screws that are to be milled should be ground if they are to run in a follow-rest bushing. Certain kinds of steel, which, because of their composition are difficult to cut smoothly with a stationary tool in a lathe are easily cut by milling.

Thread milling machines as a class have a further advantage, particularly as compared with the engine lathe, in that they are easier to operate and can be handled by unskilled labor. The fact that these machines are usually semi-automatic also makes it possible for one operator to attend to two or more machines on many classes of work. The number of machines that one man can operate to advantage depends partly upon the time required for milling the thread in one machine. For instance, with a certain type of thread milling machine, if the actual milling time exceeds forty seconds, it is possible for an operator to run two or more machines.

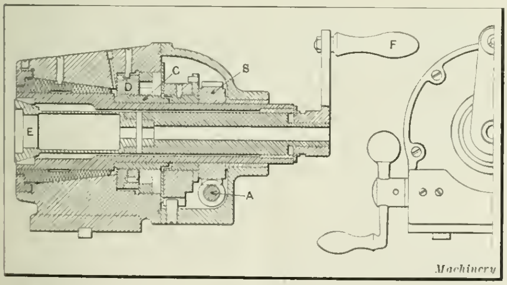

Fig. 27. Hand-operated Thread Milling Attachment having a Worm-gear Drive

General Application of the Multiple-cutter Type of Thread Milling Machine

As the multiple-cutter type of thread miller is applied to different classes of work than a machine having a single cutter, its relation to other thread-cutting methods is quite different. For work within its range, a multiple-cutter machine frequently comes into competition with dies and taps especially self-opening dies and collapsing taps. For some thread-cutting operations, it is generally conceded that the milling process is superior and more efficient than any other method. There is a decided difference of opinion, however, regarding the relative merits of these methods of cutting threads, particularly as applied to classes of work which are within the range of either the thread milling machine or a die, if the thread is external, and a tap if it is internal. The multiple-cutter type of thread milling machine has been used extensively in preference to collapsing taps when the thread must be cut close up to a shoulder or close to the bottom of a hole, as, for example, when cutting the threads, for the base plugs in shells. The sketches in Fig. 2 represent typical examples of external and internal work for which the multiple-cutter type of thread milling machine has proved very efficient, although its usefulness is not confined to shoulder work and "blind" holes. The milling cutter is used frequently in preference to a tap, because it produces a smoother thread, especially if the metal has soft stringy spots.

The diameter of the hole to be tapped and its length often have a decided effect on the preferable method of cutting threads, especially when comparing the multiple type of thread milling cutter with taps. The smaller the hole and the greater its length, the less practicable the milling process becomes. If the cutter is too large in proportion to the diameter of the hole to be threaded, the cutter does not clear itself, and if it is too long in proportion to the diameter, there is not enough rigidity for milling a straight and accurate thread, the cutter being deflected in a lateral direction. The limitations of the milling cutter as regards rigidity are subject to considerable variation and may be affected decidedly by the design of the machine, its condition, and whether the material being milled is hard and tough, or soft and easily cut.

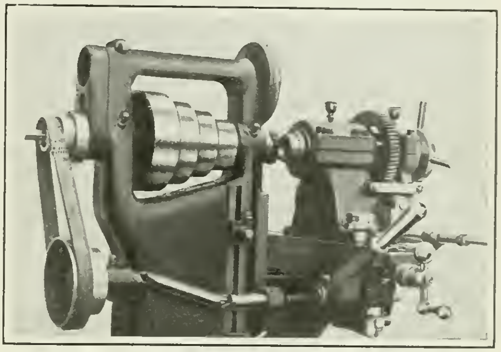

Fig. 28. Thread Milling Attachment for a Milling Machine

A simple method of increasing the maximum length of thread which can be milled with a multiple cutter is illustrated by the diagram Fig. 21. Every other row of cutter teeth is omitted, the distance between the teeth being equal to twice the pitch of the thread to be milled. By using a cutter of this kind, the lateral thrust or pressure is greatly re-

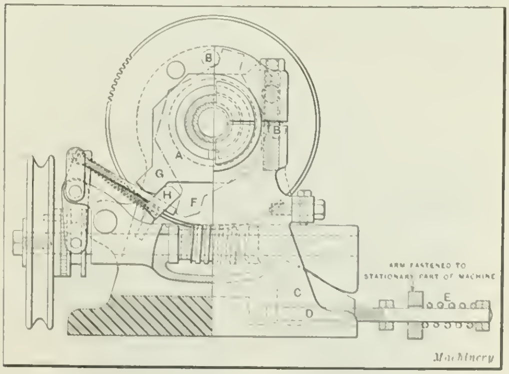

Fig. 29. Mechanism of Semi-automatic Thread Milling Attachment shown on a Milling Machine in Fig. 28

duced and a complete thread is milled by simply allowing the work to make two revolutions (plus the necessary over travel) instead of one revolution.

Milling Short Threads Close to a Shoulder

Very short threads, especially when close to a shoulder, are difficult if not impossible to cut by means of taps or dies, particularly when power is utilized for performing the operation. The throat of a die or the chamfer of a tap leaves that part of the thread adjacent to the shoulder unfinished, and if the throat or chamfer are omitted, all of the work is done by the first row of teeth which is objectionable. The milling process is very effective for this kind of work, even though only two or three threads are required, and the strength of the part will not permit cutting a recess or clearance space at the end of the thread.

An example of work illustrating the possibilities of the thread milling machine for milling very short threads close to a shoulder, is shown on an enlarged scale in Fig. 22. The thread milling operation to be described is on the central section *A* of a watch case. This central part requires a thread on both sides for receiving the bezel *B* and back of the case *C*, as indicated by the assembled view. The thread has a pitch of 1/54 inch (54 threads per inch) and a diameter of 1.800 inch. Each thread makes one and one-half turn approximately, or in other words, there is one and one-half thread on each side, and both of these threads are milled at the same time by a duplex cutter of the multiple type. The cutters *D* and *E* are separated by a collar or distance piece *F* which is just wide enough to allow for the necessary feeding movement of the work. This operation is performed on a Thomson semi-automatic thread milling machine similar to the type shown in Fig. 18. This machine is so arranged that the work-spindle is moved longitudinally by the direct action of a lead-screw when milling a thread. For this particular operation, the cutter-slide is adjusted so that one of the cutters just clears the shoulder. As the thread is milled, the work-spindle and work move in the direction indicated by the arrow, so that cutter *E* operates from the shoulder outward, whereas cutter *D* moves inward. This is a sharp V-thread having a 60-degree angle. The work is held in position on an expanding arbor *G* having shoulders for accurately locating it. These pieces were milled in this way at the rate of 160 per hour. The back *C* and bezel *B* of the case are also threaded on the same type of machine.

Screw Threads which must Qualify or Register with a Machined Surface

Thread milling is also especially applicable whenever screw threads on duplicate parts must "qualify" or maintain an exact relation with a fixed point or surface on the work. The external threads on rifle barrels and internal threads in receivers into which the barrels are screwed, are examples of work requiring threads accurately located, relative to a shoulder in the case of a barrel, and a finished face in the case of a receiver.

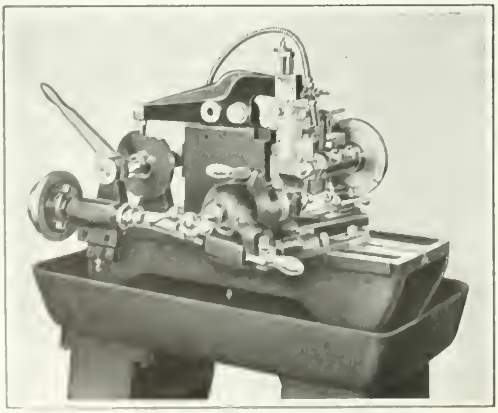

Fig. 30. Bilton Semi-automatic Worm Milling Machine

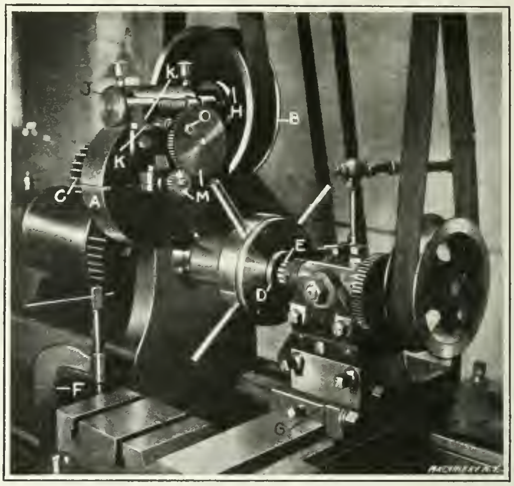

Fig. 31. Thread Milling Attachment Designed for Use on Engine Lathe

Examples of the kind of work that requires great accuracy in regard to the location of the threads are shown in Fig. 23. The thread on the rifle barrel, the end of which is shown at *A*, must not only be accurate as to diameter and pitch, but must qualify or register with the shoulder *a*. The internal thread in the receiver shown at *B* must also be accurately located with reference to the finished face *b*. When the rifle is assembled, the barrel screws into the receiver and if both threads did not register properly, the barrel would not be in the right position when screwed up against the shoulder. For instance, if the thread did not start at the right place and was, therefore, in a different location relative to the shoulder, the sight on the barrel (or the seat for an attached sight) when the latter is assembled, would not be in a vertical position or at the top.

The receiver shown at *B* has, in addition to the internal thread, an external thread which must qualify with a shoulder *c*. This particular receiver is for a Mauser rifle which has an outer tube or casing surrounding the barrel instead of the wooden grip such as is found on most military rifles. As this outer tube carries the sight, it is essential to have the thread accurately located with reference to the shoulder. For all work of this general nature, the thread milling machine is particularly adapted.

Cutter Interference when Milling Square Threads

It is difficult and often impossible to mill a satisfactory square thread, even when using a single cutter, owing to the interference between the cutter and the sides of the thread. The Acme thread, which is superior to the square thread, may be milled very easily with a single cutter, and is now used extensively for lead-screws and on many other parts which formerly had the square thread. The trouble due to cutter interference when milling square threads is more pronounced if the thread is a multiple form and, therefore, has a greater lead angle. The cutter should preferably be set to the helix angle of the thread at a point midway between the top and bottom of the thread groove. If the cutter is set to the angle at the bottom of the thread, the groove will be milled wider toward the top and have slightly curved sides. On the contrary, if the cutter is set to the angle at the top of the thread, the sides of the thread groove will be under-cut somewhat. A burr may also be formed by the cutter especially after the corners become dull. Trouble due to interference may sometimes be partly avoided by grinding the sides of the cutter slightly tapering or to an angle of from three to five degrees. Interference of the kind referred to does not occur when milling threads having angular sides because the cutting edges readily clear the angular sides after leaving the cutting position.

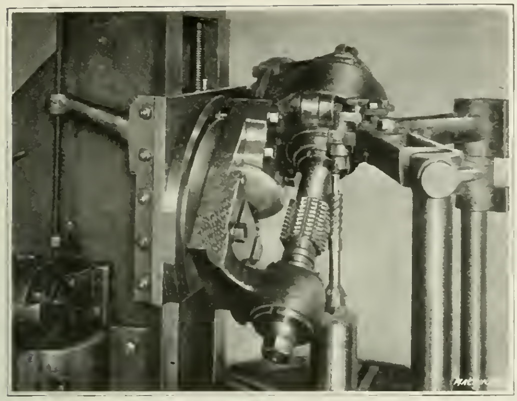

Fig. 32. Milling the Threads of a Multiple-threaded Screw by Means of a Hob and a Regular Gear-hobbing Machine

Milling Taper Threads

The milling of taper screw threads may be done on a single-cutter type of machine by traversing the cutter laterally as it feeds along in a lengthwise direction, the same as when using a taper attachment on an engine lathe. The taper attachment which is applied to some Pratt & Whitney thread milling machines is illustrated in Fig. 24. When the attachment is in use the cutter-slide is controlled by a guide-bar *A*. This guide-bar is inclined relative to the axis of the screw and it is engaged by a sliding block *B* on the front side and a roller on the rear side, which constrain the cutter to follow an angular or tapering path. This guide-bar is formed of two sections; by setting one of these sections parallel to the axis of the screw and the other to an angle, both tapering and straight screw threads can be milled. This feature is sometimes required when milling the threads on certain classes of taps having tapering ends followed by a straight section. The roller is held into contact with the rear side of the guide-bar by means of a spring which permits the use of a jointed guide-bar.

Taper threading on the thread milling machine can also be done when using the multiple type of cutter. One method of using a multiple cutter on tapering work is illustrated in Fig. 25, which shows a detailed view of a special machine used for cutting threads on taper taps. This particular machine is so arranged that it not only mills a tapering thread, but relieves it at the same time. The cutter is similar to the multiple type previously described in that it has annular rows of teeth which lie in planes perpendicular to the axis and are not helical like the teeth of a hob; the flutes are helical in this case instead of being straight or parallel to the axis. When a thread is being milled, the tap moves in a lengthwise direction as it revolves, at a rate depending on the pitch of the thread for which the tap is intended. The teeth of the tap are relieved as the result of an oscillating motion which is given to the multiple cutter. Each time the tap revolves, a complete cut is taken across every tooth so that two or three revolutions provide for both roughing and finishing cuts. The square end of the tap shank is finished before milling the thread so that this end can be inserted in a socket and used for driving the tap, while the other end is supported upon a conical center. This center is adjustable so that the tap can be located at the correct angle relative to the multiple cutter.

Speeds and Feeds for Thread Milling

The rate of production obtained with a thread milling machine may be affected greatly by the requirements as to accuracy and finish of the milled threads. The quality of the work depends considerably on the speed of the cutter and its relation to the feed. If the speed of the cutter is too slow for a given feed, the thread will not be finished as smoothly as it would be if a greater number of cutting edges passed the cutting position during a given feeding movement of the screw; therefore, to obtain a high rate of production and, at the same time, a smoothly finished screw thread, the cutter should revolve as rapidly as possible without dulling it excessively, and for this reason high-speed steel cutters are generally used for thread milling operations, although carbon steel cutters are preferable for milling such materials as aluminum, bronze and fiber as they will cut smoother threads. The surface speed of the screw blank may not exceed 2 or 3 inches per minute if the material is tough and especially if the thread is of rather coarse pitch; on the contrary, the surface speed may be increased to 6 or 8 inches per minute when the pitches are finer and the material cut more easily. Faster feeding movements are also used under favorable conditions.

The speed of the milling cutter usually varies from 100 to 125 feet per minute, with slower and faster speeds for some thread milling operations. The design of the machines and the general type may affect the speeds and feeds to some extent. The feeds and speeds recommended by the manufacturer of a single-cutter type of thread milling machine when equipped with a high-speed steel cutter are as follows: A surface speed for the cutter of about 100 feet per minute is a fair average speed for milling threads in machine steel, whereas for tool steel the speed should be reduced to about 70 feet per minute. When milling threads of moderate pitch such as 5 threads per inch and finer, the rate of feed is regulated somewhat by the quality of finish desired. When milling threads in machine steel and using a cutter 2¼ inches in diameter, a speed of 177 revolutions per minute is considered satisfactory, and a feed of about 4½ inches per minute provided there are 5 threads per inch or more; if the thread is coarser, say, 3 or 4 threads per inch, the feed should be reduced to 3 or 3½ inches per minute, and for 2 or 2½ threads per inch, to 2 or 2½ inches per minute. When milling tool steel, slower feeds are recommended and when milling brass much higher speeds and feeds may be employed. According to another manufacturer, a speed of about 125 feet per minute is approximately the maximum speed for tool-room work in steel, whereas for manufacturing operations, especially when milling soft steel, the speed may be considerably higher. When milling lead-screws or other accurate screws it is prerferable to feed rather slowly so that the stock may be thoroughly cooled, in order to avoid errors due to expansion and contraction. The cutter must also be kept sharp to prevent expansion or distortion of the stock due to the swaging action and the friction generated by the dull teeth. The condition of a cutter should be noted before beginning to mill a long screw so that it need not be changed until the milling operation is finished.

A manufacturer of a thread milling machine of the multiple-cutter type recommends a feed of 6 inches per minute and a cutting speed of 75 to 80 feet per minute when milling threads in soft steel. In fact the feed and speed mentioned have been used when milling 8 threads per inch or more in steel containing 0.55 per cent carbon. The feed for this work has also been increased to 9 inches per minute with satisfactory results. When milling threads of ¼ inch pitch in nickel

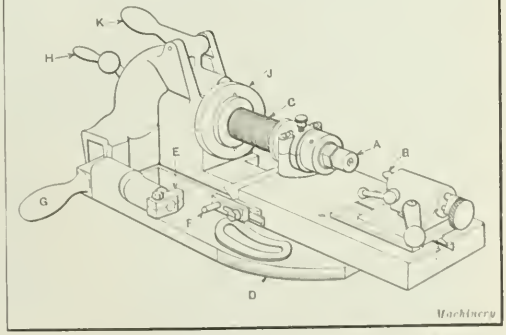

Fig. 33. Detail View, showing Lead-controlling, Indexing and Automatic Trip Mechanism of Machine illustrated in Fig. 30

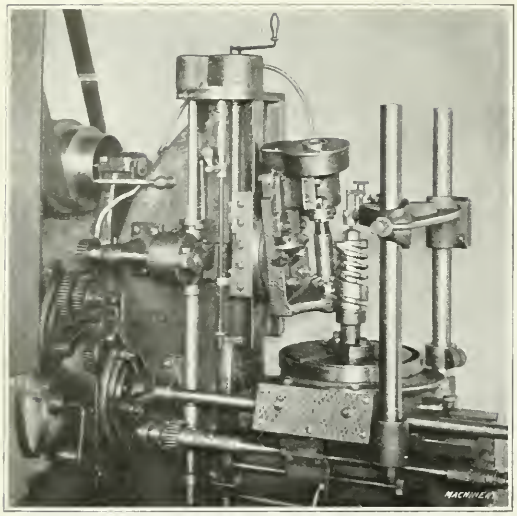

Fig. 34. Milling a Double Thread on a Farwell Gear-hobbing Machine equipped with a Single Milling Cutter

steel, a feed of 2 inches per minute and a cutting speed of about 50 feet per minute were utilized. While this is exceptionally heavy work for a multiple-cutter machine, the possibilities and limitations in any case may, of course, vary greatly, since the rigidity of a machine, its condition and the relation between the diameter of the cutter and its length are very important factors.

The speeds and feeds recommended by still another manufacturer of a multiple-cutter type of machine are given in the accompanying table which applies to a number of different materials, ranging from tool steel to brass. It is claimed that the speeds and feeds for a thread milling machine may be from 20 to 40 per cent faster than could be used when milling flat surfaces in connection with regular milling machine work. If the best results are to be obtained, cutters must be kept sharp as they will last longer, consume less power and produce more and better work. As form cutters are used the face of each cutting tooth should be ground radial to obtain the correct form of thread.

Thread Milling on Standard Milling Machines

Thread milling is frequently done on machines designed for general milling operations, such as the plain and universal milling machines of the columnm-and-knee type. There are two general methods of milling threads on ordinary milling machines. In the first place, the screw thread may be generated by using the spiral or dividing head the same as when performing any helical or spiral milling operation. The spiral head is geared to the lead-screw of the machine for traversing the table and work a distance per revolution corresponding to the lead or pitch, and the cutter is held and driven by some attachment such as a vertical spindle, universal or spiral milling attachment, the alignment of the cutter with the thread groove being obtained either by swiveling the work table or by adjusting the cutter driving attachment. While this method is commonly employed for a variety of helical or spiral milling operations, its application to thread milling is largely confined to the milling of worms or relatively short screws of coarse pitch, especially when such work is not done on an extensive scale.

The second general method of milling threads on ordinary milling machines is by equipping the machine with a special attachment designed for this work exclusively. These attachments are usually designed for milling threads on duplicate parts in connection with manufacturing and they are arranged to hold the work and rotate it along a helical path while a cutter held either directly in the machine spindle or on an ordinary arbor mills the thread groove. The simplest form of attachment consists principally of a base or frame which carries a spindle and a lead-screw connecting either with a hand crank or some combination of gearing for imparting a rotary motion to the spindle and work. A fixture intended for milling threads of fine pitch, especially in materials that are easily cut, may have a hand crank attached directly to the end of the work-spindle. With this arrangement, as the crank is turned, the lead-screw which passes through a nut attached to one of the fixture bearings, causes the work to advance at the proper rate for milling a thread. The lead-screw is a duplicate of the thread required, as far as its lead or pitch is concerned. While such a fixture may be used for the lighter classes of work, in general it is preferable to transmit motion to the work-spindle through worm-gearing. The worm-wheel may be carried by the work-spindle which is splined to permit endwise movement through the worm-wheel, whereas the hand crank is mounted on the end of the worm-shaft. Some of these hand-operated thread milling attachments are provided with indexing plates for milling multiple threads. Fixtures of the general type referred to may be used in conjunction with a single cutter or a multiple cutter may be employed for finishing a thread in one revolution of the work. If a multiple cutter is used, it is particularly desirable to have the work-spindle rotated through worm-gearing in order to obtain a more powerful turning movement.

Hand-operated Thread Milling Fixtures

The simple form of thread milling fixture shown in Fig. 26 is intended for use on an ordinary column-and-knee type milling machine. A multiple-cutter *L* is used for milling the thread and the work is held in a spring chuck or collet *E* which is opened or closed by turning hand-wheel *G*. The threaded part *D* serves as a lead-screw and passes through a tapering split bushing *B* which is held in position and adjusted by nuts *C*. The plunger *H* prevents the lead-screw from rotating when tightening or loosening the chuck. After the part to be milled is fastened in the chuck, plunger *H* is withdrawn and is held in the outward position by a small pin at *J*. The cutter is next fed in to the correct depth as determined by suitable stops and then the lead-screw *D* and work are advanced by turning handwheel *G* through one revolution. This turning movement is controlled by a sliding stop *K* which has elongated holes that permit it to move from one side of the vertical center line to the other, so that the lead-screw can make one complete turn. After a thread is milled, the cutter is withdrawn and the spindle rotated back to its starting position. The chuck is then loosened by handwheel *G* after engaging the locking plunger *H*. This attachment is intended for milling fine threads which are easily cut.

The hand-operated thread milling attachment illustrated in Fig 27, is equipped with worm-gearing for revolving the work spindle. The worm-wheel shaft *A* carries a crank at its outer end which is revolved to impart a feeding movement to the work. The worm-wheel on shaft *A* meshes with worm-wheel *B* which revolves the work-spindle. A threaded sleeve *C* at-

SPEEDS AND FEEDS FOR THREAD MILLING

Cast and Tool Steel	Machine Steel and Bronze	Wrought Iron	Cast Iron	Malleable Iron	Gun Metal	Aluminum	Brass
Cutting Speeds (Feet per Minute) for High-speed Steel Cutters							
70-100	135-155	140-160	145-165	155-175	170-190	180-220	200-240
Cutting Speeds (Feet per Minute) for Carbon Steel Cutters							
30-45	50-70	60-80	60-80	70-90	80-100	85-105	90-110
Feeding Movement of Work (Inches per Minute) for High-speed Steel Cutters							
5-8	6-9	8-10	10-15	10-15	15-20	20-30	20-30

Machinery

tached to the work-spindle passes through the nuts *D* and serves as a lead-screw. The parts to be threaded are held in the collet chuck *E* which is opened or closed by turning crank *F*. This crank is also used to return the work-spindle to the starting position after a thread is milled. This attachment is used in conjunction with a multiple cutter so that the thread is finished in practically one revolution. It is manufactured by the Hall Gas Engine Co., Inc., Bridesburg, Philadelphia, Pa.

Semi-automatic Thread Milling Attachment

A semi-automatic thread milling attachment which may be applied to milling machines having either a hand or power feed is illustrated in Fig. 28. This attachment was designed for performing internal and external thread milling operations in munitions plants although it may be used for other classes of work. The attachment is used in conjunction with a cutter of the multiple form which finishes a thread in practically one revolution. The feeding movement of the work spindle is derived from the countershaft which connects by means of a round belt with the pulley mounted at the left-hand end of the worm-spindle as seen in Fig. 29. This pulley transmits motion to the work-spindle through the worm and worm-wheel shown. When the worm is in engagement with the wheel it is held in position by a wedge-shaped part *C* connecting with rod *D* which passes through an arm which as the illustration indicates, is fastened to a stationary part of the machine. Interposed between this arm and a collar at the end of rod *D* there is a spring *E*. The purpose of this mechanism is to engage the worm automatically with the worm-wheel when the table of the machine is moved forward for bringing the work into contact with the milling cutter; on the contrary when the work is withdrawn the worm is released. This mechanism is so located and adjusted that the engagement of the worm and the rotation of the work begins before the cutter comes into contact with the part to be milled. Additional forward motion for cutting the thread to the proper depth is made possible by the compression of spring *E*. In operating this attachment the part to be threaded is placed in the collet chuck which is operated by the pilot wheel shown. This motion revolves the spindle until the stop-plate *A* which revolves loosely on the gear hub, comes against the stop *H*. The table is then run forward either by a hand-lever or the feed-screw handle, which automatically engages the worm and starts the work revolving, the rotary motion beginning just before the cutter comes into contact with the part to be threaded. When the work has made about one and one-tenth revolution the stop-plate *A* comes into position *F* and disengages the belt pulley driving clutch. As the screw thread is now milled, the table is withdrawn and the worm disengages from the worm-wheel. The finished part is then removed from the chuck and another piece substituted. Tightening the collet chuck again locates the stop mechanism in the starting position *G*. When milling internal threads it is also necessary to move the cross-slide of the machine. If a final finishing cut is required the attachment may be adjusted to automatically make two revolutions, one for roughing and the other for finishing. The thread is generated with this attachment by means of a lead-screw engaging a nut in the usual manner. This attachment is a development of the American Ammunition Co., Inc., Bordentown, N. J.

Thread Milling Attachments for Engine Lathes

Engine lathes equipped with special attachments have been used to some extent for cutting threads by the milling process especially in connection with shell work. The special mechanism for converting a lathe into a thread milling machine usually consists of an auxiliary slide which is mounted on the carriage and is arranged to carry the revolving cutter-spindle and, in addition, some form of drive for reducing the speed of the work-spindle so that the surface speed of the thread being milled will be only a few inches per minute. A thread milling attachment for the lathe designed by the New England Butt Co., Providence, R. I., is illustrated in Fig. 31, as applied to an ordinary sixteen-inch lathe. When using this attachment, the lathe is geared up the same as when cutting a thread with a single-point tool in the regular way. A multiple cutter is used so that the thread can be completed in practically one revolution of the work. The lathe spindle is driven from belt pulley *B* which transmits motion through a worm to a worm-wheel encased at *A*, and from the worm-wheel shaft through pinion *C* to the large gear on the machine spindle. This drive gives the spindle a backward motion so that the work revolves in a direction opposite to that of the cutter. The illustration shows an internal threading operation. The cutter is located longitudinally by moving the carriage against a stop at *F*. Another stop at *G* controls the crosswise position of the cutter and the depth to which the thread is milled. The work in this case is held in a collet form of chuck, and, after the cutter is located in a lengthwise direction, it is fed in to the full depth of the thread. Clutch *H* is then engaged by pulling forward knob *J* which starts the rotation of the work-spindle and the work. After the spindle has made about 1 1/10 revolution, a stop-pin at *O*, which is revolved through gearing *M*, releases stop *K* which disengages the driving clutch and the drive to the work-spindle. The thread is generated by the movement of the carriage along the bed the same as when cutting a thread in the regular way.

Bilton Worm Milling Machine

A machine designed especially for milling small worms or similar parts is shown in Fig. 30. This machine is semi-automatic in its operation, the machine stopping automatically after the worm thread is milled. The work is held in a collet chuck *A* (see detailed view, Fig. 33) and is additionally supported by a center *B* which may be either male or female. The spindle to which the chuck is attached is provided with a lead-screw or master worm *C* which is a duplicate as to lead or pitch of the thread to be milled. This lead-screw is revolved when milling a thread, through worm-gearing which connects by means of a telescopic shaft and universal joint with a belt pulley seen at the left of the machine in Fig. 30. The cutter-spindle is carried by a slide which is moved downward for locating the cutter in the proper position by the hand-lever which is also seen at the left of the illustration in Fig. 30. The required movement is imparted to the cutter-spindle slide by a cam on the hand lever shaft which operates a lever that extends forward to the cutter-slide. The work-holding fixture illustrated in Fig. 33 is set to the helix angle of the thread as indicated by graduations on the base at *D*. When a thread has been milled to the required length, the trip dog *E* comes into engagement with the adjustable stop *F* which releases lever *G* and allows the worm to drop out of mesh with the worm-wheel. The lead-screw and work-spindle are then returned to the starting point by means of handle *H*. This machine may be used for milling single, double, triple, and quadruple threads. The spindle is indexed for milling multiple threads with a single cutter, by means of index plate *J* which has holes engaged by a plunger or pin connecting with the

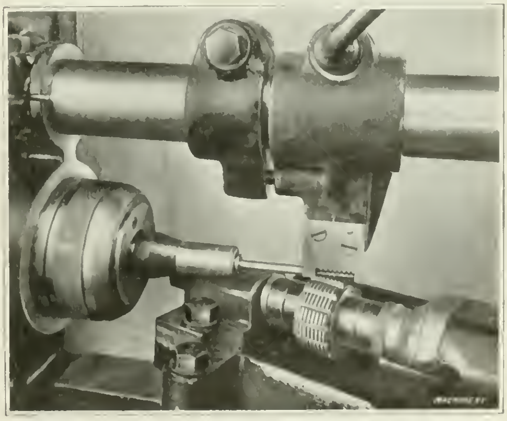

Fig. 35. Barber-Colman Gear-hobbing Machine milling a Worm Thread on the End of a Slender Spindle

operating lever *K*. For milling some double threads, a duplex cutter is used, so that both thread grooves are milled simultaneously and indexing is unnecessary. This machine has a capacity for work 1½ inch in diameter and 1½ inch long, but it has been used more extensively for milling the small worms required in phonographs, auto-horns, organs, etc., which usually vary from about ¼ to ⅜ inch in diameter.

Hobbing Method of Thread Milling

A hob is sometimes used in conjunction with a gear-hobbing machine for milling multiple screw threads. A hob used for this purpose has teeth which lie along a helical path, like a hob intended for cutting spur or helical gears, and it must be geared to revolve with the work at a definite speed ratio, the same as when hobbing a gear. The hobbing method is particularly efficient for cutting worms having several threads, because the hob finishes the different threads simultaneously. A hob having teeth of special form must be used for milling worms or other screw threads in order to generate threads having sides which are, at least, approximately straight. Fig. 32 shows a Farwell gear-hobbing machine milling a five-threaded worm. A single-threaded hob is used and the threads are cut much more rapidly than when an ordinary milling cutter is employed. The sides of the threads are not exactly straight but the curvature is slight. Multiple-threaded worms having four threads or more may often be milled to advantage with a single-threaded hob by the general method illustrated in Fig. 32, but if the worm has only a single thread or a double thread, it should preferably be milled by using a single milling cutter as illustrated in Fig. 34, instead of employing a hob. When a single cutter is used on this machine, the work-table of the machine is geared to the down feed so that a screw thread of the required lead will be milled but without reference to the speed of the cutter which may be regulated to suit the thread milling operation. When a screw thread is milled in this way, the gear-hobbing machine is practically a thread milling machine, so far as the principle of its operation is concerned.

An unusual and interesting application of a gear-hobbing machine to thread milling is illustrated in Fig. 35, which shows a No. 3 Barber-Colman machine cutting a worm thread on the end of a rather long and slender spindle. Owing to the flexibility of this spindle, a special form of work support was required. This consists of a plate supported by the overhanging arm and having two bearing surfaces which engage the screw thread at the ends, as the illustration shows.

* * *

THE SELECTIVE DRAFT

In the effort to form an army with the least possible confusion and hardship to the country, and especially to those industries on which the army's success most largely depends, all persons within the draft age have been arranged into five classes, which are as follows:

Class 1—Single man without dependent relatives. Married man, with or without children, or father of motherless children, who has habitually failed to support his family. Married man dependent on wife for support. Married man, with or without children, or father of motherless children; man not usefully engaged, family supported by income independent of his labor. Unskilled farm laborer. Unskilled industrial laborer. Registrant by or in respect of whom no deferred classification is claimed or made. Registrant who fails to submit questionnaire and in respect of whom no deferred classification is claimed or made. All registrants not included in any other division in this schedule.

Class 2—Married man with children or father of motherless children, where such wife or children or such motherless children are not mainly dependent on his labor for support for the reason that there are other reasonably certain sources of adequate support (excluding earnings or possible earnings from the labor of the wife) available, and that the removal of the registrant will not deprive such dependents of support. Married man without children, whose wife, although the registrant is engaged in a useful occupation, is not mainly dependent on his labor for support, for the reason that the wife is skilled in some special class of work which she is physically able to perform and in which she is employed, or in which there is an immediate opening for her under conditions that will enable her to support herself decently and without suffering or hardship. Necessary skilled farm laborer in necessary agricultural enterprise. Necessary skilled industrial laborer in necessary industrial enterprise.

Class 3—Man with dependent children (not his own), but toward whom he stands in relation of parent. Man with dependent aged or infirm parents. Man with dependent helpless brothers or sisters. County or municipal officer. Highly trained fireman or policeman, at least three years in service of municipality. Necessary customhouse clerk. Necessary employe of United States in transmission of the mails. Necessary artificer or workman in United States armory or arsenal. Necessary employe in service of United States. Necessary assistant, associate, or hired manager of necessary agricultural enterprise. Necessary highly specialized technical or mechanical expert of necessary industrial enterprise. Necessary assistant or associate manager of necessary industrial enterprise.

Class 4—Man whose wife or children are mainly dependent on his labor for support. Mariner actually employed in sea service of citizen or merchant in the United States. Necessary sole managing, controlling, or directing head of necessary agricultural enterprise. Necessary sole managing, controlling, or directing head of necessary industrial enterprise.

Class 5—Officers, legislative, executive, or judicial, of the United States or of State, Territory, or District of Columbia. Regular or duly ordained minister of religion. Student who on May 18, 1917, was preparing for ministry in recognized school. Persons in military or naval service of United States. Alien enemy. Resident alien (not an enemy) who claims exemption. Person totally and permanently physically or mentally unfit for military service. Person morally unfit to be a soldier of the United States. Licensed pilot actually employed in the pursuit of his vocation. Member of well-recognized religious sect or organization, organized and existing on May 18, 1917, whose then existing creed or principles forbid its members to participate in war in any form, and whose religious convictions are against war or participation therein.

The class into which a selective will be placed depends on his answers to the questions sent him. These questions have been arranged in twelve series and provide a full history of each man. Every question in the first series must be answered, as this series seeks to determine the place for which each man is best fitted. Question 3 asks for a list of all occupations at which a man has worked during the past ten years, and Question 10 asks for the length of time he has been engaged at any of a list of eighty-seven occupations, as well as any other occupation in which he may have become adept. In most of the other series only the first question need be answered in most cases.

* * *

The Bureau of Labor Statistics of the United States Department of Labor has recently made a report measuring accidents according to the time lost. A fatal injury is valued as a loss of thirty years of a man's working life, while total permanent disability is rated at thirty-five years. Other injuries are credited with losses in proportion to their probable effect upon the earning capacity. According to an investigation made in 194 plants, there were 13,647 accidents in 1912, resulting in 37 deaths, 411 permanent injuries, and 13,199 temporary disabilities. This is equivalent to an accident frequency rate of 118 per 1000 full time (300-day) workers, and a severity rate of 5.6 days per worker. These rates may be contrasted with a representative steel plant during the same year, for which the frequency rate was 154 and the severity rate of 14 days lost per worker, the accidents being only about one-third more frequent, but their severity was two and one-half times as great. The character of the machines built in the plants from which this information was taken varied greatly, from locomotives and ships to delicate electrical apparatus. In every case where the plants did not have a good safety organization the frequency rates were three or four times as high as those having a well developed system.

MEASUREMENT OF INTERNAL THREADS

BY WILLIAM S. ROWELL[1]

When a toolmaker has mating internal and external threaded parts to make, he uses a gage or gages if possible; but owing to the cost of gages and the time required for their production, this is not always possible. The measurement of external threaded work by the use of a ball-point or special type of thread micrometer is carried on to a limited extent, and any up-to-date mechanical handbook gives instructions for using wires and a standard micrometer for this purpose; but very little in this line is undertaken in the case of internal threads. For many years the writer has used an inside micrometer with ball-points to assist him in making and gaging internal threads and he highly recommends the use of such an instrument. Not only can it be used when no gage is obtainable, but it is also of use in connection with a gage. It tells what the gage cannot, namely, how much the gage lacks of entering when the thread is too small; and how much it is loose when the thread is too large.

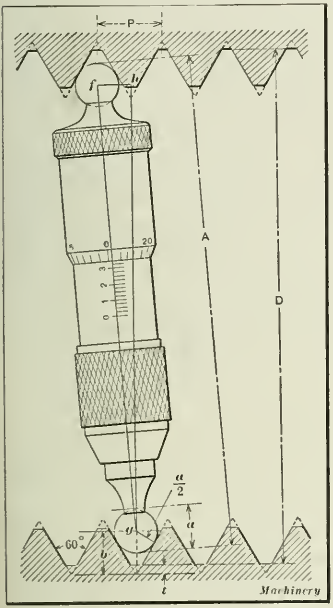

Fig. 1. Useful Type of Thread Micrometer

Inside micrometers are not yet made small enough to measure small internal threaded work, but large screws present the greater difficulty, and the toolmaker can usually adapt some inside micrometer for their measurement. Some enterprising tool supply firm should put on the market a line of attachable ball-points for external and internal thread micrometers, thereby doing both itself and the toolmaker a favor. As there is a singular lack of instruction in current mechanical works on measuring internal threads, the following may not be out of place. It may be said that the information given in handbooks on measuring external threads can be adapted to internal thread measurement, but the writer rarely finds a toolmaker who can use the information given in such books, because of the difficulty experienced in adapting these instructions to other conditions than those to which reference is made.

Referring to Fig. 1, if distance A cannot be read directly, it can be taken with an outside micrometer, after which the toolmaker proceeds to determine the outside diameter D of the thread. The following gives an expression for the different elements that enter into measurement D:

$$D = gh + 2b - 2t$$

Ball diameter a is known or easily obtained by the use of an outside micrometer and t is given by the following equation:

$$t = \frac{0.866P}{8}$$

Bearing in mind that the U. S. standard thread is a 60-degree angle, we can easily find the value of b from the following equation:

$$\frac{a}{2b} = \cos 60 \text{ degrees} = 0.5$$

Therefore, $a = b$

By construction, $fh = \frac{P}{2}$

$$gh = \sqrt{\overline{gf}^2 - \overline{fh}^2}$$

We are now ready to proceed with the solution of an actual problem. Suppose that for a given thread the following data are available. A is measured with a micrometer and found to be 3.12 inches; a by measurement is 7/32 = 0.21875 inch.

$$fh = \frac{P}{2} = 0.1666 \text{ inch}$$

Using these data, we proceed as follows:

$$t = \frac{0.866P}{8} = \frac{0.866 \times 0.333}{8} = 0.0361 \text{ inch}$$

$gf = A - a = 3.12 - 0.21875 = 2.90125 =$ hypotenuse of right-angle triangle fgh

$$gh = \sqrt{\overline{gf}^2 - \overline{fh}^2} = \sqrt{2.90125^2 - 0.1666^2}$$
$$= \sqrt{8.41725 - 0.02777} = \sqrt{8.38947} = 2.8964$$
$$b = a = 0.21875$$
$$D = gh + 2b - 2t = 2.8964 + 2 \times 0.21875 - 0.0722$$
$$= 3.2617 \text{ inches}$$

According to Mr. Converse, of the Pittsburg Model Engine Co., Homewood, Pa., comparisons of external and internal thread diameters (when measurements are taken with balls of the same diameter or with balls and wires of the same diameter) may be readily made. When internal and external threads are the same and the pitch P is standard or less, we have the following condition, illustrated in Fig. 2:

$$\text{External } A = \text{internal } A + 4a - \frac{2 \times 0.866}{P}$$

$$\text{Internal } A = \text{external } A - 4a + \frac{2 \times 0.866}{P}$$

$$\text{External } A - 3a = \text{internal } A + a - \frac{2 \times 0.866}{P}$$

If pitch P is more than one-eighth the diameter of the threaded work, or if the balls used are of maximum size, the varying angularity between internal A and external A would begin to show in the manner shown in a slightly exaggerated form in Fig. 2. Of course, it must always be borne in mind in fitting threaded parts that a certain amount of clearance must be allowed between internal and external threads, the amount of this clearance varying with the nature of the work, accuracy of thread-cutting tools and machines, and type of thread—whether single or multiple.

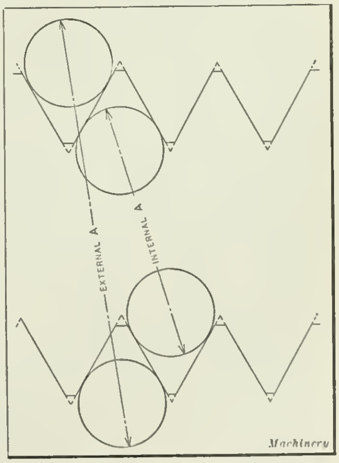

Fig. 2. Diagram explaining Formula for Relation between Measurements of External and Internal Threads

* * *

Over $163,000,000 is now invested in the dye industry in the United States. Thirteen of the plants are annually producing 49,100 tons of vegetable dyestuffs and extracts, while forty-six factories are producing 30,000 tons of artificial colors. Coal-tar dyes in a variety of colors suitable for leather, textiles, straw, paper, inks, stains, pigments, varnishes, waxes, feathers, furs, and many other purposes are regularly obtainable from domestic sources. During the year ending June 30, there were exported from this country $11,710,887 worth of dyes.

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HELICAL SPRING COMPUTATIONS

CHARTS FOR DETERMINING DIMENSIONS AND PROPERTIES OF SPRINGS IN TENSION AND IN COMPRESSION

BY DONALD H. REEVES[1]

THE accompanying charts have been devised for the purpose of giving, in convenient form, a method of determining the various properties and dimensions of helical springs in tension and in compression without the necessity of figuring them out from formulas. There are instruments for this purpose, but, as a rule, these leave some of the factors to be computed; in addition, they are rather high-priced and are much less handy to carry than these simple printed charts, which are complete in themselves, except that a straightedge of some sort is required.

The chart shown in Fig. 1 may be used for any material at any stress and with any modulus of elasticity; the chart shown in Fig. 2 is to be used for steel only. It differs from the other in that provision is made for the varying safe stresses and moduli of elasticity that are correct for different sizes of wire. The two charts are made on exactly the same principles, have the same scales, and are used in exactly the same way.

Each chart consists of ten scales and a reference line, which are used in groups of three. Knowing the factors given on any two of the scales in a group, the value of the factor given on the third scale of the group is the point where a straightedge placed across the two known values intersects the third scale. In all cases the straightedge must cross the vertical line where the short calibration line, representing the value being used, meets it. On the size wire scale *K*, the size in inches will be found to the right of the vertical line, while to the left are several columns of numbers, which are the numbers of the gages most commonly used in measuring wire. In each case, except the very top row of figures, the line immediately under the gage number is the one to be used, and its intersection with the vertical line is the point through which the straightedge is to pass. This scale can also be used as a means of finding the size, in inches, of any gage wire. The scales used together in groups are as follows: Group 1—Rate per turn *A;* total rate *J;* number of effective turns *E*. Group 2—Rate per turn *A;* pitch diameter used with rate scale *F;* size wire *K*. Group 3—Rate per turn *A;* modulus of elasticity *B;* reference line. Group 4—Total rate *J;* load *C;* deflection *G*. Group 5—Load *C;* size wire *K;* pitch diameter used with load scale *H*. Group 6—Load *C;* maximum shearing stress *D;* reference line. Scales *B* and *D*—those giving the modulus of elasticity and the maximum shearing stress—are to be used only for the square-wire correction on the chart for steel springs.

Almost any information desired may be obtained by using, successively, different combinations of these groups. In some cases the information required can be obtained from one group. For instance, when the size wire and pitch diameter are given to find the safe load for a spring stressed to the extent for which the chart is calculated, a straight line through the size of wire on scale *K* and the pitch diameter on scale *H* will give the safe load on scale *C*. However, it is often necessary to use two or more groups, requiring two or more successive operations in order to get the desired results, owing to the fact that there are more than two known factors entering into the determination. Such is the case when the spring is given and it is desired to find the rate per inch, which is the load required to deflect the spring one inch. In this case there are three known factors, the size wire, the pitch diameter and the number of turns. As all of these influence the value of the unknown factor, two operations are necessary, assuming that round wire is used with the modulus of elasticity for which the chart is calculated. With this information, it is necessary to pass a straight line through the size wire on scale *K* and the pitch diameter on scale *F*, which will give the rate per turn on scale *A*. This result in itself is practically never used, but by passing a second line through it and the number of effective turns on scale *E*, the total rate of the spring, which is the value desired, can be found on scale *J*.

In using the charts, a straightedge that is transparent will be found most convenient. Lines should not be drawn, as these would soon make the chart unreadable. An easy way to locate the straightedge correctly is to find the position of one of the known factors on its scale and place some pointed instrument, such as a hard pencil or a pin, at this point. The straightedge may be swung around this, as on a pivot, until it passes through the value of the other known factor on its scale, locating the value of the unknown factor on the third scale. If this result is simply to be used in further calculations, as in the illustration just given, it is only necessary to locate this point with the pointed instrument and pivot the straightedge around it without reading its value.

The two groups using the reference line require a little different operation from the others. These groups are only used to find rates and loads for square wire or, on the chart shown in Fig. 1, when a material is used that has some other safe stress than 60,000, or some other modulus of elasticity than 12,000,000 or when a load is given to find the stress. The method of using the reference line will be fully described under the directions for finding these values.

The formulas used in constructing these scales are as follows:

$$\text{For round wire, } W = 0.3927\frac{Sd^3}{D};\ F = 8\frac{PD^2}{Ed^4}$$

$$\text{For square wire, } W = 0.471\frac{Sd^3}{D};\ F = 4.712\frac{PD^3}{Ed^4}$$

in which W = carrying capacity, in pounds;
S = greatest shearing stress, in pounds per square inch;
d = diameter of round wire or length of one side of square wire, in inches;
D = pitch diameter of coil, in inches;
F = deflection of one turn, in inches;
E = torsional modulus of elasticity;
P = load, in pounds.

For getting the flat wire factors on the chart for steel springs, only a comparison of the capacity and rate of the flat wire and of the round wire is wanted; so it is only necessary to get the formulas for torsional deflection and stress in round and flat wire, which are as follows:

$$\text{For round wire, } S = \frac{16W}{\pi d^3};\ W = \frac{\theta\pi r^4E}{4L}$$

$$\text{For flat wire, } S = \frac{6\sqrt{b^2+d^2}\,W}{bd^3+b^3d};\ W = \frac{\theta bd(b^2+d^2)}{12L}$$

in which θ = angular deflection;
L = length of wire;
b = long side of flat wire;
d = diameter of round wire and short side of flat wire.

As most springs in general use are subjected to moderate vibration, the charts are made up for a factor of safety of 2. For brass and bronze wire, 30,000 pounds has been taken as a safe stress for ordinary service; where the service is to be at all severe, lower stresses should be used. For music wire a slightly greater stress can be used than for the same size ordinary spring wire of steel, and the modulus of elasticity will be correspondingly greater. The safe stress will range from 70,000 to 80,000, while the modulus of elasticity will be from 14,000,000 to 16,000,000. On the chart shown in Fig. 1, average values of 75,000 for stress and 15,000,000 for the modulus of elasticity have been marked for music wire; the steel chart will give results accurate enough for most work, however, except on very small sizes of music wire.

From the formulas given, it will be found that square wire will stand 1.2 times the load that round wire of the same size will stand and that the rate of the spring will be 1.7 times that of round wire. In a compression spring, the ends should always be ground square with the axis of the spring; this will make from one and one-half to two turns ineffective. A compression spring should have the ratio of length to pitch diameter as small as possible; if the ratio is more than 1:3, the spring should be guided to prevent bending.

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Directions for Using Charts for Round Steel Wire

Given Rate per Inch of Spring, Number of Turns, and Pitch Diameter to Find Size of Wire—On the steel-spring chart, Fig. 2, pass a line through the total rate on scale *J* and the number of effective turns desired on scale *E;* this gives, on scale *A*, the rate per turn. Pass a line through this point on scale *A* and the pitch diameter on scale *F* to find, on scale *K*, the size of wire necessary. The nearest standard size of wire should be taken, but its strength should be found to insure its being strong enough for the purpose. Then pass a line through the size of wire on scale *K* and the pitch diameter on scale *F* to find, on scale *A*, the rate per turn; pass a line through this point and the total rate on scale *J* to find, on scale *E*, the exact number of turns necessary to give the desired rate. If the exact number of turns given must be used, the desired rate may be obtained by varying slightly the pitch diameter; but it is usually more important to keep the given pitch diameter than the given number of turns.

Given Number of Turns, Rate, and Size of Wire to Find Pitch Diameter—On the steel-spring chart, Fig. 2, pass a line through the total rate on scale *J* and the number of effective turns on scale *E;* this gives, on scale *A*, the rate per turn. Pass a line through this point on scale *A* and the size of wire on scale *K* to find, on scale *F*, the pitch diameter required.

Given Rate, Size of Wire, and Pitch Diameter to Find Number of Turns—On the steel-spring chart, Fig. 2, pass a line through the size of wire on scale *K* and the pitch diameter on scale *F;* this gives, on scale *A*, the rate per turn. Pass a line through this point on scale *A* and the total rate on scale *J* to obtain, on scale *E*, the number of effective turns.

Given Spring to Find Rate—Pass a line through the size of wire on scale *K* and the pitch diameter on scale *F;* this gives, on scale *A*, the rate per turn; pass a line through this point on scale *A* and the number of effective turns on scale *E* to find, on scale *J*, the rate of the spring.

Given Spring and Load to Find Deflection—First, find rate of spring; then pass a line through this point on scale *J*, and the load on scale *C;* the resultant deflection is the point where the line intersects scale *G*.

Given Spring to Find Maximum Safe Load—Pass a line through size of wire on scale *K* and pitch diameter on scale *H;* this gives the load on scale *C*. If the chart shown in Fig. 1 is used, the load found will be that which gives a stress of 60,000 pounds; but if the steel-spring chart, Fig. 2, is used, care must be taken to insure that the load found will give a factor of safety of 2. In all cases, scale *H* is to be used when the load, scale *C*, is to be found, and scale *F* is to be used when the rate is desired.

Given Spring to Find Maximum Safe Deflection—First, find rate of spring and its maximum safe load, then pass a line through points on scales *J* and *C* thus found; this gives, on scale *G*, the maximum safe deflection.

Given Load and Pitch Diameter of Spring to Find Size of Wire—Pass a line through the load on scale *C* and the pitch diameter on scale *H;* this gives, on scale *A*, the size of wire required. The nearest standard size of wire should be taken, but its strength should be determined to insure that it is strong enough.

Given Load and Size of Wire to Find Pitch Diameter of Spring—Pass a line through the load on scale *C* and the size of wire on scale *K;* this gives, on scale *H*, the pitch diameter.

Given Spring and Load to Find Stress in Wire—On the chart shown in Fig. 1, find the load for the spring, which is for a stress of 60,000 pounds per square inch. Pass a line through this point on scale *C* and a point marked "steel" on scale *D;* this gives a point on the reference line. Pass a line through this point on the reference line and the actual load on scale *C* gives, on scale *D*, the maximum shearing stress.

Scale *D* consists of several sets of values between 10,000 and 100,000. If the point on the *D* scale just found lies above the first 10,000 point above the "steel" point taken, add a digit to the number given on the scale; if the point is below the first 10,000 point below the "steel" point taken, subtract a digit from the number given on the scale for every 10,000 point passed. For example, if a spring has a stress of 60,000 pounds with a load of 600 pounds, if the load is 1200 pounds the stress point will be above the 10,000 point above the "steel" point used and the stress will therefore be 120,000 pounds and not 12,000. On the other hand, if the load is only 80 pounds, the stress point will be below the first 10,000 point below the "steel" point used and the stress will be 8000 pounds and not 80,000; if the load is only 8 pounds, the stress point will be two 10,000 points below and the stress will be 800 pounds.

Given Load and Deflection to Find Rate—Pass a line through the load on scale *C* and the deflection on scale *G;* this gives the rate of the spring on scale *J*.

Given Rate and Deflection to Find Load—Pass a line through the total rate on scale *J* and the deflection on scale *G;* this gives the load on scale *C*.

Given Load to Find Pitch Diameter and Size of Wire—The combinations of pitch diameter and size of wire that will carry a given load, with a factor of safety of 2, on the steel-spring chart, Fig. 2, will be any points on scales *H* and *K* that fall in a straight line through the load on scale *C*.

Special Directions

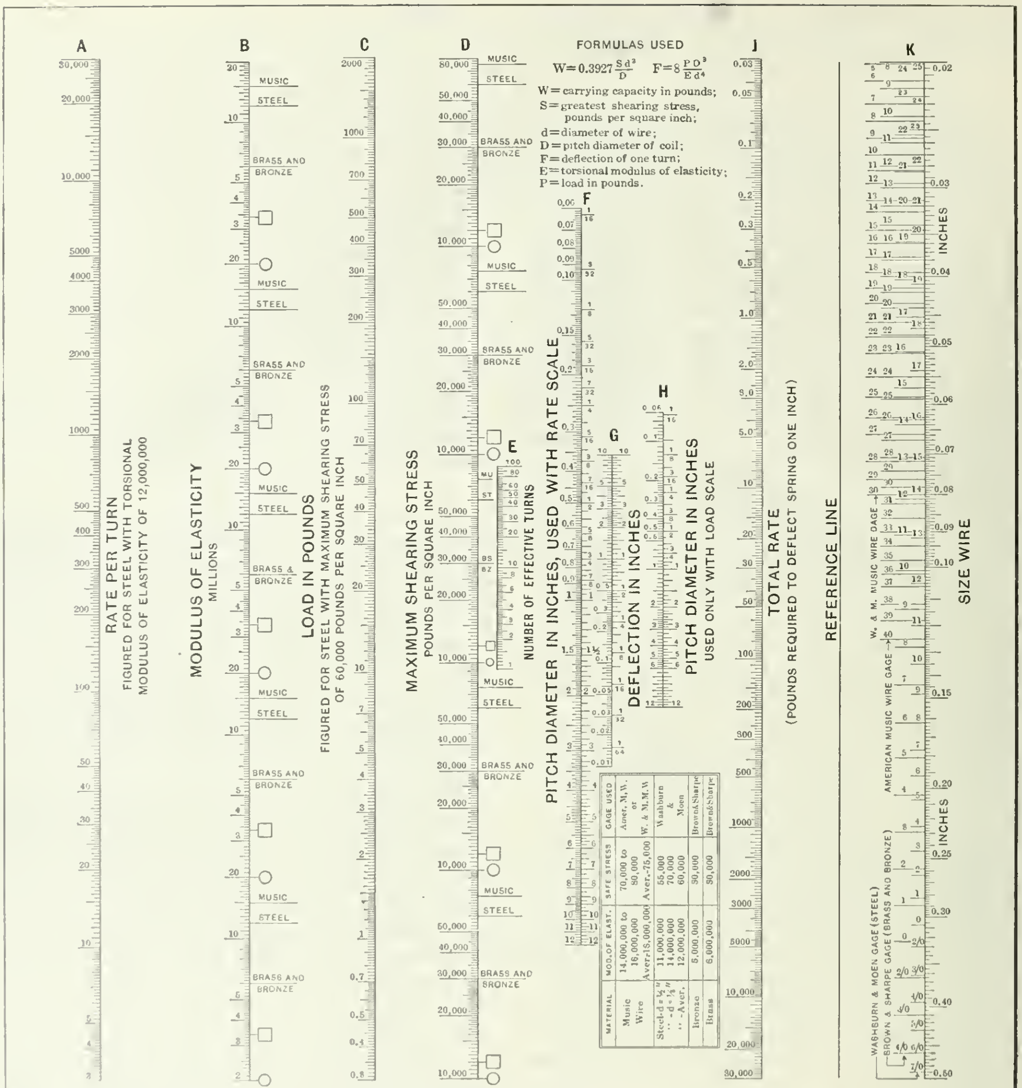
Using Charts for Square Wire—When square wire is used, the load causing a certain stress is 1.2 times the load that will produce the same stress in the same size of round wire; the rate per inch of a square-wire spring is 1.7 times the rate for an identical round-wire spring. Therefore, if the load that will give the same stress as for the same size round wire is desired, it is only necessary to find the load that an identical spring made of round wire will require and multiply by 1.2. This may be done by passing a line through the load for round wire on scale *C* and any circle on scale *D*, finding a point on the reference line. Pass a line through this point and the nearest square on scale *D* to find the desired load for square wire on scale *C*.

If the load is given for a spring made of square wire and other properties of the spring are to be found, it is necessary to find first the equivalent load for the same size round wire. This is done by passing a line through the given load on scale *C* and any square on scale *D*, finding a point on the reference line. Pass a line through this point and the nearest circle on scale *D* to find the equivalent load for round wire on scale *C*. Then proceed as for round wire. It is not necessary to get the equivalent value for round wire when the load and rate of a spring made of square wire are given to find the deflection, though care must be taken to make sure that the rate is given for square wire.

If the rate per inch of a spring made of square wire is given to find other properties of the spring, find the rate per turn on scale *A*, as directed for round wire, and divide this by 1.7 to find the equivalent rate of an identical spring made of round wire. To do this, pass a line through the rate per turn found for the square wire, on scale *A*, and any square on scale *B*, finding a point on the reference line. Pass a line through this point and the nearest circle on scale *B* to find the equivalent rate per turn for round wire on scale *A* and proceed as directed for round wire. If the rate of a spring made of square wire is desired, find the rate per turn on scale *A* for an identical spring made of round wire. Through this and any circle on scale *B* pass a line to find a point on the reference line. Pass a line through this point and the nearest square on scale *B*, to find the equivalent rate per turn on scale *A* for square wire. From this, the total rate of the spring may be found ou scale *J* by passing a line through this point on scale *A* and the number of effective turns on scale *E*.

When using the circles and squares on scales *B* and *D*, the two that are nearest together must be used or an incorrect result will be obtained.

Using Chart Shown in Fig. 1 when other Stresses than 60,000 are Desired—If the spring is given to find the load that will produce some given stress, find on scale *C* the load that will produce a stress of 60,000 pounds. Passing a line through this point on scale *C* and steel point on scale *D*, find a point on the



FORMULAS USED

$$W = 0.3927\frac{Sd^3}{D} \qquad F = 8\frac{PD^3}{Ed^4}$$

W = carrying capacity in pounds;
S = greatest shearing stress, pounds per square inch;
d = diameter of wire;
D = pitch diameter of coil;
F = deflection of one turn;
E = torsional modulus of elasticity;
P = load in pounds.

MATERIAL	MOD. OF ELAST.	SAFE STRESS	GAGE USED
Music Wire	14,000,000 to 16,000,000 Aver.-15,000,000	70,000 to 80,000 Aver.-75,000	Amer. M. W. or W. & M. M. W.
Steel-d = ¼″ ″ -d = ⅛″ ″ -Aver.	11,000,000 14,000,000 12,000,000	55,000 70,000 60,000	Washburn & Moen
Bronze	5,000,000	90,000	Brown&Sharpe
Brass	6,000,000	90,000	Brown&Sharpe

DIRECTIONS FOR USING CHART

Place a straightedge through the known values on two scales to determine a value on a third scale.

Given Rate and Pitch Diameter to Find Size of Wire—Through rate on scale J and approximate number of effective turns on scale E, find rate per turn on scale A; through this point and pitch diameter on scale F, find point on scale K. Through nearest wire size, work back to find number of effective turns needed.

Given Rate, Number of Turns, and Size of Wire to Find Pitch Diameter—Through rate on scale J and number of effective turns on scale E, find rate per turn on scale A; through this point and size of wire on scale K, find pitch diameter on scale F.

Given Rate, Size of Wire, and Pitch Diameter to Find Number of Turns—Through size of wire on scale K and pitch diameter on scale F, find rate per turn on scale A; through this point and rate on scale J, find number of effective turns on scale E.

Given Spring to Find Rate—Through size of wire on scale K and pitch diameter on scale F, find rate per turn on scale A; through this point and number of effective turns on scale E, find total rate on scale J.

Given Spring to Find Deflection—Through total rate on scale J and load on scale C, find deflection on scale G.

Given Spring to Find Safe Load—Through size of wire on scale K and pitch diameter on scale H, find safe load on scale C.

Given Load to Find Pitch Diameter and Size of Wire—Any pitch diameter on scale H and size of wire on a straight line through load on scale C are correct.

Given Spring and Load to Find Stress—Find safe load on scale C at 60,000 pounds stress. Through this point and any 60,000 point on scale D, find a point on the reference line; through this point and the actual load on scale C, find stress on scale D.

Given Load and Deflection to Find Rate—Through load on scale C and deflection on scale G, find total rate on scale J.

Given Rate and Deflection to Find Load—Through rate on scale J and deflection on scale G, find load on scale C.

Square Wire—If rate of square wire is given to find other values, find rate per turn on scale A; through this and any square on scale B, find a point on reference line; through this point and nearest circle on scale B, find equivalent rate per turn for round wire on scale A. If load is given, use scales C and D in a similar manner.

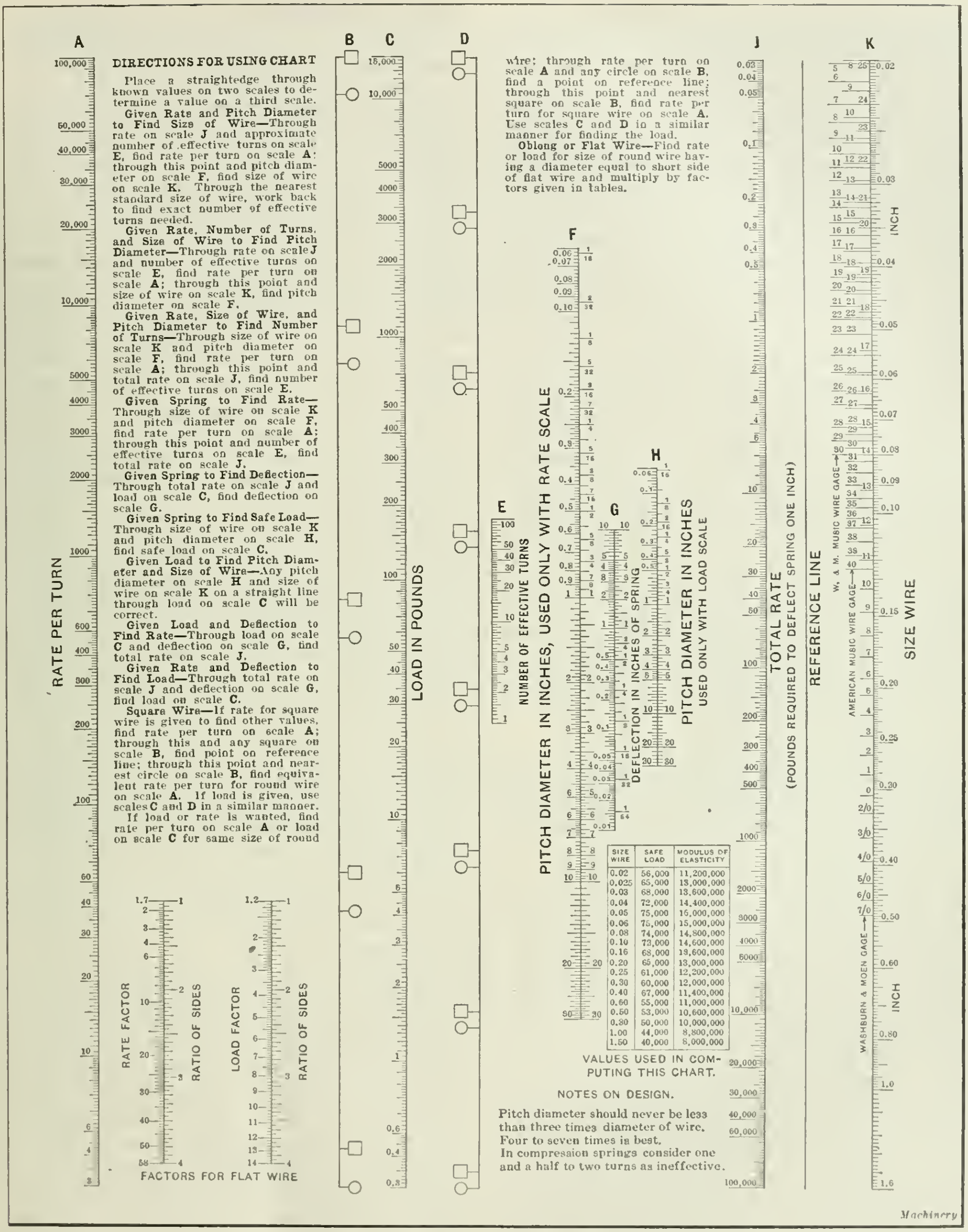
If load or rate is wanted, find rate per turn on scale A and load on scale C for same size of round wire; through rate per turn on scale A and circle on scale B, find a point on reference line; through this point and nearest square on scale B, find rate per turn for square wire on scale A. Use scales C and D in a similar manner for finding the load.

Materials Having Other Stresses or Elasticities than 60,000 and 12,000,000—Get results with these values and find equivalent results with desired values. If load and rate are given, find equivalent load and rate per turn at 60,000 and 12,000,000 and figure as usual. Find equivalent values as directed for square wire, using the desired and given values in the place of circle and square

The pitch diameter of a spring should never be less than three times diameter of wire; from four to seven times is best. In compression springs, consider 1.5 to 2 turns ineffective.

Machinery

Fig. 1. Chart for computing Dimensions and Properties of Helical Springs



DIRECTIONS FOR USING CHART

Place a straightedge through known values on two scales to determine a value on a third scale.

Given Rate and Pitch Diameter to Find Size of Wire—Through rate on scale **J** and approximate number of effective turns on scale **E**, find rate per turn on scale **A**; through this point and pitch diameter on scale **F**, find size of wire on scale **K**. Through the nearest standard size of wire, work back to find exact number of effective turns needed.

Given Rate, Number of Turns, and Size of Wire to Find Pitch Diameter—Through rate on scale **J** and number of effective turns on scale **E**, find rate per turn on scale **A**; through this point and size of wire on scale **K**, find pitch diameter on scale **F**.

Given Rate, Size of Wire, and Pitch Diameter to Find Number of Turns—Through size of wire on scale **K** and pitch diameter on scale **F**, find rate per turn on scale **A**; through this point and total rate on scale **J**, find number of effective turns on scale **E**.

Given Spring to Find Rate—Through size of wire on scale **K** and pitch diameter on scale **F**, find rate per turn on scale **A**; through this point and number of effective turns on scale **E**, find total rate on scale **J**.

Given Spring to Find Deflection—Through total rate on scale **J** and load on scale **C**, find deflection on scale **G**.

Given Spring to Find Safe Load—Through size of wire on scale **K** and pitch diameter on scale **H**, find safe load on scale **C**.

Given Load to Find Pitch Diameter and Size of Wire—Any pitch diameter on scale **H** and size of wire on scale **K** on a straight line through load on scale **C** will be correct.

Given Load and Deflection to Find Rate—Through load on scale **C** and deflection on scale **G**, find total rate on scale **J**.

Given Rate and Deflection to Find Load—Through total rate on scale **J** and deflection on scale **G**, find load on scale **C**.

Square Wire—If rate for square wire is given to find other values, find rate per turn on scale **A**; through this and any square on scale **B**, find point on reference line; through this point and nearest circle on scale **B**, find equivalent rate per turn for round wire on scale **A**. If load is given, use scales **C** and **D** in a similar manner.

If load or rate is wanted, find rate per turn on scale **A** or load on scale **C** for same size of round wire; through rate per turn on scale **A** and any circle on scale **B**, find a point on reference line; through this point and nearest square on scale **B**, find rate per turn for square wire on scale **A**. Use scales **C** and **D** in a similar manner for finding the load.

Oblong or Flat Wire—Find rate or load for size of round wire having a diameter equal to short side of flat wire and multiply by factors given in tables.

SIZE WIRE	SAFE LOAD	MODULUS OF ELASTICITY
0.02	56,000	11,200,000
0.025	65,000	13,000,000
0.03	68,000	13,600,000
0.04	72,000	14,400,000
0.05	75,000	16,000,000
0.06	75,000	15,000,000
0.08	74,000	14,800,000
0.10	73,000	14,600,000
0.16	68,000	19,600,000
0.20	65,000	13,000,000
0.25	61,000	12,200,000
0.30	60,000	12,000,000
0.40	67,000	11,400,000
0.60	55,000	11,000,000
0.50	53,000	10,600,000
0.80	50,000	10,000,000
1.00	44,000	8,800,000
1.50	40,000	8,000,000

VALUES USED IN COMPUTING THIS CHART.

NOTES ON DESIGN.

Pitch diameter should never be less than three times diameter of wire. Four to seven times is best.

In compression springs consider one and a half to two turns as ineffective.

Fig. 2. Chart for computing Dimensions and Properties of Steel Helical Springs

reference line; pass a line through this point and the desired stress on scale *D*, and find the corresponding load on scale *C*.

If the load is given and it is desired to find a spring that will have a certain stress when subjected to this load, pass a line through the given load on scale *C* and the given stress on scale *D*, finding a point on the reference line. Through this point and any "steel" point on scale *D* pass a line and find on scale *C* the load that will stress the same spring to 60,000 pounds and proceed as previously directed.

It will be noted that the stresses ordinarily used for brass, bronze and music wire are indicated on scale *D*. However, as the safe stress and modulus of elasticity for brass and bronze are just half of those given for steel, it is often easier to multiply or divide by 2, as the case may require, than to use the *D* and *B* scales and the reference line. If the desired stress is between 10,000 and 100,000, as is usually the case, it should be read on the *D* scale between the same consecutive 10,000's as the steel point used. If the desired stress is between 1000 and 10,000, add a digit and read between the two 10,000's immediately below the steel point used. If the desired stress is above 100,000, subtract one digit and read between the two 10,000's immediately above the steel point used.

Using Charts for Flat Wire—Either chart may be used for flat wire by using the flat-wire factors given on the steel-spring chart, Fig. 2. If a spring is made of flat wire, find the load or the rate, for an identical spring made of round wire having a diameter equal to the length of the short side of the flat wire. From the tables on the chart, find the rate and load factors for flat wire having the same ratio of sides as that being used and multiply the load for the round wire by this load factor and the rate for the round wire by this rate factor. The results will be the load and rate for the spring of flat wire. If the rate or load is given to find other properties of the spring, divide them by the rate factor or load factor, respectively; the result will be the rate or load for round wire having a diameter equal to the short side of the flat wire. With these values, proceed as for round wire.

Using Chart for Materials having other Modulus of Elasticity than 12,000,000—If the material used in a spring has a modulus of elasticity other than 12,000,000 the only effect on the use of the chart shown in Fig. 1 will be on the rate per inch of the spring and the deflection under a given load. In such a case if the spring is given to find the rate, find the rate per turn on scale *A;* this will be for a modulus of 12,000,000. To find the rate per turn that the spring will have with the given modulus of elasticity, pass a line through the rate per turn found on scale *A* and any steel point on scale *B*, finding a point on the reference line. Through this point and the given modulus of elasticity on scale *B*, find the corresponding rate per turn on scale *A*. A line through this point and the number of effective turns on scale *E* will give the total rate on *J*.

If the rate is given to find other properties of the spring, find the rate per turn on scale *A* by passing a line through the rate on scale *J* and the number of effective turns on scale *E*. Through this and the given modulus of elasticity on scale *B*, find a point on the reference line. Through this and a point marked steel on scale *B*, find the rate of the spring if it had a modulus of elasticity of 12,000,000 and proceed as previously directed.

It will be noted that the modulus of elasticity generally used for brass, bronze and music wire are indicated on scale *B* for convenience. If the modulus of elasticity that is being used is between 2,000,000 and 20,000,000, as will usually be the case, it should be read between the same two 20's as in the steel point used.

Examples for Round Steel Wire

Example 1—Given a spring of No. 14 Washburn & Moen gage steel wire, 0.08 inch in diameter, having 13 effective turns and a pitch diameter of 1/2 inch, to find the safe load, rate per inch, deflection and stress that will be caused by a load of 7 pounds, and the maximum deflection that will be allowable.

On the chart shown in Fig. 2, pass a line through 14 on the Washburn & Moen gage scale on scale *K* and the pitch diameter 1/2 on *H*. On scale *C*, the safe load will be found to be 30 pounds. From the table on the chart the stress used for 0.08-inch wire is 74,000 pounds per square inch. On the chart shown in Fig. 1 pass a line through 30 on scale *C* and 74,000 on scale *D* and find a point on the reference line. Through this point and the load to be imposed, 7 pounds, pass a line; the resultant stress, 17,500 pounds per square inch, is read where this line crosses scale *D* Through the size wire on scale *K* on the chart shown in Fig. 2, and the pitch diameter on scale *F*, pass another line and find its point of intersection with the rate per turn on scale *A*. Through this point and the number of effective turns 13 on scale *E*, pass another line, finding the rate of the spring 47 pounds per inch, on scale *J*. A line passed through this and the load to be imposed, 7 pounds, on scale *C*, gives the deflection that will result 0.149 inch on scale *G* Another line through the rate 47 on scale *J* and the safe load 30 pounds on scale *C* gives the maximum allowable deflection, on scale *G*, of 0.64 inch. Thus the five desired factors concerning this spring are found by the use of seven lines.

Example 2—Find the size of wire required for a spring with a pitch diameter of 2 inches and a load of 300 pounds.

On the chart shown in Fig. 2 pass a line through 300 on scale *C* and 2 on scale *H*, finding on scale *K* the size wire necessary to stand this load to be 0.29 inch. As this is not a standard size for steel wire, either No. 1 or No. 0 Washburn & Moen gage should be used. No. 1 will give a factor of safety of only 1.9, but as a rule, this would be permissible; No. 0, being larger, will of course be safer.

Example 3—A compression spring made of No. 0 wire and having a pitch diameter of 2 inches is compressed to 6 inches by a load of 300 pounds and to 6 5/8 inches by 248 pounds; find the free length of the spring and the number of turns. The difference between 300 and 248, or 52 pounds, is the load required to compress the spring the difference between 6 5/8 and 6 inches, or 5/8 inch. Using the chart in Fig. 2, a line through 52 on scale *C* and 5/8 on scale *G* shows, on scale *J*, that the rate per inch is 85 pounds. A line through this and 300 on scale *C* shows on *G* that the total deflection due to 300 pounds load is 3.6, so the free length of the spring will be $6 + 3.6 = 9.6$ inches. Passing a line through No. 0 on scale *K* and 2 on scale *F* gives the rate per turn on scale *A*. A line passed through this point and 85 on scale *J* gives, on scale *E*, the effective number of turns necessary, which is, in this case, 20.2 turns.

Examples for Round Bronze Wire

Example 4—Given a spring of No. 12 Brown & Sharpe gage bronze wire having 10 effective turns and a pitch diameter of 3/4 inch, to find the safe load, rate, and deflection with a load of 5 pounds.

Using the chart in Fig. 1, pass a line through No. 12 on the Brown & Sharpe gage scale on scale *K* and 3/4 on scale *F;* finding the rate per turn on scale *A* that the spring would have if made of wire having a modulus of elasticity of 12,000,000, which is the average for steel. Through this point and the point marked steel on *B*, find a point on the reference line. Through this point and a point marked bronze on scale *B*, find the rate per turn, on scale *A*, for the spring made of bronze wire. A line through this and 10 on scale *E* gives the rate of the spring on scale *J* to be 7.7 pounds per inch. A line through this and 5 on scale *C* gives the deflection, on scale *G*, for a load of 5 pounds to be 0.65 inch. A line through the size wire on scale *K* and 3/4 on scale *H* gives the load of 16.6 pounds on scale *C*, which will produce a stress of 60,000 pounds. Pass a line through this and a steel point on scale *D*, finding a point on the reference line. A line through this point and a bronze point on scale *D* gives the load of 8.2 pounds, on scale *C*, which will produce a stress of 30,000 pounds.

Example 5—A bronze spring is wanted that will stand a load of 10 pounds and have a rate of 20 pounds per inch with a pitch diameter of 1 inch; find the size of wire and number of turns necessary.

Using the chart in Fig. 1 through 10 on scale *C* and a bronze point on scale *D*, find a point on the reference line. Through this point and a steel point on scale *D*, find the equivalent load for a steel spring, which is 20 pounds. Through this and 1 on scale *H*, find the size of wire necessary, 0.096 inch. Taking the next higher standard Brown & Sharpe gage size, which is No. 10, 0.101 inch as the size to use, pass a line through this and 1 on scale *F*, finding the rate per turn for a spring of the same size of steel wire on scale *A*. Through this and a steel point on scale *B* find a point on the reference line. Through this and a bronze point find the rate per turn for the bronze spring. A line through this and the rate of the spring 20 on scale *J* gives the number of effective turns necessary, on scale *E*, which in this case is 3.9.

In this problem it is, of course, much easier to find the load that a steel spring would carry by multiplying the load of the bronze spring by 2 than by the method described. Also, in finding the number of turns necessary, the problem could have been worked through to conclusion for steel wire, which would give 7.8 effective turns necessary, and this is divided by 2 to get the number for the bronze spring.

Examples for Square and Flat Wire

Example 6—Given a spring made of 1/8-inch square steel wire, 1 inch pitch diameter, and 22 effective turns, to find the safe load and the rate per inch.

In Fig. 2 pass a line through 0.125, on scale *K* and 1 on

H, finding on scale *C* the load of 54,000 pounds, which would be the safe load for steel wire of round section. Pass a line through this and a circle on scale *D*, finding a point on the reference line. Through this and a square on scale *D* find the load of 65 pounds that the spring made of square wire will stand with the same stress. Pass a line through 0.125 on scale *K* and 1 on scale *F*, finding the rate per turn for round wire of that size. Through this and a circle on scale *B*, find a point on the reference line. Through this and a square on scale *B*, find the rate per turn on scale *A* for the square wire. A line through this and 22 on scale *E* shows, on scale *J*, that the rate of the spring is 35 pounds per inch.

In solving for square wire, the process is the same as in solving for some other material than steel, except that the circles and squares are used instead of the points marked steel and the desired values of stress and modulus of elasticity.

Example 7—Given a spring made of 1/8-inch by 3/8-inch flat steel wire, 1 inch pitch diameter, and 22 effective turns, to find the safe load and the rate.

Find the load for round wire as explained in Example 6, which is 54 pounds. The tables on the steel-spring chart, Fig. 2, give 8.1 as the load factor for wire having a ratio of sides of 3. Multiplying 54 by this gives, as the safe load for flat wire, 437.4 pounds. The rate per inch of a spring made of 1/8-inch round wire, in this case, would be 22.6 pounds. The flat-wire tables give the rate factor for wire having a ratio of sides of 3 as 25.8, so the rate of the flat-wire spring will be 25.8×22.6=583.1 pounds per inch.

* * *

HEAT-TREATMENT OF GRAY CAST IRON[1]

The rapid deterioration of cast-iron cylinder components, the liner, piston, and valve chambers, is a subject of vital importance to the internal combustion engine manufacturer. Frequently those components that are subjected to the direct influence of heat, crack and become utterly useless after a short life. This troublesome cracking is most pronounced in the cast-iron piston heads of Diesel engines.

The temperature that the center of the piston heads sustains during working is very high. In the ordinary four-cycle gas-engine, working at full load, the center of the head is at a dull red glow, approximately 650 to 700 degrees C. In the Diesel engine the flame, resulting from the spontaneous ignition of the charge, is driven directly against the center of the piston head so that the temperature of the inner surface in the center of the piston head (directly in line with the fuel admission valve) is at least 900 to 950 degrees C. The characteristic star cracks produced in Diesel engine piston heads after short periods of use, in many instances, can be traced to mechanical defects, such as bad design, defective cooling arrangements, etc., which tend under the influence of heat to set up unequal stresses in the material. As the strength of gray cast iron rapidly falls off with increasing temperatures, the influence of unequal stresses due to mechanical or other defects will be considerably more pronounced. The only change indicated by the analyses of cracked Diesel engine pistons is that the combined carbon is practically wholly converted into free or graphitic carbon. There appears to be no indication of oxidation of the carbon or silicon contents.

Tests on gray cast-iron bars show that at a temperature of 750 degrees C. practically all the combined carbon is rapidly converted into the free carbon form and that slow cooling is not a necessary factor in the dissociation of the pearlite. These tests also show that temperature between the limits of 750 and 900 degrees C. has little influence on the rate of decomposition, nor does there appear to be any influence exerted by the varying phosphorus content. Samples of gray cast iron heated to between 900 and 950 degrees C. for varying periods of time and quenched in water, showed that a portion of the free carbon had been reabsorbed. This reabsorption of free carbon is most important, both from a practical and a theoretical point of view.

A photomicrograph of a part of the piston that has been directly subjected to the influence of heat shows an enormous increase in the dentritic structure, and the whole of the matrix appears to be intersected by graphite plates. Near to the extreme upper edge of the piston, directly in contact with the flame, the extent of the dentritic structure is much less, and the matrix appears to be dotted with many more finely divided graphite plates; there also seems to be numerous small holes. It is probable that each individual bead or globule of cementite dissociates, depositing tiny flakes of graphitic carbon, and no doubt while some of these flakes appear to be drawn alongside the pre-existing plates of graphite, the internal pressure consequent upon the increase in volume of these newly formed free carbon plates tends to press these small flakes together, producing the numerous larger plates of free carbon. It is probable that the swelling of the graphite plates, or rather the replacement of these plates by holes, is in some manner connected with the reabsorption of the free carbon.

In all the heat-treated samples, the worm-like graphite forms appear to have swollen and become somewhat thicker. Undoubtedly this circumstance exerts a great influence on the weakening of the cast iron after subjection to heat and its consequent fracture. It is legitimate to conclude that as a result of these internal changes, which take place only in a localized portion of the piston top, the iron is rendered considerably weaker, and the slight volume changes that undoubtedly accompany these changes are responsible for a condition of internal strain. Under the conditions obtaining in the Diesel engine cylinder such a state of affairs will rapidly lead to fracture.

It has been found, as a result of long experience, that the ultimate cracking of Diesel engine piston tops, apart from those cases of mechanically defective pistons, can as a general rule be traced to the phosphorus content of the cast iron. By reducing the phosphorus content of the cast iron to the lowest possible limits, the life of the pistons may be considerably prolonged and the cracking practically eliminated.

* * *

THE LIBERTY MOTOR

When the Congress declared that a state of war existed between the United States and Germany, there was immediate general recognition of the importance of the airplane, and steps were taken to build a large number for the Army and Navy. The Liberty motor was the outcome of the effort to secure a composite design in which the best ideas of the motor builders of the United States were incorporated. Its advent was announced with a flourish of trumpets, but no details of the mechanical design were furnished for publication. Now we are informed that the Liberty motor is not quite as near perfection as at first believed, but is considered suitable only for scout duty and other comparatively minor air work. Thousands of dollars have been expended in the effort to build the Liberty motor with the utmost possible speed, and the discovery that it is not the equal of the best European motors comes as a disagreeable shock to the American people.

This unhappy development is one of the logical outcomes of secrecy and censorship. Had the design of the Liberty motor been published in the technical journals the government officials would have had the benefit of the constructive and destructive criticism of hundreds of engineers throughout the country. The effect of these criticisms that would have been leveled at the design could not have been anything else but beneficial. One important factor would doubtless have been better taken care of than it is, and that is the design of the motor as regards manufacture. It has been found by tool engineers having to solve the problem of tooling for rapid and efficient manufacture that in many cases the design could be modified with no resulting injury but with great improvement in the speed and ease of machining.

Secrecy is a firmly established war policy, but, so far as we can judge, it serves chiefly one purpose, and that is to keep the common people of the country in ignorance of conditions. The German military authorities doubtless know practically everything of military importance transpiring in this country. Their agents and spies are not dependent upon the daily and technical press as sources of information

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[1] Abstract of a paper by J. E. Hurst, read before the Iron and Steel Institute of Great Britain, September, 1917.

SCREW MACHINE TOOL EQUIPMENT—3

TOOL EQUIPMENT AND ATTACHMENTS FOR THE GRIDLEY MULTIPLE-SPINDLE AUTOMATIC SCREW MACHINE

BY DOUGLAS T. HAMILTON[1]

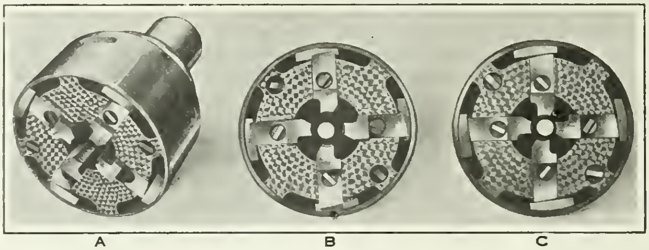

Fig. 28. National-Acme Automatic Die used on Gridley Automatics, shown Assembled and in Open and Closed Positions

Fig. 28 shows the National Acme self-opening or automatic die-head, which can be applied to the Gridley automatics in the manner illustrated in Fig. 25, which appeared in the December number of MACHINERY. *A* shows the die-head closed and assembled, whereas *B* and *C*, respectively, show the die-head in detail open and closed. The chasers, as shown in Fig. 29, are arranged to slide in slots in the body, and are held in place by plates, to which they are fastened by screws, the plates fitting in the T-slots in the body. These chasers are closed by the action of the cam ring, the body being pulled back into the hood, thus bringing the chasers into contact with the bearing arms of the cam ring. Variations in diameter of the threaded part are secured by means of an adjusting screw operating on the principle of a micrometer and located in the side of the head.

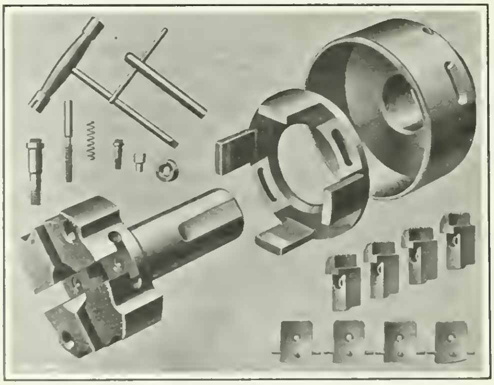

Fig. 29. Die-head shown in Fig. 28, dismantled to show Construction

Spring Screw Threading Dies

Spring screw threading dies are also used on the Gridley automatics, and are to be preferred to button or round dies, if properly handled, because of the possibility of securing more accurate adjustment. The cutting lands are wide, giving adequate support to the cutting edges and insuring the cutting of a thread to correct lead. They are, in addition, easier to sharpen, and have more chip room than a button die.

Sharpening Spring Screw Threading Dies

There are several points in connection with the sharpening of spring screw threading dies that should be closely observed. These have particular relation to the location of the cutting edges of the prongs relative to the center, and to the equal contraction of the prongs when adjustment for diameter is necessary.

For cutting steel, as shown at *A*, Fig. 31, the cutting edge of the die should be set ahead of the center, the amount being governed by the diameter of the part being threaded and the pitch of the thread. It is generally about one-tenth the diameter, although to provide for resharpening it may be a little more. The setting of the cutting edge ahead of the center gives a freer and cleaner cutting action. The faces also are set at a certain angle with reference to the radius of the thread, and in future grinding this relation should be preserved. At *C* is shown a spring screw die that is improperly ground; the proper face angle has not been preserved. Of course, all lands must be ground to the same angle and at the same distance ahead or back of the center, as the case may be.

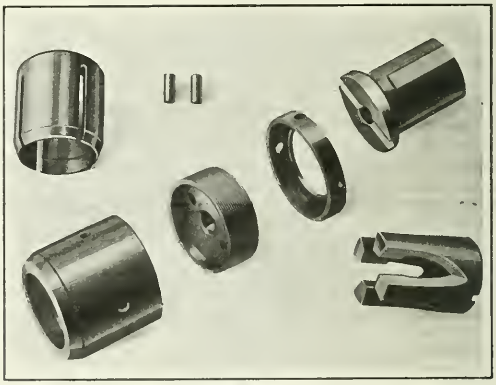

Fig. 30. Spring Screw Threading Die-holder shown in Fig. 34, dismantled to show Construction

For brass, as shown at *B*, the cutting edge of the prongs should be set exactly on the center, or a little behind it. When new, the cutting edge is set on the center, which allows for resharpening without impairing the cutting action of the die.

At *A*, Fig. 32 is shown the correct form of grinding wheel for sharpening spring screw threading dies when grinding on the face of the lands or prongs. It is known as a "dished" wheel and should be of a coarse enough grain and soft enough bond not to burn the die. It is preferable to grind dry, taking light cuts. The die should be held in a fixture provided with an accurate indexing head so that all prongs will be ground in the correct relation to the center.

It is seldom necessary to grind a spring die in the throat—that is, where the first few threads are chamfered to facilitate the die starting on the work. When this is necessary, however, the grinding should be carefully done and the proper wheel, which is shown at *B*, should be used. This wheel, which is cone shaped, is used to grind each prong separately, and care should be taken to see that all prongs are ground to the same angle and also to the same depth. If the angle or depth varies on the different prongs, the work is thrown onto two lands, with the result that

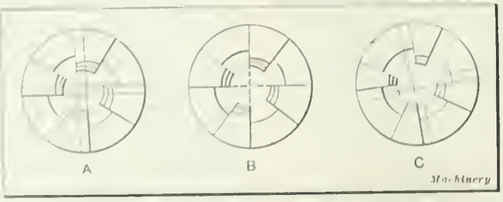

Fig. 31. Diagram showing Correct and Incorrect Methods of sharpening Spring Screw Threading Dies

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[1] Address: 47 Windsor Ave., Springfield, Vt.

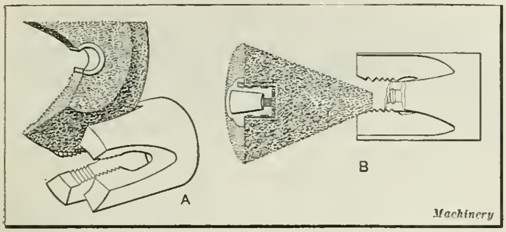

Fig. 32. Diagram showing Grinding Wheels used, and Methods of sharpening Spring Screw Threading Dies on Faces of Lands and in Throat

each prong does not perform its share of the work. If considerable grinding is done in the throat, and particularly if there is a shoulder on the piece to be threaded, a corresponding amount should be ground off the ends of the prongs to allow the die to cut up on the work to the required distance.

Another point that should receive careful attention is the position of the spot on the die for the set-screw in the holder. In the case shown at *A*, Fig. 33, the flat for the set-screw has been placed so that tightening the screw closes one of the prongs, thus throwing most of the cutting onto one land. Instead, the spot should be located between two prongs, as shown at *B*, and it should be small enough so that it will not weaken the die. It is preferable not to have any flat at all, but to use a cupped set-screw, which will effectively prevent the die from turning.

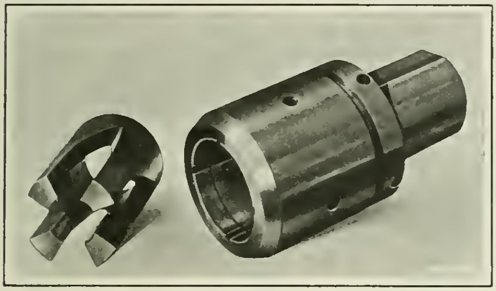

Fig. 34. National-Acme Collet Type Spring Screw Threading Die-holder

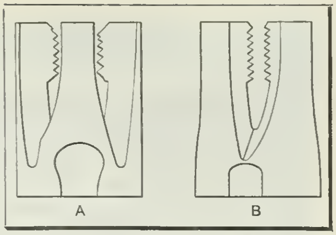

Fig. 33. Incorrect and Correct Methods of spotting Spring Screw Threading Dies for Set-screw

In order to overcome the objection of improper clamping, the National Acme Co. has designed a special die-holder, illustrated in Fig. 34. This holder, shown disassembled in Fig. 30, comprises a shank on which the die-holder is retained by a locking nut. The spring screw die is held in an adjustable spring chuck that is effectively closed on the die by a collet that fits over it. A good feature of this holder is that it allows the die to float and thus accommodate itself to the work; in addition, it is not driven by a set-screw clamped onto its exterior surface but by two pins fitting in slots in the end of the die. This holder holds spring dies accurately and prevents the troubles usually experienced with dies of the spring variety.

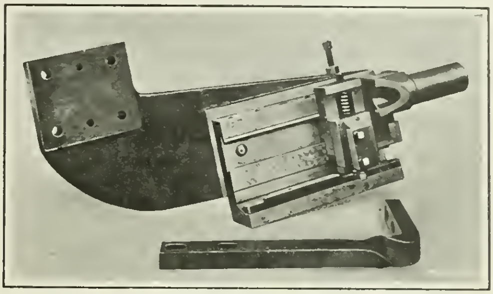

Fig. 35. Taper-turning Attachment for Gridley Multiple-spindle Automatics

Speeds for Threading

The speed of threading is determined by the type of die, material from which it is made, material being threaded, diameter and pitch of threaded part, and the cutting lubricant or coolant used. For die-heads of the chaser type, it is customary to use chasers made from high-carbon steel for threading cold-rolled steel or screw stock, Bessemer open-hearth steel, 3 to 5

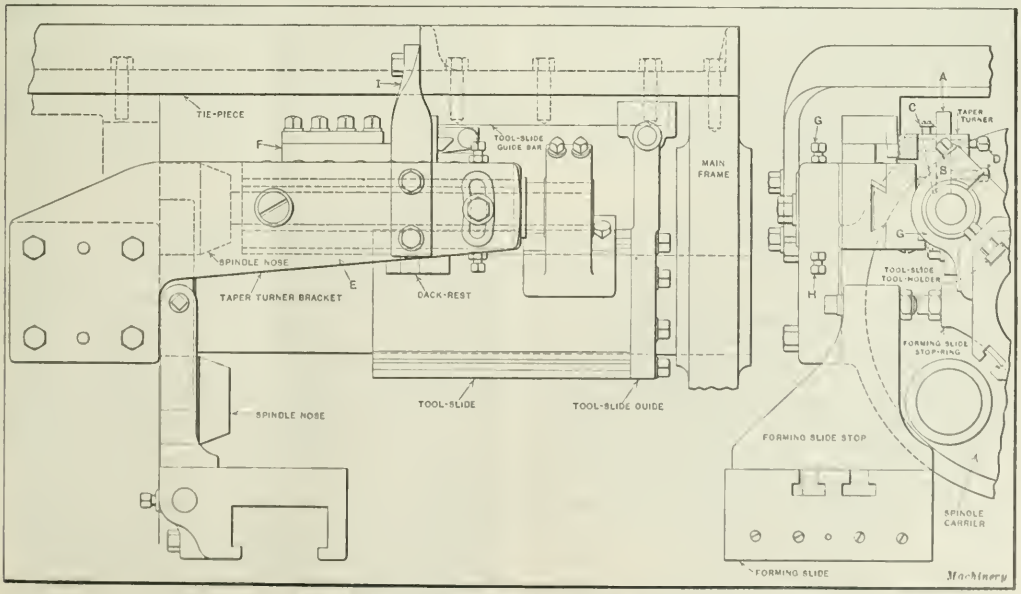

Fig. 36. Details of Taper-turning Attachment shown in Fig. 35

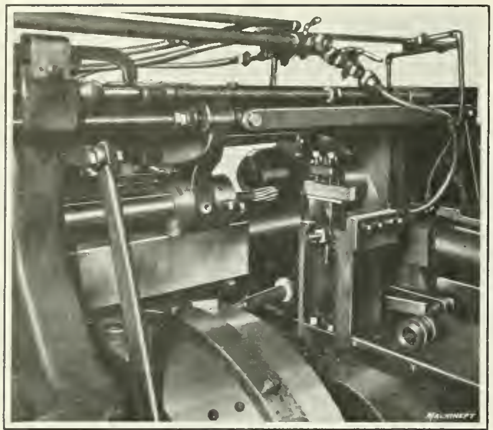

Fig. 37. Threading Mechanism being used for Accelerated Reaming

per cent nickel steel when of low-carbon content, malleable iron, brass, bronze, and similar alloys. With these chasers a cutting speed of thirty feet per minute is generally found to be satisfactory. The question of cooling the work and the chasers, however, sometimes makes it necessary to reduce the speed somewhat; whereas on pitches below twenty threads per inch, it is possible to increase the speed 20 per cent.

It is advisable to use chasers made from semi- or high-speed steel when cutting chrome-vanadium steel, tough alloy steels, cast iron, drop-forgings, and all other heat-treated steels. Under average conditions a cutting speed of twenty feet per minute will be found satisfactory; in the case of especially fine pitches, though, it may be possible to increase the speed from 20 to 50 per cent and still obtain a good clean thread, without danger of damaging the chasers. For spring screw dies, the speed of threading is generally equal to that of the chasers, although in some cases the conditions are such that a high speed is inadvisable.

Die-spindle Used for Accelerated Reaming Attachment

When it is necessary to ream a hole which is of a depth greater than the maximum travel of the tool-slide, the die-spindle in the third position, see Fig. 37, can sometimes be effectively used for this purpose. As has been previously stated, the die-spindle is independently driven and is advanced toward the work, to start the die, by a cam located on the edge of the drum carrying the cam for the operation of the stock feed. By changing the shape of the die-spindle cam and substituting one having the required throw, the die-spindle can be advanced to the required distance. When used for accelerated reaming, the die-spindle is not revolved, but is simply moved back and forth by the special cam.

Taper-turning Attachment

In the production of taper pins and similar work, when the length of the taper is too long to be produced by means of a forming tool, it is necessary to use a taper-turning attachment. The standard type of taper-turning attachment used on the Gridley automatics is shown in Figs. 35 and 36. This attachment, as shown in Fig. 36, consists of a bracket or arm *E*, which is fastened by bolts to the main frame of the machine, at the work-spindle end, and carries a slide that can be set to the required taper. The taper-turning tool proper is provided with a roll that works in a holder which is held in a standard holder clamped to the tool-slide in the regular manner. The taper-turning tool-holder carries a turning tool *A*, which is of the radial type and is adjusted for height, relative to the center of the work, by a taper wedge *B* and a collar-head screw *C*. The turning tool is rigidly clamped by two set-screws *D*.

The bracket *E*, which carries the taper guide holder *F*, has a dovetail groove cut in it in which the taper-turning tool-holder is retained by means of an adjustable gib, as shown in the end view. This guide can be swung to the desired angle by operating the screws *G* and *H*, which are provided with lock-nuts. The support for the work consists of a fixture with two rolls traveling on the work just ahead of the turning tool. This is the same holder that is used in the first position to support for forming, and is provided with a turning tool to remove a chip sufficient to give the rolls a smooth travel. The holder carrying the turning tool is operated against the tension of a spring, and on the return stroke the tool is relieved from the work, to obviate the production of the mark generally produced by a returning tool that is in contact with the work. This taper-turning attachment can only be used in the second position.

* * *

SWELLING OF ZINC BASE DIE-CASTINGS[1]

The National Cash Register Co. has had the die-casting process in operation for several years, and many parts have been produced in zinc base metal. The Cuban office complained against these castings, claiming that the metal swelled and caused trouble by binding. The castings causing most of the trouble were type wheels. These wheels have a hub casting on one side, with a recess on the other in which the hub of the next wheel runs. The dies gave 0.001 inch play between the hub and recess, and this allowance had always been sufficient for the machined bronze wheels which had been in satisfactory service for many years. It seemed incredible that this alloy should swell after having been die-cast and carefully inspected with gages, so twelve type wheels were carefully measured at four points on each wheel, and six of these were sent to the Havana office, while the other six were kept at the factory. Six months later the wheels were returned and remeasured. The results were that the wheels sent to Havana swelled 0.007 inch, while those held at the factory swelled 0.0017 inch. Tests were then conducted at various temperatures, resulting in greater swelling at higher temperatures in moist air.

The following lines of investigation were followed up to determine the cause of the swelling:

1. The effect of casting temperature.

The casting temperature was varied between wide limits. This did not have any influence on the annealing.

2. The effect of casting pressure.

The pressure was varied from 15 pounds per square inch to 200 pounds per square inch without changing the tendency to swell.

3. The effect of swelling.

Castings were annealed at various temperatures in ovens and oil baths. They were given different rates of cooling, but this did not overcome the difficulty.

4. The effect of oxidation.

Oxidation was prevented by nickel-plating and by lacquering. This procedure did not eliminate the swelling.

The effect of changes in the composition of the alloy was then tried. The zinc base alloy which was used for the casting work analyzed as follows: copper, 5.5 per cent; tin, 7.5 per cent; aluminum, 1 per cent; and zinc, 86 per cent. The first change was a decrease of the copper content. It was found impracticable to reduce the copper below 3 per cent. However, this reduction did not reduce the swelling tendency. The fact that certain aluminum alloys after a time fail by cracking and warping suggested trying the effect of different percentages of aluminum. Three alloys were made and compared with the regular metal. These alloys were cast into type wheels for comparison. In a test in moist atmosphere at 176 degrees F., the regular metal containing 1 per cent aluminum swelled 0.020 inch on a 2-inch diameter, while an alloy containing 0.1 per cent aluminum swelled 0.003 inch. These figures are averages of readings on six different wheels at four points on each wheel. The results showed conclusively that the reduction of the aluminum to 0.1 per cent practically eliminated the swelling. The analysis of this alloy was: copper, 3; tin, 7.5; aluminum, 0.1; zinc, 89.4 per cent. If the regular metal is run into pigs and allowed to cool slowly, as in standard foundry practice, no swelling will take place. This has been demonstrated on a cube which has been kept in a moist atmosphere at 98 degrees F. for over two years.

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[1] Abstract of an article by H. M. Williams, Chemist and Engineer of Tests, National Cash Register Co., published in the Journal of the American Institute of Metals, September, 1917.

LETTERS ON PRACTICAL SUBJECTS

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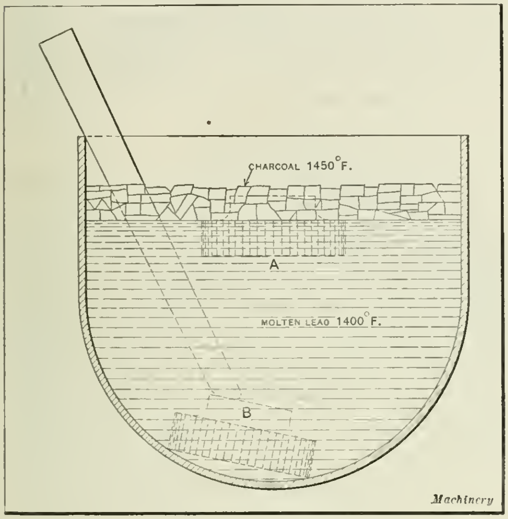
CAUSE OF GEARS WARPING WHEN HEATED IN MOLTEN LEAD

The illustration shows a lead pot in which gears are being heated in lead, with charcoal covering the molten metal. If the lead is kept at 1400 degrees F., the charcoal will be 1450 degrees F. The gear will float on top of the metal as shown at *A;* consequently the bottom becomes hot much quicker than the top, but before the gear is ready to be taken out and quenched the top will be the hotter. If the gear is forced to the bottom of the lead pot and held there by a weight, as shown at *B*, the gear becomes strained and warped. The fact is that a gear cannot remain true if heated in lead, cyanide or any molten baths, because they heat too quickly. The outside of the gear is 1400 degrees F. before the core or inside is even red, and unless a gear, or any piece of steel, is heated slowly so as to allow all sections to heat alike, it is bound to distort and lose its shape.



Gears being heated in Lead Pot

Lansing, Mich. J. F. SALLOWS

ERROR IN WIRE METHOD OF MEASURING WORM THREADS

Screw threads, worm threads, threaded plug gages, taps, etc., have for many years been measured by the three-wire method, which is ideal for checking the correct pitch diameter, and the angle of inclination for the walls of the thread. If any degree of accuracy is required, it is necessary that the diameter of the wire be correct to 0.0001 inch and that the exact reading be known. It is desirable for the wires to come tangent at the pitch circle, but in the case of worm threads they are often calculated to come just flush with the top of the thread. This brings the points of tangency just below the pitch circle, but it decreases the chances of making an error when taking the reading. The illustration shows a section through a worm thread taken parallel to the axis of the worm, showing a circle that comes tangent at *B* and is flush with the top of the thread, the points *B* coming just below the pitch line. From the formula for a standard worm thread the space at the top of the thread equals 0.665*P*. Hence the diameter of the circle is: 2 (0.3325*P* tan 37 degrees 45 minutes = 0.5149*P* = 0.5149 divided by the number of threads per inch.

In our best handbooks are found several tables of wire sizes for measuring threads that were computed from the above formula, and while this formula is correct for a circle or for a knife-edged disk placed parallel to the axis of the thread, it cannot be used for a wire unless the wire is to be used in a groove cut at right angles to the axis without any spiral whatsoever. Every thread, no matter how slight the lead, must form a series of spirals and every spiral must have an angle to the axis. Unless these angles are considered, a correct reading over three wires is impossible. The error may be slight for fine threads or for large diameters, but it increases rapidly as the angle of the spiral becomes greater than 2 degrees. As an example, consider the worm shown in the illustration to have 1¼ inch linear pitch, 3.8 inches pitch diameter, 4.596 inches outside diameter. From any handbook select a wire size that is supposed to come flush with the top of a standard 29-degree worm thread, 4/5 threads per inch, or figure the size from the formula given above, and the result is 0.6436 inch diameter. If this wire is laid in the groove of a finished worm, it does not cross the axis at right angles but is inclined an amount equal to the angle of spiral *C* formed by the worm on which the points of contact *A* fall. The tangent of this angle equals pitch of thread divided by 3.14159 times diameter of circle on which points of contact *A* fall, or in this case about 6 degrees. The length of the chord *B-B* equals cos 14 degrees 30 minutes × 0.6436 = 0.6231 inch. The length of the chord *A-A* equals cos 6 degrees × 0.6231 = 0.6196 inch. This means that if the walls of the worm are reduced until the 0.6436 inch diameter wire will come flush with the top of the thread, the walls of the tooth

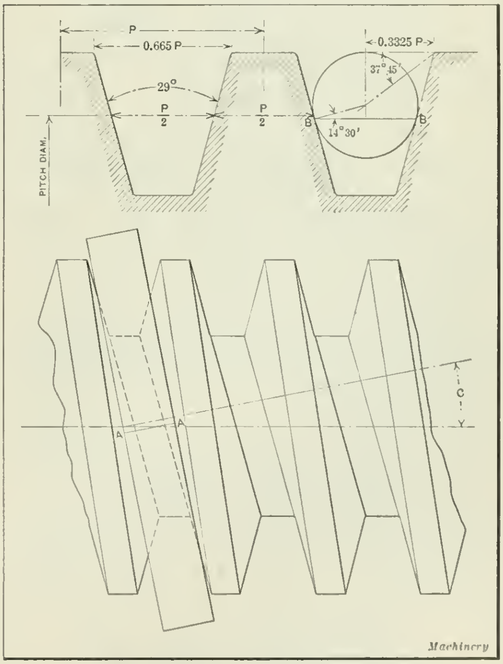
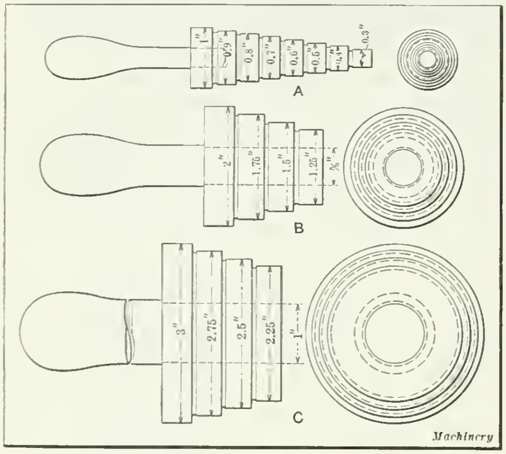


Diagram showing Error in measuring Worm Threads will be 0.0035 inch too thin. This error becomes greater as the angle of the spiral increases.

Philadelphia, Pa. **Howard H. Wright**

MICROMETER TEST GAGES

It is the work of the writer to inspect and adjust micrometers to get uniform and accurate results. For this purpose he has designed the test gages shown in the illustration, which have been found helpful. In testing with pin gages, the pin often expands, due to the heat of the hand, thus giving a false test. These gages were rough-turned, hardened and ground to within 0.005 inch, and seasoned for a period of six months to insure retention of size and shape. They were then finished, ground and measured on a Pratt & Whitney precision measuring machine. The gage *A* was made to standardize in tenths of inch, from 0.3 to 1 inch, and *B* and *C* to standardize in quarters of an inch, from 1.25 to 3 inches. The handles are made of wood to reduce the weight, but, if desired, the gages could be made in one piece.

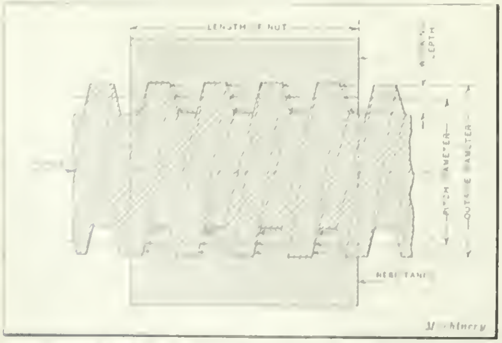


Convenient Gages for testing Micrometers

Frequently the lead of a micrometer screw will vary as much as 0.0003 inch, and these gages are extremely useful in detecting such a condition. In large shops where micrometers are issued from the tool-cribs, there is always danger of sending the micrometers out unfit for accurate work, and here these gages are invaluable.

Willow Grove, Pa. **Harry Crowther**

FINDING EFFECTIVE BEARING AREA OF ACME SCREW THREADS



Effective Bearing Area of Acme Screw Threads

TABLE FOR FINDING EFFECTIVE BEARING AREA OF SCREWS

Threads per Inch	Single Working Depth, Whole Depth Minus 0.01 Inch, Inch	Projected Bearing Area per Thread at One Inch Pitch Diameter, Square Inch	Projected Bearing Area per Inch C at One Inch Pitch Diameter, Square Inch	Threads per Inch	Single Working Depth, Whole Depth Minus 0.01 Inch, Inch	Projected Bearing Area per Thread at One Inch Pitch Diameter, Square Inch	Projected Bearing Area per Inch C at One Inch Pitch Diameter, Square Inch
1	0.5000	1.6480	1.6480	5	0.1000	0.3148	1.5740
1⅓	0.3750	1.2108	1.6144	6	0.0833	0.2620	1.5724
1½	0.3333	1.0702	1.6053	7	0.0714	0.2245	1.5718
2	0.2500	0.7952	1.5905	8	0.0625	0.1965	1.5720
3	0.1667	0.5266	1.5798	9	0.0555	0.1744	1.5700
4	0.1250	0.3938	1.5755	10	0.0500	0.1571	1.5715

Machinery

It frequently becomes necessary to obtain the pressure per square inch on Acme screw threads; the accompanying table has been arranged to reduce to a great extent the figuring required in finding the bearing area. The projected bearing surface for the various threads per inch has been calculated for nuts of unit dimensions (one inch pitch diameter and one inch long); therefore, to obtain the effective bearing surface for any nut it is merely necessary to multiply the value given by the pitch diameter of the screw and by the length of nut. Stated as a formula:

$$A = (D - W)\,LC$$

in which A = effective bearing area;

D = outside diameter of screw;

W = working depth of thread;

L = length of nut;

C = projected bearing area per inch of screw.

The projected area per thread and the working depth of the tooth are also given for convenience.

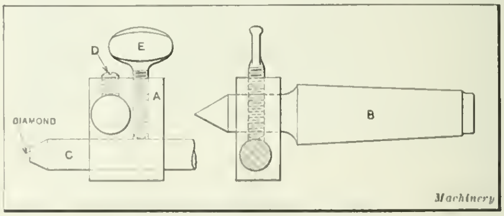
Example—Find the effective bearing area of an Acme screw that has an outside diameter of 3¼ inches, 1½ thread per inch, and works in a nut 6 inches long. The table shows that the working depth W of a screw having 1½ thread per inch is 0.3333 inch and that the projected bearing area per inch C is 1.6053. Substituting these values in the formula given:

$$A = (3.25 - 0.3333) \times 6 \times 1.6053 = 18.4277 \text{ square inches.}$$

Philadelphia, Pa. **Harry S. Kartsher**

HANDY DIAMOND HOLDER

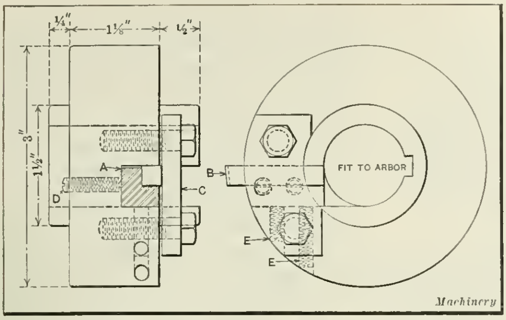
The device here shown will be found very satisfactory for holding the diamond when truing the face of wheels in a universal grinding machine. *A* is the holder, *B* is the tailstock center, and *C* is a piece of round stock in which the diamond is set. The holder is held in position by the set-screw *D* while the thumb-screw *E* serves to secure the diamond in position when needed. With this device, it is possible to true up the wheel without removing the work. S. C.



Device for truing Wheel of Universal Grinder

FLY CUTTER ATTACHMENT FOR MILLING MACHINES

In the accompanying illustration is shown a tool-holder attachment that will be found especially useful in cases where there are a number of different forms to be milled but no milling cutters of the desired shapes on hand. Special arbors are not required, the tool-holder being mounted on the same arbor as the milling cutters. The tool-holder shown is made to fit a one-inch standard arbor; but for large, heavy work, a holder six inches in diameter should be made. With holders of both these sizes, many different classes of work can be done. The tool *B* is placed in the reducing sleeve *A* and is set against



Fly Cutter Attachment for Milling Machine

the arbor, to prevent its slipping backward. By means of the reducing sleeve, any tool up to one-half inch can be used. Strap *C* holds the tool in place, while it can be set by two screws *D*. Screws *E* take all lost movement out of the reducing sleeve *A* and also serve as binding screws.

Ambridge, Pa. **August J. Lejeune**

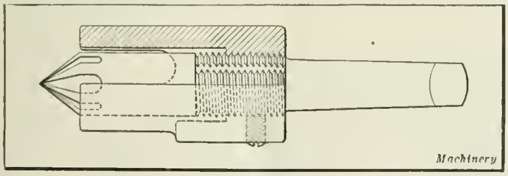
GEAR CUTTING ON SLOTTING MACHINE

The writer desired to cut a spur gear with 49 teeth, 2 diametral pitch, but as he had no cutter for that pitch, it was impossible to do the work on a gear-cutting machine, so the gear blank was mounted on a slotting machine. The shaft that revolves the slotter table was then turned until the table had made one complete revolution, and the ratio was 146:1. As there were 49 teeth to be cut, 2 48/49 turns of the crankshaft were required for the correct spacing. The worm-shaft of a dividing head was then connected with the crankshaft, and by using the circle with 49 holes, the correct spacing was easily obtained. By the use of Grant's odontograph table, the outline of a tooth for a 49-tooth, 2-pitch gear was drawn, and from this a gage was made for grinding the finishing tool. This method produced a gear satisfactory in every way.

Washington, D. C. **William F. Grover**

STOP-COLLAR FOR COUNTERSINK

The illustration shows a stop-collar that may be of interest to the readers who design or use counterbores, boring and facing bars, or countersinks. By milling slots in the stop-collars the chips can readily escape, and friction is reduced when the collar strikes the work; there is also less danger of the tang of the countersink shearing off, due at times to the operator forcing the stop-collar against the work. The slots in the countersink are milled slightly beyond the depth of the thread, and the number of slots depends upon the diameter of the countersink and the size of set-screw used. A practical adjustment is assured if the distance between the slots is uniform.



Slotted Stop-collar mounted on Countersink

Covington, Ky. **Frank Lang**

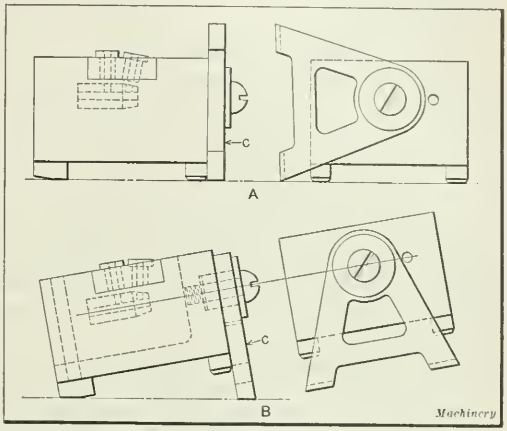
TO PREVENT LOOSENING OF TAPER SHANK DRILLS AND COLLETS

When the taper shank of drills or the surface of drill collets becomes worn and scored, it is difficult to make them stick in the drilling machine spindle. Sometimes rubbing a little chalk on them helps greatly. When this fails, as it will on work where the drill is likely to "dig," the drill or collet can be securely held by rubbing it with a piece of waste moistened with turpentine. It will be found that even the hardest service will not loosen them. In fact, the only way the drill or collet can then be removed is by using the drift.

East Walpole, Mass. **James A. Kirk**

JIG FOR STRAIGHT AND ANGULAR DRILLING

The writer designed the jig shown in the illustration for drilling two holes, one of which was on an angle. By the use of this jig, the operator can bring the jig quickly into the correct position for drilling the two holes. When drilling the straight hole, the jig is in the position shown at *A*, and when the operator wishes to drill the angular hole, he simply lifts the front of the jig, and the swinging leg *C* falls down, thus bringing the jig into the position shown at *B*, and placing the hole to be drilled in a line with the drill. By using this jig, extra parts, such as a cradle or angle-block, are eliminated.



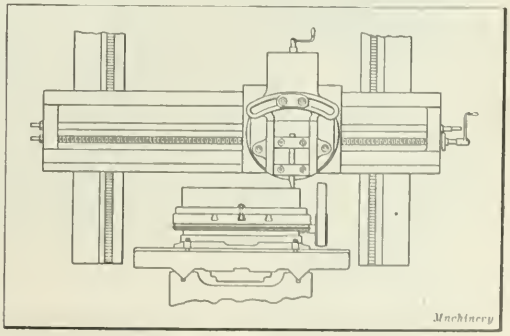
(A) Jig in Position for drilling Straight Hole. (B) Jig in Position for drilling Angular Hole

Hartford, Conn. **James W. Boyce**

USING PLANER AS BORING MILL

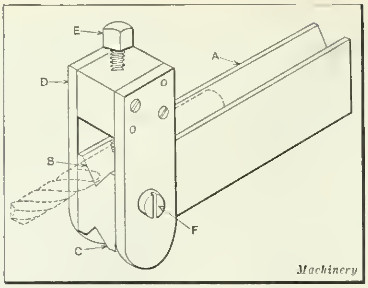
Some time ago it was necessary to do a large boring mill operation in a shop where a boring machine was not available. The illustration shows the method used in doing the work. A revolving milling machine table was securely bolted to the platen of a planer. Then the axis of rotation of the milling machine table was placed in a line perpendicular to the travel of the tool on the planer head. The regular planer belts were thrown off and a small pulley was mounted on the milling machine table to take the place of the crank, the pulley being driven by a belt from a convenient countershaft. The operation was then satisfactorily performed.

Jackson, Mich. **Richard Gibbs**



Performing a Boring Job on a Planer

DRILL-HOLDER FOR THE LATHE



Drill-holder to fit in Toolpost of Lathe

The accompanying illustration shows a tool-holder for small drills to be used in the toolpost of a lathe. Its convenience will be evident to anyone who has had to drill small work held in the lathe chuck. The drill may be easily removed, ground and replaced in identically the same position. As will be seen, the shank *A* has two grooves *B* and *C*, one larger than the other, to accommodate varying sizes of drills. The clamp *D*, carrying the clamping screw *E*, can be swung around pivot *F* and used with either groove.

Brooklyn, N. Y. **Ernest Schwartz**

CONCRETE AGGREGATES

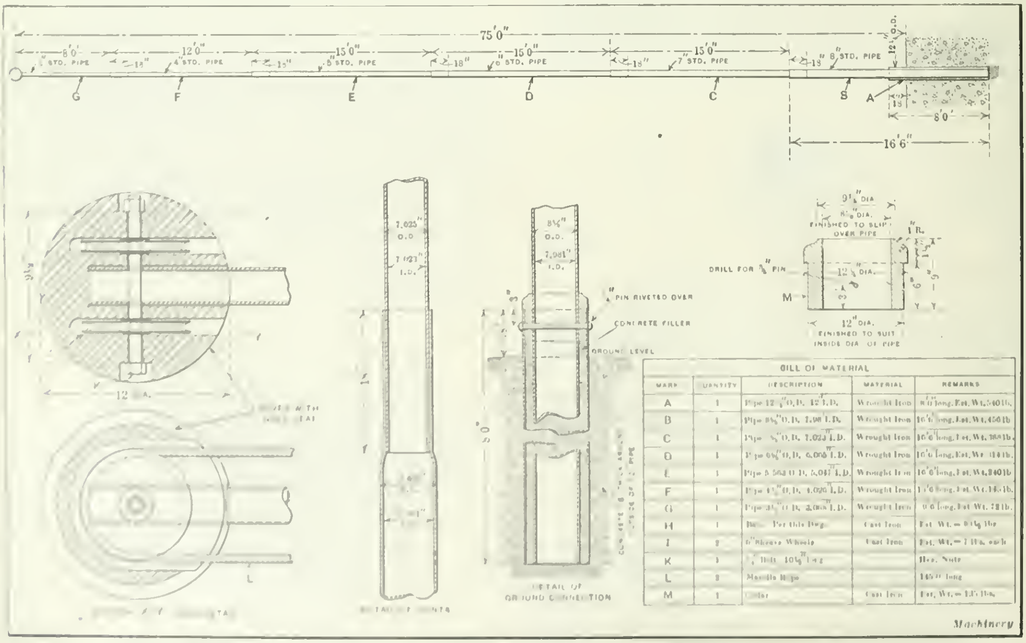
Apropos of the article on washing concrete aggregates in the November number of Machinery, the writer would say that general usage in the matter of proportion of cement and aggregate (for instance, the 1-2-3 method) is wrong, being either wasteful of cement or productive of a non-homogeneous mixture. Cement, like joiners' glue, should be used as a bond and not as constructive material. As little should be used as will exactly cover all adjacent surfaces; and the surfaces to be joined should be made to fit as accurately as possible. This principle of making a glue joint applies in making a cement mixture; the aggregates should fit each other closely, and not leave large spaces between to be filled with cement, which costs more than stone or sand.

For example, take a granite block and break it up into chunks that will pass through a two-inch ring. These, thrown together, will weigh much less per cubic foot on account of the interstices. If the other aggregate is granite spalls used in the proportion of 3 to 2, shoveling the two together dry will result in a bulk exceeding that of the large pieces. The proper proportion of spalls may be found by filling a barrel with the chunks in layers, filling the interstices with water until the barrel runs over, then tapping off the water and measuring it, next shaking spalls into each layer until it will hold no more; the mixture will then contain the maximum amount of spalls that should be used. If, after all is dry again, sand is sifted into the layers of blocks and spalls, until they will hold no more, the maximum desirable amount of sand has been added. If water is now poured into the barrel until it runs over, it will be seen that the total volume of all the interstices is less than was the case just after the spalls had been added, and still less than that among the blocks alone. The difference between the volume of the interstices among the blocks and that of the triple mixture will represent approximately the amount of cement saved by properly proportioning the three sizes of aggregate.

New York City **Robert Grimshaw**

METAL FLAG POLE

At this time all manufacturing plants should display the national flag, and the illustration shows a drawing for a pole that the writer believes to be far superior to a wooden one. It was constructed for a flag 12 by 20 feet. The pole is 75 feet above the ground level and is constructed of six sections of iron pipe that are 3, 4, 5, 6, 7 and 8 inches in diameter, with the joints shrunk together. These joints are made by inserting the smaller pipe 18 inches into the larger pipe, while the latter is at a red heat, then swaging down the heated portion and allowing it to cool. The swaging may be done either by a hydraulic press or under a hammer. Surrounding the lower piece of pipe, 8 inches diameter, is a piece of 12-inch pipe, 8 feet long, and securely held in place by concrete, and the latter pipe is sunk 6½ feet below the ground level. The space between these pipes is filled with a rich concrete, and then collar *M*, which can be moved freely over the 8-inch pipe, is slipped into position and securely pinned. At the top of the pole is mounted a cast-iron ball, 12 inches in diameter, having two 6-inch cast-iron sheaves with brass bushings, securely held in pockets in the ball by a ¾-inch bolt. Computations



BILL OF MATERIAL

MARK	QUANTITY	DESCRIPTION	MATERIAL	REMARKS
A	1	Pipe 12 [illegible]" O.D. 12" I.D.	Wrought Iron	8'0" long. Est. Wt. 340 lb.
B	1	Pipe 8⅝" O.D. 7.981" I.D.	Wrought Iron	16'0" long. Est. Wt. 450 lb.
C	1	Pipe 7⅝" O.D. 7.023" I.D.	Wrought Iron	16'0" long. Est. Wt. 380 lb.
D	1	Pipe 6⅝" O.D. 6.065" I.D.	Wrought Iron	16'0" long. Est. Wt. 310 lb.
E	1	Pipe 5.563 O.D. 5.047" I.D.	Wrought Iron	16'0" long. Est. Wt. 240 lb.
F	1	Pipe 4½" O.D. 4.026" I.D.	Wrought Iron	13'0" long. Est. Wt. 140 lb.
G	1	Pipe 3½" O.D. 3.068" I.D.	Wrought Iron	9'0" long. Est. Wt. 72 lb.
H	1	[illegible] for this [illegible]	Cast Iron	Est. Wt. = [illegible] lbs.
I	2	6" Sheave Wheels	Cast Iron	Est. Wt. = 7 lbs. each
K	1	¾" Bolt 10⅛" long		Hex. Nuts
L	2	Manila Rope		[illegible] long
M	1	Collar	Cast Iron	Est. Wt. = [illegible] lbs.

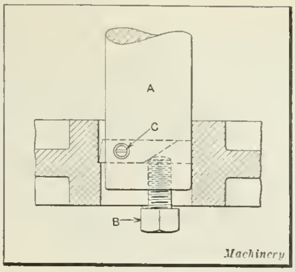
Drawing of Metal Flag Pole

show that a load of approximately 300 pounds applied at the top of the pole will produce a stress of 17,000 pounds per square inch in the 8-inch pipe near the ground level.

Chester, Pa. **George W. Childs**

KEYWAY CUTTING TOOL FOR DRILL PRESS

The illustration shows a tool that was used for cutting keyways in a shop where the amount of work did not warrant the purchase of a keyseater. One end of bar *A* fits into the spindle of the drill press, and it is worked up and down by the rack handle on the machine. The screw *B* is given a slight turn for each stroke, thus causing the tool bit to advance, until the required depth is cut. A headless set-screw *C* is forced against the tool bit to keep it rigid. Bar *A* should be a sliding fit in the bore of the piece being machined, so that it will also be kept rigid. With this tool, keyways ¼ and ⅜ inch wide have been successfully cut.



Tool for cutting Keyway in a Drill Press

Philadelphia, Pa. **M. C. Melincoff**

IDLE MACHINE HOURS

The proposition of dealing with idle machines in the shop has come to the front much of late. It has been estimated that the cost of an idle machine may be as high as two dollars a day. In jobbing shops where no special machine is assigned to any particular person, it is hard to get a correct estimate of the number of hours a machine works each day, as the conditions governing the work are widely different from those in a manufacturing shop. However, in shops where a hundred or so machines have been installed it is essential that an account of the equipment be kept. There are occasional instances where the nature of the work is such that one or two machines may be idle for a considerable length of time before any official notices it.

Many ingenious schemes have been devised for recording the time a machine is in use and the time it is idle. The method most commonly used, however, is for the operator to put on his time ticket the number of hours worked to the nearest tenth of an hour. This method is objectionable, as the time required for the mechanic to do this clerical work should be used more economically; and as this record does not affect the workmen's pay envelope, it is often far from being correct. The following method will be found more satisfactory; the little clerical work necessary is easily done by the tool-crib attendant marking the correct time on a chart like the one shown. When a man is ready to use a machine he goes to the tool-crib for his tools. When he gives the man his tools, the attendant puts a brass check bearing the man's number on the machine chart and at the same time makes a blue mark on the chart at the proper place. When the man returns his tools, the attendant draws a short red line across the blue line at the proper place. The distance from the beginning of the blue line to the red cross-line shows the time the machine was busy. A man who requires any kind of machine will inquire of the tool-crib attendant, who can at any time tell immediately what lathe, planer, shaper or drill press is idle, and thus makes it unnecessary for the men to walk about the shop trying to locate a suitable machine and conversing with every workman on the various topics of the day.

New Haven, Conn. **Eric Lee**

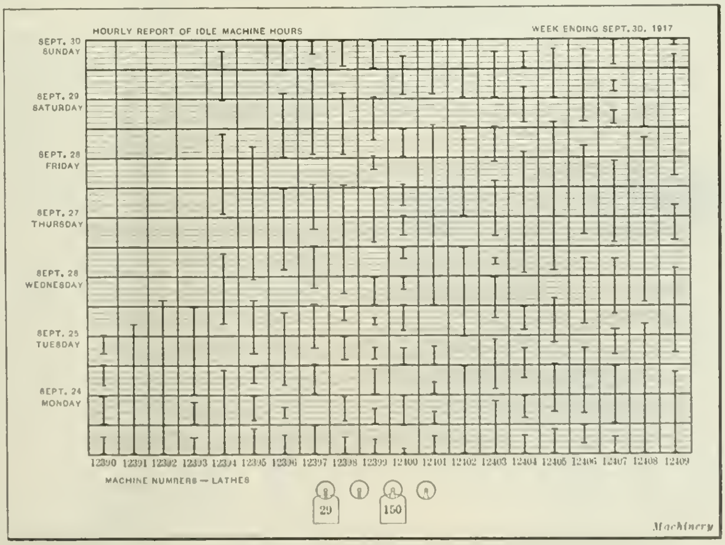


Chart showing Time Machines and Tools are in Use

AMMONIA FOR FIRE EXTINGUISHING

In a recent conversation with the superintendent of a manufacturing concern relative to a fire in its storehouse, it occurred to the writer that the use of ammonia would be an improvement on the present method of using water for protection. Combustion, in the sense that we use the word as applied to fire, depends entirely upon the supply of uncombined oxygen obtainable. The greater the quantity and quality of this gas, the more rapid and effective the fire. Naturally the supply of oxygen is obtained in the majority of cases from the atmosphere, which contains but 23 per cent, the remainder being practically all nitrogen. Oxygen is the greatest supporter of combustion known; so great that in it we can burn such refractory substances as iron, steel, diamonds, etc., depending on the purity of the gas. Nitrogen on the other hand, is the most negative element there is. Ammonia gas is composed of one part of nitrogen and three parts of hydrogen. Notwithstanding the fact that hydrogen is itself combustible, when combined with nitrogen to form ammonia, it has a peculiar effect of suffocation on the respiratory organs and seems to exert a similar action on combustion, and a little ammonia gas will go a long way toward extinguishing a good sized fire. This is undoubtedly due to the fact that it cuts off the air or oxygen supply which is so essential to combustion. To just what extent this will work can be determined by experiment.

It would seem that if a building were piped from a tank outside, containing ammonia, either in the liquid or gaseous state, similar to the present water system, that could be turned on from an outside valve or by means of fusible alloys, it would have some advantages over the present system. There would be this difference, however, that in case of ammonia the pipes should be run on or under the floor instead of at the ceiling, for the reason that ammonia, being a gas, will naturally rise and in this manner will immediately invade every part of the building, whereas if it were turned loose from above it would have a tendency to remain there, and would take some time for diffusion, especially so in the case of a higher temperature. It would, of course, be necessary to have the outlet pipes clear at all times, which could be accomplished by having them end in a T, with one open end of the T larger than the other, and the smaller opening uppermost, which would prevent any possibility of clogging up with dirt. Two advantages that the use of ammonia has over water are that the fire can be extinguished more rapidly, and that the work will be done by a gas which can be removed by ventilation and which has little or no effect on most substances, eliminating the enormous loss that is frequently caused by water alone.

A. Schleimer
Rutherford, N. J.

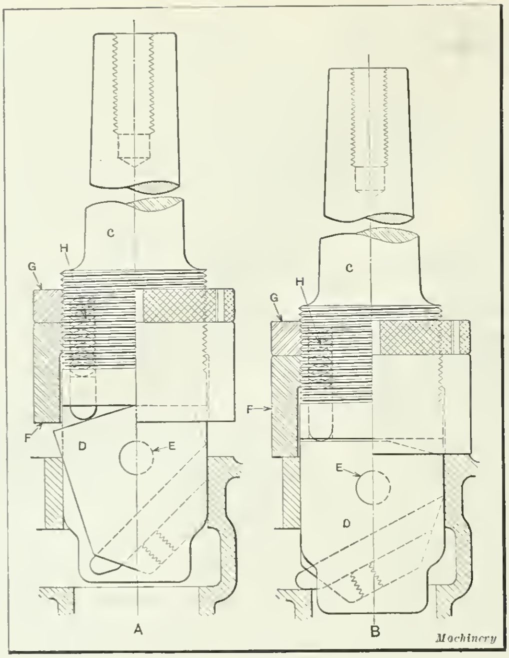


Fig. 2. Tool for facing around Valve Seat

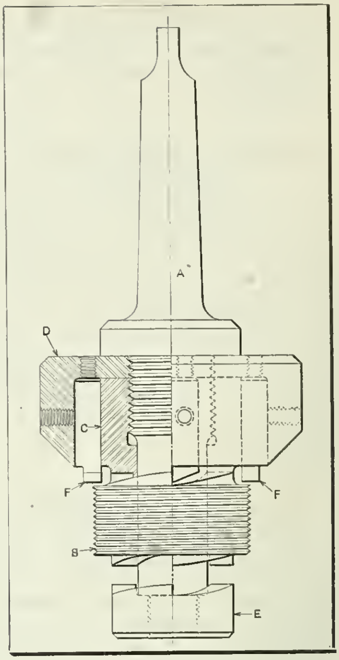


Fig. 3. Tool for machining Valve Plug Seat

CYLINDER VALVE CHAMBER TOOLS

The tools here described are used in machining the valve chambers of gas engine cylinders. The tool shown in Fig. 2 is used in facing off the surface *A*, Fig. 1, being used before the hole is tapped, and fitting into the tap-drill hole. Referring to Fig. 2, stem *C* was turned up with a shank at one end to fit the machine, and in the other end is a slot for tool-holder *D*, which is held in place by pin *E* and pivots about it, the latter being a drive fit in *C*. A square stellite tool-bit is held in holder *D* by means of a set-screw. An adjustable stop-collar *F* screws on stem *C*, and is held in place by lock-nut *G*. It is readily seen that as the tool advances into the work, as shown at *A*, the tool-bit will swing into the position shown at *B*, the stop-collar governing the depth of cut. As the tool is withdrawn, spring *H* forces *D* back into its initial position. Pieces *C* and *D* are tool steel, and *F* and *G* are casehardened machinery steel.

The tool illustrated in Fig. 3 is used for machining the valve plug seats *B*, Fig. 1, and is used after the hole has been tapped. Part *D* is screwed up against a collar, while cutter blank *C* screws under and against *D*. Four stellite tool-bits *F* are held in *C* by means of eight set-screws in *D*, and are ground in place. The plug seat *B*, Fig. 1, has a right- and left-hand set of jaws that fit into corresponding jaws on *E* and *C*. The tool is shown in the position it is in when it is started to be fed into the tapped hole in the cylinder. The threaded part of *B* acts as a pilot for the tool, making the counterbore absolutely concentric as well as perpendicular with the threads in the cylinder. The tool is fed or screwed into the cylinder until it has cut to the required depth. The machine is then reversed and the tool is pulled out until the jaws of *E* interlock with the lower jaws on *B*. Part *B* will then unscrew, releasing the tool, and the operation is complete. Parts *A*, *C*, *D* and *E* are casehardened machinery steel, and *B* is tool steel left soft.

Chicago, Ill. Harold A. Peters

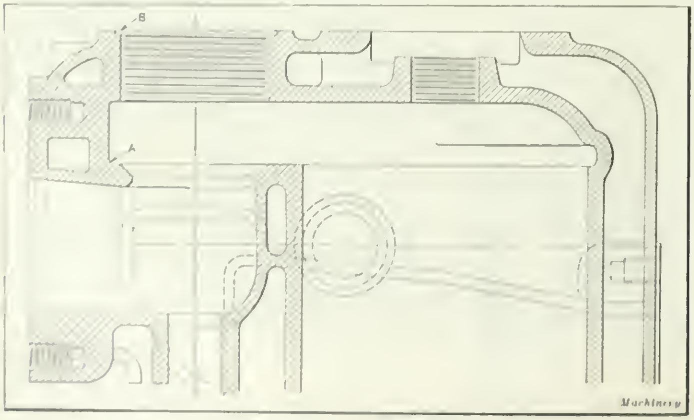
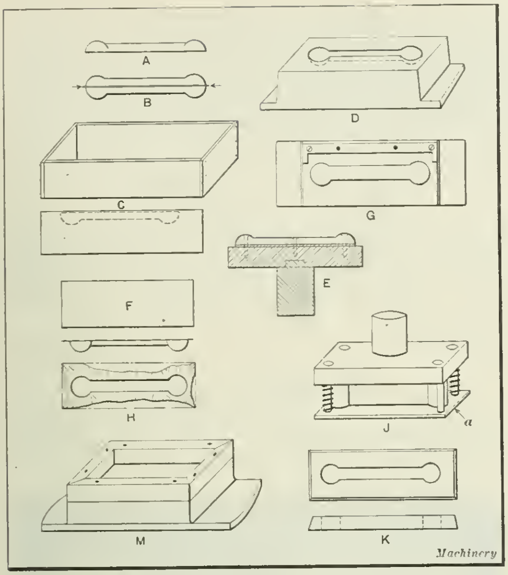


Fig. 1. Valve Chamber of Gas Engine Cylinder

ECONOMICAL DIE-MAKING

The time required in die-making may be reduced by the use of plaster of paris, as here described. In the illustration at *A* is shown the piece that is to be produced by dies. A piece of material is first turned to the required dimensions, as shown at *B*, and then sawed lengthwise. A wooden box *C* somewhat larger than the die is made. Plaster of paris should then be mixed with water until it becomes a thick paste, and box *C* is filled with it. The model *B* is carefully laid on top of this paste and gently pressed downward until it is slightly below the top surface of the box, as illustrated; as this material settles and hardens rapidly, the pressure on the model should be maintained until the plaster becomes hard. The model is then removed and the mold extracted, which may be machined as shown at *D*, or any desired shape. Filling up the holes in the mold and smoothing over is the last operation preparatory to making a steel casting die. The punch-holder *E* is made of wood and the model *B*, or a lead casting



Making Dies by the Use of Plaster of Paris

made from the die, is fastened to *E* as shown. A piece of cardboard or wood equal to the thickness of the material is placed between the punch and its holder to allow for shrinkage. The punch mold is then ready for the foundry.

A blanking die may be provided, or the metal may be cut into strips, as shown at *F*, and located upon the forming die by the nest illustrated at *G*. After the forming operation, the strip *F* will appear as shown at *H*, and it must be trimmed by the trimming punch *J* and die *K*. The formed piece *H* is inserted into the die, the punch trimming off all excess metal, which is prevented from clinging to the punch by the stripper *a*. If forming tools are to be frequently made in this manner, it would be well to have a wooden box *M* in which the plaster of paris molds could be formed innumerable times.

East Rutherford, N. J. GEORGE F. KUHNE

EFFECT OF RAPID COOLING OF CASTINGS ON MACHINING

One of the important factors in the economical production of parts from cast iron is to have an iron that will machine easily. The question of the effect of slow or quick cooling upon castings often arises. In an effort to arrive at some conclusion relative to this, a series of tests were run. The method of procedure was as follows: Rings were cast from various mixtures of iron; some of these were removed from the sand as soon as they had cooled sufficiently to handle, while others were left in the sand until they were practically cold. These rings were then placed on a boring mill and cuts were taken to determine the relative ease of machining, after which they were given a machining test by using a 3/16-inch "Novo" drill, properly ground. This drill was run a fixed number of revolutions with a constant weight upon it. The comparative depth of the holes drilled was taken as an indication of the machining qualities of the iron. Test specimens were taken from each mixture of iron handled in the foundry under exactly the same conditions as the machined rings. A condensed record of the test is shown in the accompanying table. The results show that increased difficulty in machining is to be expected with an increased rate of cooling of the metal. There were twenty different pieces tested, and although these data may not be sufficient to lay down definite information as to exactly what could be expected in every case, they indicate that a more exhaustive test along this line would be of value to manufacturers and result in a more easily machined and hence a cheaper casting.

EFFECT OF RAPID COOLING ON HARDNESS OF CAST IRON

Run No.	Casting No.	Time Casting Remained in Sand, Hours	Ultimate Tensile Strength, Pounds per Square Inch	Ultimate Compressive Strength, Pounds per Square Inch	Comparative Hardness
1	4	2	19,000	86,880	110
1	5	17	19,150	87,260	100
2	6	2½	20,700	95,610	196
2	7	17	17,800	93,630	118
3	11	1¾	20,500	97,170	197
3	14	17	20,600	100,910	139

Machinery

Manhattan, Kan. W. W. CARLSON

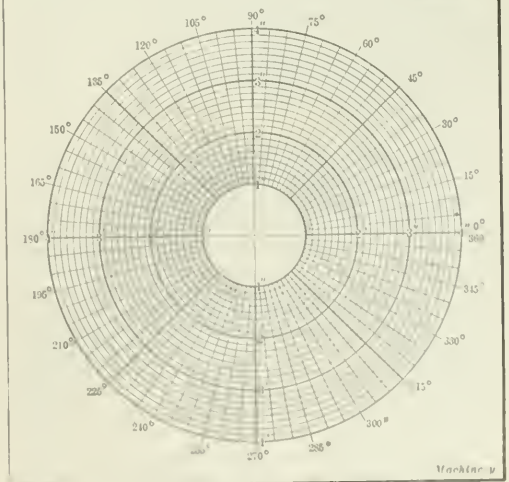
CUTTING OFF STOCK FOR LATHE WORK

In these days of efficiency and economy, it is still possible to stop many leaks of high-price material and time. One place needing reform in many shops is the shop order department or whatever other department may be responsible for cutting off stock for lathe work in the tool-room. Stock is often ordered cut to short lengths when the bar would be more economical of both time and material. The blade of a power hacksaw is sometimes thinner than the cutting-off tool used on a lathe, but the allowance that must be made for running and other inaccuracies causes a serious loss. This allowance is usually one-eighth inch in addition to the metal removed by the saw; if the diameter of the bar is more than one inch, this allowance must be increased in most cases. In the case of high-speed steel, which costs nearly five dollars a pound, a dollar's worth of material is soon converted into shavings; and unless a large amount of the material is being worked, the salvage on these shavings is slight. Besides, the saving of time in working from the bar, as compared with the short pieces, is often considerable. Most tool-room lathes have hollow spindles, and though the diameter of the hole is slightly larger in some new lathes than it was twenty years ago, in the opinion of many excellent mechanics it might be still further enlarged with benefit.

Wilkinsburg, Pa. WILLIAM S. ROWELL

TEMPLET FOR LAYING OUT CAMS

The accompanying figure is not a draftsman's artistic attempt to draw a spider web. It is merely a convenient method of drawing circular cams. In places where automatic machinery is designed there is a demand for such cams, and some convenient method of drawing facilitates experimenting with different cams, and also saves time in drawing or erasing



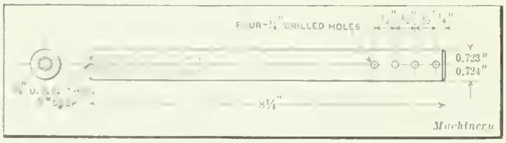
Cross-section Templet for laying out Circular Cams a number of times. This templet consists of concentric circles spaced about one-eighth inch apart, the largest being about six or eight inches in diameter; radial lines extending out from the center divide the circles into segments of about five degrees each. If this is inked on tracing cloth, it can be used a number of times by merely drawing, in pencil, the desired shape of cam on the tracing cloth and then changing this pencil lay-out until the right contour of cam is attained.

Chicago, Ill. RALPH R. WEDDELL

WHO BLUNDERED—THE DRAFTSMAN OR THE MACHINIST?

In the November number, page 250, an error is described and the question is asked, "Who blundered—the draftsman or the machinist?" In the writer's opinion, both were to blame; the machinist because he did not request more information, and the draftsman because the drawing was not as definite as was possible. A note should have been placed on the drawing informing the machinist that the only work required was to make the slot to the dimensions given. The great fault with many drawings seems to be the absence of notes. The draftsman often takes it for granted that the machinist is as familiar with the design as he is and neglects sufficient information. The results are mistakes in the shops. The writer has seen drawings showing only one view and a note, as "½ by ¾ inch." It can readily be seen that these dimensions could be covered by a number of shapes, such as rectangular, oval or elliptical. The correct method is to make all drawings to as large a scale as is practicable and to make them as simple as possible. A drawing should not look like a crystal maze, and the ordinary machinist be expected to interpret it, because he will not. He will do the best he can and guess the remainder.

Some time ago the writer was given a job and was supplied with a drawing like the one illustrated. It was a shaft with a number of holes drilled through it, and the end view indicated these holes by dotted lines. At one end of the shaft a hole was to be drilled through its center for about three inches. One of the holes drilled on the length of the shaft went into this hole at the end, on one side only. Owing to the fact that the various holes were shown in the end view, the fact that the hole mentioned only went part way through the shaft was not as obvious as it should have been, and the result was a number of spoiled pieces. In the writer's opinion the draftsman was at fault, but the machinist was made to shoulder the blame. If the following note (one ¼-inch drilled hole through one side only) had been placed on the drawing, the error would not have occurred.



Drawing of Shaft to be drilled

Providence, R. I. ROBERT MAWSON

INCREASING PRODUCTION WITH MORE RIGID INSPECTION

Increased production from increased inspection may be unusual, but it is the experience of a large manufacturer of engine lathes, who has, with the increased demand, tightened the inspection all through the shop instead of letting down the bars, as might be the tendency when the plant is rushed. The inspection has been tied up with the production so that it is constructive. At each operation, the first piece of every lot is examined to be sure the workman is started right. In addition, every piece in every lot is inspected. It is not merely an inspection that places one piece into one pile because it passes the necessary tests, and another piece into another pile because it fails; but it is an inspection that finds the reason of the spoilage and prevents its recurrence. That is why increased production has resulted from increased inspection.

The inspection and time keeping have been made to work together, too. Before the timekeeper can let out a job, the piece must have been inspected for the last operation. This insures the piece being scrapped the moment it is spoiled without useless machining, and at the same time makes the timekeeper a "punch-up" man for the inspector. Not only is the work in the shop inspected, but every purchased piece as well—every cap-screw, nut and bolt. There are no men jamming over-size cap-screws into a hole and stripping the threads, nor are there parts poorly secured because the nuts ran on too hard. Also the work is standard, and there is no special filing, scraping and fitting to cause grief later if the customer needs a repair part. As a result, on the erection floor, with 70 per cent of the force used in 1914, the men are erecting 100 per cent more machines to closer limits than have ever been used before. It is small wonder that the works manager says that it seems to him that "Inspection can hardly be overdone."

Cincinnati, Ohio D. M. PERRILL

AN UNUSUAL SCREW

Recently it became necessary to make screws like the one shown at *B*, Fig. 1, and at *D*, Fig. 2, the specifications being a screw of extreme lightness, cheapness of construction and having a neat appearance. A circular blanking die was made that was used to stamp the disk *A*, Figs. 1 and 2, from sheet steel 0.032 inch thick. Then an embossing die was made by making a series of indentations on a die-block, by the use of a slotting machine, using a 60-degree center punch and setting the stroke to the proper height, then spacing it by the automatic feed. The clearance in the center of the die was then turned out on a lathe, and the outside was also turned so as to make a concentric die. The upper half or the punch was flat. This die completed the disk as it is shown at *A*, Figs. 1 and 2.

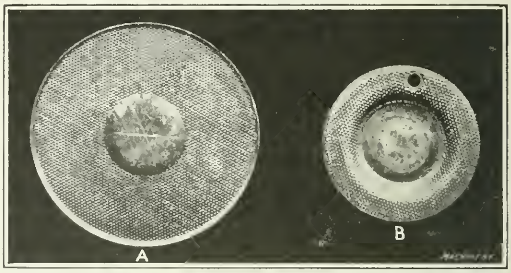


Fig. 1. Embossed Disk and Finished Screw

A drawing die was then made which drew the disk into the shape shown at *B*, Fig. 2. The screw portion, shown at *C*, was turned on screw machines from bar stock. A fixture was then made for a welding machine, holding the two pieces *B* and *C* in place while they were being electrically welded. The screw is shown in its finished form at *B* in Fig. 1, and at *D* in Fig. 2.

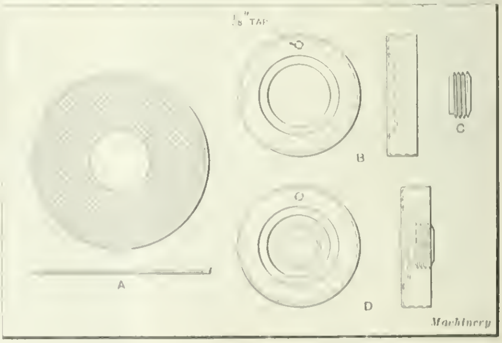


Fig. 2. Screw in Various Stages of Manufacture

Elizabeth, N. J. EDWARD J. BESSOM

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

TO GRADUATE A PLANER HEAD WITHOUT SPECIAL APPLIANCES

E. J. R.—Can any reader of MACHINERY suggest a way to graduate the head of a 36-inch planer in a shop where there are no milling machines or graduating machines? Any information that can be offered on the subject will be appreciated.

The question is submitted to readers for suggestions.

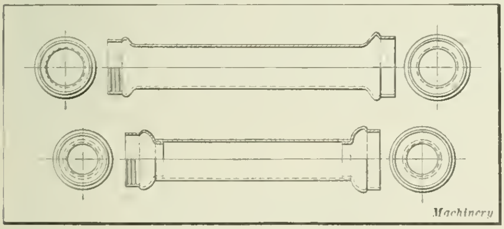
HOW TO EXPAND A THREAD PLUG GAGE

D. D.—Can any reader of MACHINERY tell me of a way to enlarge or swell a worn thread plug gage so that it can be lapped to the original size?

A.—The subject of salvaging worn gages is one of great importance, but very little has been done in this line because of the practical impossibility of increasing the diameter of a hardened plug without softening it by heat and distorting the shape. If any reader of MACHINERY can offer a practical method for expanding plug gages and thread gages so that they can be lapped to size, we shall be glad to give his article space.

TOOL EQUIPMENT FOR MAKING STUD OF A BICYCLE PEDAL

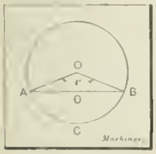
H. E. H.—The accompanying illustration shows two designs used for the central part or stud of a bicycle pedal. That shown at the top illustrates a piece of tubing drawn at the ends as shown; that at the bottom, a part made from three pieces, the central part being a piece of straight tubing into which are inserted two formed pieces, one at each end. What tool equipment would be required for making these parts?



Two Designs for Stud of Bicycle Pedal

GIVEN AREA AND RADIUS OF A SEGMENT TO FIND THE HEIGHT

J. F. F.—A cylindrical tank, 30 inches long, lies with its axis horizontal. The radius *OA* is 5 inches; what must be the depth *DC* when the tank contains 231 cubic inches?



Illustrating Method of finding Height of Segment when Area and Radius are given

A.—The area of the segment *ACB* in the accompanying illustration is 231 ÷ 30 = 7.7 square inches; whence, $7.7 = \frac{5^2}{2}(v - \sin v)$, from which:

$$f(v) = v - \sin v - 0.616 = 0 \qquad (1)$$

To find a value for v, substitute in this equation the first three terms of the sine series, obtaining $v - \left(v - \frac{v^3}{6} + \frac{v^5}{120}\right) - 0.616 = 0$. Clearing of fractions, combining, and reducing,

$$v^5 - 20v^3 + 73.92 = 0 \qquad (2)$$

Solving this equation, $v = 1.620+$. Substituting 1.62 for v in Equation (1), $f(v) = 0.00521$; substituting 1.61 for v, $v = -0.00523$; hence, v lies between 1.61 and 1.62. Tabulating the results and finding the difference, $v = \frac{523}{1044} \times 1 + 161 = 161.501$, or 1.61501 after restoring the decimal point, when $f(v) = 0$. Substituting this value of v in Equation (1), $f(v) = -0.00001$, showing that the value of v as calculated is exact enough for all practical purposes.

$$DC = 5\left(1 - \cos\frac{v}{2}\right) = 5\left(1 - \cos\frac{1.61501}{2}\right) = 1.5435 \text{ inch.}$$

v	$f(v)$	
1.61	-0.00523	1044
1.62	0.00521	

J. J.

RULE FOR MEMORIZING FUNCTIONS OF 30, 45 AND 60 DEGREES

E. N. U.—I should like a rule easily remembered for the natural trigonometric functions of 30, 45, and 60 degrees; I mean, of course, when these functions are expressed as surds.

A.—There are several convenient rules for this purpose; the one preferred by the writer is given in Table 1 and, when once memorized, is not easily forgotten. When these values have been reduced, they take the forms shown in Table 2. If the secant is desired, simply take the reciprocal of the cosine; thus, sec 30 deg. $= \frac{1}{1/2\sqrt{3}} = \frac{2}{\sqrt{3}} = 2/3\sqrt{3}$. The cosecant is the reciprocal of sine; thus cosec 45 deg. $= \frac{1}{1/2\sqrt{2}} = \frac{2}{\sqrt{2}} = \sqrt{2}$. It will be noticed that it is necessary to remember only the values for the sines and tangents, since the cosines and cotangents occur in the reverse order, being the corresponding functions of the complementary angles. Thus the complement of 0 degrees is 90 degrees; of 30 degrees, 60 degrees; and of 45 degrees, 45 degrees. To ten decimal places, $\sqrt{2} = 1.4142135624-$, and $\sqrt{3} = 1.7320508076-$. J. J.

TABLE 1. FUNCTIONS OF 30, 45 AND 60 DEGREES

	0 deg.	30 deg.	45 deg.	60 deg.	90 deg.
sin	$\frac{1}{2}\sqrt{0}$	$\frac{1}{2}\sqrt{1}$	$\frac{1}{2}\sqrt{2}$	$\frac{1}{2}\sqrt{3}$	$\frac{1}{2}\sqrt{4}$
cos	$\frac{1}{2}\sqrt{4}$	$\frac{1}{2}\sqrt{3}$	$\frac{1}{2}\sqrt{2}$	$\frac{1}{2}\sqrt{1}$	$\frac{1}{2}\sqrt{0}$
tan	0	$\frac{1}{3}\sqrt{3}$	$\frac{1}{3}\sqrt{3^2}$	$\frac{1}{3}\sqrt{3^3}$	∞
cot	∞	$\frac{1}{3}\sqrt{3^3}$	$\frac{1}{3}\sqrt{3^2}$	$\frac{1}{3}\sqrt{3}$	0

Machinery

TABLE 2. VALUES IN TABLE 1 REDUCED

	0 deg.	30 deg.	45 deg.	60 deg.	90 deg.
sin	0	$\frac{1}{2}$	$\frac{1}{2}\sqrt{2}$	$\frac{1}{2}\sqrt{3}$	1
cos	1	$\frac{1}{2}\sqrt{3}$	$\frac{1}{2}\sqrt{2}$	$\frac{1}{2}$	0
tan	0	$\frac{1}{3}\sqrt{3}$	1	$\sqrt{3}$	∞
cot	∞	$\sqrt{3}$	1	$\frac{1}{3}\sqrt{3}$	0

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A GEOMETRIC PROBLEM

S. C. D.—Will you please show me how to find the distance *s* from the dimensions given?

A.—Referring to the illustration, $AC = \sqrt{30^2 - s^2} = \sqrt{900 - s^2}$, and $BO = \sqrt{400 - s^2}$. From the similar triangles *AOC* and *DOE*, $\frac{AC}{OC} = \frac{DE}{OE}$, or:

$$\frac{\sqrt{900 - s^2}}{s} = \frac{10}{x}, \text{ or } x = \frac{10s}{\sqrt{900 - s^2}} \qquad (1)$$

Draw *DF* parallel to *CO;* then, from the similar triangles *BCO* and *BFD*, $BO \div OC = BF \div FD$, or:

$$\frac{\sqrt{400 - s^2}}{s} = \frac{\sqrt{400 - s^2} - 10}{x} \qquad (2)$$

Substituting in Equation (2) the value of x from Equation (1), and clearing of fractions,

$$90{,}000 - 100s^2 = 400{,}000 - 1400s^2 + s^4 - 20(400 - s^2)\sqrt{900 - s^2}$$

from which:

$$s^4 - 1300s^2 + 310{,}000 = 20(400 - s^2)\sqrt{900 - s^2}$$

Squaring, transposing, and combining terms:

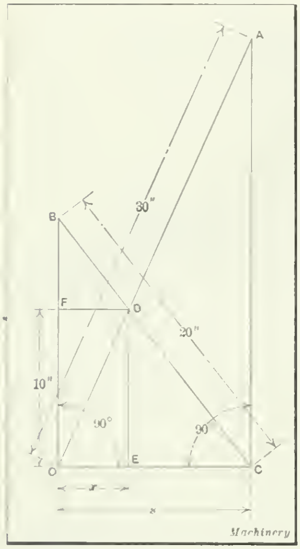
$$s^8 - 2200s^6 + 1{,}630{,}000s^4 - 454{,}000{,}000s^2 + 38{,}500{,}000{,}000 = 0$$

This is an eighth-degree equation; but since all the exponents are divisible by 2, the equation may be reduced to one of the fourth degree and the coefficients simplified by substituting $10\sqrt{y}$ for s. The equation then becomes:

$$y^4 - 22y^3 + 163y^2 - 454y + 385 = 0$$

Solving this equation, preferably by Horner's method, $y = 1.5212$; hence:

$$s = 10\sqrt{y} = \sqrt{100y} = \sqrt{100 \times 1.5212} = \sqrt{152.12} = 12.334 \text{ inches}$$



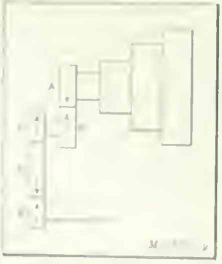
Illustrating a Geometric Problem

If the angles *AOC* and *BCO* are also desired, substitute the value of s in Equation (1) and obtain $x = 4.5101$ inches. Then, $\tan AOC = \frac{10}{4.5101}$; from which AOC = 65 degrees 43 minutes 27 seconds. $CE = s - x = 12.334 - 4.5101 = 7.8239$. Therefore, $\tan BCO = \frac{10}{7.8239}$; from which BCO = 51 degrees 57 minutes 39 seconds. J. J.

CALCULATING CHANGE-GEARS FOR 4.5-MILLIMETER PITCH

H. S. R.—The lead-screw of my lathe has five threads per inch, and the fixed gear on the stud has twice as many teeth as the gear it meshes with on the spindle. I wish to cut a thread having a pitch of 4.5 millimeters; what change-gears must I use if the variation is not to exceed 0.01 millimeter?

A.—It is assumed that your lathe is simple geared and that the arrangement of the gears is as shown in the illustration. It is first necessary to express the pitch of the thread to be cut and the pitch of the lead-screw in the same units; this may be done by reducing the 4.5 millimeters to inches or the pitch of the lead-screw to millimeters; the writer prefers the former. Since 1 millimeter = 0.03937 inch, 4.5 millimeters = 0.03937 × 4.5 = 0.177165 inch. The limit of variation being 0.01 millimeter, the pitch of the thread must be greater than 4.5 − 0.005 and less than 4.5 + 0.005 millimeters. But 0.005 millimeter = 0.000197 inch; hence the pitch of the thread must be greater than 0.177165 − 0.000197 = 0.1770 inch and less than 0.177165 + 0.000197 = 0.1774 inch, expressed to the nearest 0.0001 inch. The pitch of the lead-screw is 1 ÷ 5 = 0.2 inch. If gears *A*, *B*, *C* and *E* have the same number of teeth, one spindle turn will produce one turn of the lead-screw, and the tool will advance 0.2 inch. Assuming for the present that gears *A* and *B* have the same number of teeth, gear *C* must be smaller than gear *E*, since the pitch of the screw to be cut is less than that of the lead-screw, the ratio being $\frac{0.177165}{0.2} = \frac{0.885825}{1} = \frac{35433}{40000}$. Expressing this last fraction as a continued fraction (see MACHINERY for July, 1916, page 989), the following convergents are obtained: $\frac{0}{1}, \frac{1}{1}, \frac{7}{8}, \frac{8}{9}, \frac{31}{35}, \frac{225}{254}$. The last fraction is very accurate, being equal to 0.885826; that is, when the spindle makes one turn, the lead-screw makes 0.885826 turn, and the tool advances 0.885826 × 0.2 = 0.1771652 inch. However, the terms of this fraction are too large; hence, trying the preceding one, $\frac{31}{35} = 0.885714$, and 0.885714 × 0.2 = 0.17714 +, a value that is within the specified limits. Since gear *B* has twice as many teeth as gear *A*, gear *C* must have 31 × 2 = 62 teeth, and gear *E* must have 35 teeth. J. J.



Change-gears for Thread Cutting

HELIX WITH VARIABLE PITCH

M. A.—I wish to cut a helical groove in a cylinder 2.10 meters long, having a diameter of 0.25 meter. The helix has a variable pitch, being 3.70 meters at the beginning and 2.25 meters at the end of one turn. How can I lay out the developed helix, and what is the ordinate corresponding to a point on the helix 1.25 meter from the beginning?

A.—In the illustration, *ABCD* and the circle represent two projections of the cylinder and $A_1B_1C_1D_1$ represents the development of the cylinder, the length A_1D_1 being 3.1416 × 0.25 = 0.7854 meter. It will be more convenient to express all dimensions in centimeters. This being understood, the length of the cylinder is 210, its diameter is 25, the circumference A_1D_1 is 78.54, the pitch at the beginning (the initial pitch) is 370, and the pitch at the end (the final pitch) is 225. Assuming that the pitch varies uniformly from 370 to 225, a point on the helix at the end of one turn will be half way between 370 and 225 and situated on the line C_1D_1 produced. In other words, the developed helix will intersect C_1D_1 at a point distant $\frac{370 + 225}{2} = 297.5$ from D_1. Designate this point by *H* (it is omitted from the diagram for lack of space); then $D_1H = 297.5$, which is the pitch at the point *H*. The pitch at *H* is also equal to $370 - \frac{370 - 225}{2} = 370 - 72.5 = 297.5$, as before.

The pitch at any intermediate point *P* will be proportional to the distance $EP = x$; that is, the pitch at *P* is $370 - 72.5 \times \frac{x}{78.54}$. The distance $A_1E = y$ is equal to the pitch at *P* multiplied by $\frac{x}{78.54}$. Hence, the relation between y and x is expressed by the equation:

$$y = \left(370 - 72.5 \times \frac{x}{78.54}\right)\frac{x}{78.54} = 4.710976x - 0.011753x^2$$

It is to be noted that if the pitch were uniform and equal to 297.5, the developed helix would be the right line A_1F, which cuts C_1D_1 at the point *H*, 297.5 centimeters from D_1. Since the pitch is variable, the developed helix cannot be a right line, but a curve, represented by line A_1PG. To draw this curve, divide the circle, representing the bottom view of the cylinder, into any convenient number of equal parts, say 16, and divide A_1D_1 into the same number of equal parts. The arc 0-1 = 1-2 = 0_1-1_1 = 1_1 2_1 = etc. = $\frac{78.54}{16}$ = 4.90875. 0_1 2_1 evidently equals 2 × 4.90875; 0_1 3_1 = 3 × 4.90875; etc. Substituting these values for x in the foregoing equation, the corresponding values of y are found, which are the points 1, 2, 3, etc., on the curve A_1PG, and through which the curve

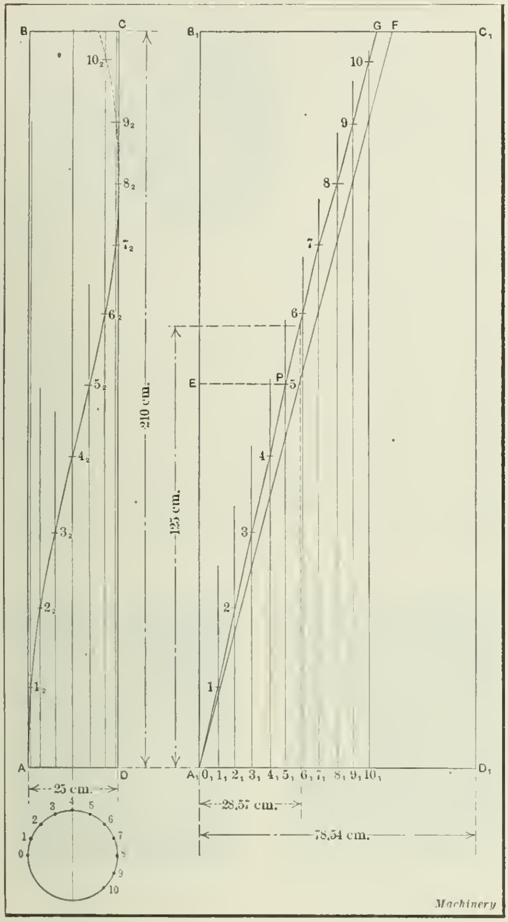


Diagram of Helix with Variable Pitch

is traced. To find the value of x for any particular value of y, substitute the value of y in last equation and solve for x; for instance, if $y = 125$, as shown in the illustration, $x = 28.57$. Similarly, the value of x for $y = 210$ is $51.09 = B_1G$.

To draw the projection of the helix on the cylinder, draw vertical lines through the points 1, 2, 3, etc., of the circle and horizontal lines through the points 1, 2, 3, etc., of the curve A_1PG; they intersect in 1_2, 2_2, 3_2, etc., through which the curve may be traced as shown. When applying the formula to calculate the various values of y, first substitute the value of $x = 0_1\text{-}1_1 = 4.90875$, obtaining $y = 23.1251 - 0.2832 = 22.8419$. For $x = 0_1\text{-}2_1 = 2 \times 0_1\text{-}1_1$, $y = 23.1251 \times 2 - 0.2832 \times 2^2$; for $x = 0_1\text{-}3_1 = 3 \times 0_1\text{-}1_1$, $y = 23.1251 \times 3 - 0.2832 \times 3^2$; etc. This method of calculating values of y is much easier than direct substitution of x, and is one of the reasons for dividing the circle into equal parts. Since the equation giving the value of y is of the second degree between two variables, it is the equation of a conic section. Applying the usual test, the curve A_1PG is found to be an arc of a parabola. Note that when 78.54 is substituted for x, $y = 297.5$, as it should. J. J.

* * *

CORRECTION

An error appeared in the article "Economical Production of Accurate Hardened Gears" in the December number. The sentence "The hole is ground to within 0.0001 inch of finish size, this amount being allowed for grinding after the gear is hardened," should read, "The hole is ground to within 0.001 inch of finish size," etc.

MALLEABLE IRON AND ITS USES

At a meeting of the American Iron and Steel Institute an article on malleable iron and its uses was presented by Henry F. Pope. He said that iron as it is run from the furnace and poured into the molds in the process of making malleable iron castings is not malleable at all, but is extremely hard and brittle. When broken, it shows a white fracture. But this brittle iron is of such composition that when subjected to the proper annealing heat for the requisite length of time, it is transformed into an iron with entirely different physical qualities. After annealing, instead of showing a white fracture, it shows a black one, giving it the name of "black heart." This distinguishes the malleable iron made in this country from that made in Europe, which has a steely fracture, due to the fact that the carbon is almost entirely removed by oxidation in the annealing process. The black fracture of American iron is due to the fact that in the annealing process the carbon, which in the original casting was all combined, has been separated out by decarbonization and is now found as free carbon or graphite of non-crystalline form deposited between the molecules of the iron. This form of carbon is called "temper carbon." The presence of a large amount of temper carbon gives the material its black appearance. The iron itself, therefore, is left almost entirely free from any combination with carbon and possesses the malleable quality of wrought iron. It can be bent without fracture and withstands great shock and stress without breaking. It has the superiority of wrought iron in the respect of malleability without the sometimes objectionable fibrous structure of that material. Someone will say, "Why use malleable iron any more when steel castings may be had?" That is a pertinent question, for great strides have been made in steel casting production and certain castings have been changed from malleable iron to steel with improved results; but there are several reasons why steel will never displace malleable iron for a multitude of articles. In the first place, in most cases, if the steel could be produced in the form and section of the malleable casting, it would be more expensive and no better; for, while the tensile strength of malleable iron is somewhat below that of soft steel, its elastic limit is just as high, which means that it will stand just as severe service as the steel. Years ago malleable iron began to be used advantageously for agricultural implements, all sorts of farm tools, wagons and carriages, harnesses, stoves, pipe fittings, and for many other purposes. Later the railroads began to use it, for many parts of cars could be made lighter and less subject to fracture by the substitution of malleable for gray iron. The railroads also used it in places where the iron is exposed to the corrosive action of the weather, for malleable iron is as non-corrosive as any of the iron products and much more so than steel. More recently malleable iron has become popular in automobile construction. Other good qualities are its high permeability and its low magnetic hysteresis, qualities which render it desirable for certain electrical machinery.

* * *

EDITORIAL CONFERENCE OF ASSOCIATED BUSINESS PAPERS

At the Editorial Conference of the Associated Business Papers, a society representing more than one hundred and fifty trade and technical journals, held in Washington, December 13, the subject of the excess profits law was explained to the editors by Internal Revenue Commissioner Roper, who mentioned that it was intended to make the tax burden as light as possible under the law. For partnerships and individuals, reasonable salaries would be allowed as reductions from profits before determining the taxable residue. Competent revenue officers will be sent early in the year to different parts of the country to aid in the making out of income tax returns. An interesting feature of the meeting was the address by Anna Howard Shaw, chairman of the Women's Section of the Council of National Defense, who urged the editors to use the influence of their journals to induce technical schools to train women for engineering work.

DIE-CASTING DIES

Some remarkable die-casting dies recently made by the Marf Machine Co., New York City, are shown in the accompanying illustrations. Fig. 1 shows the castings that are produced, which are made of pure tin. The dies used in producing casting *A* are illustrated by Figs. 2 and 3.

Fig. 2 shows the lower member of the die in position for the casting to be ejected. The arms of casting *A*, Fig. 1, serve as tubes, and the holes are formed by steel cores, which must be withdrawn from the casting before it can be ejected. These cores are withdrawn by operating levers turning shafts having teeth that engage with racks cut on the rods upon which the moving parts slide. There are seven operating levers, and six of these must be turned their entire movement before the seventh one, which ejects the casting, can be operated. This lever raises a plate on which there are twelve vertical pins; six of these are locking pins, and the others are ejectors. The locking pins engage with holes in the moving parts of the die, so that these parts must be placed in the correct position by the levers mentioned before the final lever can be turned; this makes an effective locking device. Several of these locking pins may be seen at *A*, *B* and *C*, Fig. 2. The ejector pins, which raise the casting, are indicated by *D* and *E*. A part of the die itself, *F*, rises at the last operation and assists in ejecting the casting. Instead of the usual method of cutting grooves on the shafts for oiling, there are drilled spots that form oil-pockets for conveying the oil to the bearings. Fig. 3 shows the upper member of the die that was made from a solid block of steel and has no moving parts. The hot metal is forced in at hole *A*, into which the sprue cutter extends. The sprue cutter is shown at *G* in Fig. 2. The upper member is guided by pins.

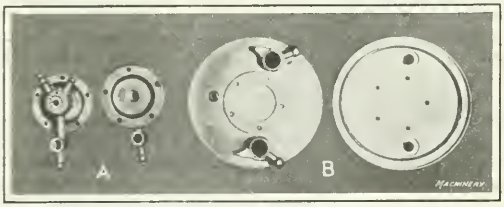


Fig. 1. Castings that were formed in Dies illustrated

This die is for use on a hand-operated machine, but can also be used on machines operated by steam or compressed air. The total weight of the die is about 500 pounds. There is a water jacket in the die, surrounding the casting, for cooling purposes. The die is blown out by compressed air after each use. It is estimated that one hundred castings can be made per hour with three men operating the die-casting machine.

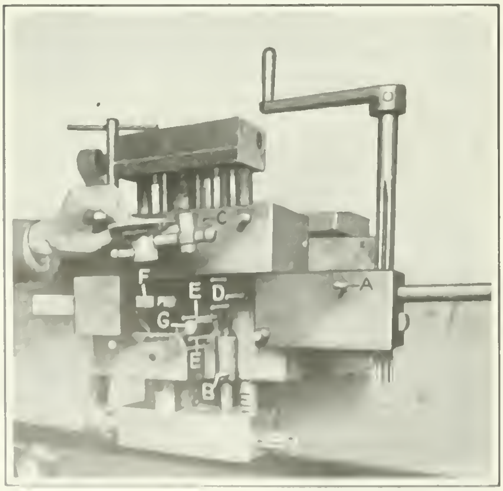


Fig. 2. Lower Member of Die for Casting A, Fig. 1

The die used for casting *B*, Fig. 1, is illustrated in Figs. 4 and 5. The die is shown in Fig. 4 in position for removing the casting. An interesting feature of this die is that, in order to get the form of the under-cut beneath the arms, it is necessary to have two loose pieces that remain on the casting when it is removed. One of these is seen on the casting at *A*, while *B* shows it replaced. After these pieces are again in position, the operating lever is turned, and through the medium of the teeth on the shaft, and slanting teeth on the slides of the die, these slides are brought forward, holding in place the loose pieces and completing the shape of the die, also forcing in the round cores that make the holes in the arms of the casting. There are five brass, tapped, hexagon inserts cast in the piece, which are held in position by the pins shown. The metal is forced in through hole *C*. The sprue cutter is illustrated at *A*, Fig. 5. The method of forming the under side of the casting is shown in Fig. 5.

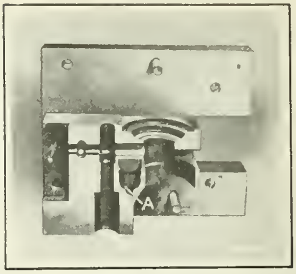


Fig. 3. Upper Member of Die for Casting A, Fig. 1

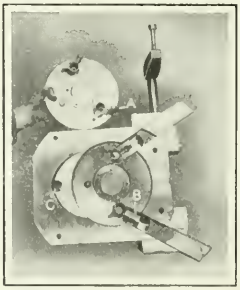


Fig. 4. Lower Member of Die for Casting B, Fig. 1

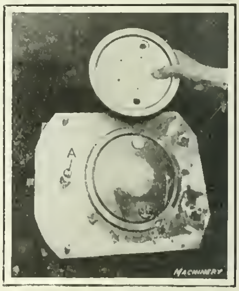


Fig. 5. Upper Member of Die for Casting B, Fig. 1

* * *

IMPORTANT SAVING BY NEW METHODS OF HANDLING FREIGHT

Less-than-carload freight shipped from Philadelphia, under the new "shipping day" or "sailing date" plan, is moving to destination with more than three times the average speed achieved under the old method of handling. Observations of actual car movements from Philadelphia to a large number of points on the Pennsylvania lines, both east and west of Pittsburg, the results of which have just been tabulated, show that, from the placing of the freight in the car until it reaches its destination, the average speed of movement has been more than tripled. For instance, where the average time in transit was formerly three days, it is now less than one day, and where it was formerly six days, it is now less than two days. In addition to the benefit resulting to shippers from greater speed in transit, the "shipping day" plan, as hitherto announced, by saving the use of nearly 100 cars per day in handling less-than-carload freight from Philadelphia, is helping to increase the car supply for other purposes.

This information given out by the Pennsylvania Railroad verifies the contention that American railroads were inefficiently managed as regards their car equipment and system of handling both freight and passenger traffic. It would be well if the war would teach those responsible for the management of American railroads that they have a great deal to learn before the roads will be run efficiently.

WILL HIGH PRICES MAKE TWO CUTS DO WHAT TEN DID BEFORE?

BY D. M. PERRILL[1]

The conversation had been about tooling and cuts taken with engine lathes in the average manufacturing plant. Possibly it was the ability to see the silver lining in any cloud that caused the visitor at a large machine tool plant to say that he believed the present high prices of machine tools would force manufacturers to obtain the best possible production from their machine tools; certainly this has not been done in the past.

For instance, a lathe company found it necessary to place one of its demonstrators, for a few months, in a plant that was turning out work for it, to test the work and see that it came up to the required standard. At the end of this time, the writer visited the plant and was surprised to see the way in which the lathe work was being done. In explaining the situation, the demonstrator said he would have been only too glad to assist, but was helpless in the matter, as he had no authority over the operators or methods used in turning out the work, and so could only make suggestions. While there had never been any particular objection to his showing the men the proper cuts and feeds to use in turning out work, when he stopped watching an operation, the operator immediately slipped back to the old methods, and did in ten cuts what should have been done in about two or at the most, three. In this case the fault was purely a matter of depth of cut, feeds, and speeds, but when we come to tooling, examples can be found in wholesale numbers. These faults are not confined to the use of engine lathes; failures to secure the proper results from every kind of machine tool will be found.

It is the belief of the writer that this is a form of lethargy on the part of the operator, foreman, and superintendent. For the two latter it is a question simply of what point they shall apply their attention to, and since the work is turned out under the present methods, they are willing to let it drift. If the present prices of machine tools will cause the operators, foremen, and superintendents to concentrate their attention on proper methods of obtaining the greatest production from every machine tool, the silver lining seen in the cloud of high prices by the visitor will not only be pure metal but a lot of manufacturers will cash in on it at their banks.

In the meantime there is no reason why every machine shop cannot cash in on some of the silver lining, even if they do not have to buy additional machine tools at the new prices. With the sales limit purely a matter of production capacity in every metal-working shop, anything that will increase that capacity is naturally of greatest interest. The first step is for each shop to find out what is possible in the way of metal reduction, remembering that these things are most profitable when applied to standardized work and quantity production. And by increasing its production, a shop assists in meeting the greater demand, in offsetting the effect of the diminishing labor supply, and in helping the government through the present crisis. It is like buying Liberty Bonds; you are performing a helping act, but really no one is helped quite as much as yourself.

* * *

The fire waste in the United States is appalling, being considerably more than $200,000,000 yearly. Some fires have their origin in conditions that could not be foreseen, but by far the greater part could have been avoided by taking the simple precautions that experience has shown to be effective. When one visits a manufacturing plant consisting of wooden buildings without sprinkler equipment or the more primitive fire-fighting apparatus, and sees waste piled against wooden partitions, floors littered with excelsior, work-benches set against the walls with greasy boxes and litter piled beneath, he feels that the foolkiller is on his way and will arrive sooner or later A clean and orderly shop not only favors production but insures against accidents and fires. The insurance costs comparatively little and is worth many times the price.

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[1] Address 846 Probasco Ave., Cincinnati, Ohio

WOMEN WORKERS IN THE SHOP

BY DONALD A. BAKER[1]

There has been much discussion of late as to the advantages and disadvantages of employing women to replace men in the mechanical industries. As the writer has had considerable to do with women in munition factories both here and in Canada, it may be that his experience will be of value to others.

While on general principles one dislikes the thought of employing women on work that has been done entirely by men, industrial conditions seem to warrant such employment at the present time; and as the conditions have been forced on us, we must make the best of them. Disregarding sex and looking at the problem from a purely economic or commercial standpoint, the employment of women in mechanical lines has many advantages. When proper care is exercised in assigning work that is fitted to a woman's strength, when the hours of labor are kept well within reason, and other things are equal, there is no more reason why women should not be employed than in other lines. Actually, a great deal of the work on which they can be employed in machine shops is lighter and less monotonous than many occupations that have fallen to their lot in the past.

The fact that women, as a rule, are not naturally of a mechanical turn of mind is, strange to say, one of the best reasons for employing them on repetition work, and especially for running machines of a more or less delicate and complicated construction that require some adjustment from time to time. This fact is illustrated by the experience of a Canadian fuse factory. When men were employed on a number of semi-automatic machines it was almost impossible to keep the machines in repair. In spite of everything that could be done, the men insisted upon trying to make their own adjustments and minor repairs. Not being mechanics, they were not provided with the proper tools for this work, and so would use anything they could lay their hands on. Fuse bodies and monkey-wrenches were used for hammers and pieces of pipe, old files, etc., were jammed into the mechanism of the machines. Bearings were tightened until they ran hot and scored. Gibs were tightened until they bound and refused to work or were loosened until the slides ran out of true and spoiled work. Sight-feed oil-cups were stolen and presumably sold for junk. As soon as the men were replaced with women, the repair of the machines became normal. Besides, production began to increase as the girls acquired the necessary skill, until in a few days their production was much greater than that of the men.

These results were due to two things: the misplaced mechanical initiative on the part of the men operators, and the entire lack of this faculty on the part of the women operators. The men would not give the mechanics or toolmakers a proper chance to keep the machines in repair, while the women, when anything went wrong, instead of trying to fix it themselves, were only too glad of the chance to sit back and take a rest while a competent man did the work.

On other classes of work it was found that, when properly managed and disciplined, the women operators acquired greater skill and speed than men employed on similar work. This was especially true of work of a light nature that required speed and accuracy of handling. This is due, in part, to the fact that women's hands and minds are practically untrained to systematic motion, so that they more readily lend themselves to instruction, and when once taught the proper rotation of movements required to do a given task in the least time, they stick to these movements and soon become efficient operators. Men, on the other hand, especially if left to themselves long enough to acquire a wrong method, are more inclined to be stubborn and assume that because the way they are doing the work seems easy to them their way is best, without stopping to analyze it.

As this is the case, if women must be employed, they should be paid equal wages for equal work. Their strength must not be unduly taxed, suitable convenience must be provided for them, and the hours of labor restricted. In return, they will give higher production and lower operating costs.

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[1] Address Care of Anderson Forge Machine Co., Detroit, Mich.

INSPECTION OF SCREW GAGES FOR MUNITIONS OF WAR[1]

MEASUREMENT OF PITCH AND OF FULL, EFFECTIVE AND CORE DIAMETERS

UNTIL recently, the matter of accuracy of pitch of screw gages has been almost entirely neglected, attention in the inspection of such gages being given only to the correctness of the ruling diameters of the thread; that is to the core[2], effective and full diameters.

This measurement must be made with great exactness, since any error in the pitch of a plug screw requires that the pitch diameter be reduced by about twice the amount, in order that the gage may function in an identical way to a similar gage with the proper pitch. In a ring screw gage, the pitch diameter must be increased in a corresponding manner. Within the last two years the question of pitch has forced itself to the front because of the accuracy required in the screw gages used on munitions work, where the allowances for incorrectness of workmanship of the product are very small, being a matter of only a few thousandths of an inch, as a rule, especially in fuse work. For example, a very important gage used on British shells is that which checks the screw in the nose, into which the fuse is fixed. This is a "go" or "low" plug gage, and the tolerances for the accuracy of the gage are as follows:

Tolerance	+ 0.0003 inch — 0.0006 inch	Range 0.0009 inch

If the error in the pitch = 0
- Normal effective diameter: 1.9513 inch
- Maximum effective diameter: 1.9516 inch
- Minimum effective diameter: 1.9507 inch

Thus, for each 0.0001 inch error in the pitch of the plug gage, the gage-maker reduces his "high" limit of the tolerance for the pitch diameter by 0.0002; and finally, if the error amounts to 0.00045, he has no tolerance left on the pitch diameter, but must make it to the low limit. In practice, an error in the pitch of more than 0.0002 inch ought not to be exceeded, in order to leave sufficient margin of tolerance for the effective diameter, to meet workshop requirements.

TABLE 1. LIMITS OF EFFECTIVE DIAMETER

If the Error in the Pitch is	Limits of Effective Diameter	
	High	Low
± 0.0001 inch	1.9514 inch	1.9507 inch
± 0.0002 inch	1.9512 inch	1.9507 inch
± 0.0003 inch	1.9510 inch	1.9507 inch
± 0.0004 inch	1.9508 inch	1.9507 inch
± 0.00045 inch	1.9507 inch	1.9507 inch

Machinery

Errors in the pitch are of two kinds: (1) Variable error; that where the distance from thread to thread varies in an erratic manner. This is generally due to distortion after hardening (through want of proper seasoning, to permit the molecular structure of the steel to come to a stable form. The great demand for gages during the war has prevented sufficient time being given to seasoning, and the distortion that arises affects not only the pitch but also the roundness of the screw), or to faulty adjustment of the thrust bearing of the lead-screw of the lathe or grinding machine. (2) Progressive, or gradually increasing, error is due to a bad lead-screw or else to the lap used for finishing the gage not having an identical pitch to that of the lead-screw on the machine in which the gage was made. The latter cause of bad pitch shows the necessity of making both the lap and gage on the same lathe or grinding machine. In practice, both kinds of error in pitch usually occur in combination; thus a variable error is the resultant, since the positive progressive error is reduced or increased in places by variable errors of the opposite or same sign. The maximum error in pitch between thread and thread, or over a number of threads, is the ruling error in determining the reduction to be made in the effective diameter. Until recently, it was a common practice to stipulate the maximum error in pitch permissible over a given length of thread, such as one-half inch or one inch. This is an incorrect manner of specifying the correctness of the pitch, since thereby an assumption is made that the error is of the progressive type, whereas, as already indicated, it is usually not so. In fact, with the common form of variable error in pitch, cases may happen where a positive error between a thread or two is annulled a little farther on by a similar negative error, and over one-half inch or one inch the resultant error would measure as zero. There exist a number of devices to measure the pitch, based on the idea of measuring over a given number of threads. For example, sometimes two blocks, similar to Johansson blocks, are used with their ends ground to a triangular form of the same included angle as that of the screw to be checked; between these are placed Johansson blocks to give the correct distance corresponding to the number of threads over which the measurement is to be made. The piece is then inserted into the screw and the bearing of the points on the slopes of the screw observed under a magnifying glass; if the bearing is not satisfactory, the Johansson blocks are changed for others differing by the number of tenths of a thousandth of an inch considered convenient to give the desired bearing. The objection to this method of measuring the pitch is the personal equation brought in by the observer having to watch by eye for the proper bearing of the points in the thread, and, further, the fact that the points cannot be brought near enough together to measure between adjacent threads, because the blocks have to be of a certain minimum thickness. Another instrument has two V-pointed pieces, one of which is fixed and the other movable, parallel to the first. The movable point is connected to a long lever arm which moves over a scale graduated to give readings in thousandths of an inch. The screw is inserted between centers and gradually raised to the V-points, being turned on its axis, meanwhile, until both V-points bear evenly in the thread. The bearing is observed under a magnifying glass, assisted by a light fixed behind the screw. This instrument does not give readings reliable to more than 0.0002 or 0.0003 inch, and, further, the pitch is measured on the fixed distance of one-half inch. There are numerous other devices of a similar nature, which all suffer from the fundamental defects noted in the instruments described. There are a few machines to measure the pitch from thread to thread, but they have the defect that the accuracy of the operation depends on the care taken by the user.

In England an ingenious method has been used by Mr. Vidal in his patented pitch measuring machine. The V-point is substituted by a ball, so that it can bear evenly in the thread whatever the inclination of the spindle to which it is fixed, and the ball is split, with a lamina of mica interposed to insulate the two portions. Electric circuits are made between the halves of the ball and the screw, and will close only when the ball is touching the slope of the thread on both sides. The spindle with the ball is connected to a longitudinal carrier of a triangular truss form with a spring arranged to press it toward the screw, and so keep the ball in continual light contact with the thread. The adjustment given by the spring is so delicate that the carrier can be blown away from contact by the breath. The carrier is attached to a micrometer head. To obtain a perfect contact with the screw, the latter and the ball must be quite clean and free from all grease, since otherwise the electric circuit will not close. This incidental condition of working gives a further guarantee of accuracy, because the operator of the instrument knows that he is obtaining a true contact on the thread, without a film of oil intervening.

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[1] Abstract of a pamphlet by H. J. Bingham Powell, the inspector in charge of the department of gages and standards of the British Ministry of Munitions of War in the United States, 165 Broadway, New York City. Published by permission of the author.

[2] In this abstract, the terms employed for the ruling diameters of a screw are those adopted by the Engineering Standards Committee of Great Britain, and are as follows: "full" (or major) diameter, "effective" (or mean) diameter, "core" (or minor) diameter, corresponding, respectively, to the terms "outside," "pitch," and "root" diameters, used in the United States.

A very good pitch measuring machine is used by the National Physical Laboratory of the Department of the British Government in charge of the inspection of gages. The screw is mounted on the centers of a stiff bed which carries a saddle sliding parallel to the line of centers. The feeler carried by the saddle takes the form of a small spherical ball at the end of a bent lever. The ball is held pressed into the threads of the screw by a light spring, and as the saddle is traversed along, the ball moves to and fro, always remaining in contact with the screw. The ball is too large in diameter to reach the bottom of the thread. In its motion it slides down one flank of the thread until it is arrested by contact with the opposite flank, when it immediately begins to move up this flank; this change of motion is very sharply defined. By noting on the micrometer screw the positions of the slider at which these changes of motion take place, we clearly have a means of measuring the pitch of the screw. To effect this, a mirror is attached to the arm carrying the small sphere and rotates backward and forward as the arm moves. A spot of light reflected from the mirror onto a scale moves in one direction, then stops and moves back; after a time, its motion is again reversed, and so on. The sharp reversals caused by the point of contact of the sphere passing from one flank of the screw to the opposite flank are clearly defined, and by their means an accurate measure of the pitch is obtained.

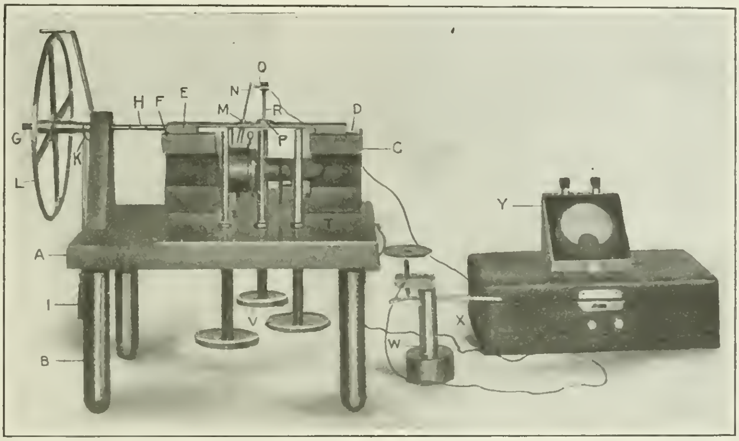


Fig. 1. Bingham Powell Pitch Machine

By a suitable arrangement of the "feeler," the pitch of ring screw gages can be measured, the gages being fixed on a faceplate at the end of the instrument. Fig. 1 shows a machine used by the gage department of the British Ministry in the United States. It consists of a base *A* in the form of a surface plate supported at the corners by screwed legs *B* for leveling purposes. At the back of the base are two cast-iron brackets *C* with double V-ways of hard steel *D* to carry balls. On the bracket runs a "carriage" *E* made in the form of a long, narrow plate of suitable thickness for stiffness, and with the ends carrying V-ways *F* corresponding to those on the brackets. The carriage is pushed to and fro by a micrometer head *G* bearing on a round-ended spindle *H* screwed into the carriage, the spindle being maintained in contact with the micrometer spindle by a light weight *I* on cords passing over hooks *K*. The micrometer head carries a large aluminum disk *L* divided into 250 divisions on the periphery, each spacing being 1/10 inch long, so it is easy to read to ten-thousandths of an inch and even to a fifth of that amount, if a good micrometer is acquired. On the axis of the carriage is a V-opening *M*, against which the ball-ended spindle *N* rests (at a point about two-fifths of its length from the ball), in a slightly inclined position (about 7 degrees with the vertical). The lower end of the spindle is restrained from side movement by parallel guides *O* ground in the foot of an L-piece fastened to the under side of the carriage. The opening in the guides is only about 0.00015 inch wider than the diameter of the spindle; thus, although the latter has entire freedom of movement in the vertical plane containing the axis of the carriage and the screw gage, it has none in a plane at right angles. The spindle is of smaller diameter in the portion *P* projecting above the carriage, and at the top can be brought to bear, by moving the carriage to and fro, into contact with a knife-edged electric contact *Q* carried on a small post *R* fixed into the carriage. The screw gage *S* is carried on V-blocks and held from longitudinal movement by a stout rubber band passing through hooks in the base of the machine *T*. The blocks have ways at the sides, to slide on carefully adjusted posts, fixed in the base of the machine, so that the axis of the gage, carriage and ball-ended spindle are always in the same vertical plane. The V-blocks can be slowly raised or lowered by fine screw motions at *V*. It is most important that the top of the threads of the gage should be truly horizontal; this is obtained by using an electric level *W* in the form of an adjustable arm *X* carried on a post whose base rests on the surface plate or base of the machine.

The level is brought over one end of the screw gage and the latter is then slowly raised by screwing up the V-block until the arm of the level just lowers at the back from contact with its adjustment screw; this is shown by an electric circuit being broken through a galvanometer *Y*. Then the level is moved along to the other end of the screw, which is similarly raised to the proper height by the V-block at that end. The ball-ended spindle is afterward placed into the first thread of the screw, and the carriage slowly moved to the left or right until the top of the spindle (which swings about and slides through the V-support) just touches the knife-edge, as shown by the electric circuit being completed through the galvanometer. The reading of the micrometer is noted. The spindle is raised and inserted into the second thread and the carriage again moved until electric contact with the knife-edge is obtained. The difference of readings of the micrometer will give the pitch between the first and second threads; and so on for the succeeding threads. The ball point and gage must be free from oil or dirt, to obtain an electric circuit, and thus an additional factor in favor of accuracy is obtained.

To take the pitch of ring screw gages, a special appliance has been designated in which the mold is made and afterward placed into the V-blocks of the machine and treated as a plug screw gage. This appliance has centers so that it may be also used to carry the casts in the projection apparatus for throwing an enlarged (fifty times) image of the thread onto a screen, to see that the angle of the slopes and the rounding at the crest and root are correct. It is useless to take a cast filling up the ring, as it is usually spoiled in being withdrawn, and, further, as the cast has to be unscrewed to do this, the material, if plastic, will take the form and pitch of the last thread, and so be worthless. Thus only a small segment of the thread should be molded. In the ordinary way it is troublesome to do this; also, as usually obtained, the cast has no centers or reference axis parallel to the thread for setting up in a pitch or other measuring machine. As the gage is made against a faceplate, the cast should be carried in an apparatus with its axis exactly at right angles to the face of the gage in order to be able to use it in a pitch machine. The apparatus used is shown in Fig. 2, and consists of a small square base of plate steel with the surfaces ground true. Into the plate is screwed exactly at right angles a spindle with an inclined wedged shape slot at the bottom. The gage is placed

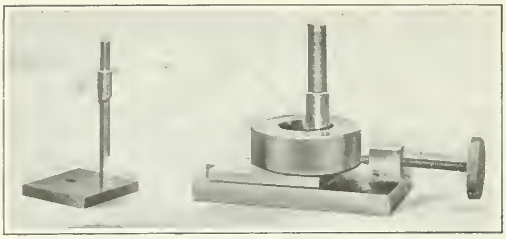


Fig. 2. Apparatus to take True Casts of Ring Screw Gages

on the plate and held against the slot of the spindle by a clamp. The sleeve on the spindle is brought down, so that the slot is not open more than the proper length where the screw bears. A melted composition of 7 per cent graphite and 93 per cent sulphur is poured into the slot. When set, the clamp is removed and the gage carefully drawn away from the spindle, over the baseplate. A perfect cast of the thread remains in the spindle, and it cannot fall out, as the smaller opening of the wedge is below when the spindle is placed in the pitch machine. The cast of the thread as taken is absolutely parallel to the spindle and at right angles to the baseplate, and so is in the correct condition for measurement.

Measuring Plug Screw Gages

The usual way of measuring the full diameter of plug screw gages is by an ordinary micrometer. This is sufficient, since a machine, such as described below for checking the other diameters, is not suitable, for the reason that the micrometer spindle face may not be absolutely parallel to the face of the screw, and so give a false reading; whereas for the effective and core diameters, a slight want of squareness of the micrometer face will not appreciably alter the result, because the bearing is on a wire or triangular piece, and is therefore self-adjusting. However, in measuring the full diameter, care must be taken to see that this is done on several diameters at right angles to each other, to note distortion, and also at different points along the screw for taper. The effective diameter is measured by either thread micrometers or wires or, preferably, by both, as any difference observed by the two methods shows that the thread is of either bad form or else is "staggered" (inclined to one side along the axis of the screw); but these defects are better seen in a projection apparatus. The thread micrometer should never be used alone, because it bears only on protruding points on the slopes of the thread. Also, the point of a micrometer wears rapidly, and it is difficult to check it accurately, the V-pieces supplied by makers being generally not very reliable.

Screw measuring machines have been devised where the thread micrometer principle is used. One of these has a true surface base and, suspended above, a micrometer head with the spindle ground at the point to the angle of the thread (55 degrees for the Whitworth thread, 60 degrees for the metric and U. S. standard thread, and 47½ degrees for the British Association thread). On the base rest little blocks, with the tops ground to a V-edge, of the same angle. The screw is seated on two of these blocks, placed as near together as possible, and then the micrometer point brought down to bear, the "feel" being obtained by moving the screw to and fro on the blocks. The objection to this instrument is that the bearing on the blocks must be at a number of threads apart, because of the thickness of the blocks, and so the result obtained is only the mean effective diameter along the screw between that number of threads, which is an inaccurate condition if the gage is at all tapered.

The wire system of measuring the effective diameter is the most satisfactory, but only when properly carried out. The system used by the writer is to have two diameters of wires for each pitch of the thread, one to give the wire a bearing just on the theoretical effective diameter of a correct screw, and the other such that the wire rests in the screw just near its crest, but avoiding the rounding of the crest in the case of the Whitworth thread. The wires resting on the true pitch diameter of a correct screw are known as "best" diameter wires, and their sizes are as follows:

TABLE 2. BEST DIAMETER WIRES

Number of Threads per Inch	Best Diameter Wire	
	Whitworth Thread	U. S. Standard Thread
12	0.0470 inch	0.0481 inch
14	0.0403 inch	0.0412 inch
20	0.0282 inch	0.0289 inch
24	0.0235 inch	0.0241 inch
32	0.0176 inch	0.0180 inch
36	0.0156 inch	0.0160 inch
40	0.0141 inch	0.0144 inch

Machinery

These diameters are calculated from the simple formula:

Best diameter of wire $= D$;

Pitch of thread $= \dfrac{1}{\text{Number of threads per inch}} = P$;

Included angle of the thread $= A$;

then $D = \dfrac{P}{2} \times \sec\dfrac{A}{2}$.

For the different types of threads, we thus have:

Whitworth: $D = 0.5637P$;
U. S. Standard: $D = 0.5774P$;
British Association: $D = 0.5463P$.

The wire that bears near the crest of the thread is known as the "maximum" diameter wire, and for both the Whitworth and U. S. standard threads the size can be taken as 1½ times the best diameter wire for the same pitch.

Therefore the maximum diameter wires for the several pitches will be as follows:

TABLE 3. MAXIMUM DIAMETER WIRE

Number of Threads per Inch	Maximum Diameter Wire	
	Whitworth Thread	U. S. Standard Thread
12	0.0705 inch	0.0721 inch
14	0.0605 inch	0.0618 inch
20	0.0423 inch	0.0434 inch
24	0.0353 inch	0.0362 inch
32	0.0264 inch	0.0270 inch
36	0.0234 inch	0.0240 inch
40	0.0212 inch	0.0216 inch

Machinery

These maximum diameter D wires are calculated from:

Whitworth Thread: $D = 0.8456P$;
U. S. Standard Thread: $D = 0.8661P$;
British Association: $D = 0.8195P$.

It is not much use employing wires of a smaller size than the best diameter, as they would get too far down into the thread and give no free bearing on top for the micrometer. The thread micrometer, used in conjunction with the two sizes of wire recommended, will generally show anything wrong in the thread below the point where the wire bears, if the screw is correct in form. The wires must be accurately ground to size and be round; also, the exact size of the wire must be taken in a measuring machine to a hundred thou-

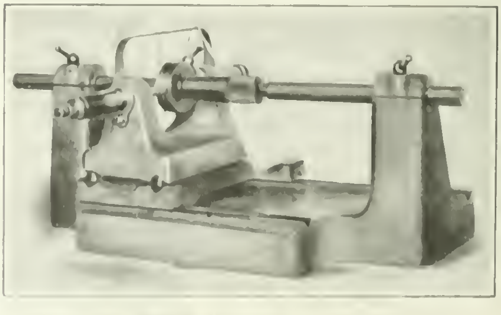


Fig. 3. Screw Measuring Machine used by the National Physical Laboratory of England

sandth of an inch. These conditions are most essential, because any difference in the diameter of the wire is multiplied by three (or more, see formula for K below), in the reading of the effective diameter. A convenient specification for wires is as follows:

1. Each wire must be round and to the diameter given; the combined error in roundness and diameter not to exceed 0.00005 inch.
2. Each wire must be measured on a measuring machine to 0.00001 inch and the mean diameter given on a label attached to the wire.
3. Each wire will be two inches long (this is an average size; for very large screws the length will be in proportion). Only the center half inch will be of the exact dimensions specified; the remaining portions of the wires can be blackened, and should be approximately 0.001 inch to 0.002 inch less in diameter than the central portion.
4. The wires are to be of hardened steel, and one end softened, and bored or turned over to make a loop to fasten the thread of the label to.

To use these wires a constant K must be calculated.

Let D = mean diameter of the two or three wires used;
A = included angle of the thread;
P = pitch of the thread.

Then: $$K = D\left(1 \cos \frac{A}{2}\right) - \left(\frac{P}{2} \cot \frac{A}{2}\right)$$

Thus, for the several types of thread, we have:

Whitworth: $K = 3.1657D - 0.9605P$;
U. S. Standard: $K = 3.0000D - 0.8660P$;
British Association: $K = 3.4829D - 1.1363P$.

Given K, the micrometer reading over the wires minus K equals the pitch diameter of the screw. In use, the diameters of the wires should be checked from time to time for wear, and, if necessary, the constant K recalculated.

The common way to use the wires in workshops is to employ three in number, two in adjacent threads on one side of the screw and one in an intermediate position in the corresponding thread on the other side. The wires are usually held down into the screw by elastic bands. If the wires are sufficiently large in size not to bend under the pull of the bands, there is no objection, but often this is not so, and should the wires bend, a false reading is obtained. A better method is to use Johansson blocks in the holder provided with the set, and to make the distance between the jaws equal to the measurement over the wires corresponding to the correct effective diameter. The caliper so made is placed over the screw and the needles pushed into the thread; if the feel is not satisfactory, the distance between the blocks is varied by 0.0001 inch until it is. But the best system of measuring the effective diameter is to have a special machine for the purpose. In Fig. 3 is shown a machine designed by the National Physical Laboratory of England, consisting of a light carriage moving on balls in V-ways, across a platform, or base, underneath. On each side of the carriage are brackets, one of which carries a micrometer anvil which can be clamped in the bracket at any position along its length, and the other has a fixed micrometer head. By adjusting the position of the anvil, the gap of the micrometer can be arranged to suit the diameter of the gage being inspected, the zero of the reading being fixed by Johansson blocks. The carriage can be moved along the platform laterally to bring the micrometer opposite any thread of the screw; this motion is over small cylinders resting in V-ways in the platform and the under side of the carriage. Cylinders are used to permit an easy motion, but at the same time allow sufficient friction to keep the carriage in any given position. The screw gage is carried in adjustable centers in brackets on the ends of the platform. Across the carriage is a light steel support, with a narrow groove to allow the thread of the wires to pass, carrying the wires. An attachment for the Pratt & Whitney measuring machine has been made from designs by the writer, based on the principle of the screw measuring machine just described. With this attachment, master plug screw gages can be checked to about 0.0001 inch.

With these screw measuring instruments it is better to use one wire only at each side of the screw, of diameters as nearly equal as possible. The wires are suspended into the thread, opposite one another, and the micrometer head screwed in until it touches them. The feel is almost perfect because of the frictionless movement of the carriage. To check the core diameter of plug screw gages, small triangular pieces are employed, ground to an included angle of a few degrees less than that of the screw, the edge of the piece that bears on the thread being slightly rounded; these pieces are suspended in a similar way to the wires. The width across each triangular piece being known, the subtraction of the sum of the widths of the two pieces from the micrometer reading gives the core diameter of the screw. To check the core diameter, an ordinary micrometer, with the spindle ground to a convenient angle and the sharp point removed, may be used, or an ordinary micrometer may be employed in conjunction with triangular pieces, such as those described above for the machine. When the three ruling diameters of a screw have been checked, in planes at right angles to each other, at different points along the thread, the concentricity of these diameters should be measured over a few places. This is an important proceeding if separate laps are used for bringing the gage to size on the core, effective and full diameters, respectively, since, as this is thus done in three distinct operations, the diameters may not be concentric. Alterations in the structure of the steel after hardening would also cause the same defect. The same reasoning would apply to screws ground to size, when employing different wheels for correcting the three diameters. The eccentricity is readily found by using one wire or one triangular piece, in the diameter measuring machine previously referred to, and measuring the full diameter. Observations are made on the variation in reading the full diameter obtained during one revolution of the gage, keeping on the same thread. Eccentricity of core and effective diameters can be similarly found by using the triangular piece and wire, respectively, on opposite sides of the gage. Before leaving the subject of the measurement of the three diameters of plug screw gages, attention may be drawn to the difficulty of obtaining the core diameter correct within the low limit where the gage is ground to size. Also there are two other important objections to grinding to size. (1) The surface of the thread always has grinding marks, which bring about more friction when using the gage in the product, and so increased wear. (2) The rough surface of the thread may cause seizing of the gage in the product in the cases of a tight fit. Thus it is advisable to lap threads after grinding.

Checking Ring Screw Gages

The checking of ring screw gages is very little understood, as at present usually practiced. The common method is to employ a single screw plug of normal dimensions on the core, effective and full diameters; or else on the effective and full diameters only and with a low core diameter, so that a plain plug has to be used to check the latter element of the thread of the ring gage. If such checks go into the gage, the test is considered satisfactory. But, of course, it is not so, for the plug may give a good fit if it bears on one diameter only, and the other diameters of the ring gage could be large, beyond the tolerance. Logically, if in the case of a plug screw gage each diameter is checked separately, the same procedure should be observed in the case of a ring screw gage, but this is rarely done. Of course, it is practically impossible to so check a ring screw gage by direct measurements, but it can be carried out quite easily by indirect methods. For instance, if for a ring screw gage the following set of plug checks is provided, each diameter is duly taken care of. The checks are:

1. A "not go" full diameter check. This is a screw check of a full diameter equal to that of the ring screw gage, on the high limit. The angle between the slopes of the thread at the crest is made a couple of degrees less than the included angle of the normal thread. The rounding at the top of the thread is of sharp radius, and the core diameter that corresponding to a V-root. Such a check can only bear on the full diameter. Not more than a couple of threads are advisable, to minimize the effect of errors on the pitch entering into the result

2. A "not go" effective diameter check. This has the effective diameter equal to the high limit of that element of the ring screw gage. The crest of the thread is made flat, and the root of the thread carried down to a vee. Two threads are enough. This check can only bear on the effective diameter of the screw ring gage.

3. A "go" effective diameter check. This is similar to No. 2, only the effective diameter is made to the low limit of the effective diameter of the screw ring gage.

4. A full form "go" check. This should have the dimensions of the low limits of the ring screw gage on the full, effective and core diameters, and contain the same number of threads. The rounding at the crest and root must be correct. Such a check tests the three diameters on the low limit, the roundness at the crest and root, and also proves that the pitch is correct if it screws right home into the gage.

5 and 6. "Go" and "not go" core diameter checks. These can be in the form of a double ended plain plug, with the two diameters the same as the high and low limits, respectively, of the core diameter of the ring screw gage.

The ruling diameters of each of these checks should not have a greater tolerance, in any case, than + 0.0001 inch for the "not go" checks and — 0.0001 inch for the "go" checks. The error in the pitch should not be beyond ± 0.0001 inch.

With a set of checks on this system the manufacturer knows at every stage of the finishing of the ring screw gage how the work is proceeding, and a great number of spoiled gages will be avoided by their use. For inspection purposes, a set of checks as above is also desirable, but not essential, since a ring screw gage can be satisfactorily inspected if only Nos. 1, 2, 3 and 4 are used.

The form of the thread of a ring screw gage is checked by No. 4, but as an additional measure it can be observed by taking a cast of the thread, employing such an apparatus as that shown in Fig. 2. The cast should be placed in a projection apparatus, so that an exact image, enlarged fifty times, can be thrown onto a screen and compared with a carefully drawn out enlargement of the thread made on cardboard and adjusted on the image.

In concluding this account of accurate methods of checking screw gages, a recapitulation of the essential equipment may be made. This should consist of:

1. A pitch measuring machine to read from thread to thread, to at least 0.0001 inch.
2. An appliance to take casts of ring screw gages, so arranged that the cast may be accurately set up in the pitch machine, or projection apparatus.
3. A screw measuring machine to check the governing diameters of a plug screw gage with accuracy to 0.0001 inch. An equipment of best diameter and maximum diameter wires, and triangular pieces for same.
4. Thread micrometers, checked for accuracy, to use in conjunction with the screw measuring machine.
5. Ordinary micrometers, to measure full diameters, with Johansson blocks to keep them accurate.
6. Complete sets of check plugs for the several diameters, pitch and form of thread of ring screw gages.

Finally, the equipment would be complete with a projection apparatus for observing the angle between the slopes of the thread, and the form of the thread.

• • •

STATE REVENUES

According to the United States Bureau of the Census, twenty-six states are not paying, from their revenues, their total expenses for governmental costs, interest on indebtedness and outlays for permanent improvements; and of this number eleven are not even meeting their current expenses and interest. In twenty-two states, however, the revenues exceed the total expenditures for current expenses, interest and outlays. The aggregate revenues of all the states during last year were $466,946,74[illegible], the aggregate expenditures for current governmental costs, including interest on indebtedness, $425,071,093; and the aggregate outlays for permanent improvements, $85,063,206. About 78 per cent of the total revenues is received from taxes.

SPECIFICATIONS AND INSPECTORS

A little knowledge is a dangerous thing, and nowhere, perhaps, as dangerous as in the mind of an inspector of war materials who tries to fulfill his duties conscientiously, but whose previous training for this work has not made it possible for him to master all the little details of mechanics and metallurgy. Recently, at a large factory building airplane motors for the government, the superintendent brought the inspector a record of the analysis made of some nickel steel specified in the contract. The specifications called for 3.5 nickel steel with certain physical properties, and the analysis read as follows: Nickel, 3.47 per cent; manganese, 0.63 per cent; phosphorus, 0.03 per cent; sulphur, 0.02 per cent; carbon, 0.33 per cent. When the inspector came to the carbon content, he promptly pushed the paper away from him, saying, "Rejected; this should be nickel steel and it contains carbon, and is a low carbon at that."

In another case, a conscientious inspector carefully added together the percentages of the chemical analysis for a nickel-chromium steel and found that the total of the chromium, nickel, manganese, carbon, phosphorus and sulphur added up to exactly 5.73 per cent. Turning to the superintendent, he said: "Your chemist must have made some mistake here; his analysis ought to add up to 100 per cent, and it only adds up to 5.73. Probably he has got the decimal point wrong somewhere!"

* * *

RESERVOIR CONTROL FOR OHIO RIVERS

Plans have been made for checking floods in the Miami Valley of Ohio which, it is confidently believed, will prevent a repetition of the Dayton disaster, the plans adopted being a combination of channel improvements and reservoirs. The system of reservoirs is capable not only of taking care of ordinary floods, but of emptying gradually into the river a flood lasting from eight to twenty days, if any such flood should occur. The reservoir control is to be accomplished by five retarding basins, one above Piqua, four above Dayton and one above Hamilton. These basins will be formed by dams built across the Miami, Mad and Stillwater Rivers, and some of the smaller streams. Each dam will have a permanent opening through its base through which the ordinary flow of the river will pass unimpeded. During large floods the water which cannot pass through the outlet conduits will be held back temporarily in the basins above the dams. The conduits are proportioned so that no more water can pass through them than can be carried safely in the channels through the cities below.

* * *

TECHNICAL MEN FOR U. S. SERVICE

The attention of technical graduates is called to the opportunities for war service in an announcement issued by Major J. E. Bloom, U. S. A., Newark, N. J. Men skilled in any line of science or mechanics, electrical or chemical work, ordnance, explosives, mining or shipbuilding, railroads, motors, metallurgy, building of airplanes, water supply or sanitation are urgently needed. The Army wants such men between the ages of eighteen and forty years to enlist for the period of the war. Men with a technical education but unable to volunteer are invited to cooperate by organizing guilds, societies and other bodies that can be made most helpful to government war work by expert direction

* * *

EXPERT TOOLMAKERS WANTED

The National Bureau of Standards has not yet obtained all the men needed to fill expert toolmaker positions with salaries of $1500 per year. The duties in such positions are the making of apparatus for testing gages for military purposes. Seven and a half hours constitute a day's work, and a vacation of thirty days with pay is given except when conditions prevent. Men who are qualified to fill such positions are urged to communicate at once with the Bureau of Standards, Washington, D. C., stating their training and experience, age, place of birth and references

WAR DEPARTMENT TOLERANCES FOR SCREW THREADS

The tolerances recorded in the accompanying table have been established by the Ordnance Department for use in the manufacture of artillery ammunition, trench warfare material, and gun parts, in cases where the U. S. standard form of thread is used. At the present time, nearly all ordnance designs of screw threads are based upon the "medium fit" given in the table, but it is proposed to use all three fits, in each case allowing the largest tolerance that can be permitted without affecting the proper function of the parts under consideration.

In the manufacture of artillery ammunition, where the parts are only expected to function temporarily, or perhaps only one time, it would manifestly be absurd to require such fits as are necessary on machinery subjected to vibration and wear. Another consideration of great importance is that the production is decreased when the closer fits are required, and evidently production is one of the main requirements at the present time. It is believed that manufacturers will find no difficulty in meeting the requirements of the medium fits, and judging by the experience of American manufacturers in fulfilling the early requirements of the British and Russian governments, there should be little difficulty in meeting even the close fits.

The last column in the table, which gives the minimum strength corresponding to the various fits on the assumption

ORDNANCE DEPARTMENT TABLE OF TOLERANCES FOR SCREW THREADS (U. S. STANDARD FORM)

CLOSE FIT

Number of Threads per Inch	Tolerances on Screws			Neutral Space between Maximum Screw and Minimum Nut	Tolerances on Nuts			Minimum Per Cent Strength (Approximately)
	D Full Diameter	E Effective Diameter	K Core Diameter		D_1 Full Diameter	E_1 Effective Diameter	K_1 Core Diameter	
4–6	+ 0.000 — 0.008	+ 0.000 — 0.008	+ 0.000 — 0.025	0.008	— 0.000 + 0.025	— 0.000 + 0.008	— 0.000 + 0.008	87
7–10	+ 0.000 — 0.006	+ 0.000 — 0.006	+ 0.000 — 0.016	0.006	— 0.000 + 0.016	— 0.000 + 0.006	— 0.000 + 0.006	84
11–18	+ 0.000 — 0.005	+ 0.000 — 0.005	+ 0.000 — 0.010	0.005	— 0.000 + 0.010	— 0.000 + 0.005	— 0.000 + 0.005	76
20–28	+ 0.000 — 0.004	+ 0.000 — 0.004	+ 0.000 — 0.008	0.004	— 0.000 + 0.008	— 0.000 + 0.004	— 0.000 + 0.004	70
30–40	+ 0.000 — 0.003	+ 0.000 — 0.003	+ 0.000 — 0.006	0.003	— 0.000 + 0.006	— 0.000 + 0.003	— 0.000 + 0.003	68
44–56	+ 0.000 — 0.002	+ 0.000 — 0.002	+ 0.000 — 0.004	0.002	— 0.000 + 0.004	— 0.000 + 0.002	— 0.000 + 0.002	70
64–80	+ 0.000 — 0.0015	+ 0.000 — 0.0015	+ 0.000 — 0.003	0.001	— 0.000 + 0.003	— 0.000 + 0.0015	— 0.000 + 0.0015	70

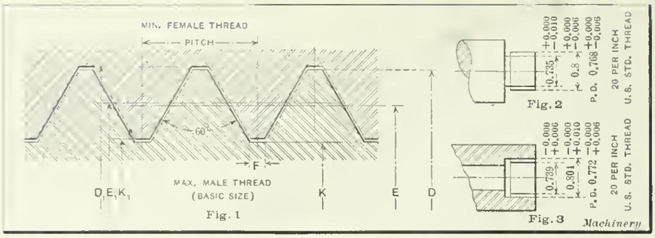
MEDIUM FIT

Number of Threads per Inch	Tolerances on Screws			Neutral Space between Maximum Screw and Minimum Nut	Tolerances on Nuts			Minimum Per Cent Strength (Approximately)
	D Full Diameter	E Effective Diameter	K Core Diameter		D_1 Full Diameter	E_1 Effective Diameter	K_1 Core Diameter	
4–6	+ 0.000 — 0.016	+ 0.000 — 0.016	+ 0.000 — 0.035	0.008	— 0.000 + 0.035	— 0.000 + 0.016	— 0.000 + 0.016	78
7–10	+ 0.000 — 0.012	+ 0.000 — 0.012	+ 0.000 — 0.022	0.006	— 0.000 + 0.022	— 0.000 + 0.012	— 0.000 + 0.012	72
11–18	+ 0.000 — 0.008	+ 0.000 — 0.008	+ 0.000 — 0.014	0.005	— 0.000 + 0.014	— 0.000 + 0.008	— 0.000 + 0.008	65
20–28	+ 0.000 — 0.006	+ 0.000 — 0.006	+ 0.000 — 0.010	0.004	— 0.000 + 0.010	— 0.000 + 0.006	— 0.000 + 0.006	60
30–40	+ 0.000 — 0.004	+ 0.000 — 0.004	+ 0.000 — 0.007	0.003	— 0.000 + 0.007	— 0.000 + 0.004	— 0.000 + 0.004	60
44–56	+ 0.000 — 0.003	+ 0.000 — 0.003	+ 0.000 — 0.005	0.002	— 0.000 + 0.005	— 0.000 + 0.003	— 0.000 + 0.003	59
64–80	+ 0.000 — 0.002	+ 0.000 — 0.002	+ 0.000 — 0.003	0.001	— 0.000 + 0.003	— 0.000 + 0.002	— 0.000 + 0.002	63

LOOSE FIT

Number of Threads per Inch	Tolerances on Screws			Neutral Space between Maximum Screw and Minimum Nut	Tolerances on Nuts			Minimum Per Cent Strength (Approximately)
	D Full Diameter	E Effective Diameter	K Core Diameter		D_1 Full Diameter	E_1 Effective Diameter	K_1 Core Diameter	
4–6	+ 0.000 — 0.030	+ 0.000 — 0.030	+ 0.000 — 0.045	0.008	— 0.000 + 0.045	— 0.000 + 0.030	— 0.000 + 0.030	61
7–10	+ 0.000 — 0.020	+ 0.000 — 0.020	+ 0.000 — 0.030	0.006	— 0.000 + 0.030	— 0.000 + 0.020	— 0.000 + 0.020	56
11–18	+ 0.000 — 0.012	+ 0.000 — 0.012	+ 0.000 — 0.018	0.005	— 0.000 + 0.018	— 0.000 + 0.012	— 0.000 + 0.012	51
20–28	+ 0.000 — 0.008	+ 0.000 — 0.008	+ 0.000 — 0.012	0.004	— 0.000 + 0.012	— 0.000 + 0.008	— 0.000 + 0.008	48
30–40	+ 0.000 — 0.006	+ 0.000 — 0.006	+ 0.000 — 0.008	0.003	— 0.000 + 0.008	— 0.000 + 0.006	— 0.000 + 0.006	46
44–56	+ 0.000 — 0.004	+ 0.000 — 0.004	+ 0.000 — 0.006	0.002	— 0.000 + 0.006	— 0.000 + 0.004	— 0.000 + 0.004	48
64–80	+ 0.000 — 0.003	+ 0.000 — 0.003	+ 0.000 — 0.004	0.001	— 0.000 + 0.004	— 0.000 + 0.003	— 0.000 + 0.003	47

Machinery



Figs. 1 to 3. Illustrations showing the War Department's Method of giving Tolerances on Screw Threads

that the male and female threads have the same lead, will prove of considerable interest. The figures give the strength in per cent of the strength of the unthreaded bolt.

In connection with drawings of screw threads, the Ordnance Department specifies that all diameters of the maximum male thread, or basic size, are to be expressed in the closest thousandth of an inch. In the table, the expressions "full diameter," "effective diameter," and "core diameter" are used. The full diameter is the outside diameter; the effective diameter is what is also often known as "pitch diameter" or "angle diameter"; and the core diameter, what is frequently known as "root diameter." The tolerances specified in the various classes of fits for the core diameter of a screw and the full diameter of a nut differ from those specified for the other diameters. This condition results in the possible production of a thread of which the flat at the root is less than that of an accurate U. S. form of thread. This is permitted in order to allow additional wear of the cutting tools and thus facilitate the manufacture. The tolerances for the core diameters of screws and the full diameters of nuts are so proportioned that taps and threading tools may be made with a flat which is 75 per cent of the standard flat. In order to prevent errors in the construction of gages and threading tools, however, a note should appear conspicuously on all part drawings, as follows: "Threads do not conform at root to U. S. form, owing to the additional tolerances allowed."

In the accompanying illustration, Fig. 1 illustrates the condition of what might be called the "neutral" space, when the female part, or nut, is at its minimum and the male part, or screw, is at its maximum. The maximum screw is the basic size from which all dimensions are computed. All tolerances applied to the diameters on the screw are "minus" (—); all tolerances applied to the diameters on the nut are "plus" (+). Fig. 2 illustrates the dimensions and application of the tolerances of a screw as they would be given on a drawing, and shows how a screw thread of medium fit would be dimensioned. Fig. 3 shows the dimensions and tolerances of a nut corresponding to the screw shown in Fig. 2.

* * *

CONTINUOUS MILLING

In any scheme of so-called "continuous milling" the object is to keep the cutters at work the maximum time possible. Continuous milling machines are of the rotary work-table and planer-table types. The rotary table machine is set with its table axis either vertical or horizontal. The vertical axis type has the advantage of easy loading and inspection of the cutter at work, while the horizontal axis table can be made to work between opposed cutters, which mill the pieces on both ends simultaneously and to length. This machine requires a polygonal work-table with work-holding fixtures on the respective faces. More time is lost while the cutter is feeding from one piece to the next in the horizontal axis machine than on the vertical because of the fixed diameter of the loading circle, but this lost time may be considerably reduced by automatically speeding up the feed motion between cuts.

The planer table type machine may be used for continuous milling in several ways. The work pieces may be strung on the table and milled with the table feeding "against the cutter" until the limit of traverse is reached, and then the feed is reversed to travel "with the cutter." The work pieces are removed as soon as finished and replaced by others. The objection to this method is the difference in cutter action on the forward and return feed. Another method successfully employed in motor car work is to remove parts as soon as they are milled and return the table by a quick traversing motion. The work pieces in the first rank are quickly clamped in position and the feed thrown in. The filling up of the table is done while the pieces first placed are being milled. This plan is most successful on large machines on which two men can be kept busy. On light milling suited to Lincoln type machines the "drop table" may be employed to secure rapid production. The table is reloaded as the work is milled, and at the end of the traverse it drops a fraction of an inch to clear the cutters and reverses. On completing the reverse motion, the table rises to the cutting level and the operation is repeated. In this way the work always approaches the cutter from the same side.

A new way of continuous milling on planer-type machines has come into limited use during the past few years, which is known as the removable platen method. The work is loaded onto a short platen while at rest on a bench alongside of the machine, and the platen is then hoisted and lowered onto the ways. A rack on the under side engages the longitudinal feed-screw and feeding toward the cutter begins. Meanwhile a platen ahead carrying similar parts has passed beyond the cutters and is ready to be unloaded. This is hoisted and trolleyed to the head end of the machine and lowered onto the bench, where the work is removed and more pieces put on. The operation is thus kept up continuously. The minimum number of platens required is two, but three, four or five are often used.

* * *

ANNUAL CONVENTION OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

As the keynote of the annual convention of the American Society of Mechanical Engineers, which was held in New York City, December 4 to 7, was the service rendered by the mechanical engineer in time of war, it is evident that all the important papers and sessions had some bearing upon war work. The report by the gage committee and the resolution passed in connection with the presentation of this report is mentioned elsewhere in this number; the machine shop session also being concentrated upon gaging and inspection, gave this subject due prominence during the convention. It may be expected that on the basis of what was said and done further progress will be made, and more detailed attention given to many of the important problems in connection with the manufacture and inspection of war materials.

Charles T. Main, who was elected president of the society, has for many years been prominent as a consulting engineer in Boston, having designed and supervised the construction of many steam and water power plants, some of his largest undertakings being the Wood Worsted and the Ayer Mills in Lawrence, Mass., and four hydraulic developments for the Montana Power Co., aggregating about 280,000 horsepower. Mr. Main has been a member of the American Society of Mechanical Engineers since 1885 and has served on its board of managers for the past three years. He is also a member of the American Society of Civil Engineers. Since 1892 he has practiced as a consulting engineer, and until 1907 was associated with F. W. Dean in the firm of Dean & Main.

The conferring of honorary membership upon Major-General George W. Goethals in recognition of his achievements in engineering and the presence of ex-President Taft, who addressed the society at the opening session, were events that marked the convention and aided in making it an important event in the history of the society. The spring meeting this year will be held in Worcester, Mass., the exact date not having been yet definitely settled upon.

* * *

Of the 131 electric steel melting furnaces in Great Britain, 70 are in Sheffield, which is probably the largest number of such furnaces in any one center in the world.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

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WEBSTER & PERKS NO. 1 UNIVERSAL CYLINDRICAL GRINDER

In a No. 1 universal cylindrical grinding machine which has recently been placed upon the market by the Webster & Perks Tool Co., Springfield, Ohio, the design has been worked out to secure the combined features of rigidity in the machine and accuracy of the work produced on it. Of course, these two conditions are closely related; in fact, they represent a typical example of cause and effect. Exceptionally heavy sliding and swivel tables are provided on the machine, and the wheel-stand is furnished with large bearing surfaces. The table drive and cross-feed mechanism are assembled in a unit, making it an easy matter to remove them from the machine. The wheel-stand and headstock bearings are liberally proportioned, and the dead center pulley bearing is equipped with a double-row ball bearing. Both the headstock and tailstock are aligned against the front edge of the swivel table by T-head bolts engaged in a 45-degree angle T-slot in

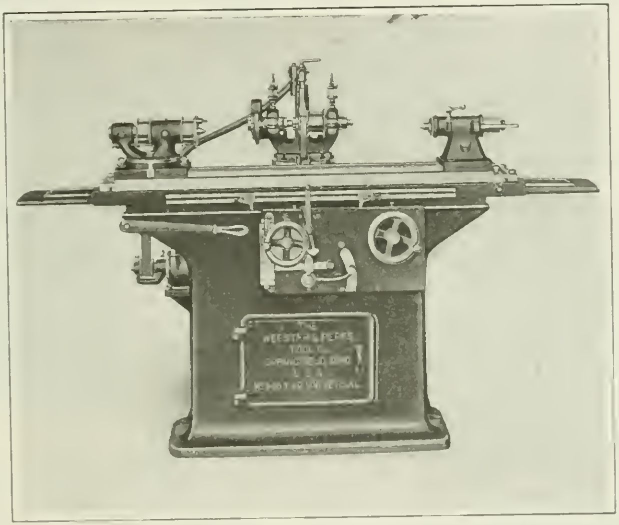


Fig. 1. No. 1 Universal Cylindrical Grinder built by Webster & Perks Tool Co.

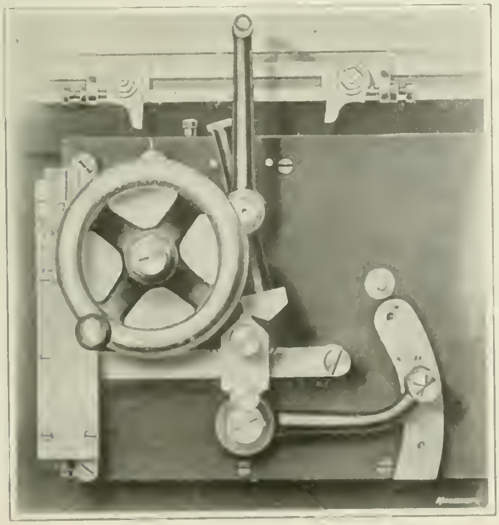


Fig. 2. Feed Mechanism of Webster & Perks Grinder

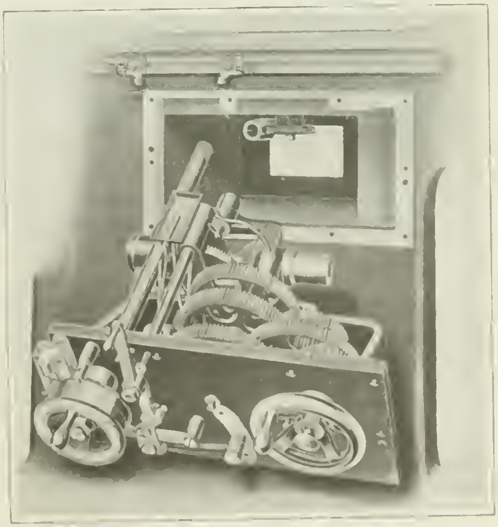


Fig. 3. Transmission Gearing of Webster & Perks Grinder

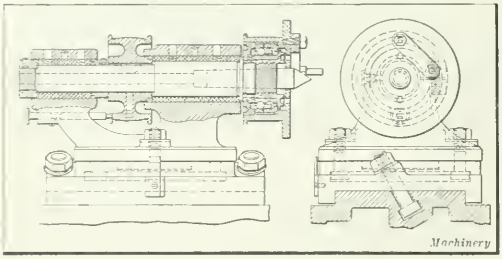


Fig. 4. Arrangement of T-bolts for accurately aligning Ball-bearing Tailstock

the swivel table, which insures absolutely accurate alignment. This arrangement will be best understood by referring to Fig. 4.

Automatic cross-feed permits of feeding at either or both ends of the table travel by means of a movable cam roller. The micrometer feed is controlled by a knurled nut which gives a quick reading from 0.00025 to 0.004 inch. The arrangement of this feed mechanism is shown in Fig. 2 and it is said to be very satisfactory in operation. A lever at the front of the machine provides for obtaining either fast or slow table travel, and with a four-step cone pulley on the countershaft eight changes of table speed are obtainable. Fig. 5 shows the arrangement of an internal grinding attachment provided for use on this grinding machine; the internal attachment and countershaft are both equipped with adjustable ball bearings which are required in this connection because the internal attachment is designed for operation at speeds of 15,880 and 19,600 R.P.M.

In developing this new grinding machine, the Webster & Perks Tool Co. has made every effort to provide an equipment which will grind work within the most exacting limits of accuracy that can be expected from machines of this type; and an effort has also been made to simplify the design and construction in order to reduce as far as possible the possibility of the machine getting out of order, and also to eliminate all unnecessary complications from the operation.

The principal dimensions of the machine are as follows: range, for handling work up to 10 by 30 inches; maximum diameter of work that can be ground with full sized wheel, 10¾ inches; maximum grinding length, 32 inches; range of graduations on swivel table, 8 degrees, range of graduations on headstock, 90 degrees; length of headstock bearings, 3 and 4 inches, respectively; range of graduations on wheel-slide base, 90 degrees each side of center; width of wheel driving belt, 2 inches; dimensions of grinding wheel, 10 inches in diameter by ¾ inch face width, diameter of hole in grinding wheel, [illegible] inches, dimensions of end grinding wheel, 6 inches in diameter by ½ inch face width, diameter of hole in end grinding wheel, 2 inches, minimum reduction by automatic cross-feed, 0.00025 inch, maximum reduction by automatic cross-feed, 0.004 inch, minimum reduction indicated by cross-feed hand-wheel dial, 0.00025 inch; number of available work speeds, 4; number of available table speeds, 8, range of table speeds, 7 to 70 feet per minute, number of wheel speeds, 2, available wheel speeds, [illegible] and 2800 revolutions per minute, type of bearings used in countershaft, Hyatt roller; speed of countershaft, [illegible] revolutions per minute, width of countershaft driving belt, 4 inches; floor space occupied by machine, 43 by 112 inches; and complete weight of machine, approximately, 3600 pounds.

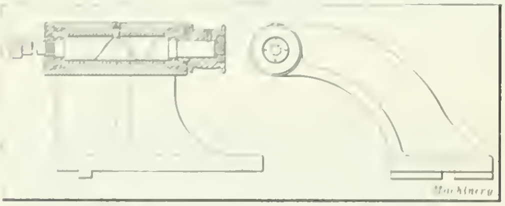


Fig. 5. Internal Grinding Attachment for Use on Machine shown in Fig. 1

NOBLE & WESTBROOK MARKING MACHINE

In Fig. 1 there is shown a special machine for impressing graduations and figures on circles and half circles in a single operation. This machine is a recent product of the Noble & Westbrook Mfg. Co., Hartford, Conn., and represents an addition to the line of marking machines of this company's manufacture. It is of simple construction, accurate, and easy to operate; and its use effects quite a saving for the manufacturer when a large quantity of pieces has to be graduated. The graduating die is carried in a holder keyed to a rotating shaft which runs in bronze bearings provided with means of adjustment. The work is held in the proper relation to the die with accurately cut gears, and the depth of impression is provided by foot pressure applied through a lever and cam, which is adjustable so that it is possible to regulate the depth of impressions to 0.010 inch. This means that even and accurate impressions can be secured; and the possibility of completing the graduating and numbering operation at a single turn of the machine assures a highly satisfactory rate of production. Machines of this type are suitable not only for graduating round circles, but also half circles of the kind used on compound rests for lathes and for numerous other classes of work. An idea, of the range of work handled will be obtained from Fig. 2

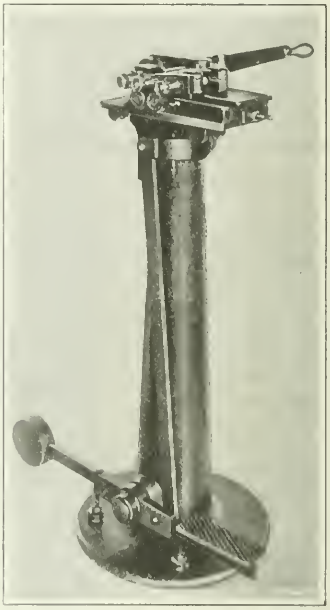


Fig. 1. Graduating and Marking Machine built by Noble & Westbrook Mfg. Co.

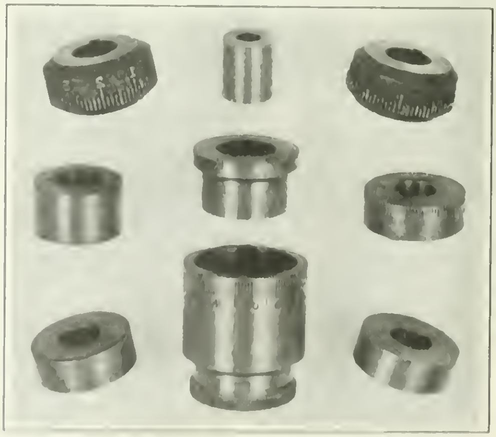
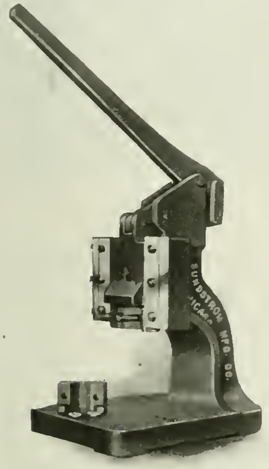


Fig. 2. Examples of Work done by Noble & Westbrook Marking Machine

SUNDSTROM DIE TESTING PRESS

The "Rex" die testing press was originally designed and built by the Sundstrom Mfg. Co., 3201 Shields Ave., Chicago, Ill., for use in its own shop in spotting dies, shearing and scraping in punches, etc., but has proved so satisfactory a tool that a decision was recently reached to build the press for the market. It is stated that the ideal way to use this press is to place one between each two mechanics in the toolroom, who are engaged on die work, so that the press may be used for die testing without requiring men to leave their bench. With such an equipment no time is lost by having men carry their work to a large press, and there is not the tendency for men to stand around and "visit" while some other mechanic is working the machine which they desire to use, but serious as this loss of time is sure to be, it is liable to be cumulative in its effect, because a mechanic will often have to go back and forth several times between his bench and the press before he has secured the desired result. Also, the heavy press may destroy a die that is being tested under it. With these convenient bench presses, the men lose no time and the work of testing a die may be performed with greater rapidity than on a large machine.



"Rex" Die Testing Press built by Sundstrom Mfg. Co.

The principal dimensions of the "Rex" die testing press are: die space with ram down, 6½ inches; stroke of press, 1¼ inch; depth of throat, 7 inches; capacity of square shank holder, for shanks up to 2 inches in diameter; ratio of leverage, 20 to 1; and weight of press, about 260 pounds.

PROGRESSIVE DRILL CHUCK

The Progressive Machine & Metal Products Co., Inc., 210-212 Canal St., New York City, is now manufacturing the quick-change drill chuck shown in Fig. 1. Probably a better conception of the way in which this chuck operates will be gathered by referring to the cross-sectional view, Fig. 2. This chuck is intended for driving taper shank drills, and it will be seen that the tang at the end of the drill shank extends up into a slot *A* which is cut in the chuck body that is integral with the shank of the chuck. To provide for centering the drill in the chuck, a block *B* is provided which has a taper hole corresponding to the taper of the drill shank. When the drill is not in contact with the work, two springs *C* force block *B* down onto the drill shank, so that frictional resistance may be depended upon to hold the drill in place in the chuck. Shell *D* and inner case *E* are held together by screws, and it will be seen that there is a 1/8-inch space between the top of shell *E* and the annular flange on block *B*. When it is desired to release a drill from the chuck, the operator grasps shell *D* and pushes it up until the top of case *E* strikes the flange on block *B*. In this position the drill can be removed from the chuck and another drill substituted. These drill chucks are made in two sizes to carry drills with No. 1 and No. 2 Morse taper shanks.

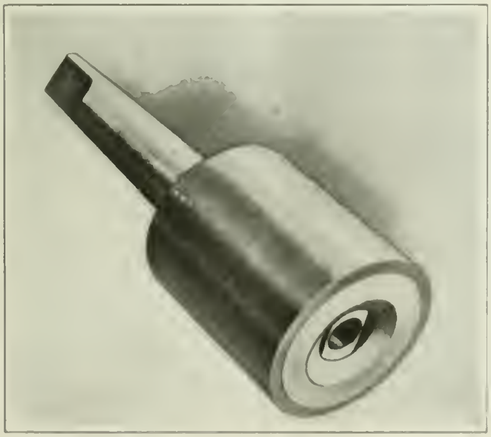


Fig. 1. Drill Chuck made by Progressive Machine & Metal Products Co.

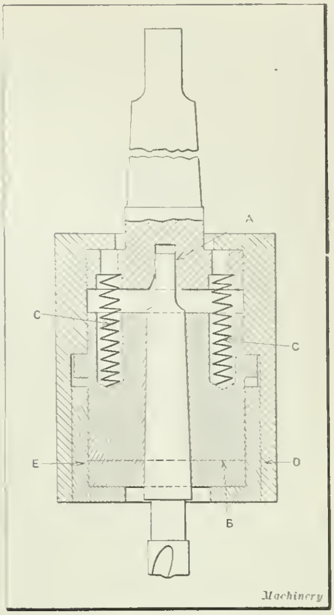
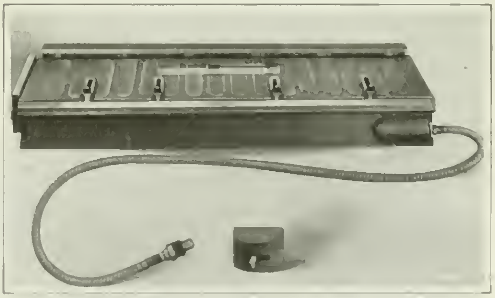


Fig 2. Cross-sectional View of Progressive Chuck, showing Method of Operation

HEALD MAGNETIC CHUCK

In the accompanying illustration there is shown a Style 1436 rectangular magnetic chuck which is manufactured by the Heald Machine Co., 20 New Bond St., Worcester, Mass. This chuck has a large working surface, and it is claimed that the holding power is approximately 200 pounds per square inch with a current consumption of 300 watts, this high efficiency being obtained through a special arrangement of the magnetic coils. In the body there are two cores and two coils for each pole piece in the working surface of the chuck, and the coils are made up of enameled insulated wire of large gage. There is plenty of space in the interior of the chuck between the coils, which reduces to a minimum the possibility of developing short circuits. Another desirable feature, which is a result of the liberal air space in the interior of the chuck,



Rectangular Magnetic Chuck made by Heald Machine Co.

is that no ventilation is required and the chuck can be used wet or dry without change.

At the right-hand end of the chuck there is a "volt box" which is integral with the body and designed so that the user may change the voltage from 110 to 220 volts, or *vice versa*, without returning the chuck to the factory. Access is made to the box by removing the pipe bushing, and when this is again screwed into place after the change has been made, an absolutely waterproof connection is provided. The lead wires are protected by a heavy armored conduit, and the end of this cable terminates in a standard attaching plug. A special demagnetizing switch is furnished with the chuck, and the unit coil system of construction not only provides liberal holding power, but also assures a practically uniform holding power over the entire chuck surface. Another feature of this chuck is that the faceplate or top plate is removable and interchangeable, making it possible to replace an old plate with a new one without requiring any change in the original body and complete set of coils.

The top plate is made of liberal thickness, so that a great amount of wear and resurfacing can be obtained before it is worn out. This plate is attached to the body of the chuck by hex-headed capscrews which are closely spaced, and draw the plate down firmly onto the chuck body. The screws enter the top plate from the under side, extending up through the body, so that there are no screw holes in the working surface of the chuck where water and grit can find their way into the interior. The front edge of the top plate is provided with a T-slot to receive straps, fingers, etc., which may be required to hold the work; and adjustable side-stops and end-stops are also provided. The ends of the chuck are machined, so that it is possible to shove one chuck tight against another, in cases where two or more chucks may be used to advantage for holding long work. As previously mentioned, the chuck is adaptable for either 110 or 220 volts direct current, and if the right current or voltage is not readily obtainable, a suitable direct-current generator can be furnished to belt direct to a countershaft.

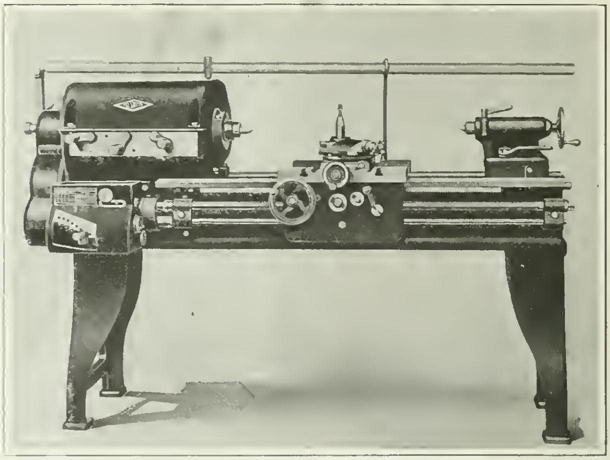


Fig. 2. "Filsmith" 14-inch Quick-change Engine Lathe with All-geared Head

"FILSMITH" QUICK-CHANGE LATHES

In Fig. 1 is shown a high-power 14-inch quick-change engine lathe equipped with a three-step cone pulley and double backgears, which is a recent product of the Philip Smith Mfg. Co., Sidney, Ohio. Lathes of this type are also built with a geared head, as shown in Fig. 2, which provides twelve changes of speed, this head is heavily constructed and made oil-tight, so that flooded lubrication may be employed. The spindle bearings are bushed with phosphor-bronze and all gears are pack-hardened, with the holes ground true to the pitch line of the gears. The entire transmission runs on ball bearings, and all changes of speed are made from the front of the head. The range of available speeds is from 18 to 479 R.P.M. This head is of the friction pulley type and can be run direct from the lineshaft or through a countershaft. The spindle is made of 50-point carbon crucible steel and accurately ground to size.

This machine is built with a bed which has heavy walls and box girders to provide the necessary strength. The tailstock is rigidly clamped to the bed and so shaped that the compound rest can be set at right angles when the lathe is engaged in turning pieces of small diameter. A bearing 18 inches in length is provided for the carriage, and the bridge is 7¼ inches wide. The compound rest is furnished with taper gibs and is graduated in the usual way. When so desired, a plain rest may be substituted for the compound rest. A feature of the apron is that it is cast with the bearings an integral part of the apron, which affords a stiff construction. All small apron gears are made of steel and the studs are hardened and ground to size. A safety device prevents throwing in the half-nuts when either feed is connected. The power cross-feed and compound rest screws are provided with the usual graduated dials and the lead-screw is cut from a master, which is frequently tested to assure the maintenance of its accuracy. The quick-change gearbox is furnished with either the cone-driven machine or the geared-head machine and provides for cutting threads from 4 to 46 per inch. Special gears can be furnished to provide for the performance of special operations, which do not come within the range of the machine. The lead-screw is disengaged by means of a slip gear, so that it only runs while the lathe is engaged in the performance of thread-cutting operations. All gears are thoroughly guarded to provide for the safety of the operator. Equipment furnished with this machine includes a compound rest, follow-rest, steadyrest, double friction countershaft, large and small faceplates and the necessary wrenches for making all adjustments.

The principal dimensions of this 14-inch lathe are as follows: swing over bed, 14 1/8 inches; swing over carriage, 9 inches; distance between centers for 6-foot bed, 35 inches; maximum tailstock travel, 5 1/4 inches; diameter of tailstock spindle, 1 3/4 inch; taper of centers, No. 3 Morse; dimensions of the front spindle bearing, 2 3/8

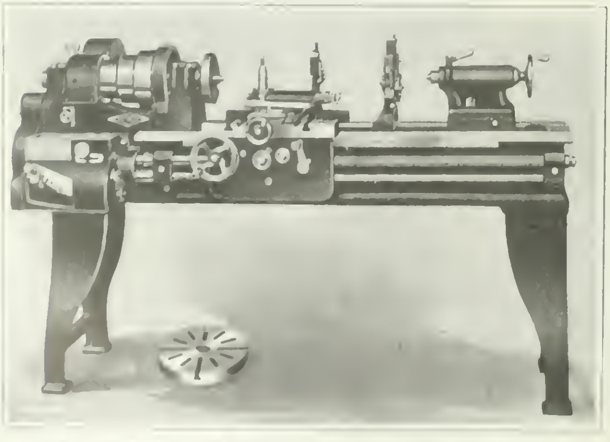


Fig. 1. "Filsmith" 14-inch Quick-change Engine Lathe with Cone Pulley Drive

by 4 inches; dimensions of the rear spindle bearing, 1 13/16 by 3 inches; diameter of hole through spindle, 1 5/16 inch; diameter of spindle nose, 2 1/16 inches; range for thread cutting, 4 to 46 threads per inch; range of feeds, three times threads; cone pulley diameters, 5 1/2, 6 1/4 and 8 inches; width of driving belt, 2 1/2 inches; size of countershaft pulleys, 10 by 3 1/2 inches; ratio of back-gears, 3 to 1 and 8 to 1; number of spindle speeds, 18; countershaft speeds, 300 and 400 R.P.M.; range of spindle speeds, 27 to 600 R.P.M.; toolpost capacity, for tools up to 1 1/4 by 5/8 inch; and weight of machine with 6-foot bed, 1350 pounds. Machines of this type are also built in a 16-inch size, and similar machines of the gap bed type are built in 14- and 16-inch swings.

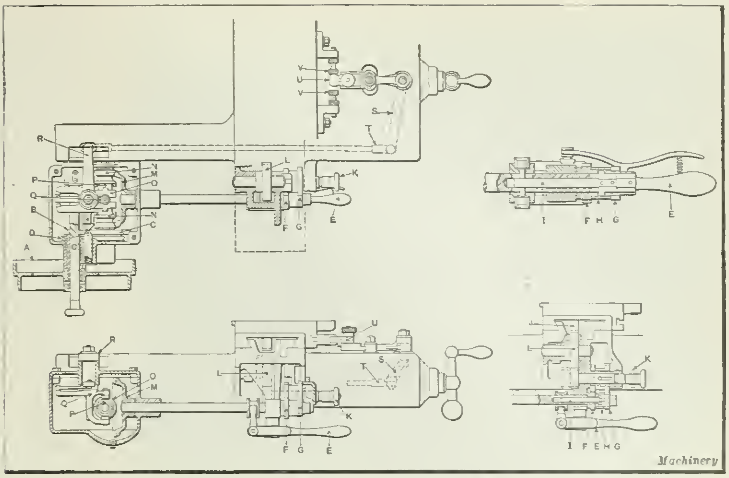


Fig. 2. Details of Automatic Feed Mechanism for Wilmarth & Morman Tool Grinder

AUTOMATIC FEED MECHANISM FOR WILMARTH & MORMAN UNIVERSAL CUTTER AND TOOL GRINDER

The Wilmarth & Morman Co., 1180 Monroe Ave., N. W., Grand Rapids, Mich., is now equipping its No. 1 universal cutter and tool grinder with an automatic feed mechanism. As will be noted from the illustration of the complete machine shown in Fig. 1, the means of obtaining the drive on this reversing mechanism is provided by a gear-box with all the mechanism necessary for obtaining the eight table speeds contained in one unit. This is arranged so it can be attached to the hand feed machines of this type already in service, with very little work. The gear-box is attached to the saddle on a pad at the rear, and is driven by a two-step cone pulley *A*, Fig. 2, from the main countershaft, this cone pulley providing two changes of speed. The sliding pinion shaft *B* engaging with two-step gear *C* provides one speed; and sliding the pinion shaft out of engagement and engaging the key with gear *D*, changes the speed, making a second speed from the same pulley.

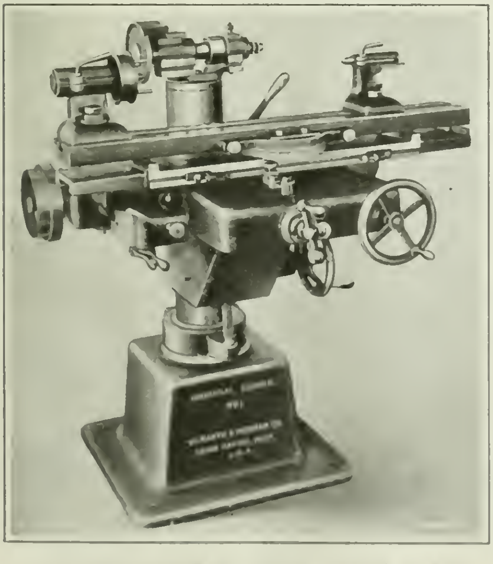
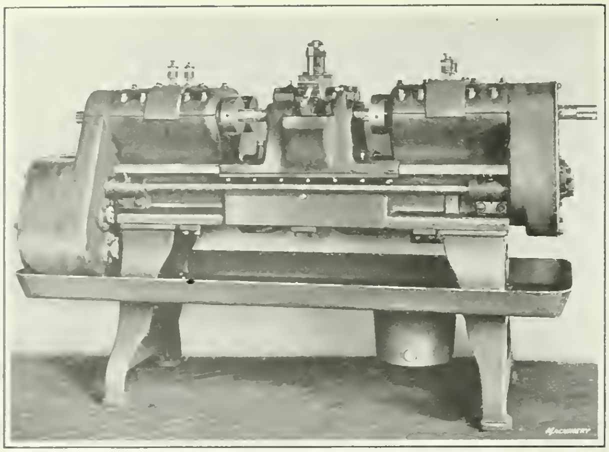


Fig. 1. Wilmarth & Morman No. 1 Universal Cutter and Tool Grinder equipped with Automatic Feed Mechanism

Two other changes of speed are obtained in the bracket or bank of gears with the starting lever *E*, which is engaged with the sliding shaft *I* by a key working through a slot, being thrown into engagement with the two clutch gears *F* and *G*. This starting lever *E* is held in position by a plunger actuated by a lever and spring to lock it in position when a change is made by this lever. The two clutch pinions *F* and *G* are spaced by a collar *H*, which allows the same sliding shaft *I* to be held in a neutral position, disengaging this shaft and establishing a neutral position, and in that way disengaging the mechanism from operating the table. Engaging the key on shaft *I* with gear *F* by moving lever *E*, gives a third speed of the table; then by disengaging lever *E* from pinion *F* and engaging it with pinion *G*, the fourth speed of the table is obtained. To obtain four other speeds in the mechanism, simply shift the belt onto the other step of pulley *A*. Lever *E* is also used for stopping the table.

It will be noted that the motion of the table is obtained by a small pinion meshing through an idler gear with the rack *J* which is secured to the table. The pinion shaft *K* is so arranged as to make it possible to disengage it from the idler gear *L*. In this way the power feed to the table is entirely disengaged so that the table can be operated by the handwheel at the front of the saddle or the lever at the rear, without operating any of the power feed mechanism which drives the table. The gear-box contains a bevel gear *M*, two bevel clutch pinions *N* and a clutch *O*. Clutch *O* is free to be engaged into clutch teeth on clutch pinion *N* which reverses the motion at its engagement with either one side or the other. Clutch *O* is secured to a shaft which runs through the above mentioned clutch gears, and this shaft carries a bronze bushing *P* that has a double spline, on which the clutch *O* is free to be engaged in the pinion *N* by the lever *Q* which is operated by bellcrank *R* connected to bellcrank *S* by rod *T* operated from the table by lever *U* which, in turn, operates from the table by the dogs *V*. These dogs are carried in a T-slot in the front of the table and are easily adjusted so as to bring the work in the correct position in relation to the grinding wheel, allowing the operator to shorten or lengthen the stroke as desired.

As will be seen, this mechanism is entirely self-contained with none of the working parts exposed to the grindings or dirt, and all of the gears are run in a bath of oil which insures the least possible wear. The eight speed changes obtainable on this machine provide table speeds as follows: 12, 16, 22, 28, 34, 41, 61 and 75 inches per minute. As the power feed on this type of machine is very desirable both for cylindrical and internal work, the utmost care has been taken to equip the Wilmarth & Morman No. 1 universal grinding machines with a simple automatic mechanism.



Boring, Reaming and Facing Machine built by Reed-Prentice Co.

REED-PRENTICE BORING, REAMING AND FACING MACHINE

A special boring, reaming and facing machine built by the Reed-Prentice Co., Worcester, Mass., to ream and face a steel forging used as an engine support in an automobile is illustrated herewith. The work is held in quick-acting clamps mounted on a revolving triangular turret on the carriage. All the operations are automatic, with the exception of placing the work in the machine and indexing the turret. Each time the work-holder revolves 120 degrees, the finished piece at the top is removed and another rough forging is placed in position with little loss of time. There are four spindles. Two pieces of work are operated on simultaneously. The cycle of operations is as follows: The carriage moves to the right and the piece is drilled; the carriage next moves to the left and the piece is reamed; the turret is then indexed by the operator and a new piece is put in; the carriage now moves to the right, and one side of the piece is faced; and the carriage is then moved to the left, and the other side of the piece is faced. A ten-horsepower motor is used to drive the machine.

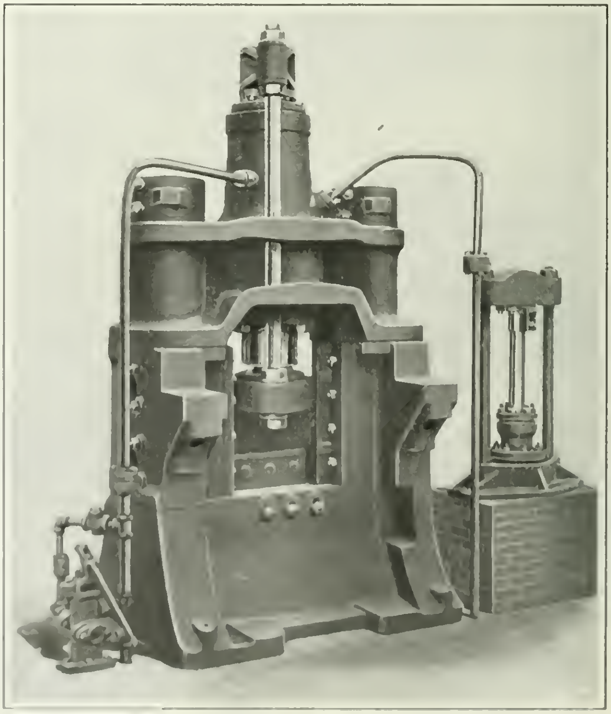
WESTINGHOUSE PORTABLE PANELS FOR ELECTRIC WELDING

An electric welding outfit to be of maximum service should be so arranged that it can be taken to the work no matter where the latter may be located. For instance, in a railroad shop there should be outlets adjacent to each stall in the roundhouse and in various places through the shop. One solution of the problem would be to locate a panel outlet of a suitable type wherever it is anticipated that electric welding might be desired, but this is rather an expensive proposition. The Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has developed a simple and inexpensive portable outlet panel for electric welding service. Two types of portable outlet panels are furnished, both being mounted on light trucks. They consist of a control panel mounting a handle trip railway type of circuit breaker having overload release with magnetic blow-out, and a 13-point faceplate connected to a resistor mounted in the rear of the panel. The face of the panel is protected by a metal cover through which the handles of the rheostat and circuit breaker project. The Type E panel is intended for metal electrode welding only, having a capacity of from 80 to 170 amperes. With this outfit one metal electrode holder and one shield are supplied. For a wider range of work a Type F panel should be used. This will handle metal electrode work from 80 to 160 amperes, and light graphite electrode work up to 300 amperes. The outfit includes one metal electrode holder, one graphite electrode holder and one mask.

In installing an electric welding system using these portable panels, a Westinghouse arc welding motor-generator set may be placed at some central point. Where suitable, low-resistance ground connection can readily be made throughout the shop, as, for instance, where metal floors or cast-iron bed plates are in general use or in a railway shop where the track system can be used, only one connector need be extended to the various receptacles. The iron floor-plates may be arc welded to each other and isolated sections tied together by an iron rod or heavy copper cable, while the track rails may be bonded by arc welding the fish plates to the rails. Receptacles should be provided throughout the shop of a capacity appropriate for the service for which they are intended. These receptacles may readily be mounted out of doors if they are provided with protection from the weather. Only single-pole receptacles and a single wire cable to the portable panel need be provided. The flexible cable leading from the panel to the electrode holder should be as short as is consistent with the class of work to be done. Where metal floors or tracks are not available, the ordinary two-wire system of distribution with double-pole outlets and two-wire cables should be provided.

SOUTHWARK 500-TON BILLET SHEAR

A billet shear of large capacity, intended for cutting hot billets in rolling mills, has recently been brought out by the

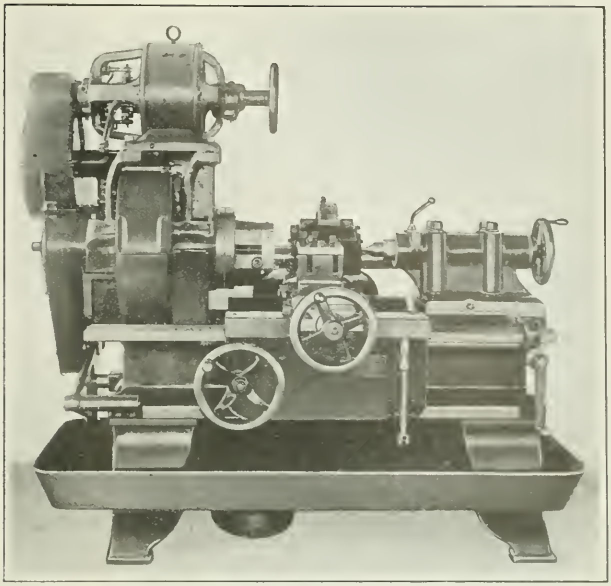


Southwark 500-ton Billet Shear

Southwark Foundry & Machine Co., Philadelphia, Pa. The machine has a capacity for shearing two 6-inch square billets simultaneously, has a knife 24 inches long, and is hydraulically operated, having a 16-inch ram working under 5500 pounds hydraulic pressure supplied by a steam-hydraulic intensifier which is part of the machine. The displacement of the intensifier is sufficient for the 10-inch stroke required for cutting off the billet. On the return stroke, the water in the working cylinder returns to the intensifier and is used over again. In addition, a valve is provided for supplying the slight amount of water which is lost by leakage. The pull-back works under 650 pounds pressure.

The complete control for the cutting of billets is obtained by one lever, which takes care of both the press and intensifier. There are three positions for this lever—when it is raised, the ram will rise also; when it is lowered, the ram will descend; and, in addition, there is a neutral position; when the lever is at this position, the ram will remain at rest.

The whole design of the machine is unusually heavy. The tension bolts, for example, are 12 inches in diameter. An interesting feature in connection with the design of the nuts on the tension bolts is that the latter are split and clamped by smaller bolts, so as to prevent any loosening of the nuts. All castings, except those for the rams, are made from cast steel. The rams are made from close-grained cast iron. The sliding block to which the shear blade is attached is provided with adjustable bronze liners which slide on steel liners on the stationary part. All the rams are outside-packed with flax packing. The total weight of the machine without the intensifier is over 100,000 pounds, and with the intensifier, 140,000 pounds.


Reed-Prentice Special Crankshaft Flange Turning Lathe

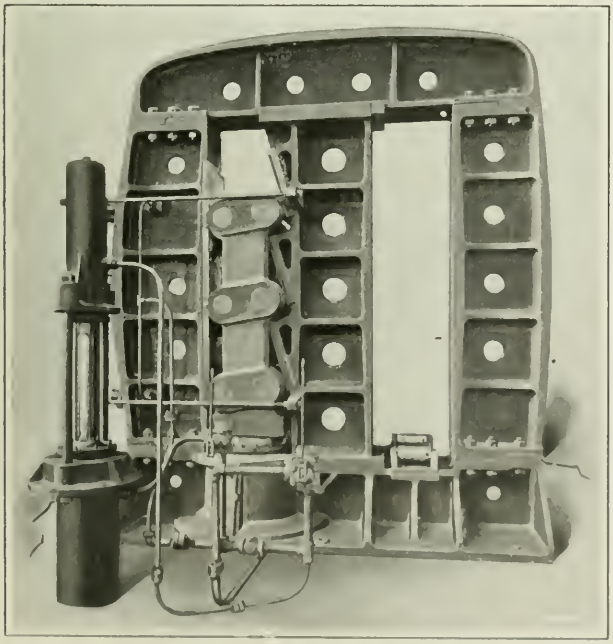
REED-PRENTICE CRANKSHAFT FLANGE TURNING LATHE

This is a special-purpose machine designed to turn and face the flywheel flange of a crankshaft. The spindle is a large iron casting with a 7-inch hole through its entire length. Properly located in this hollow spindle is a positive dead center to support the front end of the crankshaft. So that this center can be located quickly, a cone-shaped piece is pressed into the spindle, which directs the crankshaft onto the center immediately. The shaft is held to the faceplate by an adjustable chuck arrangement which holds the shaft rigidly and accurately. It is clearly shown in the accompanying illustration. The flange end of the crankshaft is supported on a tailstock center. The tailstock is of heavy construction, and is fastened to the bed by four large bolts.

A compound tool-block is fitted to the rest, and three tools are placed in the required positions to turn the flange to its predetermined thickness. These tools face both sides of the flange and turn the fillet at each end of the main bearing. There is a secondary cam-actuated tool-block which turns the outside diameter of the flange while the three other tools are facing. The lathe is a motor-driven machine with the reduction accomplished through heavy gearing. A one-speed and one-feed system is used, as the most advantageous speed and feed has been determined for the work at hand for which the machine was especially designed. This machine is a recent product of the Reed-Prentice Co., Worcester, Mass.

SOUTHWARK PLATE BENDING PRESS

The accompanying illustration shows an improved vertical hydraulic plate bending press built by the Southwark Foundry & Machine Co., Philadelphia, Pa. These presses are now being used by many of the leading marine and stationary boilermakers for bending boiler shells and similar work, and especially when thick plates have to be operated upon, as they bend plates completely up to the end, which cannot be done by rolls; they can also be used for bending the butt straps. These machines will bend plates to a complete circle, as the top tension member can be arranged with a swinging bolt so that the shells can be drawn up from the top. Plates can be bent to a given radius by once

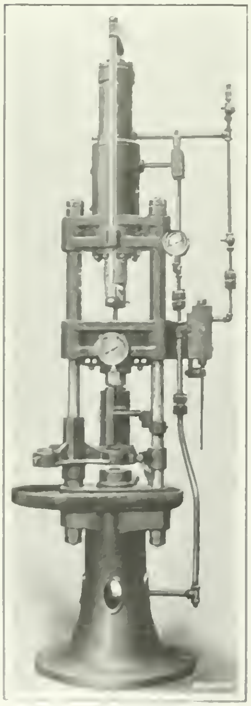

Southwark Vertical Hydraulic Plate Bending Press

passing through the machine, and unskilled labor can be used, as when the stroke of the ram is once adjusted the required curve will be given independently of the operator.

One of these machines having an inclined plane and roller arrangement needs a much smaller ram than if working direct; it is therefore much more economical to work, a saving of fifty per cent of the water used being effected. The advantages claimed for these machines over rolls are economy in work and power, and the requirement of less space. They can be erected at any place without considering driving arrangements.

SOUTHWARK SHELL TESTING PRESS

To meet the demands of the United States specifications for common steel shells, the Southwark Foundry & Machine Co., Philadelphia, Pa., has developed a complete line of hydrostatic shell testing presses. The general arrangement of these machines is as illustrated herewith. Owing to the fact that each type and size of shell requires a different test pressure, it was found necessary to develop two basic designs, to which modifications have been made to provide a machine for each particular type of shell. The machine illustrated herewith is for testing 75-millimeter (3-inch) shells. As will be noted, the machine is purely hydraulic in its operation, is of the two- or three-column type, and has a revolving table suitably indexed, so that when one shell is being subjected to the hydrostatic test pressure (the maximum in the case of the 75-millimeter shell being 18,000 pounds), a second shell has been revolved into a convenient position for inspection, while a third shell is being filled with water in readiness for the test.



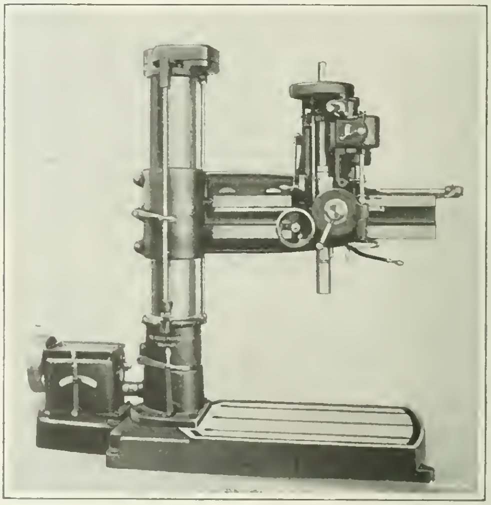
Southwark Hydrostatic Shell Testing Press

The capacity of this machine, under ordinary working conditions, is about 120 shells per hour. Its operation may be briefly described as follows: The first movement of the single lever operating valve admits the line pressure 1500 pounds to the lower cylinder. This cylinder, moving upward, engages the slotted base-plug in the revolving table and forces the open end of the shell nose into an ingenious sealing gland. When the full pressure on the lower cylinder has been reached, the line pressure is automatically admitted to the top cylinder, which is arranged with an intensifier ram projecting through a suitably packed gland in the stationary cross-member into the open nose of the shell, which, having been previously filled with water, acts as the high-pressure intensifier cylinder, and the pressure is instantaneously raised to the predetermined amount. This pressure is read from a gage communicating with the chamber intervening between the circular shell nose and the intensifier ram.

The same principle applies in general to machines for the 4.7-inch, 6-inch, 8-inch, 9.5-inch and larger shells. From this it will be noted that the high pressure of the test is developed only in the body of the shell, all other parts of the machine, including the operating valves, piping and the cylinders, are never subject to a higher pressure than the extremely nominal one of 1500 pounds per square inch. The entire action of the machine is controlled from a single lever operating valve, insuring rapidity of action and proper sequence of movements. All machines have been designed so that they will develop at 1500 pounds line pressure a pressure in the shell body equivalent to within 5 per cent of the elastic limit of the metal. In this way, by decreasing the line pressure, the machine is applicable to any change in pressure which our government may deem desirable to make at some future date.

MORRIS PLAIN RADIAL DRILLING MACHINE

The illustration shows a plain radial drilling machine with speed-box drive, which is built in 4- and 4½-foot sizes by the Morris Machine Tool Co., Court and Harriet Sts., Cincinnati, Ohio. This drilling machine can also be arranged for cone pulley drive, constant-speed motor drive in connection with speed-box, or for variable-speed motor drive. The arm slides up and down on a column by power, with safety stops in the extreme positions, and the column swings around a stump that runs through to the top of the column. At the top of the stump a combination annular and thrust ball bearing is mounted, which carries the entire weight of the column and arm. At the bottom of the column there is a plain bearing on the stump. This construction permits the arm to swing with ease. The stump is securely mounted on a heavy base, which is deep and well ribbed. Around the edge of the base there is a lubricating channel which drains to a reservoir, and the base is so arranged that the oil-pump and piping can be attached at any time.



Plain Radial Drilling Machine built in 4- and 4½-foot Sizes by the Morris Machine Tool Co.

The lever at the bottom of the stump, standing in a vertical position, controls the friction clutches on the pulley shaft in the speed box. This lever, which is convenient to the operator, when in the neutral position stops every gear on the machine, and in connection with the double back-gear lever on the head, the operator can secure any of six spindle speeds instantly. With the speed-box, eighteen spindle speeds are available, and on the cone pulley drive there are fifteen spindle speeds. The double back-gear is mounted at the back of the head and is fully enclosed.

Back-gear clutches and clash gears are made of nickel steel, heat-treated and hardened. Tapping attachment miter gears are also mounted back of the head and are enclosed in an oil-tight case and run in oil. Frictions are of the expanding ring type capable of pulling the maximum capacity of the drill and controlled from the front of the machine. The friction rings are adjustable. The head is heavily constructed with long bearings for the spindle. It travels on the arm on wide bearings by means of a handwheel, movement being through reduction gears to a rack and pinion. The spindle is equipped with a ball thrust bearing, and the bearings throughout are lined with bronze and provided with felt wipers. A recess around the bearing acts as an oil reservoir.

Through the feed gear box mounted on the head, six rates of feed are obtainable. A direct reading depth gage is provided, arranged to throw the feed out; and a safety feed throwout is arranged at the end of the spindle travel. All gears are of steel except the spindle gear, which is semi-steel, made of a one-third scrap steel mixture. The speed-box is fully enclosed and gears run in heavy oil. A tool tray is mounted on top of the box, and a speed plate is furnished, giving the operator all spindle speeds at certain positions of the lever.

The principal dimensions of this machine are as follows: drills to center of circle, 8 feet, 6 inches in diameter; maximum distance from spindle to base, 60 inches; minimum distance from spindle to base, 10 inches; maximum distance from spindle to table, 39 inches; maximum spindle traverse, 16 inches; diameter of spindle above sleeve, 1 15/16 inch; spindle taper, No. 5 Morse; range of spindle speeds with cone pulley drive, 19 to 350 R.P.M.; range of speeds with speed-box drive, 20 to 350 R.P.M.; speed of countershaft with cone drive, 400 R.P.M.; size of tight and loose pulleys, 14 inches in diameter by 4¼ inches face width; size of single pulley for speed-box drive, 14 inches in diameter by 3¾ inches face width; speed of pulley for speed-box drive, 400 R.P.M.; size of working surface of base, 36 by 51 inches; size of working surface of table, 18 by 24 inches; diameter of column, 11¼ inches; overall height with arm and spindle in highest position, 120½ inches; power required for motor drive, 5 horsepower; ratio of variable speed motor, 4 to 1; and weight of machine crated, approximately 7500 pounds.

REED-PRENTICE BRASS DRILLING MACHINE

The four spindles of this machine are driven by hardened steel spiral gears running in an oil bath, and the gears are equipped with ball bearings. All spindles are adjustable, and any one may be worked independently of the others. The feed for each spindle is self-contained, a cam being mounted with ball thrust bearings in each post, driven by a hardened steel worm and phosphor-bronze worm-gear running in oil. After the cam has made its cycle, the feed is automatically stopped by a rod disengaging the worm-gear clutch. The starting device is arranged so that by a slight pressure from the operator's knee the clutch is engaged immediately. This is a saving of time, when it is considered that the spindle revolves 770 R.P.M. and the cam makes a cycle every 77 revolutions of the spindle. The rate of feed is 0.078 inch per revolution. Both speeds and feeds can be easily changed.

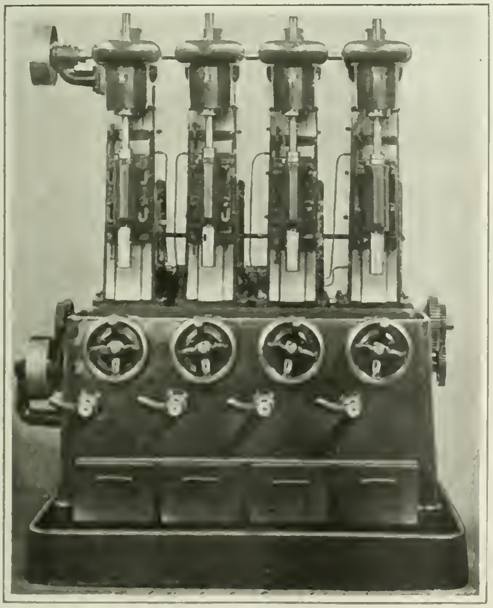


Fig. 1. Four-spindle Reed-Prentice Brass Drilling Machine

The work is held in a three-jawed chuck and at the end of the operation is allowed to fall through into a chute. The bottom of the chute is perforated to allow the chips to fall through into one pan, while the work is collected in another.

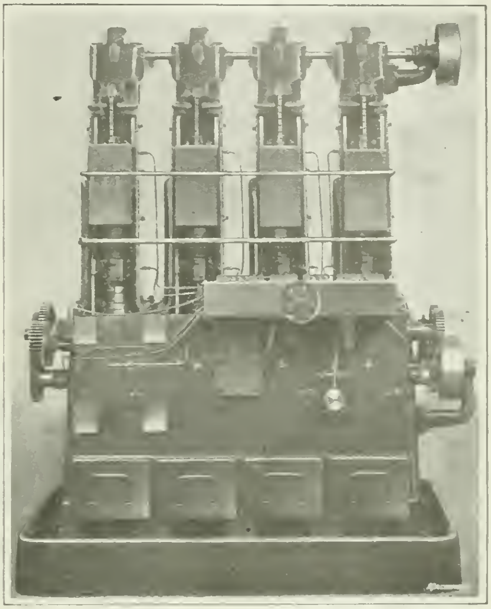


Fig. 2. Opposite Side of Brass Drilling Machine shown in Fig. 1

The motor is mounted on the back of the machine driving through gears. A Detroit force-feed oiler mounted on the back of the machine lubricates the twenty-two principal bearings, while the lubrication of the less important ones has been adequately taken care of. All gears are properly guarded. This machine is built by the Reed-Prentice Co., of Worcester, Mass.

The principal dimensions of this machine are as follows: size of spindle bearing in head, 1 7/16 inch in diameter by 10 inches long; size of spindle bearing in branch head, 1 1/4 inch in diameter by 10 1/2 inches long; taper of hole in spindle, No. 4 Morse; maximum travel of spindle, 6 inches; distance between spindles, 13 inches; power developed by motor, 3 1/2 horsepower; over-all height of machine, 88 inches; spindle speed, 770 R.P.M.; spindle feed per revolution, 0.078 inch; and floor space occupied by machine, 46 by 73 inches.

SIDNEY POWER PRESS

The Sidney Power Press Co., Sidney, Ohio, is now building a line of open-back inclinable power presses ranging in size from No. 1 to No. 6, and in weight from 1000 to 6000 pounds. Although these machines represent no radical departure from ordinary power press construction, their design has been worked out to incorporate the most up-to-date features of machines of this type. In addition, all Sidney presses are equipped with an automatic safety clutch, which insures the combined features of positive action and safety for the operator.

PERSONS-ARTER MAGNETIC CHUCK

The Persons-Arter Machine Co., 72 Commercial St., Worcester, Mass., has recently completed what is believed to be the

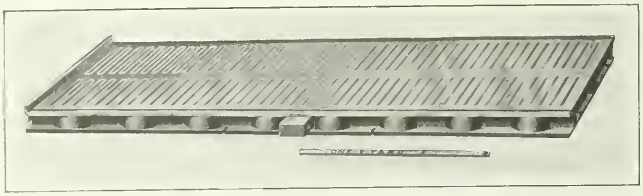


Fig. 1. Persons-Arter Magnetic Chuck 100 Inches Long and 25 Inches Wide

largest magnetic chuck ever built for holding precision work. This chuck was built especially for the Simonds Mfg Co., Fitchburg, Mass., for use on a large grinding machine recently designed and built by that company. Fig. 1 shows the finished chuck ready for mounting on its machine. This chuck is 100 inches long, 25 inches wide and 5 inches deep, and an idea of its size may be gathered by comparison with the yard stick shown with it. It has a pulling capacity approaching 250 pounds per square inch and is magnetically alive all over its face, making every square inch available for the holding of work.

In building the chuck, advantage was taken of the adaptability for such a purpose of the Persons-Arter rectangular chuck units, that is, four standard size individual chucks were used in the making of this large chuck, each individual chuck being constructed of standard units. Fig. 2 shows the units used, including the polar shell, the polar core and the coil for magnetizing the shell and core. Each chuck section is composed of one shell, four cores and four coils, all being interchangeable and readily replaceable. Almost any size of chuck desired can readily be supplied by using standard sized units in multiple. This method greatly lessens the necessity of carrying a great amount of various sized chuck parts in stock and insures quick delivery, as requirements can be met without any special work being entailed.

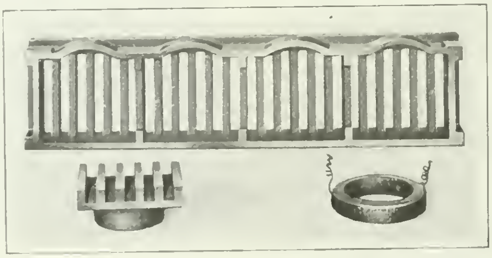


Fig. 2. Units used in Construction of Persons-Arter Magnetic Chuck

The chuck face has been designed to secure a large amount of magnetic edge and a high holding capacity for all classes of work, whether large or small. In building the circular form of chuck made by this company a special design was evolved, *viz.*, radiating arms to and from the center with interlocking concentric arms. It is a well known fact that the greater the magnetic edge, the greater the holding capacity of the chuck; therefore, when considering the magnetic face alone, it is necessary in obtaining the greatest holding effect to provide the greatest length of magnetic edge for the least enclosed area. In the rectangular type chucks, this is a simple matter, as it is only necessary to produce a series of narrow magnet poles running right across the chuck face (the narrower, the better, within practical limits). It is obvious that any divergence from a plain narrow rectangular shape would mean less magnetic edge for a given enclosed area and less magnetic effect.

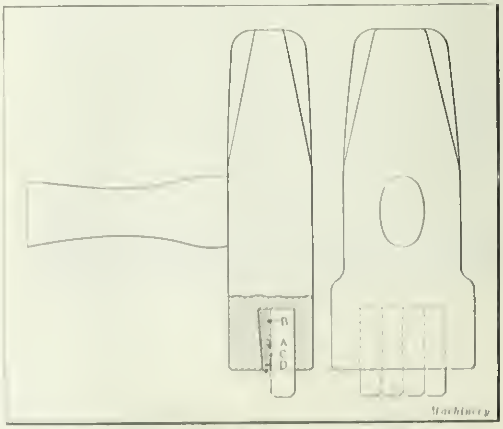
When, however, we consider the electrical magnetizing force, or the magnetic coil, the conditions are the opposite to those of the magnetic face. Thus to produce the greatest efficiency it is necessary to enclose the greatest area for the least perimeter. It is a well known fact that a greater magnetizing force can be obtained by using a circular coil with a given electrical power than by any other shape of coil, and the more the shape of the coil diverges from a circle the less the magnetizing force for a given electrical power consumption.

The problem, therefore, was how to obtain the two opposite conditions and secure the greatest magnetic face and the greatest magnetizing force at the same time. By using a core of the shape shown in Fig. 2, it is claimed that the necessary conditions were obtained. This comprises a circular base body forming a distributing plate at the top, from which [illegible] strips, all made integral, to interlock with those of the polar shell. Not only does this shape meet the above conditions, but it provides another important feature in leaving only a very narrow space between the walls of the polar shell and the distribution plate. The importance of this is apparent when considering the question of filling in between the poles with white metal. Only a narrow space is left between the shell and core, and it is an easy matter to calk this space and make an absolutely water-tight joint. After the coils are assembled, all open spaces are filled with a high-grade insulating and water-proofing compound, making it impossible for water or foreign matter to get near the coils.

The material of which the chuck is made is another fact of great importance. A metal with a high permeability is absolutely desirable. Gray iron is out of the question, and a soft steel is probably the only solution. All the chuck parts comprising the magnetic circuit are, therefore, made of a soft steel of high permeability; an electric furnace product, equal in quality to Swedish or Lancashire iron, is sometimes used for chucks. This means that a greater number of magnetic lines of force per unit area are obtained for a given magnetizing force than would be if some other material were used. By carefully following these details, the results have been all that could be expected. The chuck is powerful, is economical in the consumption of electrical power, and has a liberal sized magnetic area. On this 100- by 25-inch chuck, as well as on all Persons-Arter chucks, the bottom plate is made in one piece, and on large rectangular chucks hexagon head bolts are used to bind the plate to the chuck body. Therefore, a large size wrench can be used and the plate securely fastened to the chuck body, thus insuring freedom from water entering the chuck. The rectangular chuck rests on a number of non-magnetic supporting feet, which insulate the chuck from the machine bed and also provide a clear path underneath for the cutting compound to flow. These feet also make it an easy matter to true the chuck in position.

PITTSBURG STEEL TYPE HOLDER

The interchangeable steel type holder which is illustrated and described herewith, is a recent product of the Pittsburg Steel Stamp Co., 316 Penn Ave., Pittsburg, Pa. The chief advantages claimed for this device are as follows: It does



Interchangeable Steel Type Holder made by Pittsburg Steel Stamp Co.

not require grooved type, and as a result is equally efficient for holding all kinds of grooved and straight type. The claim is also made that it is the only holder which will carry ungrooved type on heavy stamping, and a further advantage is that type can be quickly changed. No strain is imposed upon the gripping members. A hole, the side of which opens into the socket for the type, runs at an angle as shown in the partial cross-sectional view. A steel ball *A* backed up by a spring *B* is carried in this hole. When the type is pushed into the socket in the holder, the ball is forced upward against the spring tension; and when the type has been put into place, the spring forces this ball down between the type and the inclined side of the hole, thus preventing the type from falling out. A pin *C* held by a light bushing *D* is used to push up the ball when it is required to change the type. This interchangeable steel type holder was developed by E. T. Hudspeth, tool-room foreman of the Pittsburg Steel Stamp Co.

NEW MACHINERY AND TOOLS NOTES

Seam-welding Machine: Thomson Electric Welding Co., Lynn, Mass. A line of four electric seam-welding machines which are for welding material up to sixteen gage. These machines are known as Nos. 306, 312, 318 and 324, and are of sizes to permit work to be handled up to 6, 12, 18 and 24 inches in length, respectively.

Bench Grinding Stand: Luther Grinder Mfg. Co., 289 S. Water St., Milwaukee, Wis. A No. 306 power grinding stand adapted for the use of grinding wheels 6 inches in diameter by 1¾ inch face width. The machine is built with bearings of ample size to assure smooth operation, and it is adapted for mounting on a bench or heavy table; it weighs 15 pounds.

Ratchet Tap Wrench: Moss-Ochs Co., 3387 E. 116th St., Cleveland, Ohio. A ratchet tap wrench made in two sizes, namely, a No. 1 wrench with a capacity up to ¼ inch and a No. 2 wrench with a capacity from ¼ to ½ inch. This wrench is furnished with a T-handle which is made a sliding fit to permit of operation in corners or other places where the space is limited.

Six-spindle Vertical Lathe: Bullard Machine Tool Co., Bridgeport, Conn. An automatic vertical lathe which comprises six independent lathes arranged in a circle and five tool-heads. This machine is built in two types, *viz.*, a universal type, facing, boring and turning to any angle; and a compound type, facing, boring and turning in vertical and horizontal directions only.

Gas Furnaces: Capital Die, Tool & Machine Co., Columbus, Ohio. A line of "Ever-Ready" gas furnaces which are operated without a blower and are claimed to be economical in gas consumption. They are made in a number of different sizes ranging from 4 by 6 by 12 inches with a gas consumption of 30 cubic feet per hour, up to 6 by 12 by 20 inches with a gas consumption of 90 cubic feet per hour.

Elevating Truck: Holyoke Truck Co., Holyoke, Mass. A Type RL-10 truck which has a capacity for handling loads up to 5000 pounds. The truck platform is 40 inches in length and the extreme width of the truck is 27 inches; the height with the platform lowered is 10 inches and the platform may be raised a distance of 2 inches. This truck has two closely spaced wheels at the front and two wheels at the rear.

Blueprint and Drawing Holder: National Co., 273 Congress St., Boston, Mass. A holder for blueprints, drawings, charts, etc., which is furnished with a top strip or binder that secures the sheets onto the holder. This top strip is removed by means of catches which may be quickly operated. Three catches are used so that provision is made for holding narrow prints. These holders are made in three sizes of 30, 36 and 42 inches in length.

Shell Trimmer: De Mant Tool & Machine Co., 79 E. 130th St., New York City. A semi-automatic shell trimmer which is adjustable for trimming shells from 1/4 to 2 inches in length and from 1/16 to 1/2 inch in diameter. The toolpost is designed to permit positive operation with a minimum effort, and a release lever ejects the finished work without the necessity of stopping the machine. Shells may also be fed while the machine is running.

Blow Torch: Naab Mfg. Co., Cleveland, Ohio. A blow torch which operates with either natural or illuminating gas and which is designed to produce high temperatures by employing a pressure fan which is integral with the torch to provide for mixing gas and air ready for combustion. This apparatus consists primarily of a portable gas torch which is entirely self-contained; the pressure fan is attached directly to the burner, thus tending to eliminate any air leakage.

Drilling Machine Turret Head: Spafford Tool Works, 10 Hoadley Place, Hartford, Conn. A five-spindle turret head for use on single-spindle drilling machines to provide for the performance of a sequence of operations at a single setting of the work. The turret may be moved around either way to bring any spindle into the operating position, regardless of whether the machine is running or at rest. All of the spindles are at rest except the one which is in the operating position.

Expanding Reamers: Cutter & Wood Supply Co., 68-70 Pearl St., Boston, Mass. A line of expanding reamers which are fitted with six adjustable blades, so that a micrometer may be used for setting the reamer to size. Adjustment is made by means of nuts at the ends of the blades that slide in inclined slots. Each reamer will expand from 0.010 to 0.015 inch over its maximum listed size so that provision is made for considerable grinding before new blades are required.

Elevating Truck: Lewis-Shepard Co., 48 Binford St., Boston, Mass. In the November number of MACHINERY a description was published of a Type L truck built by this company for carrying loads up to 2500 pounds. Recently, the same firm has added to its line a Type K truck which is of the same general design, except that it has a capacity for handling loads up to 8000 pounds. For a full description and illustration of the Lewis-Shepard elevating trucks the reader is referred to the November number of MACHINERY.

Shell-heating Furnaces: Electric Furnace Co., Alliance, Ohio. Automatic electric shell-heating furnaces which are especially adapted for the performance of heat-treating operations on shells. They represent an adaptation of furnaces of similar size and design, which have been used for the heat-treatment of steel parts for railway and motor car equipment. The outfit consists essentially of two furnaces, the quenching mechanism and the automatic control by means of which all operations or movements of the shells are accurately timed.

Tool and Cutter Grinder: Woods Engineering Co., Alliance, Ohio. An improved form of the No. 2 universal tool and cutter grinding machine formerly built by this company. The new machine is equipped either for belt drive or with self-contained motor drive. The knee is of box section and entirely encircles the column, sliding on a V-key which is adjustable for wear. Both the elevating and cross-feed screws are furnished with micrometer dials. The head may be swiveled through 180 degrees and is provided with a ⅝-inch clamping nut and graduated column.

Milling and Drilling Machine: Moline Machinery Co., Moline, Ill. A machine designed primarily for the performance of milling and drilling operations on automobile steering knuckles, both operations being performed at a single setting of the work in order to insure proper alignment. This machine is of the continuous-operation, six-station type, and is provided with a revolving table that enables the operator to set up the work while another piece is being operated upon by the cutters. In addition to milling and drilling, other operations of a similar character may be performed.

Truck Platform: McMyler Interstate Co., Cleveland, Ohio. A pressed steel platform for use in connection with hand or power elevating trucks, this type of platform being designed to meet the need for a rigid portable platform which is not excessively heavy. Platforms of this kind are furnished with grooves or ribs which are pressed into the single steel plate to give the required strength and rigidity. Standard sized units are made with inside clearance heights varying from 5½ to 10¾ inches, inside clearance widths from 23½ to 39½ inches, and standard lengths from 24 to 78 inches.

Drilling Machine: Buckeye Tool & Machine Co., New Philadelphia, Ohio. Single-spindle 17-inch vertical drilling machine, with upper half of column in the form of an enlarged D-section and containing the gear-box. There are eighteen spindle speed changes and six feed changes ranging in geometrical progression from 0.006 to 0.048 inch per revolution of the spindle. The crown gear at the upper end of the spindle and the driving pinion are mounted in Hyatt solid race type roller bearings. This machine is equipped with a tapping attachment and automatic trip and depth gage with suitable graduations.

Expanding Mandrel and Tool-holders: H. P. Louden, Sr., Lebanon, Pa. A swinging expansion mandrel adapted for all classes of hollow work, although especially designed for shell finishing. It can be arranged for either a friction or an automatic grip. An advantage claimed for the swinging arrangement is the elimination of energy consumed in lifting the mandrel in and out of the machine. The tool-holders are intended for diamond-point and round-nose tools, respectively, and it is claimed that increased production is secured with these holders as well as an economy in tool steel obtained through the utilization of short pieces of steel.

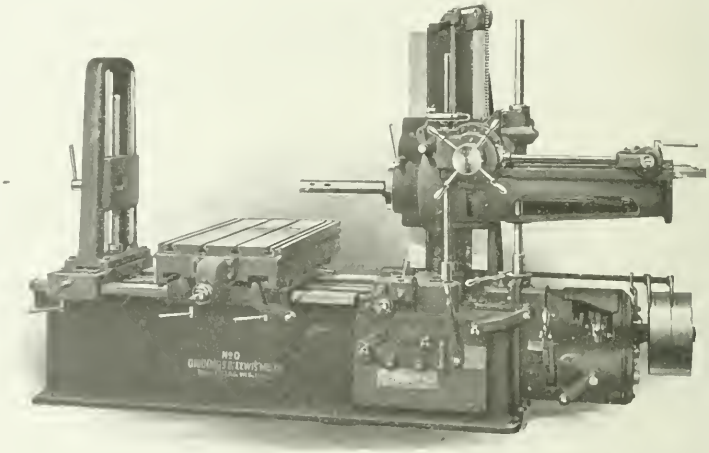
• • •

The new Quebec Bridge was formally opened to traffic on December 4. The first freight train, composed of sixteen freight cars, one van, and one private car with a total weight of 1245 tons, crossed and recrossed the bridge.

GIDDINGS & LEWIS HORIZONTAL BORING MILL

In the October, 1913, number of MACHINERY, a description was published of the No. 0 horizontal boring, drilling and milling machine built by the Fosdick Machine Tool Co. Recently the Giddings & Lewis Mfg. Co., Fond du Lac, Wis., acquired the manufacturing rights for this machine. After purchasing the drawings, patterns, etc., the Giddings & Lewis Mfg. Co. at once started to prepare for building these machines on a large scale. Many features of the design were revised. There are certain shops which have use for a machine of this type, that require a long traverse for the spindle. The standard traverse is 26 inches, and to materially increase the production and supply this demand, provision was made to build the machine with a double-spindle traverse feed which doubles the standard spindle traverse. This result is obtained by collars on the spindle placed in front of and behind the driving nut portion of the ram. Experience has shown that operators of all types of boring mills frequently fail to know when they have fed the spindle to the end of the rack, and to overcome this trouble, an indicator has been provided that shows the exact travel of the spindle at all times. This indicator is positioned directly before the operator, and in this way prevents an over-feed of the spindle ram, thus eliminating danger of lost time in driving the rack back into mesh with the pinion.

Many small changes have been made in the general design of the machine to assure additional rigidity and to simplify both the operation of the machine and machining operations involved in its manufacture. Changes have been made in the design to provide a perfect support for all moving parts and to afford efficient lubrication of all bearings. The internal gears run in oil, so that they are thoroughly lubricated at all times; and an indicator placed at the front of the machine shows the level of the oil in the case, which is a feature that not only adds to the life of the machine, but eliminates wear and aids in the production of accurate work by the machine. To avoid the probability of costly shutdowns of the machines while in operation, due to carelessness on the part of the operator, "fool-proof" safety devices have been provided on all feed movements. The gearing is so designed that the machine is started at a slow rate, and when the desired rate is selected and engaged, a disastrous shock is prevented because the load is already in movement. Two feeds cannot be engaged at the same time; each separate feed is selected by one lever. The single clutch lever is supplied with a spring latch, making it impossible for the clutch to accidentally engage. The same lever controls the rapid traverse friction and has a spring release, causing the friction to be released as soon as pressure is removed. The location of several of the operating levers has been changed so that the entire control is centralized at the operating position, making it possible to secure maximum results from the machine.



No. 0 Horizontal Boring, Drilling and Milling Machine built by the Giddings & Lewis Mfg. Co.

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During December, the War Department took control of the plants of the General Vehicle Co. and the Stewart-Warner Speedometer Co. in Long Island City. Colonel George Montgomery, in command of the Frankford Arsenal, Philadelphia, Pa., will have charge of both plants. These plants are among the most modern and best equipped in Long Island City. It is said that the Stewart-Warner plant, which has not been occupied, will be used for the manufacture of gas masks and other articles used by the soldiers in France. The other plant, which has been manufacturing Gnome motors for about a year, will be devoted to the manufacture of airplane motors and other parts.

CLOSER COOPERATION OF ENGINEERING SOCIETIES

The removal of the American Society of Civil Engineers from its former home on 57th St., New York City, to new quarters in the Engineering Societies' Building, into which they were formally welcomed in conjunction with the annual convention of the American Society of Mechanical Engineers on December 7, marks an interesting epoch in the history of American engineering societies, as now all the national engineering associations—the civil, mechanical, electrical, and mining—are housed under one roof. It is believed that the four national societies will henceforth be able to do greater things because of the strength they will derive from closer cooperation. The union of the societies under one roof is a symbol of the movement toward unity in the engineering profession which has become more pronounced during recent years. The Engineering Societies' Building, at 29 W. 39th St., New York City, is now truly the center of engineering activities in the United States, and as the war has done a great deal to focus attention upon the importance of engineering in all the activities of civilized life, this is an opportune time for an amalgamation of the engineering societies.

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TEMPERLESS COLLETS

It is one thing to do a difficult job well and another to avoid the necessity of doing it at all. An example in point is the collets used in screw machines designed for handling large work. Collets as ordinarily made must have a spring temper in sections back of the jaws, in order that they will open and release the work when the sleeve is withdrawn. If the collet fingers are not properly tempered, there will be trouble. If too hard, the fingers will break; and if too soft, they will lose their springiness and refuse to release the work, thus causing the operator trouble and delay.

One machine tool manufacturer was clever enough to recognize this defect of spring collets and succeeded in devising a collet chuck that is positively operated both when closing the jaws on the work and when releasing them. His collets are left soft in the thin parts and hardened only in the jaws. The difference in cost on large collets is an important item. Out of several hundred collets made for 9.2-inch British shells, not one was lost in the heat treating, because the vital and delicate portion was left as it came from the machine; thus we have a case of avoiding trouble rather than correcting it.

• • •

The executive committees of the Master Car Builders' and American Railway Master Mechanics' Associations have decided to abandon the annual conventions for 1918 similarly as was done in 1917. The Railway Supply Manufacturers' Association has also announced that the annual exhibition of appliances is postponed.

COMPARISON OF FORGE, OXY-ACETYLENE AND ELECTRIC WELDING

ESSENTIAL FACTORS IN FORGE-WELDING AND THEIR IMPORTANCE IN THE OTHER PROCESSES

BY H. JAMES

THE old method of welding in a forge fire, where so many variables tend to produce poor work, is being superseded on certain classes of work by the electric and oxy-acetylene processes. Successful forge-welding is dependent on a correct analysis of the material, method of joining the work, fuel, blast pressure, quality of flux and ability of operator. Other important factors are the cost of labor and material. The fuel supplied by the purchasing department is sometimes bought irrespective of analysis. A few analyses will show what is required, and in the case of coal with which the smiths claim that good work cannot be done, it will be noted that the principal difference is in the ash content and the number of British thermal units. Why these slight variations should cause any material difference is hard to explain, but a piece of work unsuccessfully welded in a fire using "bad coal" can be successfully welded in a fire using "good coal." Sulphur is not considered as objectionable in coal today as formerly, but the less there is of it the better. The analyses of smithing coals are given in Table I.

TABLE I. ANALYSES OF SMITHING COAL

Brand	Moisture	Volatile Combustible Matter	Volatile Matter	Total Combustible Matter	Fixed Carbon	Ash	Coke	Sulphur	B.T.U.
Logan	0.64	18.18	18.82	91.18	73.00	8.18	81.18	2.82	14,170
Georges Creek	0.30	18.80	19.10	91.95	73.15	7.75	80.09	1.09	14,504
Good Coal	0.34	19.66	20.00	89.21	69.55	10.45	80.00	0.89	14,033
Bad Coal	0.25	18.90	19.15	86.80	67.90	12.95	80.85	1.03	13,404

Machinery

One of the disadvantages of forge-welding is that regulation of the blast is difficult, and perfect combustion is never realized. Besides, the oxidizing influences that are present tend to produce a poor weld. The flux used is generally borax or sand; but very little is used, and in large shops the welding is done at a high temperature, which results in coarsening the grain. The work is then annealed to restore the grain. If it were not for this high temperature, the welds would be considerably poorer.

That there is considerable variation in the strength of welds is well known. A comparison of results from varied sources shows that the ratio of the strength of welds to the strength of solid pieces, in the case of iron, varies from 60 to 85 per cent, and from 55 to 85 per cent in the case of steel. Chain welding, which is probably the most exact work done, varies from 72 to 95 per cent.

Tests on the safe ending of boiler tubes give a good idea of the erratic results one may expect to find in practice. The point to be settled in the tests was the feasibility of welding the Parksburg iron safe ends onto steel tubes supplied by the National Tube Co. In the first test, Parksburg iron safe ends were welded onto Parksburg iron tubes; in the second test, the five iron ends were welded onto National Tube Co.'s steel tubes; and in the third test, steel ends were welded onto the steel tubes. In all cases, the tubes were two inches in diameter and the tensile tests were on eighteen-inch lengths.

Test No. I

Sample	Heat	Appearance	Tensile Strength, Pounds
1	Bright yellow		
2	Bright yellow, plus	Good	30,040
3	Bright yellow	Poor	28,390
4	Very bright yellow	Very good	31,730
5	White	Fair	27,440

The foreman said that the first three samples were not hot enough, but the smith contended that the second sample was. The first, second and fourth samples broke at the weld, but did not pull apart.

Test No. 2

Sample	Heat	Appearance	Tensile Strength, Pounds
A	Bright yellow	Good	26,810
B	Bright yellow	Very good	28,280
C	Bright yellow	Very good	26,920
D	Bright yellow	Very good	31,440
E	Bright yellow	Fair	23,860

The first four samples broke at the weld, but did not pull out; the fifth broke back on the steel tube about one inch from the weld, at a point where it was overheated.

Test No. 3

Sample	Heat	Appearance	Tensile Strength, Pounds
1	Very bright red	Good	28,220
2	Very bright red	Good	30,980
3	Very bright red	Poor	31,590
4	Very bright red	Poor	25,400
5	Bright yellow	Good	29,450
6	White	Fair	19,280

The first four samples pulled apart at the weld; the fifth and sixth were burned; the last sample broke back on the tube about one inch, where it was overheated.

The labor element is also an important factor in the making of a successful weld. Even in a well organized, up-to-date shop the writer has seen two smiths, working on large work at separate fires, draw the work, knock off the clinker, rush to the hammer a few feet away, and find the hammer boy far down the shop wrestling with a friend. Then after the piece was welded and the men thought a good job was done, they found that the weld practically fell to pieces.

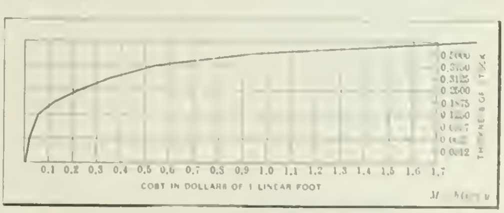
Oxy-acetylene Welding

When welding with acetylene, the analysis of the material is known because this method is generally used on parts that have failed in service. Generally, also, the quality is determined; in any case, the difference between iron and steel is not so noticeable. The material used to make the weld is purchased in the correct form and to the right analysis. The blast pressure is registered by a gage, so that there is less danger of oxidation, and the quantity of acetylene is regulated. A flux is nearly always used, though its composition may vary considerably, as is here shown:

Analyses of Fluxes

	Per Cent
Borax	57.35 to 33.79
Calcium carbonate	6.47 to 38.16
Siliceous matter	33.03 to 1.06
Carbon	3.15 to 26.99

In acetylene or electric welding, the operator generally does little else, whereas a smith may do several other kinds of work, and the old saying that practice makes perfect holds good. An intelligent handy-man is generally employed, and his wages are a trifle less than a smith's. The cost of material, which includes gas, is greater, however, than when the welding is done in the forge fire. The cost of welding in-



Cost of Oxy-acetylene Welding per Hour

TABLE 2. RESULTS OBTAINED WITH ELECTRIC WELDING AND OXY-ACETYLENE WELDING

Method	Breaking Strength, Pounds	Original Strength of Material, Pounds	Efficiency of Weld, Per Cent	Thickness at Weld, Inch	Thickness of Material, Inch	Remarks
Electric	19,420	24,700	78	0.306	0.508	Ground joint
Electric	23,790	24,700	96	0.315	0.513	Ground joint
Electric	25,530	24,700	100	0.324	0.580	Not ground, broke 2½ inches from weld
Electric	24,230	24,700	100	0.317	0.621	Not ground, broke 2½ inches from weld
Electric	24,350	24,700	100	0.322	0.625	Not ground, broke 2½ inches from weld
Oxy-acetylene	17,120	24,590	69	0.305	0.305	Ground joint, broke at weld
Oxy-acetylene	22,690	24,590	92	0.311	0.311	Ground joint, broke at weld
Oxy-acetylene	22,520	24,590	92	0.317	0.418	Not ground, broke at weld
Oxy-acetylene	24,590	24,590	100	0.320	0.463	Not ground, broke 2½ inches from weld
Oxy-acetylene	22,900	24,590	93	0.320	0.359	Not ground, broke at weld
Oxy-acetylene	19,900	24,580	81	0.328	0.415	Not ground, broke through weld
Oxy-acetylene	21,520	24,580	88	0.317	0.390	Not ground, broke through weld
Oxy-acetylene	19,610	24,580	80	0.312	0.420	Not ground, broke through weld
Oxy-acetylene	23,890	24,580	97	0.318	0.385	Not ground, broke through weld
Oxy-acetylene	22,410	24,590	91	0.334	0.415	Not ground, broke through weld
Oxy-acetylene	13,590	21,500	63	0.279	0.337	Not ground, broke through weld

Machinery

creases with the thickness of the work, as the consumption of gas naturally increases with the cross-section of the work. This is indicated in the accompanying chart, which shows the cost of one linear foot of welding for stock varying from 0.03 to 0.5 inch in thickness.

When welding with acetylene, it is necessary to preheat the surrounding parts, as the sudden expansion due to the great temperature of the gas is likely to cause rupture, particularly if there are strains in the casting or forging. In forge-welding, conduction and radiation are more gradual, so that this preheating is not necessary; moreover, very intricate castings are not usually forge-welded. In forge-welding, the amount of hot work performed at and continuing until the right temperature is reached is sufficient to reduce the grain size of the metal, but with acetylene welding the work must be annealed. If the weld is poor, failure will undoubtedly occur through it. If the metal around the weld is affected by the heat and the work is not annealed, failure will occur adjacent to the weld. If the annealing has been done correctly, failure will occur through the weld, but the tensile results will be higher than those obtained with a poor weld.

Table 2 shows the results obtained by electric welding and oxy-acetylene welding. Table 3 shows the results obtained by these methods and the oxy-hydrogen process as well.

Cast iron, when welded and annealed, often shows considerably less strength after treatment than before. This is because annealing, besides relieving internal strains, causes a molecular rearrangement due to the graphite change. A 1¼-inch square bar tested on 24-inch centers had a strength of 3250 pounds before welding and 3000 pounds afterward. In another test, the strength of the bar was 3350 pounds before welding and 3200 pounds afterward. The welding sticks were high in silicon, about 3 per cent, and the outside was thoroughly cleaned so that no sand or dirt could get into the weld and cause trouble in subsequent machining.

TABLE 3. COMPARISON OF OXY-HYDROGEN, OXY-ACETYLENE, AND ELECTRIC PROCESSES

Process and Treatment	Breaking Strain, Pounds per Square Inch	Percentage of Elongation	Percentage of Reduction of Area
Oxy-hydrogen, original plate, ¼ inch thick	68,400	20.0	....
Oxy-hydrogen, welded	32,300	3.0	....
Oxy-hydrogen, welded	29,800	5.0	....
Oxy-hydrogen, welded and annealed	31,000	3.0	....
Oxy-hydrogen, welded and annealed	41,300	4.5	....
Oxy-acetylene, original plate	68,400	20.0	....
Oxy-acetylene, welded	59,450	7.0	....
Oxy-acetylene, welded	53,300	12.0	....
Oxy-acetylene, welded and annealed	56,900	14.0	....
Oxy-acetylene, original plate	49,100	33.4	64.00
Oxy-acetylene, welded with steel plate	46,900	9.0	....
Oxy-acetylene, welded with iron wire	48,600	13.5	9.40
Oxy-acetylene, cold rolled shafting, original bar[1]	73,740	19.0	50.99
Oxy-acetylene, welded	36,590	1.5	8.12
Oxy-acetylene, Norway iron, original bar[1]	46,000	43.0[2]	66.42
Oxy-acetylene, Norway iron, welded	36,900	6.5[2]	3.91
Electric weld, original plate	61,150	22.0	....
Electric weld, welded	44,000	6.0	....
Electric weld, welded	37,680	4.0	....
Electric weld, welded and annealed	36,400	....	....

Machinery

[1] All bars machined to original area. [2] Elongation in two inches.

The whole of an intricate piece of material should be preheated before welding, so that any internal strains that may exist will be relieved. This preheating and annealing should, of course, be gradual and the parts treated should be kept away from drafts. It is evident that the nearer a piece can be brought to the welding heat in this treatment the less will be the local expansion, proportionately, and therefore the less will be the strains set up. Preheating or annealing is accomplished by an oil torch or oven, neither of which is as expensive as acetylene gas.

The chief difference in the cost of oxy-acetylene welding and forge-welding appears to be the adaptability of the oxy-acetylene process to the work and the fact that in many cases stripping of a machine is unnecessary. A smith may not be available, but an acetylene apparatus is now quite easily found.

TABLE 4. THERMIT WELDS

	Tensile Strength, Pounds per Square Inch	Percentage of Reduction in Area	Percentage of Elongation in 2 Inches
Fracture coarsely crystalline	50,750	2.60	Not measured
Fracture coarsely crystalline	58,480	4.92	Not measured
Fracture coarsely crystalline	56,800	3.00	2.67
Fracture coarsely crystalline	61,800	....	1.00
Fracture coarsely crystalline	61,000	9.00	5.00

Machinery

Electric and Thermit Welding

Locomotive flue welding is now done extensively by the electric process. A comparison of costs shows that the electric method is cheaper than the acetylene. But as far as putting the tubes in is concerned, both are dearer than setting them by hand. But the service conditions give a greater mileage for the welded tubes. The approximate cost by beading is 7.3 cents per flue; by oxy-acetylene welding, 9.8 cents; by electric welding, 7.7 cents.

Firebox sheets are welded and patched successfully by the electric process without removing the sheets. Taking out the sheets or removing a locomotive frame is costly in time and money. Frames have been welded in place by blacksmiths, but it is a difficult job; the better method is to employ thermit. Thermit has also been used successfully for welding side rods. Ordinarily, when welding a channeled rod the flutes are filled with iron, which is allowed to project over the edges of the break. Holes are sometimes drilled a few inches from the ends of the break; when welding, these holes serve to rivet the work together. The rods, after welding, are annealed but are not refluted, being left solid. In Table 4 are given the results obtained by thermit welding. All the test-pieces were cut from risers. The coarse fracture indicates that this steel could be improved by annealing.

BRIQUETTING OF NON-FERROUS LIGHT METAL SCRAP[1]

METHOD OF BRIQUETTING AND PRESS USED

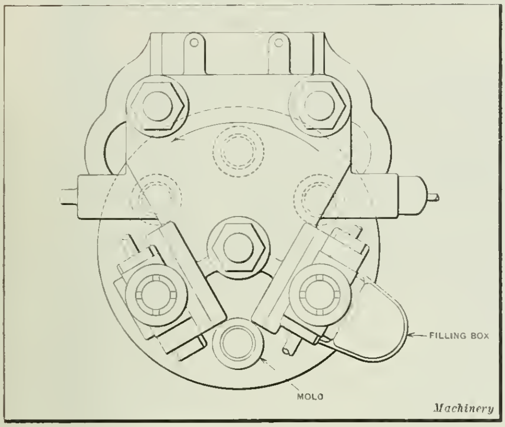


Fig. 1. Plan View of Ronay Briquetting Press

PRICES of metals of all sorts have been subject to rapid advances during the last twelve months, and never before has there been so great a need for rigid economy in metallurgical and melting practice. Ingot metal and heavy scrap have shown a far larger proportional increase in price than have the light scrap, chips and borings. It is evident that if the light scrap can be so treated, or pressed, that it will be cheaply fabricated into a form metallurgically equivalent to the heavy scrap, a great industrial economy will be realized. At present the use of light scrap in the crucibles means a great loss in handling, charging time, and also actual metal losses from burning, oxidation and vaporization.

Bundling or cabbaging, whereby long strips or sheets of metal are pressed into rectangular bundles suitable for melting, has long been an established practice. It is a recognized economy, and bundles are quoted at an advance over the loose scrap. Bundling, as such, is limited to the long, flexible turnings and sheets. Nothing can be done, so far as these cabbaging operations are concerned, with the loose, fine needles, borings, punchings and brass washings. That is the function of metal briquetting. The briquette and the bale are in no sense competitive, at least so far as the non-ferrous metals are concerned, for the reason that they use material in absolutely different forms. The bundling or baling machine calls for the long, flexible material, while the usual briquetting apparatus handles best the short, easily fed boring. The following is a comprehensive definition of briquetting: The process of fabricating small or fine materials, usually the breakage or wastage from larger blocks of the same nature, into large sizes more convenient for the purpose in hand, that purpose involving the destruction of the product or briquette, as such, either by useful consumption or as a step in a melting or reducing operation.

In the manufacture of metal briquettes for the melt, it is generally advisable that no binder be used unless the binding material is in the nature of a flux. Binders, however apparently harmless in themselves, too often introduce metallurgical complexities in the final product. In all metal briquetting it is considered desirable to achieve the desired results through the medium of pressure alone. When heavy, slow pressure is applied to metal particles or chips, a condition arises exactly analogous to the natural formation of sandstone or conglomerate rocks in nature. Rocks formed from sand and like fine material are of two sorts—those formed by pressure alone, and those cemented by a natural binding material, or chemical action. It is from the first variety that we draw our analogy. Fine materials, whether rock particles or metal chips, show characteristic strains under compression. In some cases but little pressure is necessary to obtain distortion and consequent flow. The malleable metals, notably lead, change shape under compression. The surfaces soften and adhere as particles of ice adhere when held together. This is a principle applying to but few types of metal or rock particles. Lead alloys and babbitt metals are consequently extremely easy to briquette. Copper, aluminum and their alloys, notably brass—and incidentally to a greater degree iron and steel—do not show great changes of shape under pressure other than simple bending. None the less, a strong cementing action takes place between the particles under pressure heretofore explained by the term "flow." After the preliminary packing pressure has been exerted, whereby the metallic units are interlocked or forced against each other and the included air has been slowly expelled, the building up to extreme pressures causes a new interrelation of the particles, a strong bond of adhesion, resulting in a briquette that is so strong, so homogeneous that it is frequently accepted as the metallurgical equivalent of heavy scrap. The little heat generated is insufficient to cause binding through the medium of melting. In the brasses, aluminum alloys and the like there is not the pressure flow characteristic of the more malleable metals—for even minute surface imperfections are not greatly affected. What, then, causes the bond, assuming that mere interlocking is insufficient?

Materials under strain are subject to what is known as "skin tension." Considering the outer layer of a metallic particle as the "skin," we may imagine it, under pressure, to be subjected to strains within and without which will cause alter-

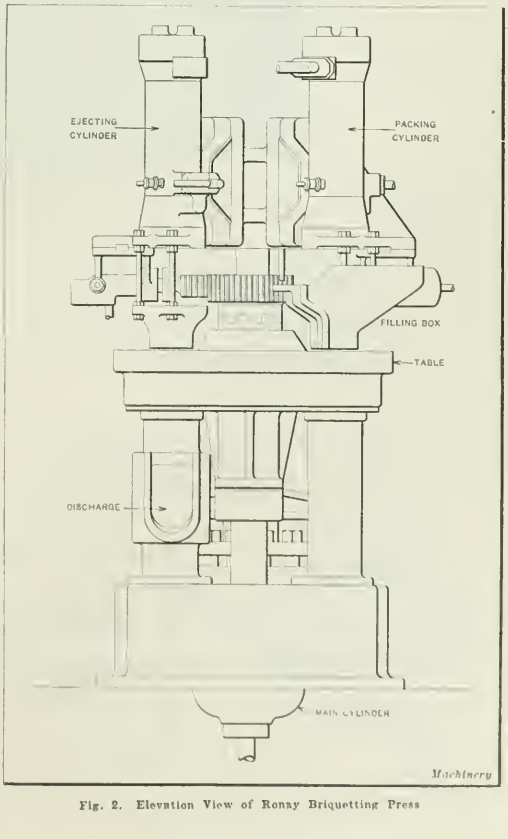


Fig. 2. Elevation View of Ronay Briquetting Press

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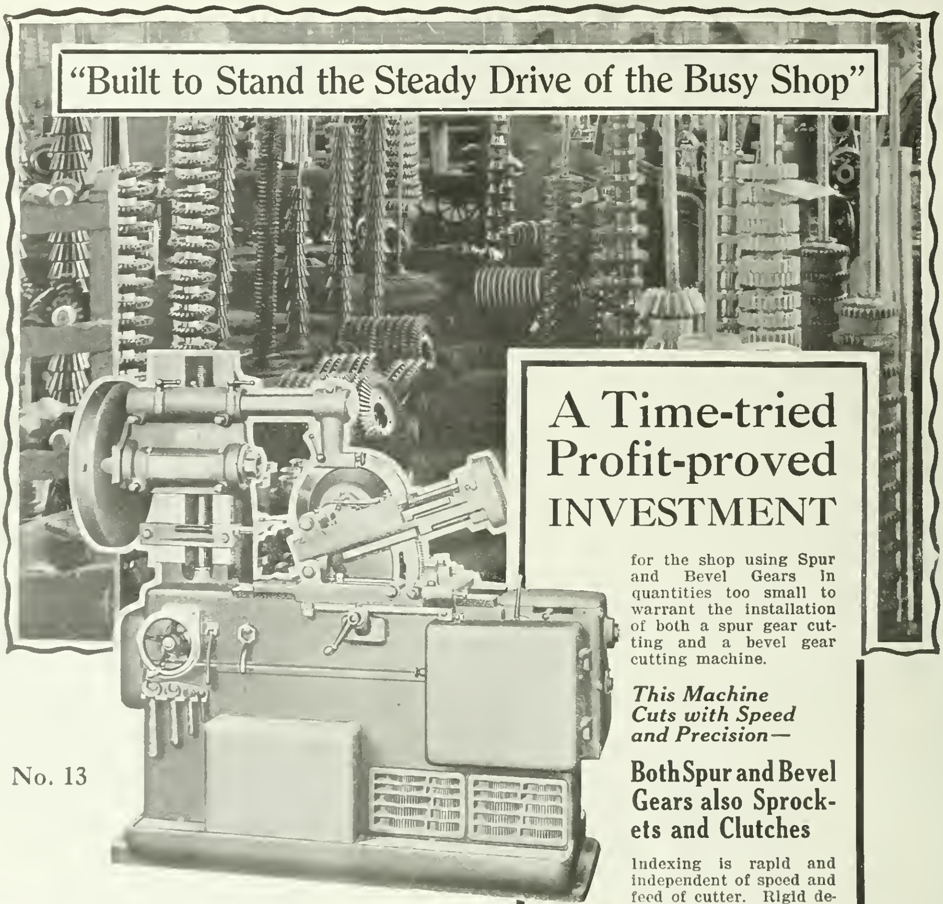
[1] Abstract of an article by A. L. Stillman, published in the "Journal of the American Institute of Metals," September, 1917.

"Built to Stand the Steady Drive of the Busy Shop"



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nating minute stretch and contraction, with or without fissility. Two such surfaces in contact will show a tendency to merge into each other. If microscopic cracks or fissures occur, it is reasonable to assume that the bonding action is heightened thereby. This "skin tension" is offered as an explanation of the bonding that unquestionably occurs without change of shape. It is not "flow," as such, but may be regarded as the preliminary symptom of flow. It is true that with very hard steels, and even some bronzes, the very high pressures today realized are insufficient to produce even the slight skin tension necessary for bond, and in these cases it is the practice to use a binding material to assist the action. In the case of hard bronze, milk of lime has proved satisfactory as an aid to briquette making.

Of first importance in the manufacture of metal briquettes is the expulsion of the air surrounding the loose chips. Sudden application of force, impact by hammer blow or explosion will not make briquettes suitable for melting, because the sudden force gives no opportunity for the escape of air. Briquettes have been made thus all to frequently in the past. They contain minute chambers of air under high compression. In melting, this air breaks out, rending and tearing, and the least damage to be expected is the reduction of the briquette to its original state, thereby forfeiting all the economy anticipated. An ordinary hydraulic press can be used to make successful briquettes provided it is operated slowly, to get rid of included air. The result is usually a sacrifice of capacity and consequent expense. The few who have attempted commercial briquetting in ordinary hydraulic presses are gradually abandoning it. Special design is necessary to obtain simultaneously high capacity and quality of product.

Some progressive firms have presses especially designed to handle their chips which are working satisfactorily. Latterly there has been a tendency to adopt foreign practice. In Europe the necessity for conserving resources has been a problem far more pressing than in the United States for a great many years. So far as study and investigation proceeded, the result may be said to be standard briquettes of all classes of metals which are daily quoted as a market commodity. The problem has been solved in many ways; but the most successful and indeed the one system originating abroad that has made a definite progress in this country is the Ronay process. Here the problems solved may be summarized as follows: The pressure is brought to the maximum commercially permissible—the capacity is high and the cost per ton extremely low. The illustrations show the large size vertical Ronay press manufactured by the General Briquetting Co., 25 Broad St., New York City, under the name "Type A." Briefly, it consists of six molds 5 or 6 inches in diameter set in the horizontal rotary table. This table is automatically rotated, one-sixth revolution between each operation. The operation is controlled by the automatic hydraulic valve gear. In the operation, three molds are simultaneously subjected to different operations while the other three are idle. The succeeding operation brings these three idle molds under the three pistons. Briquettes are turned out on every sixth revolution of the table. In the first sector the mold is filled by gravity from a filling hopper and subjected to the action of a hydraulic packing plunger working from above in the center of the hopper. Imagining the machine in operation. Immediately after the filling and packing is completed, one-sixth revolution of the table brings the mold to the idle position, where it waits the filling of the succeeding mold. This complete, another one-sixth revolution brings it to the heavy pressure piston. The mold is directly under a stationary counter plunger and over a sliding plunger operated by a hydraulic piston. Pressure is admitted by valve gear to the hydraulic piston, and the lower plunger is forced against the chips in the mold. Under compression the mold rises, thereby avoiding friction of the chips against its sides and causing the counter plunger to exert a pressure practically equivalent to that of the lower plunger, causing compression of the chips on both sides. To prevent inclusion of air, a downward pressure is exerted against the mold by adjustment of counterweights to obtain a difference of pressure between upper and lower plungers whereby the contained air escapes from the top. The counterweights prevent too rapid rising of the mold and the maintenance of the proper differential of pressure. The counterpressure is regulated in accordance with the character of the material briquetted. The increase in hydraulic pressure is not continuous, as a slight decrease in pressure takes place with each stroke of the pump. Here the weight of the mold overcomes somewhat the frictional resistance and the mold recedes slightly. The lifting of the mold is, therefore, somewhat spasmodic, resulting in a movement like shaking, which facilitates the expulsion of the air from the material.

With the expulsion of the air the pressure is brought up to maximum, which in the five-inch molds amounts to 33,000 pounds per square inch. Pressure is held just long enough to insure a permanent set to the briquette, which is now completely formed. The pressure is removed and another one-sixth turn brings the mold to the idle position. Then another one-sixth turn brings the mold containing the finished briquette to the ejection plunger, which is also hydraulically operated. From this point, another one-sixth turn brings the empty mold to an idle position, preliminary to the next position, where, the revolution having been completed, it is again under the feeding hopper. It is seen that the three operations of feeding (with packing plunger), pressing and ejection take place simultaneously with three different molds, the other three being in intermediate positions awaiting the same operations.

This press is designed to turn out four briquettes per minute, and the table is designed to complete forty revolutions per hour. The question of tonnage capacity depends entirely upon the kind of material fed into the hopper. Loose, fluffy stuff is difficult to feed and considerable air space is left in the mold prior to the preliminary packing operation. Briquettes of this material are sometimes but 1/2 to 2 inches high. This condition, fortunately exceptionally rare, would bring the machine down to a little over a ton per hour. The finer material feeds more readily, and briquettes as heavy as forty pounds apiece can easily be made—representing a capacity of a little less than five tons per hour. In general, expressed in terms of brass, two tons per hour may be regarded as an extremely conservative estimate, and for aluminum it would, of course, be lower, due to its lightness.

The labor required depends upon the degree to which automatic operation is carried. If the material is fine and uniform, automatic feeding is practiced. Usually, however, one man is necessary to watch the feeding and operation of the machines. If a conveyor is installed, the delivery of finished briquettes is automatic; if not, another man is required to remove and pile the briquettes. A first-class mechanic should be able to give part time to this machine, but the entire time of a skilled artisan is not required. In general, the cost of briquetting by this process—everything included—is less than $1.50 per ton (somewhat more for aluminum). So far as repair expense is concerned, it is common experience for a press to run regularly for several years without repair other than the renewal of the dies, which is done about once every three months. This type of press is of such capacity that it is adapted particularly to the needs of the larger foundries and metal industries, the scrap dealers handling a large tonnage and custom plants where several interested parties unite on a single briquetting installation.

* * *

The Society of Automotive Engineers, which will meet in the Engineering Societies' Building in New York City, January 9 and 10, has selected for one of the topics of discussion "The Reasons behind the Liberty Engine," this discussion being scheduled for Thursday afternoon, January 10. Major Jesse G. Vincent, who was largely responsible for the design of the engine and who is now responsible for its development at the aviation headquarters in Dayton, Ohio, will present a special address, going into the reasons for the present twelve-cylinder Liberty engine, after which the discussion will be opened by Colonel Clark, who is chief in charge of aviation engineering in the Signal Corps. His phase of the discussion will deal with the military requirements of aviation engines. A number of other aviation experts will also take part in the discussion.

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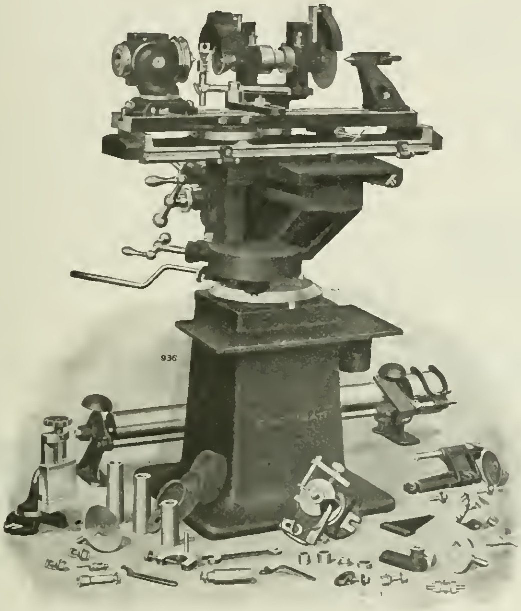

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CINCINNATI **OHIO, U. S. A.**

HEAT-TREATMENT OF AUTOMOBILE PARTS[1]

The art of improving steel by heat-treatment was known and used by a few men for quite a number of years, but it has been considered a commercial manufacturing possibility only in recent years. As the benefits and significance of heat-treatment became recognized, research and progress in all subjects closely allied with the treatment of steel were stimulated. The results of this stimulation were better furnaces to produce the steel, different steels, and many radical changes in the design of machine tools. We have only to go back fifteen or twenty years to realize what this progress has been. The writer can recall one time when a gear hob six inches in diameter and eight inches long had to be hardened. With the aid of a few firebricks, an oven was built in the coals in the smith's forge, which was in a dark corner of the shop, the hob was put into this oven, and the blast turned on. When the human pyrometer guessed that the hob was hot enough, it was pulled out and hung on a wire in the same air blast until cool. While we do not know a great deal more about the fundamental principles of heat-treating than our fathers did, more people know these principles, so that today there is a special kind of steel for almost every purpose.

Few men, other than the designing engineers, have any idea of the number of steels there are and the great variety of treatments these steels receive. For instance, in one automobile the wire-wheel hubs are drawn up from special, soft, deep-drawing low-carbon steel, and finally given a treatment to bring the steel to condition after drawing. Vanadium steel may be substituted for this deep-drawing steel before long. The wire-wheel spokes are a high-carbon steel drawn dowu with extra care and set up cold. The steering knuckle and arms are 0.28 to 0.35 per cent carbon, chrome-vanadium steel, and are treated to have about 105,000 pounds tensile strength. The knuckle ball cups and races are of 0.15 to 0.22 per cent carbon chrome-vanadium steel and are casehardened to about 75 on the scleroscope.

The front-axle forging is a straight 0.35 to 0.45 per cent carbon steel forging treated to a tensile strength of 100,000 pounds; the center of the beam is drawn back to 65,000 pounds. The ball studs in the knuckle arms are 0.15 to 0.25 per cent carbon chrome-nickel steel and are carburized. The cross-tie rod tube is a 0.25 to 0.35 per cent carbon 3.5 per cent nickel-steel tube and is heat-treated. The springs that fasten the axle to the frame are of 0.42 to 0.52 per cent carbon chrome-vanadium steel and are heat-treated. The frame itself is from hot-rolled sheets about 0.12 to 0.20 per cent carbon; special attention is given to sulphur and phosphorus to allow of cold pressing.

Practically all the levers, pedals and small brackets on the chassis are drop-forged from 0.25 to 0.35 per cent straight carbon steel and are heat-treated so as to have an average tensile strength of about 90,000 pounds. The motor shell is a steel casting of a special analysis and treatment that give it the magnetic properties; the armature core plates are punched from steel sheets especially produced for that purpose. The armature shaft is a 0.28 to 0.35 per cent carbon chrome-vanadium steel and is treated to have a tensile strength of 110,000 pounds. The universal joint forgings are of 0.25 to 0.35 per cent carbon, 3.5 per cent nickel steel, and are treated to have a tensile strength of 100,000 pounds; the pins for these joints are of 0.15 to 0.22 per cent carbon chrome-vanadium steel, casehardened.

The propeller shaft tube is especially swaged from 0.25 to 0.35 per cent carbon steel that contains 3.5 per cent nickel. This propeller shaft revolves inside an especially swaged torque tube made from Mayari 0.25 to 0.35 per cent carbon, 1.5 per cent nickel-chrome steel, and is connected with the pinion shaft, which is made of 0.15 to 0.22 per cent carbon, [illegible] per cent nickel electric steel, and is especially carburized with one tempering heat. This pinion drives the rear axle gear, which is made of 0.15 to 0.22 per cent carbon, 3.5 per cent nickel electric steel, and is especially carburized and tempered in a Gleason tempering machine. Inside this driving gear are the differential gears made from drop-forged 0.15 to 0.25 per cent carbon chrome nickel steel and carefully carburized. Exactly what is the strength of either the driving gear or the differential gears, it is impossible to say, owing to their shape, but destruction tests show them to possess enormous strength and the casehardening gives the spiral gears an almost indefinite life. The drive shafts from the differential to the hubs are of 0.42 to 0.52 per cent carbon chrome-vanadium steel, and are heat-treated to have a tensile strength from 160,000 to 180,000 pounds; the driving flanges at the hubs are of 0.25 to 0.35 per cent straight carbon steel and are heat-treated to have a tensile strength of about 100,000 pounds. The upper bracket, which connects the main spring with the chassis, is a 0.28 to 0.35 carbon chrome-vanadium steel forging that has been heat-treated to give a tensile strength of from 110,000 to 120,000 pounds. Even the irons that support the fenders are of 0.28 to 0.35 per cent chrome-vanadium heat-treated steel.

This list shows that there are many different alloy steels to be produced and treated for the manufacture of automobiles; and, in addition, there are many kinds of steel sheets finished in all conditions from dull black to extra bright and having a wide variation of deep drawing qualities. If the mills are required to produce this great variety of steels for the automobile trade only, how much more must they have to do to take care of the locomotive, rolling stock, rails, construction work, ammunitions, guns, armor plates, shipbuilding, electrical engineering, airplanes, and every other business using any form of steel? Many people tell us that the war in Europe will be won with airplanes, but, indirectly, heat-treating will win the war, for the success of the trucks, automobiles, air engines, guns, ammunition, etc., depend upon successful heat-treating of the steel used in the construction of these articles.

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[1] Abstract from an address delivered before the Steel Treating Research Society, of Chicago, Ill., by Arthur W. Medhurst, assistant general manager of the Anderson Electric Car Co., of Detroit, Mich.

PERSONALS

Sherwood H. Standish, formerly assistant superintendent of the Northwestern Malleable Iron Co., Milwaukee, Wis., has become associated with the Stowell Co., South Milwaukee, Wis., in the capacity of works manager.

Alfred D. Flinn has been appointed permanent secretary of the Engineering Council for the United Engineering Society and the Engineering Foundation, succeeding Calvert Townley, who has held office since the organization of the council.

George A. Rees has been appointed general purchasing agent of the Chicago Pneumatic Tool Co., with headquarters at 913 Fisher Bldg., Chicago, Ill. Mr. Rees succeeds R. S. Baker, who has found it necessary to devote his entire time to his official duties as auditor.

Daniel Willard, president of the Baltimore & Ohio Railroad and head of the advisory committee of the Council of National Defense, has been appointed chairman of the War Industries Board, succeeding Frank A. Scott, who recently resigned on account of ill health.

L. F. Hamilton, for several years in charge of the advertising department of the National Tube Co., Frick Bldg., Pittsburg, Pa., has resigned to become advertising manager of the Walworth Mfg. Co., of Boston, Mass. Mr. Hamilton is succeeded by W. L. Schaeffer.

A. N. Martin, industrial agent of the Baltimore & Ohio Railway Co. has resigned and taken the position of general sales manager for the Fulflo Pump Co., of Cincinnati, Ohio, manufacturer of small centrifugal pumps for machine tools, automobile motors, airplane motors, etc.

W. H. Harman, vice-president and general sales manager of the Southwark Foundry & Machine Co., Philadelphia, Pa., was elected president of that company on November 1, 1917, to fill the vacancy caused by the election of Robert Radford to the chairmanship of the board of directors.

J. H. Schneider, formerly with the Lodge & Shipley Machine Tool Co. and later assistant superintendent in charge of special organization and engineering work with the Gurney Electric Elevator Co., Honesdale, Pa., has been made head of the efficiency department of the American Tool Works Co., Cincinnati, Ohio.

Raymond G. Hutchinson, who has been division engineer of all branches of the American Brass Co. for several years, has been appointed superintendent of the Buffalo branch of the American Brass Co. in Buffalo, N. Y. This plant was formerly the Buffalo Copper & Brass Rolling Mill, and was acquired by the American Brass Co. last June.

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E. W. Ames, manager of agencies of the American Steel Export Co., Woolworth Bldg., New York City, and A. G. Dowden, assistant purchasing agent of the company, sailed on November 30 en route for Japan. Together they will visit in the Far East, Japan, China, Philippine Islands and Straits Settlements. Mr. Ames will also go to India, Australia and New Zealand.

E. F. Lake, metallurgical engineer, formerly located in Detroit, Mich., has moved to 557 E. 50th Place, Chicago, Ill., and taken the position of assistant superintendent of the Rich Tool Co. The company is manufacturing one-piece valves from high-speed steel for airplane and automobile engines. It is also making valves from a high chromium steel similar to the stainless steel recently placed on the market.

George N. Peek, vice-president of Deere & Co., of Moline, Ill., has been appointed industrial representative of the War Industries Board. He will confer with manufacturers who have facilities for the production of munitions or other material required by the government or the Allies, and will select his own assistants subject to the approval of the chairman of the War Industries Board. This action creates, in effect, what has been forecasted as a Bureau of Manufacturing Resources.

J. C. Bannister has been made a vice-president of the Walworth Mfg. Co., Boston, Mass., manufacturer of iron pipe fittings, valves, Stillson wrenches, etc. Mr. Bannister has been connected with the manufacture of this type of product for twenty-six years, starting as foreman of the tapping department of the Haxtun Steam Heater Co., at Kewanee, in 1891. Mr. Bannister was made manager of the Kewanee Works when purchased by the National Tube Co., and continues in the same capacity under the present management.

Charles Piez, president of the Link-Belt Co., Chicago, has been appointed vice-president of the Emergency Fleet Corporation, Washington, D. C. Mr. Piez entered the employ of the Link-Belt Engineering Co. in Philadelphia immediately following graduation in 1889, as a draftsman, and with the growth of the company held successively the positions of chief engineer, general manager, and vice-president until 1906, when the Link-Belt Engineering Co. was merged with the two affiliated companies in the West, forming the Link-Belt Co., of which Mr. Piez was elected president.

John S. Myers, contributor to MACHINERY for many years, has left the employ of the Southwark Foundry & Machine Co., of Philadelphia, to take a position in the machinery fabrication department of the American International Shipbuilding Corporation, Philadelphia, Pa. Mr. Myers was one of the original force that helped to build the New York Shipbuilding Co.'s plant at Camden, N. J. He went to this job from the Chambersburg Engineering Co. Mr. Myers later had charge of the design of a general line of ship auxiliary machinery with the Williamson Bros. Co., now the American Engineering Co. For the past five years he has devoted most of his time to the design of steam turbines.

OBITUARIES

Henry Gaul, employed for many years by the Ajax Mfg. Co., Cleveland, Ohio, and widely known among the railroad, locomotive, car building and industrial forge departments as a resourceful and brilliant forging machine expert, died at his home in Cleveland, November 25, aged sixty-six years.

R. B. Dangeleisen, sales manager of the Globe Machine & Stamping Co., Cleveland, Ohio, died at Saranac Lake, N. Y., November 12, aged thirty-one years. He entered the employ of the company in 1902 and because of his efficiency and executive ability was advanced rapidly to the position that he held at the time of his death. He was conspicuously instrumental in developing the company's resources and facilities.

COMING EVENTS

January 14—Annual meeting of the American Institute of Consulting Engineers, New York City. F. A. Molitor, 35 Nassau St., New York City, secretary.

January 16-17—Convention of the American Society of Civil Engineers at the Engineering Societies Building, 29 W. 39th St., New York City. Charles Warren Hunt, secretary.

January 31—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

February 7-9—National Foreign Trade Council conference in Cincinnati, Ohio; Gibson Hotel, headquarters. Secretary, O. K. Davis, 1 Hanover Square, New York City.

April 24-25—Annual convention of the National Metal Trades Association at the Hotel Astor, New York City. Homer D. Sayre, secretary, 1021 Peoples Gas Bldg., Chicago, Ill.

May 15-17—Joint convention of the National Supply and Machinery Dealers' Association, Southern Supply and Machinery Dealers' Association and the American Supply and Machinery Manufacturers' Association in Cleveland, Ohio. Secretary of the American Supply and Machinery Manufacturers Association, F. D. Mitchell, Woolworth Bldg., New York City.

June 20-22—Fifth annual convention of the American Drop Forge Association held at the Iroquois Hotel, Buffalo, N. Y. E. B. Horne, "The American Drop Forger," 108 Smithfield St., Pittsburg, Pa., secretary.

NEW BOOKS AND PAMPHLETS

Operator's Handbook. 180 pages, 6 by 9¼ inches; 79 illustrations and diagrams, and 18 tables. Published by the Fellows Gear Shaper Co., Springfield, Vt.

This book gives adequate instructions for the setting up and operation of the Fellows spur and helical gear shapers, and the numerous illustrations make these instructions easily understood. It also deals with the care and maintenance of the shapers, sharpening the gear-cutters, cutting compounds, gaging and inspecting gears, etc. Rules, formulas and examples are given for calculating spur, internal and helical gears, as well as several tables of gear tooth parts.

Design of Splines and Clutch Teeth. 22 pages, 6 by 9 inches, 17 illustrations and diagrams. Published by the Fellows Gear Shaper Co., Springfield, Vt.

This pamphlet deals with the application of the involute curve in the production of splines and clutch teeth by the generating process. The features in favor of this application are accurate generation and duplication, making possible the manufacturing of strictly interchangeable parts, and also reducing the cost of manufacture. The pamphlet describes the use of this curve in connection with airplane, automobile and gun parts, electric starter shafts and couplings, and shrapnel and high-explosive shells.

Oxy-acetylene Welded Joints in Steel Plates. By Herbert F. Moore, 21 pages, 6 by 9 inches; illustrated. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill., as Bulletin No. 98. Price, ten cents.

The pamphlet records the result of a series of tests of oxy-acetylene welded joints in mild steel plates. For joints made with no subsequent treatment after welding, the joint efficiency for static tension was found to be about 100 per cent for plates one-half inch thick or less, and to decrease for thicker plates. For static tension tests, the efficiency of the material in the joints welded with no subsequent treatment was found to be not greater than 75 per cent. The joints were strengthened by working the metal after welding, and were weakened by annealing at 800 degrees C.

Our Army and Navy and How to Know Them. By Albert A. Hopkins. 124 pages, 4 by 5½ inches; illustrated. Published by Munn & Co., Woolworth Bldg., New York City. Price, 25 cents.

This little book is really two books in one; it is of pocket size, and thus is convenient for the soldier and sailor. The section on the U. S. Army is full of useful information in condensed form. The uniforms are described and the meanings of the various insignia. The location of the army posts, barracks, arsenals and cantonments, aviation camps and national guard tent camps are given, as well as a war map of the United States. The section on the U. S. Navy is quite similar in make-up and nature of contents. It treats on the naval reserve force, the naval militia, how to tell the rank of a naval officer, and contains a map showing the navy yards, etc.

United States Rifles and Machine Guns. By Fred H. Colvin and Ethan Viall. 332 pages, 9 by 12 inches; over 2300 illustrations. Published by the McGraw-Hill Book Co., Inc., 239 W. 39th St., New York City. Price, $3.

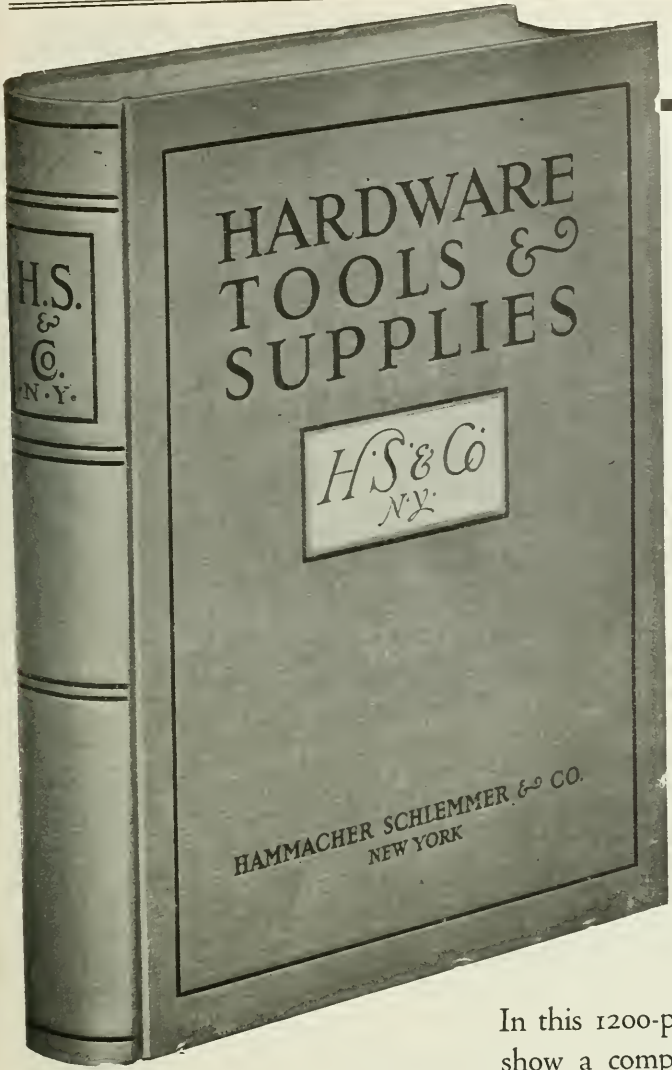
This book is a detailed account of the methods used in the manufacture of the Springfield 1903 model service rifle. The book is composed of reprinted pages from the "American Machinist" in which articles on the subject have been running for the past year. It goes into extreme detail, showing operations on all the component parts of the Springfield rifle. Brief chapters explaining the principal features of machine guns are also included. The book should be of value to men responsible for the design of tools and fixtures for making Springfield model rifles, and it is also likely that men engaged in the making of rifles of other models will find suggestions of value. It should be understood, however, that the work is specifically on the Springfield rifle and does not attempt to lay down general principles.

Kinematics of Machinery. By Arthur Warner Klein. 227 pages, 6 by 9 inches, numerous illustrations. Published by the McGraw-Hill Book Co., Inc., 239 W. 39th St., New York City. Price, $2.50.

This book is the outcome of many years of experience in teaching the subject of kinematics at the Lehigh University, where the author is professor of mechanical engineering. The book is especially intended as a text book for use in engineering schools, and is believed to be particularly timely on account of the increasing attention that is given to this subject at the present time. The book is divided into eleven chapters, dealing with general principles; centrode construction; inversions, skeleton diagrams; displacement diagrams; velocity diagrams; special locus construction; kinematic analysis; acceleration determinations; governor gear accelerations; and force and mass reduction. Unfortunately, the book is not provided with any index, so that, while it may be excellent as a text-book, it cannot be used readily for general reference. In the last section of the book, the figure numbers do not follow consecutively, which also gives a peculiar appearance to the make-up.

MACHINERY'S Encyclopedia. Compiled and edited by Erik Oberg and Franklin D. Jones. Seven volumes, 8 by 11 inches; 3558 pages; 4634 illustrations. Published by The Industrial Press, New York City. Price, $36.

This encyclopedia is a work of reference covering practical mathematics and mechanics; machine design; machine construction and operation; electrical, gas, hydraulic and steam power machinery; metallurgy; and kindred subjects in the engineering field. There are articles on over 1200 different subjects, alphabetically arranged; in preparing this vast number of articles the editors were assisted by a large number of engineers, specialists in their respective fields, a list of seventy of the principal contributors and collaborators being given in conjunction with the preface in the first volume of the work. In addition, the editors have drawn upon all the sources of mechanical information available to them. Numerous articles have been abstracted and condensed from the volumes of MACHINERY, and hundreds of authorities on the leading engineering subjects were consulted. It was found, however, that there was a considerable number of mechanical subjects that had never been adequately treated in any existing work, and it became necessary for the editors to prepare treatises on many phases of machine design, construction and operation. The encyclopedia, therefore, is not merely a compilation in convenient form of mechanical data that had from time to time been published elsewhere, but contains a vast amount of original matter published here for the first time. This is true not only with regard to the subject of machine design and machine shop practice, but also in regard to the articles on electricity, all of which were specifically prepared for this work by electrical engineers of high standing and under the supervision of Eric A. Lof, engineer with the Power and Mining Engineering Department of the General Electric Co., who acted as special editor of the electrical departments. Throughout the work the practical side has always been given careful consideration, and the theory of any mechanical subject has been omitted when not necessary to make the subject intelligible or more easily comprehended. Academic discussions have been avoided. Some subjects have been dealt with briefly, either because the information relating to them constitutes common knowledge, or because they are comparatively unimportant. Other subjects, again, have been dealt with in great detail, either because of their particular importance to the field covered by the encyclopedia, or because they deal with newly developed fields upon which information is more difficult to obtain and upon which a complete treatise, therefore, is more valuable. The work is illustrated with line engravings made by the wax process, which permits an unusually clear and distinct presentation, and the typographical appearance has been pronounced unusually good, great care having been taken in selecting the proper kind of type, size of page, and general arrangement. The same kind of type, only of a larger size, as was used in MACHINERY'S Handbook, and which has been generally commended, is employed in this work.



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NEW CATALOGUES AND CIRCULARS

Fred. C. Dickow, 33-35 S. DesPlaines St., Chicago, Ill. Circular of 10-inch index universal centers.

Ready Tool Co., Bridgeport, Conn. Circular advertising "Red-E" butt-welded and top-welded stellite tools.

Fulflo Pump Co., 126 Opera Place, Cincinnati, Ohio. Circular of the "Fulflo" centrifugal pump, for use on grinding machines.

J. A. Moller, 57 Lawton St., New Rochelle, N. Y. Circular of ball-bearing lathe centers, suitable for high-speed engine lathe work.

Nagle Corliss Engine Works, Erie, Pa. Bulletin 30 descriptive of Class Y-C-E duplex, direct-connected, electrically driven air compressors.

Weaver Mfg. Co., Springfield, Ill. Circular of Weaver garage equipment, including tire spreader, auto hoist, auto oiler, tire changer, twin jacks, etc.

Oliver Machinery Co., Grand Rapids, Mich. Circular descriptive of the Oliver No. 56 motor-driven speed lathe, using either direct- or alternating-current motors.

David A. Wright, 568 Washington Blvd., Chicago, Ill. Price list of the line of triple-geared Fifield engine lathes, which are built in sizes from 24 to 96 inches swing.

Wetmore Mechanical Laboratory Co., 605 Enterprise Bldg., Milwaukee, Wis. Circular of special taps, hobs, reamers, cutters and small tools for shell manufacturers.

Link-Belt Co., Chicago, Ill. Book 310, entitled "The Ideal Drive for Clayworking Machinery," illustrating the Link-Belt silent chain drive installed in a clayworking plant.

Kelly Reamer Co., Cleveland, Ohio. Catalogue G of Kelly production tools, including adjustable reamers and boring tools. The catalogue illustrates these tools in use and gives the actual production obtained with them.

Gisholt Machine Co., 1200 E. Washington Ave., Madison, Wis. Bulletin entitled "Standardizing in the Machine Shop," showing work performed on the Gisholt turret lathe with standard tools, and giving time for each case.

New Departure Mfg. Co., Bristol, Conn. Circulars 103 FE to 105 FE inclusive, illustrating New Departure ball bearing mounting in combination grinders, ball bearings in centrifugal pump, and ball bearings in small generator set.

Thompson Grinder Co., Springfield, Ohio. Circular of the Thompson 10- by 36-inch universal grinding machine, illustrating the machine arranged for cylindrical grinding, surface grinding, knife or edge grinding and internal grinding.

Bacharach Industrial Instrument Co., Pittsburg, Pa. Catalogue D, describing the design and construction of "Hydro" pressure and draft recorders and illustrating the different types of recorders as well as their application in various fields of industry.

Tate-Jones & Co., Inc., Pittsburg, Pa. Bulletin 160, on "Recuperative" gas oven furnaces, a line of furnaces for accurate temperature work for use in hardening carbon steel, preheating or reheating high-speed steels, annealing and hardening.

Terminal Machine Co., 30 Church St., New York City. Catalogue of new and used first-class machine tools, including drill presses, turret lathes, engine lathes, grinders, milling machines, planers, power presses, radial drilling machines, screw machines, shapers and tappers.

New Britain Machine Co., New Britain, Conn. Circular descriptive of New Britain drop-head polishing and buffing machines equipped with either plain or ball bearings. These machines are driven by belt from below, thus eliminating countershafts, idlers, loose pulleys, and shifting belts.

J. A. Moller, 57 Lawton St., New Rochelle, N. Y. Circular of the Moller shaper saw, which consists of a frame made in two sizes that is held in the tool-block of a shaper, thus converting an ordinary shaper into a powerful hacksaw machine. Frames are furnished for 14- and 18-inch blades.

Sundstrom Mfg. Co., 3201 Shields Ave., Chicago, Ill. Circular of the "Rex" die testing press, which is a simple bent hand press with slides, that is adapted for testing punches in dies when working them down to fit. The testing press may be also used for cutting blanks, setting dowel pins and as an arbor press.

Electric Furnace Co., Alliance, Ohio. Bulletin of the Baily automatic electric furnaces for the heat-treatment of high-explosive and shrapnel shells. The equipment provides for accurate temperature control and an automatic manipulating device by which the shells are charged into the furnace and quenched when heated to the required temperature.

Pratt & Whitney Co., Hartford, Conn., has through its welfare department begun the publication of a factory newspaper called "Bench and Board." The first number contains the biography of Jeremiah H. Coffey, who has been in the service of the Pratt & Whitney Co. fifty years, and who was one of five employes who recently received a cash bonus in gold for long service.

Taft Peirce Mfg. Co., Woonsocket, R. I. Bulletin 101, describing in detail the construction of the Martell adjustable reamers and the uses to which they may be put. By the use of a gang of Martell reamers, it is possible to ream simultaneously any number of bearings in a machine to true size and in alignment that is correct within 0.00025 inch.

Metals Coating Co. of America, 100 Summer St., Boston, Mass. Circular of the Schoop metal spraying process by which finely divided metal is sprayed on the object to be coated, thus forming a metal protection similar to electroplating or galvanizing. The circular illustrates the application of the process to bridge work, gas ovens, objects of art, and shows the principle of the Schoop pistol.

Globe Machine & Stamping Co., 1250 W. 76th St., Cleveland, Ohio. Booklet entitled "Sherardizing—The Globe Way," discussing the subject of sherardizing and pointing out the value of this process of rustproofing. The booklet takes up the application of the sherardizing process to threaded material, castings, nails, rivets, etc., forgings, steel tubes or mandrels and piping, as well as other special work.

Globe Machine & Stamping Co., 1250 W. 76th St., Cleveland, Ohio. Catalogue entitled "The Globe Tumbling Book," illustrating and describing the various types of Globe tumbling and burnishing barrels. Some effective tumbling methods are also described. A separate price list is issued with the catalogue giving the prices of tilting tumbling barrels equipped with sheet steel, cast iron or wooden shells.

Norton Co., Worcester, Mass. Pamphlet entitled "Tool Grinding" applying to cutters, reamers, drills, taps, lathe and planer tools and dies. The pamphlet is 3½ by 6⅛ inches, and as it contains only forty pages, is of convenient pocket size. Machinists, toolmakers and others concerned with the maintenance of tools in use in metal-working will find much valuable material in this little treatise on tool grinding.

Ajax Metal Co., Frankford Ave. and Richmond St., Philadelphia, Pa. Circular of Ajax "Bull" babbitt, outlining the principles on which the formula for this babbitt is based. The advantages claimed for Ajax "Bull" babbitt are slow rate of wear, cool running at any speed, and low cost. It is adaptable for all general uses except where the pressure is very great or where it must sustain the shock of severe pounding.

Transmission Ball Bearing Co., Inc., Buffalo, N. Y. Catalogue 3 describing the Chapman type of ball bearings for transmission. The catalogue gives a formula for the load-carrying capacity of ball bearings, and reproduces power curves for different types of bearings. Apparatus for testing ball bearings is described and the results of comparative tests made on ordinary journal bearings and Chapman ball bearings are included.

Wilson Welder & Metals Co., Inc., Vanderbilt Ave. and 45th St., New York City. Catalogue entitled "Electric Welding," treating specifically of the Wilson System of welding, its scope and advantages. Specifications of the equipment are given, and results of tests on work welded by this system are included. The book is liberally illustrated with halftones, line cuts and blueprints, showing the equipment and examples of work done.

Langelier Mfg. Co., Providence, R. I. Catalogue of drilling and tapping machines for general manufacturing use, giving specifications for belt-driven plain-bearing pedestal drilling machines, belt-driven, plain-bearing bench drilling machines, belt-driven plain-bearing floor-type gang drilling machines, belt-driven plain-bearing bench gang drilling machines, motor-driven plain-bearing bench drilling machines, motor-driven plain-bearing pedestal drilling machines, single-spindle horizontal bench tapping machine with and without tailstock, and single-spindle vertical drilling and tapping machine made in bench and floor pedestal types.

New Britain Machine Co., New Britain, Conn. Catalogue of New Britain automatic multiple-spindle chucking machines, built in two types, the single-head for machining pieces which require operations on only one end, and the double-head for machining pieces which require operations on both ends. The catalogue gives specifications for the various sizes of these two types of machines and contains a detailed description of the work-holding devices and various parts. An interesting section of the book is that which shows illustrations of work done in New Britain automatics. Line drawings of the work are reproduced, and the descriptive matter specifies the material, operations performed and type and size of machine used.

Lefax, Inc., Sheridan Bldg., Philadelphia, Pa., is now publishing a number of sheets on military subjects as a part of its loose-leaf data sheet service. The sheets so far issued consist of digest of government publications on such subjects as the cleaning and care of rifles, semaphore and other forms of signaling, drill regulations, range tables, description and operation of rifles, principles and modern developments of trench warfare, and methods of estimating distances. The sheets are of uniform size, punched to fit the standard loose-leaf pocketbook, and are indexed on the same plan as the "Lefax" data sheets covering the various branches of engineering and general subjects.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Catalogue 80 on Westinghouse direct-current motors and generators, covering the company's complete line of direct-current motors and generators for industrial service. Several pages are given over to general information regarding the ordering, classification and selection of direct-current motors following which are description, rating and dimensions for Type SK commutating-pole motors; various modifications of Type SK elevator motors; reversing planer motor equipment; Type CD motors; headstock equipment for woodworking plants; Type SK and CD motor generators; and arc-welding equipment. Considerable information is given on arc welding, headstock equipment, motion-picture service and battery-charging service.

TRADE NOTES

Economy Drawing Table Co., has moved from Toledo, Ohio, to Adrian, Mich.

Springfield Grinding Co., Chester, Mass., will hereafter be known as the Maxf Grinding Wheel Corporation.

Biggs-Watterson Co. has removed its offices from the Guardian Building to 1235-1237 W. 9th St., Cleveland, Ohio.

United Bearings Co., formerly at 2033 Mapes Ave., Bronx, New York City, is now located at 63 Lincoln Blvd., Hempstead, L. I.

Driggs Mfg. Corporation, New Haven, Conn., has bought out the business of the New Haven Mfg. Co., and will continue to manufacture the New Haven lathes.

Craley Mfg. Co. has moved its factory from Mount Joy, Pa., to Lancaster, Pa., where increased facilities have been provided for making the locating fixture known as the "Master Toolmaker," which was described in the December number of MACHINERY.

Daniele Stussi, formerly Stussi & Zweifel, Milan, Italy, dealer in machine tools and woodworking machinery, announces that on account of the death of Frederich Zweifel, Mr. Daniele Stussi has become the exclusive proprietor of the firm, which will henceforth be conducted under the name Daniele Stussi.

Gorham & Goddard Co., 39 Congress St. W., Detroit, Mich., maker of standard and special milling cutters, announces that L. C. Gorham has retired and the corporation will hereafter be known as Goddard & Goddard Co. The president and general manager is Archibald N. Goddard and the treasurer is Dwight Goddard.

Greaves-Klusman Machine Tool Co., Cincinnati, Ohio, has acquired the plant of the Champion Tool Works Co. on Spring Grove Ave., Cincinnati, and will fit it up for the manufacture of the Greaves-Klusman lathes. The Champion Tool Works Co. has built a new plant at Winton Place, Cincinnati, which will be occupied in the near future.

Greenfield Tap & Die Corporation, Greenfield, Mass., has purchased the Bickford Machine Co. of Greenfield. It will be known hereafter as a division of the Greenfield Tap & Die Corporation. The Bickford Machine Co. has been in business for about ten years and has specialized in building milling machines, screw machines, special machinery for tap and twist drill manufacture, etc.

Excelsior Tool & Machine Co., 30th to 32nd Sts., Ridge to Jefferson Ave., East St. Louis, Ill., has made plans to extend its factory and add to its foundry building a steel extension, with brick and metal sash siding; also large core oven and ten-ton and two-ton electric cranes. The company will also erect a two-story fireproof pattern storage, pattern-shop, stock-room and garage building.

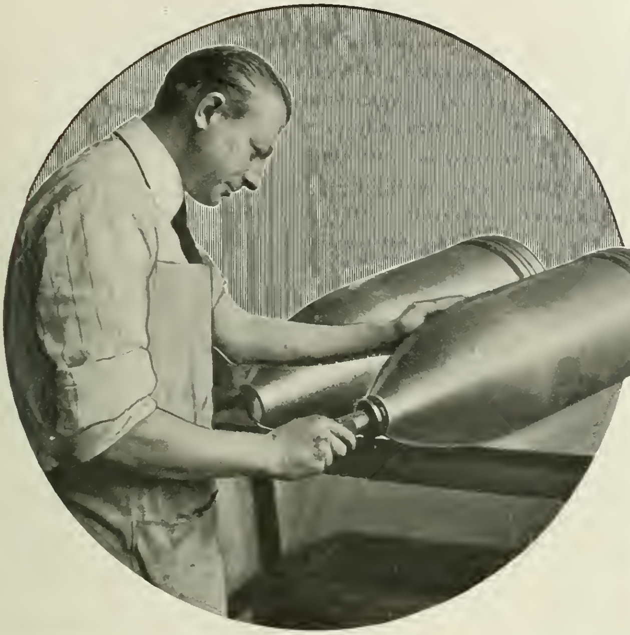
Fulflo Pump Co., 126 Opera Place, Cincinnati, Ohio, manufacturer of "Fulflo" pumps, has acquired five acres of ground at Blanchester, Ohio, on the main line of the Baltimore & Ohio Railroad, on which a two-story machine shop and foundry is being erected. The company expects to raise its production up to five hundred small centrifugal pumps per day by March 1, and to produce one thousand per day by midsummer.

Bridgeport Brass Co., Bridgeport, Conn., has instituted group insurance for its workers that includes in addition to life insurance, benefit for accidents and sickness along the lines of the compensation laws of some states. Under the company's plan any employe may receive half of his wages up to a certain maximum for a period not exceeding twenty-six weeks, for disability or sickness, and a maximum life insurance policy of $1000. The company has issued a pamphlet entitled "A Cooperative Plan of Benefits Covering Accidents, Sickness and Death."

Abell-Howe Co., 565 Washington Blvd., Chicago, Ill., has established branch offices at 30 Church St., New York City, in charge of J. R. Shays, Jr.; at 5080 Jenkins Arcade, Pittsburg, in charge of C. W. Wheeler and Wayne Paulin; and at 803 Ford Bldg., Detroit, Mich., in charge of H. G. Bates. The company is also represented in connection with the sale of Howe trucks at Boston by the Boston Steel & Mfg. Co., and in the Atlantic Coast states, Pittsburg and Cincinnati territory by the Howe Scale Co. and J. S. McCormick Co. In addition, it is represented in New England by the Watkins Engineering Supply Co., of Boston, and in the Northwest by Frank J. Rose Co., Minneapolis, Minn., for the sale of "American" high-speed chain.

Glidden Varnish Co., Cleveland, Ohio, and its subsidiary, the Glidden Varnish Co., Ltd., of Toronto, Canada, have been purchased by a newly formed corporation headed by Adrian D. Joyce, who was recently director and general manager of sales and distribution of the Sherwin-Williams Co. The new company will be known as the Glidden Co., and will have a capitalization of $2,600,000, fully paid in. Members of the Glidden family, including F. A. Glidden, president of the Glidden Varnish Co., will retire. The officers of the new corporation will be Adrian D. Joyce, president; O. A. Hasse, vice-president; and R. H. Horsburgh, secretary-treasurer. The present Glidden plant occupies nearly seventeen acres and is a model in completeness of equipment and modern arrangement.

FEBRUARY MACHINERY 1918



Making Whitworth Thread Gages[1]

by Walter D. Woodworth[2]
and
Herman H. Bender[3]

The Whitworth screw thread having an included angle of 55 degrees and a rounded crest and root is specified for British munitions. Thousands of Whitworth thread gages have been made for use in the manufacture and inspection of the enormous number of guns and shells that have been manufactured here during the past three years. As a result this branch of gage making has become highly specialized and methods have been developed for producing highly accurate gages at comparatively low labor cost. This article reviews the practice followed by one successful gage manufacturer. It includes the selection and preliminary treatment of the steel, and the operations are described step by step. The latter include machining the blanks, preliminary annealing, rough-threading, carburizing, finish-threading, hardening, grinding, selection of wheels for grinding, shaping the wheel, lapping, wire measurement, final heat-treatment and hardness testing.

SINCE the beginning of the war, the demand for thread gages has increased greatly owing to their use in the manufacture of munitions; consequently many concerns that were in a position to handle this kind of work began to make thread gages, and as some of these manufacturers who had little or no experience in gage making were obliged to do more or less experimenting, a large number of inaccurate gages was the natural result, especially where certain well established principles of gage making were not followed. In this article the methods and general practice which have proved satisfactory in the production of accurate thread gages will be described, and as the Whitworth thread presents the greatest number of difficulties, the important features connected with the making of this form of gage will be considered in detail. The different operations will be taken up in the order in which they follow in actually making a gage and will include methods of machining the gage blank, grinding and lapping the thread, heat-treating processes that are essential at different stages of the work, and the final inspection of the gage to insure that it is up to the required standard of accuracy. While much of the general practice described may be applied to the making of any thread gage, a specific example of gage making has been selected in order to enable the subject to be presented in a more definite manner. The gage selected as an example is illustrated in Fig. 2. This is a sectional form of gage, consisting of a handle A, disk B (for testing the angle of a conical seat when the gage is inserted in the work), threaded shell or gage proper C, screw D for holding the various parts together, and dowel-pin E. The gage thread has two flutes or "dirt grooves" F, which are slightly deeper than the thread and extend across it to form edges that will scrape off any dirt that may be in the thread to be tested. As it is the object of this article to deal principally with the production of an accurate thread on a gage of this kind, only the operations on part C will be considered.

Whitworth Standard Screw Thread

In order to avoid misunderstanding in regard to the different terms used throughout this article, these will be defined at the outset and specifications for the Whitworth standard thread will also be given. The Whitworth thread consists essentially of three parts, namely, the top or crest of the thread (see Fig. 3), the sides or slope of the thread, and the root or bottom of the thread. The top and root are rounded to a curvature that corresponds to an arc having a radius r equal to 0.137329 times the pitch of the thread. The radius for the top of any given pitch of thread may be found accurately enough for practical purposes by dividing 0.1373 by the number of threads per inch. For example, if there are 14 threads per inch, the radius of the top and bottom of the thread $= 0.1373 \div 14 = 0.0098$ inch. The angle between the sides of the thread measured in an axial plane is 55 degrees. The depth of the thread or distance from the top to the bottom measured in a line perpendicular to the axis of the gage is equivalent to the pitch $\times$ 0.640327 or 0.640327 $\div$ number of threads per inch. To avoid confusion in specifying dimensions, the following names will be used:

Full Diameter: The full diameter F is the outside diameter, and is the distance across the highest points of the threads.

Effective Diameter: The effective diameter E (of a screw having a single thread) is the distance between the points at which a line drawn through the center of the gage perpendicular to its axis intersects the sides of the thread and is equivalent to the full diameter minus the depth of one thread.

Nominal Core Diameter: The nominal core diameter C or the root diameter is equal to the distance across the lowest points of the thread groove measured in a line perpendicular to the axis of the thread, when the latter is of standard depth. The actual core diameter of the gage shown in Fig. 2 is made from 0.001 to 0.002 inch less than the nominal core diameter. The full diameter may vary from 1.997 to 1.9973 inch, and the effective diameter may vary from 1.9513 to 1.9516 inch. The nominal core diameter is 1.9056 inch and the actual core diameter may vary from 1.9036 to 1.9046 inch. There is a tolerance of 0.0003 plus or minus in the lead of the gage thread, but it is advisable to reduce the lead error as much as possible. In spite of the greatest precautions, however, in cutting laps accurately in lead and grinding gages accurately, slight lead errors are usually found. If a gage is out 0.0001 inch in lead, it is necessary to make it approximately 0.00016 inch smaller than a gage that has a perfect lead to make it enter the same master gage. This means that if there is a plus tolerance of 0.0003 and a female master is set to fit a gage having a perfect lead that is plus 0.0003 in effective diameter, another gage that has an error in lead of 0.0001 inch would have to be 0.00016 inch smaller on the effective diameter in order to enter the same master gage.

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[1] For information on making thread gages previously published in MACHINERY, see "Master Whitworth Thread Gages" and "Production of Accurate Thread Gages," in the September, 1917, number.

[2] Address: 944 Gates Ave., Brooklyn, N. Y.

[3] Address: 38 Fountain Ave., Brooklyn, N. Y.

Steel for Thread Gages

Machine steel containing 0.50 per cent carbon and pack-hardened is generally specified for making thread gages. In practice, it has been found that any good grade of machine steel of even or homogeneous grain, free from flaws or fissures, will produce a good thread gage if given the proper heat-treatment. Some fissures occur in machine steel that cannot be detected readily until after a gage has been hardened and is being ground. Therefore, it is advisable before cutting up a bar and machining it into gage blanks to cut a disk about 1/4 inch thick from the center of the bar and examine it carefully. If no flaws or fissures can be detected with the naked eye or a magnifying glass, drill a hole in the center, take a cut over the outside, carburize and quench the piece. Then grind and lap the side and top, and if no defects or flaws are visible, fracture the sample and examine the case and core carefully. If the metal appears to be perfect, it is safe to use the bar. All bar ends should be discarded, and it is also necessary to use a bar that is 3/16 inch larger in diameter than the finished gage in order to avoid all surface cracks.

Machining Gage Blanks

After the proper material has been selected and tested, if the number of gage blanks is large enough to warrant it, the blanks may be machined in a turret lathe or automatic. A roughing cut is taken over the outside, the bar faced off, a hole drilled and reamed about 0.005 or 0.006 inch under size and the blank cut off about 3/32 inch longer than specified. If a rigid engine lathe is the best machine available, one end of a bar of sufficient length should be held in the chuck, while the other end is supported in the steadyrest. The bar is then centered at this end, and after the tailstock is brought up to support the bar, a cut is taken over the outside. The steadyrest is next adjusted to the turned surface and a hole is drilled and reamed and the blanks cut off. The bar should extend far enough to allow about six blanks to be cut from it, assuming that a number of gages are to be made.

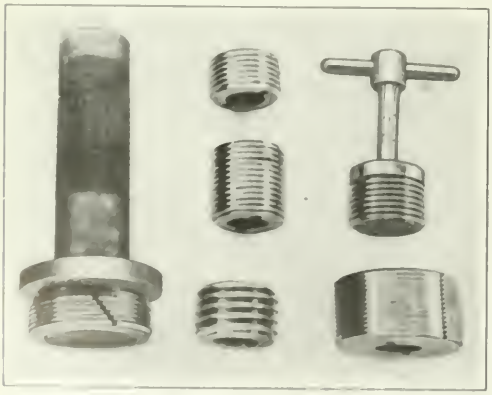

Fig. 1. Group of Whitworth Thread Gages made for testing Threads in Shells

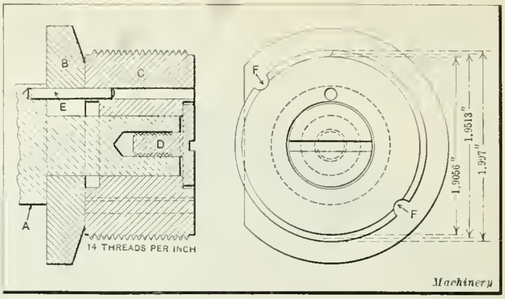

Fig. 2. Whitworth Thread Gage

If a rigid lathe is not available, the blanks may be cut off about one-eighth inch longer than required, in a hacksaw machine. They are then placed in a chuck, faced off, and center-drilled and reamed. The blanks are next driven on an arbor placed between centers and a roughing cut is taken over the outside and the other face.

Preliminary Annealing Process

After the blanks have been rough-machined all over, sufficient material has been removed to disturb the internal strains in the metal and leave it in an unbalanced state. In order to avoid warping of the metal as much as possible during the subsequent rough-machining and carburizing, the blanks are now placed in a gas furnace, such as can be found in almost any machine shop or tool-room, and are heated slowly to a temperature of 1450 to 1550 degrees F.; they should be kept at this temperature about one hour to allow them to become thoroughly saturated or evenly heated. The blanks are then taken out and buried in a mixture of sawdust and lime and allowed to remain there until cold. This is practically a short annealing process, and if this heat-treatment is omitted, it will be found, after finish-machining and pack-hardening, that a large percentage of the blanks will not "clean up" in grinding, owing to the distortion and warping that takes place in carburizing and hardening.

Reaming and Counterboring

When the blanks are removed from the annealing mixture, the holes are cleaned of scale and reamed out to within 0.001 inch of size with a machine or hand reamer. They are then taken to a drill press and are counterbored deep enough to allow for facing off the surplus stock on the sides or faces. Counterboring before facing off makes it possible to face off the blanks on an arbor without digging into it or injuring the point of the tool. They are then driven on an arbor and are turned off on the outside 0.012 inch over size and are faced off on the sides, leaving about 0.020 inch on a side. The holes for the key pins are next spotted with a jig, which is then removed and each hole drilled about 0.010 inch larger than the key pin to allow for the change that takes place in the size and position of the hole during carburizing and hardening.

Rough-machining the Thread

The thread on the blank can be roughed out on any lathe having a fairly accurate lead-screw and a tool of the proper shape. The compound rest of the lathe should be set to an angle of 27½ degrees with the axis of the work, allowing the tool to cut on one side only, so that the point will not be subjected to the strain which is caused by the crowding of the chips when the tool is cutting on both sides.

A simple and inexpensive thread milling fixture that has been used for this work in conjunction with a hand milling machine is shown in Fig. 4. This fixture consists essentially of a base *A*, which is machined and slotted at *J* for lining up the front and back bearings *C* and *E* which carry shaft *B*.

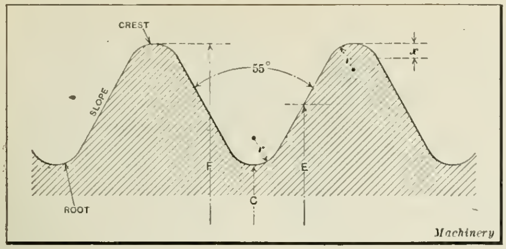

Fig. 3. Section of Whitworth Standard Thread

Bearing *C* is babbitted with *B* in position, so that the babbitt surrounds the threaded portions of *B*, which is cut on a fairly accurate lathe to the same pitch as the gage. Bearing *E* is bored out to a snug fit for the straight bearing on shaft *B*. A train of gears *F* from pulley *H* to shaft *B* reduces the speed to about 6 inches surface travel of the work per minute. The fixture is constructed so that gears from a lathe may be used. Shaft *B* is machined off square on end *G* to fit the handle of the milling machine for a quick hand return movement. The fixture is set to align the cutter with the helix angle of the thread. After a thread has been milled on the blank *D*, the belt is thrown onto the idler pulley and the shaft is returned to its original position by turning it backward with a handle placed on the squared end *G*. This operation is repeated until all the gage blank threads have been milled. The form of cutter shown at *K* is next removed and a cutter of the kind illustrated at *L* is placed on the arbor. This cutter is then used to mill away the end threads up to the point where a full thread begins. This operation leaves the gage 0.025 inch over size on the effective diameter and 0.008 inch under the core diameter on the reduced end threads.

Carburizing the Threaded Blanks

For carburizing the threaded blanks, any good gas furnace may be used which has a heating chamber that will receive a pot sufficiently large to provide room for an inch and a half of carburizing material all around the blanks. A cast-iron pot having a heavy cover will be satisfactory. The material for carburizing can be granulated raw bone or any other good carburizing agent or compound that is certain to give good results. It is well to avoid using materials that penetrate too rapidly for carburizing thread gages, as too rapid penetration causes excessive movement in the structure of the metal and results in an unusual distortion of the thread. A mixture of equal parts of granulated raw bone, charred bone, and used bone that has not been decarburized sufficiently to render it practically useless as a carburizing agent, has given excellent results, as the rate of penetration is not too rapid and the amount of phosphorus contained in the mixture is not excessive. A high percentage of phosphorus tends to cause great brittleness in hardened steel. There are a number of case-hardening and carburizing compounds on the market that have given very good results, but for anyone who endeavors to pack-harden a gage for the first time, bone is the safest to use.

In packing the threaded blanks in the pot, the bottom should be covered to a depth of at least 1¾ inch with carburizing material, and the pieces to be carburized should be laid upon it, leaving at least one inch of space for material between them. The spaces between the pieces and the pot walls should be filled in and packed tightly, using a thin wooden stick to tamp with, thus allowing the material to fill up all the spaces and the pieces to settle about ¼ inch deeper in the bone. The pot is then filled up to the top and tamped down solidly, more material being added until the carburizing agent is packed firmly to the top of the pot. There should be a space of about 1¼ inch above the gage blanks for the carburizing material. The cover is luted carefully all around the edges of the pot and covered with moistened fireclay. The pot is then put in the furnace and allowed to heat gradually until its entire contents have reached a temperature of from 1750 to 1800 degrees F. This temperature should be maintained for at least six hours. The pot is then allowed to cool as slowly as possible. It is preferable to allow the pot to remain in the furnace over night and cool in it, as the furnace and pot will retain the heat for a considerable length of time, and allow the process of penetration to continue. If this method of cooling is not followed, the gages are likely to have an excessive amount of carbon near the surface, giving them a tendency to chip; therefore, under no conditions should the blanks be removed from the pot until they are thoroughly cooled.

After removing the blanks from the carburizing pot, inspection will show that the hole in the blank is closed in from 0.003 to 0.004 inch during carburization and cooling, and it is necessary to again ream the hole to within 0.001 inch of size. The blanks are then replaced on an arbor and the sides faced, leaving about 0.008 to 0.010 inch on a side for grinding. This facing is necessary to make the sides square with the hole.

Finish-machining after Carburizing

A light finishing cut is next taken over the threaded part of the gage. This can be done with an accurate lathe having a tested lead-screw. The gage blank is placed on an arbor held between the centers and a finishing cut is taken, preferably with a gooseneck tool-holder carrying a tool ground and lapped to fairly accurate form. The effective diameter of the thread is finished to within 0.012 inch of size. Instead of using a lathe, the finishing cut may be taken with a milling cutter, the milling fixture shown in Fig. 4 being employed. The dirt grooves are now milled on an ordinary milling machine. A 1/16-inch radius cutter is used, and the grooves are milled at least 0.015 inch below the root of the gage thread. These grooves were formerly made helical, but are now milled parallel with the gage axis (see Fig. 1).

Finish-machining after carburizing is necessary to reduce the number of defective blanks to a minimum. If the blanks are finish-machined before carburizing, the complete change in the molecular structure of the metal during the process of carburizing will cause such distortion of the thread that an allowance of 0.015 inch for grinding is scarcely sufficient, and many blanks will not "clean up" in spots. Moreover, if the hole is not reamed to size after carburizing and the blank is immediately quenched after taking it out of the furnace, the hole will close in from 0.008 to 0.010 inch, thus leaving an excessive amount to be lapped out and making it almost impossible to lap the hole true with the axis of the thread except with an excessive expenditure of time and labor.

Hardening Gage Blanks

The blanks are now ready for hardening. They should again be placed in a pot and decarburized bone should be packed all around them in the same manner as in carburizing. The cover is then put on, packed and sealed with moistened fireclay. The pot is then placed in the furnace and heated slowly until the entire contents reach a temperature of 1550 degrees F. This temperature is maintained about thirty minutes, allowing the work to become thoroughly saturated. The pot is then taken

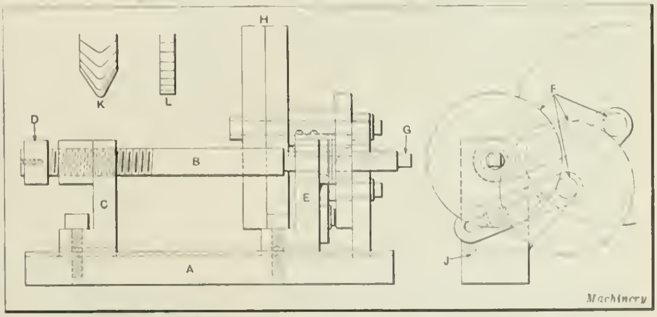

Fig. 4. Special Machine or Attachment used for milling Threads on Gages

from the furnace, the cover removed and the blanks quenched. This can be done by taking the blanks out of the pot one by one and quenching them, but a better way is to dump the entire contents of the pot into the bath. The latter should have a sieve or net suspended in it, and a free circulation of running water entering from the bottom. When the blanks have been dumped into the sieve, the latter should be moved up and down to allow the blanks to be cooled off rapidly and evenly. The latter method has the advantage of quenching all blanks at the same heat, thus insuring a uniform degree of hardness and avoiding the scale that forms when the blanks are carried through the air before immersing in the bath.

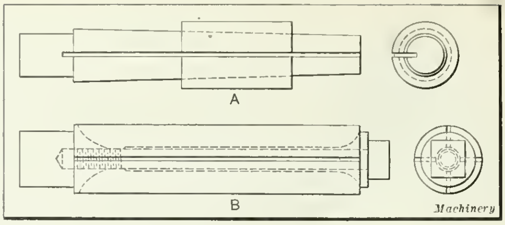

Fig. 5. Two Forms of Laps used for lapping Holes in Thread Gages

The blanks are taken from the bath when cool and placed in a pot containing a solution of water and washing soda, in which they are boiled for about ten minutes; they are then removed and allowed to cool. This is really a light tempering or "letting down" process and prevents excessive brittleness, or, in the vernacular of the toolmaker, it takes the "snap" out of them. This light tempering should be done immediately after taking the blanks out of the quenching bath.

Lapping Hole in Gage

The hole is now ready to be lapped. When this is done, the blank should be held in the hand (using a piece of emery cloth or old leather belting to protect the hand from injury) and the lap should be held in the chuck of a lathe or drilling machine. This allows the lap to follow the hole and insures finishing the hole fairly accurately with reference to the thread. It is well to see that the hole cleans up evenly all around as it is gradually lapped out. The hole, previous to lapping, will be found considerably bell-mouthed, and may be about 0.002 inch under size at the ends and about 0.004 inch under size at the center of the blank. It can readily be seen that if a blank is held in a vise in the drill press, or is confined in a similar manner, there is serious danger of lapping the hole out of true with the axis of the thread. Two different forms of laps are shown in Fig. 5. The split lap shown at *B* should be used for roughing, as it allows of rapid and easy adjustment and removes the stock rapidly. The lap shown at *A* should be used for finishing, as it keeps the hole straight and round. The abrasive used for lapping may be Turkish or Chester emery (grade F), as it is tough and sharp, and if applied properly, will charge satisfactorily and lap out the hole without much wear of the lap. The lap should be adjusted lightly to the work—just enough to make the abrasive cut well—for if the lap grips too tightly, all the emery will be crowded out and the operation will be greatly lengthened. The hole in the gage shown in Fig. 2 should be lapped out until a 0.625-inch standard plug passes through it. The blank is now driven on a perfectly true arbor and is placed between the centers of a universal grinder or bench lathe and both faces are ground just enough to true them. The blank is then ground on the outside or full diameter until it is from 0.003 to 0.004 inch over size.

Advantages of Grinding Thread before Lapping

Before taking up the subject of rough-grinding the thread, the advantages of a preliminary grinding operation as compared with lapping the thread to size will be considered. A thread that is to be finished after hardening by lapping alone must be very accurately machined in order to leave as little stock as possible for lapping. This threading operation generally takes three times longer than when cutting the thread for grinding, because if the thread is to be rough-ground, it need not be nearly as smooth nor accurate as to size and angle as would be required if lapping were the only means employed to bring it to the required size. As lapping is a very slow process as compared with grinding, two or three times the allowance for lapping can be left for grinding, and the surplus stock can be removed in this way much more rapidly than the smaller amount left for lapping. The amount of stock left for grinding also insures that all threads will clean up when reduced to the finish size.

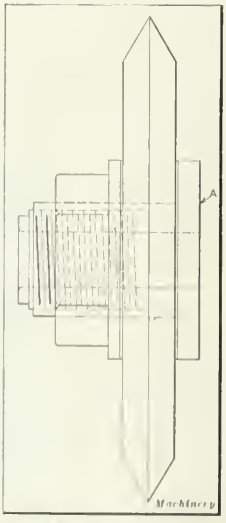

Fig. 6. Method of mounting Grinding Wheel to Insure Accuracy and reduce Dressing

Another great advantage of grinding threads is that they can be finished within 0.0004 or 0.0005 inch of size on the effective and full diameters, and the core diameter can be ground right down to size, leaving just enough to remove the slight wheel marks and lap the thread to a high finish. As threads are ground extremely accurate as to form and lead, two or three laps for the angle or slope of the thread, one for the crest and another for the root are all that are required, because, as the angle and lead are accurately ground, the laps will continue wearing accurately and will need little correction. On the other hand, if the thread is finished exclusively by lapping, a number of laps will be required for roughing and finishing, because the thread, after hardening, is distorted and inaccurate as to lead, thus requiring continual correcting and renewal of laps, especially where many thread gages are made. Making thread laps is an accurate and tedious job and may greatly increase the cost of production.

Special Thread-grinding Machine

Thread grinding can be done on a lathe having an accurate lead-screw and equipped with a grinding attachment mounted on the cross-slide. Better results can be obtained, however, with a special thread-grinding machine similar to the one shown in Fig. 7. This machine has a cast-iron base *C* upon which is mounted the frame for supporting shaft *X*. This shaft carries three pulleys. The outer pulleys are loose and the central one tight on the shaft. Two bearing brackets *A* and *B* support the master screw shaft *E*, upon the outer end of which is mounted the gage *G* to be ground. The cross-slide *D* carries spindle *F* and grinding wheel *R*. The wheel-spindle may be adjusted to locate the wheel in line with the thread. The belt pulleys for driving the master screw *E* should be so proportioned that the gage will have a surface speed of about 40 feet per minute. The surface speed of the grinding wheel should be about 8000 feet per minute, unless a lack of balance in the wheel or other conditions make it unsafe to revolve the wheel so rapidly.

When this machine is in operation, the master screw *E* is revolved in first one direction and then the other by means of open and cross belts, which are alternately shifted onto the central or tight pulley *Q*. The drive from the pulley shaft to the master screw is through faceplate *Y*, stud *Z* and a dog *W*. The threaded section of the master screw *E* passes through a babbitted bearing in the bracket *A*. This screw must be cut in a precision lathe that has been thoroughly tested for accuracy or one that is equipped with some device that will compensate for slight errors in the lead-screw. The spindle of the grinding machine is driven from a bench motor by a belt running over the grooved pulley shown at the right-hand end of the spindle. When the machine is first started, shaft *E* travels forward and the grinding wheel is adjusted in a lengthwise direction until it is in alignment with the thread groove. After shaft *E*

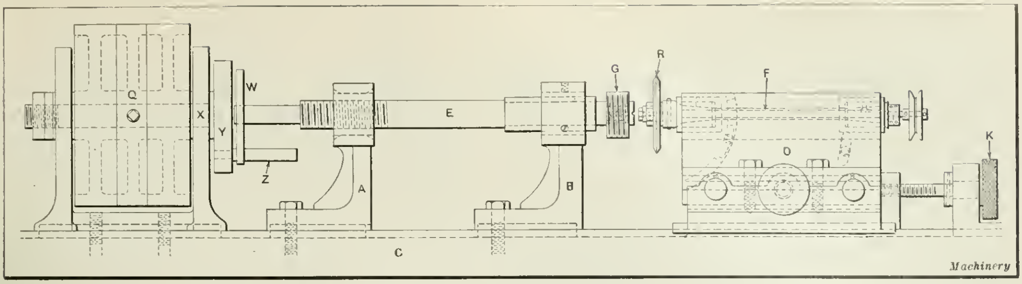

Fig. 7. Special Machine used for grinding Gage Threads Preparatory to Lapping Operation

has made a certain number of turns, the gage is carried past the grinding wheel and then the rotation of shaft *E* is reversed by shifting the belt; the gage then traverses past the grinding wheel in the opposite direction, so that the machine is grinding almost continuously and is more rapid in its operation than a machine arranged to grind in one direction only. The gages ground on this machine are duplicates of the master screw, so far as the lead of the thread is concerned.

Wheels Used for Thread Grinding

The grain of the wheel used for grinding thread gages should be fine enough to allow the wheel to be dressed to a point or edge sufficiently sharp to meet the necessary requirements. The abrasive should be free-cutting and the bond sufficiently tough to prevent the edge of the wheel from crumbling too rapidly, but not so hard as to retain the abrasive long enough for the wheel to become glazed. Alundum wheels of 120 grain, grade J, and 120 grain, grade K, have proved satisfactory for thread-gage grinding. The 120 J wheel is suited for rough-grinding and the 120 K wheel may be used either for roughing or finishing, but is best adapted for finishing. Another grinding wheel that is giving satisfactory results for roughing is a 180 M aloxite wheel. If the threads on the gage are coarser than 12 per inch, a 120 J alundum wheel may be used for finishing. If the threads are finer than 16 per inch, a 200 M alundum wheel should preferably be used.

The grinding wheels used for this work should be mounted permanently on bushings as shown in Fig. 6. The face *A* of this bushing that comes into contact with the ground shoulder of the wheel-spindle is finished square and true with the hole; consequently, when the wheel is placed on the grinding machine spindle, it will always run true and be in the same position relative to the master screw.

Adjustment of Grinding Wheel

When adjusting the grinding wheel so that the working side is in line with the helix angle of the thread, the angle of the helix may be determined as follows: Multiply the full diameter of the gage by 3.14 and divide the pitch by the result. Then find in a table of natural tangents the angle having a tangent that corresponds to the quotient. For example, if the full diameter is 2 inches and there are 10 threads to the inch, the pitch is 0.100.

$$2 \times 3.14 = 6.28$$

$$0.100 \div 6.28 = 0.0159$$

The corresponding angle is about 55 minutes, which is the amount the wheel should be inclined from the vertical. After the wheel has been set to the required angle, it is dressed to an angle of 55 degrees when measured in a plane intersecting the axes of the gage to be ground, and the edge or apex of the wheel is left sharp. The diamond is mounted in a block held in the hand, and it is guided by the dressing fixture shown in the plan view Fig. 8. The plate *A* of this fixture has two grooves in the form of the letter X, which incline 55 degrees relative to each other. The block *B* carrying the diamond tool *C* is pushed through first one groove and then the other when truing the wheel. The plate *A* is supported upon two brackets (only one is shown), each containing two guide-pins *D* which engage slots in the plate and hold it in position when in use. The diamond *C* is located at the same height as the grinding wheel center. The slope or angular sides of the thread are now ground by using the machine shown in Fig. 7. The wheel is set central with the thread groove and the grinding is continued until the thread has been ground true, so that a measurement can be taken. The means used for measuring the full diameter, effective diameter, the angle of the thread and the core diameter will now be described.

Use of Wires for Measuring Effective Diameter

The effective diameter can be measured with a thread micrometer, but as this tool has only a limited range as to size and number of pitches it can measure, it may be desirable or necessary to check up the angle and effective diameter by using an ordinary micrometer and two or more sets of different size wires. When measuring the effective diameter by the wire method, there should be two wires on one side of the thread and one on the opposite side, as illustrated by diagrams *A* and *B*, Fig. 9. The two wires on one side should be spaced as far apart as is practicable. In some cases, if the thread is of fairly coarse pitch, it may be necessary to place the wires in adjacent thread grooves, as illustrated by the full and dotted lines at *a* and *c*, whereas, for a thread of finer pitch, the wires may be spaced farther apart, as at *a* and *b*.

Table 1 gives the sizes of wires to be used for checking up Whitworth threads of different pitches and the amount to add to the full diameter when using a wire of given size. The smallest and largest wires that can be used conveniently with ordinary micrometer calipers are listed in the table. In applying the table to the gage shown in Fig. 2, which has 14 threads per inch, we see that the first number under "Threads per Inch," in the column headed 14, is the decimal 0.00437. This is the amount to be added to the outside or full diameter 1.997 to obtain the measurement over wires 0.0375 inch in diameter, which is the size of wire in the column to the left and on the same line with the decimal 0.00437. This is the smallest wire to be used for measuring 14 threads per inch. The last decimal in the column under 14 is 0.05977, which is the amount to be added to the full diameter when using wires 0.055 inch in diameter—the largest wires to be used for measuring 14 threads per inch. The distance over the wires or the micrometer reading equals:

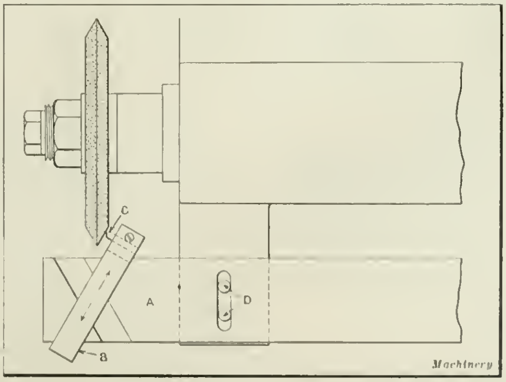

Fig. 8. Fixture for dressing Sides of Wheel to Angle of Gage Thread

$$\text{Full diameter} - \frac{1.6008}{\text{number of threads per inch}} + (3.1657 \times \text{wire diameter})$$

This formula expressed as a rule is as follows: Divide the constant 1.6008 by the number of threads per inch; subtract the quotient from the full diameter and add to the difference 3.1657 times the wire diameter. The result equals the micrometer reading or the measurement over the wires.

The difference between the distance over the wires and the full diameter represents the dimensions given in Table 1 for various pitches and sizes of wires. It may not always be convenient or advisable to use wires corresponding to the diameters given in the table. For instance, it may be preferable to use wires that are 0.0385 inch in diameter instead of 0.0375-inch wires, which is the minimum size for 14 threads per inch. In that case, multiply the difference between 0.0385 and 0.0375 by 3.1657 and add this product to the dimension given in the table for the 0.0375-inch wires to obtain the distance over 0.0385-inch wires.

The multiples of 3.1657 at the lower part of Table 1 are convenient to use when figuring dimensions over wires. Suppose wires that are being lapped down to 0.0375 inch are perfectly round at 0.0381 inch. It would be inadvisable and a waste of time to lap them to 0.0375 inch. The difference between 0.0381 and 0.0375 is 0.0006; therefore, in order to get the dimension over 0.0381-inch wires, take the number 18.9942, which is six times 3.1657, from the table of multiples, and move the decimal point four places to the left, which makes the number 0.00189942 and is the same as multiplying 3.1657 times 0.0006. Add the result to the value given in the table for 0.0375-inch wires to obtain the amount to be added to the outside diameter of the gage when using wires 0.0381 inch in diameter. For instance, if 2.00137 equals the measurement over 0.0375-inch wires, 2.00137 + 0.001899 = 2.00327 equals the distance over 0.0381-inch wires. If wires become worn or are under size, the distance over them can be figured in the same way by subtracting the difference instead of adding.

Measuring Core Diameter

The core diameter of the gage can be checked by using the triangular wedges as shown at *C*, in Fig. 9. (See also the detail view at the upper part of the illustration). When measuring with these wedges, twice their height should be subtracted from the micrometer reading in order to obtain the core diameter. Micrometer points, such as are shown at *D*, can also be used for checking the core diameter. These points are so made that they can be removed from the anvil and spindle of the micrometer, and they are more convenient to use than the wedge blocks in roughing. With micrometer points, a hardened plug should be ground down to a diameter corresponding to the size of the core diameter and the micrometer points set from it. The use of a thread micrometer is illustrated at *E*, and at *F* are shown methods of testing the radius of the root and crest. A wire of the correct radius is laid in the root, and a templet is used for the crest.

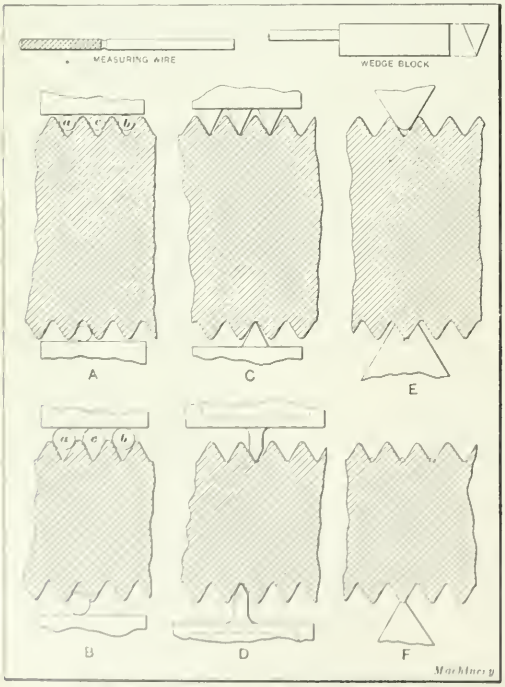

Fig. 9. Methods of measuring Diameter of Gage Thread

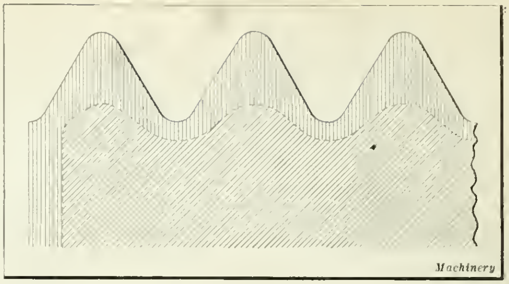

Fig. 10. Diagram showing Depth to which Thread Gage is carburized and hardened

When measuring the diameter with wires, rubber bands are sometimes placed over each end of the wires to hold them in place, but this is not good practice, as the rubbers cramp the wires and make it impossible to obtain a good measurement with the micrometer. To use the wires properly, two should be placed in the threads, the micrometer opened about 0.010 or 0.015 inch more than the probable measurement over the wires, and the spindle brought down on them in such a manner as to hold them in place. The third wire is then slipped in between the anvil and the lower thread groove; the micrometer is then adjusted until it just holds the wires and a reading is taken. In measuring the angle and effective diameter of the thread while grinding, three sets of different size wires should be used. Assuming that the gage has 14 threads per inch, as in this particular case, the 0.0375-inch, 0.040-inch and 0.055-inch wires should be employed. As 0.003 or 0.004 inch has been left on the full diameter for finish-grinding, and wires 0.0375 inch in diameter only extend 0.00437 inch beyond the full diameter, the larger wires should be used until the full diameter is ground nearly to size. The wedge blocks for measuring the root are inserted and held in the thread groove the same as wires.

After rough-grinding the gage sufficiently to true it, a measurement will usually show that the amount of stock left for finishing has been reduced from 0.004 to 0.005 inch, leaving approximately 0.007 or 0.008 inch on the effective diameter and usually 0.008 to 0.009 inch on the core diameter. The wheel is now redressed to a sharp vee as before, and the root is ground until the relation between the root and effective diameter is right and the size is plus 0.003 or 0.004 inch.

Heat-treatment to Prevent Subsequent Distortion of Gage

The gage is now passed through another heat-treatment consisting of an immersion in boiling soda water for a period of at least thirty minutes. This is absolutely necessary, especially at this stage of the work. The remainder of the material to be removed from the gage by machining or lapping is extremely slight, and the precautions to be taken to insure a permanent set of metal and to eliminate as much as possible any likelihood of distortion of the gage after it is completed, makes it absolutely necessary for it to be subjected to this additional heat-treatment.

Since the gage has passed through the hardening, there has been approximately 0.008 inch of stock removed from almost all the surfaces. This removal has reduced the case or binder of the gage sufficiently to affect its interior structure in such

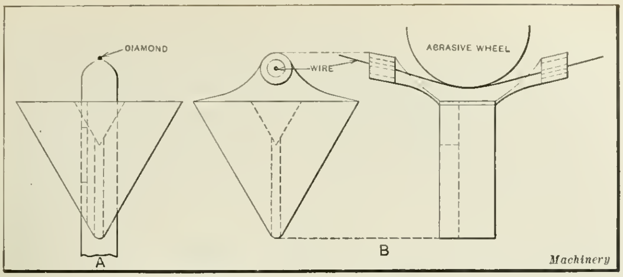

Fig. 11. Equipment for forming Concave Groove in Periphery of Wheel for grinding Crest of Gage Thread

a way as to cause it to shrink in some spots. As it is impossible for the gage to assume immediately the shape which it tends to take as the result of the strains caused by the removal of metal, this change of form should be quickened as much as possible by a heat-treatment that subjects the gage to more extremes of temperature than it will undergo while in use. This effect is obtained by the heat-treatment referred to.

After the gage has been rough-ground, enough metal has been removed to alter the internal strains and leave the structure of the metal in an unbalanced state. As previously mentioned in connection with carburizing and quenching, the hole in the gage blank closes in from 0.006 to 0.008 inch. If the outside diameter is carefully measured before and after carburizing, it will be seen that there is an increase of from 0.003 to 0.004 inch. The introduction of more carbon between the molecules of the steel would naturally tend to increase the distance between them and the size of the gage itself. The diagram Fig. 10 illustrates in a general way the form of the carburized portion of the case, which is represented by the vertical section lines, whereas the soft core is shown by the diagonal lines. When the gage blank is quenched, the threads cool first, so that the interior and the hole have a marked tendency to contract. As the outside surface and the faces of the gage are gradually reduced by the machining processes, these parts of the gage are gradually weakened, and the result is a slight contraction due to the interior strains. The gage remains comparatively cool throughout the grinding operations, so that the hardened surface does not become very elastic, and, therefore, is not affected directly by the forces acting upon it. For this reason, it is necessary to subject the gage to a high enough temperature to insure its taking a permanent set. A pack-hardened thread gage that has not been seasoned or subjected to some rapid seasoning process will change in diameter and lead so that it becomes practically useless. If such a gage is finished at the normal temperature and is allowed to remain near a furnace or other warm place, it will decrease in size and lengthen in lead. If a gage is heated to the equivalent of a light straw color and allowed to cool off, accurate measurement will show that it has reduced in size from 0.0002 to 0.0003 inch. Frequently in shops where gages are made, rejected gages are found which have changed considerably since the inspection previous to shipment, owing to the lack of proper seasoning. The effect of the lack of proper heat-treatment is illustrated by the following experience of a gage-maker: All the operations on the gage, such as grinding and lapping, were finished without any special heat-treatment of the kind previously referred to, and the gage was made to the required size and passed inspection. This particular gage was kept as a master to be used in making duplicate gages. In less than two weeks, this gage had distorted to such an extent that it was from 0.0002 to 0.0004 inch out of round and the lead had shortened about 0.0002 inch.

Changes Due to Removal of Metal

The removal of metal will also cause appreciable changes of form or size which are often sufficient to spoil the gage entirely. For instance, a gage that had been finished to size was afterward altered by cutting away the threads at the ends back a distance of about one inch farther than they had been previously. This gage at the time was the right size and passed through a female master gage perfectly and without interference of any kind. In less than a week after cutting away the end threads, the gage had changed so much that it would not even enter the master gage one and one-half turn. The gage had a longer lead at each end and the outside diameter also decreased from 0.0002 to 0.00025 inch.

TABLE 1. AMOUNT TO BE ADDED TO OUTSIDE DIAMETER FOR MEASURING WHITWORTH THREADS WITH WIRES

Diam. of Wire	Threads per Inch							
	36	32	30	24	20	18	16	14
0.015	0.00302	....	....	....	....	....	....	....
0.0175	0.01093	0.00538	0.00204	....	....	....	....	....
0.020	0.01885	0.01329	0.00995	....	....	....	....	....
0.0225	0.02676	0.02121	0.01787	0.00453	....	....	....	....
0.025	....	0.02912	0.02578	0.01244	....	....	....	....
0.0275	....	....	....	0.02036	0.00702	....	....	....
0.030	....	....	....	0.02827	0.01493	0.00604	....	....
0.0325	....	....	....	0.03618	0.02285	0.01395	0.00284	....
0.035	....	....	....	....	0.03076	0.02187	0.01075	....
0.0375	....	....	....	....	0.03867	0.02978	0.01866	0.00437
0.040	....	....	....	....	....	0.03770	0.02658	0.01229
0.0425	....	....	....	....	....	0.04561	0.03449	0.02020
0.045	....	....	....	....	....	....	0.04241	0.02811
0.0475	....	....	....	....	....	....	0.05032	0.03603
0.050	....	....	....	....	....	....	....	0.04394
0.055	....	....	....	....	....	....	....	0.05977

Diam. of Wires	Threads per Inch							
	12	11	10	9	8	7	6	5
0.0425	0.00114	....	....	....	....	....	....	....
0.045	0.00906	....	....	....	....	....	....	....
0.0475	0.01697	0.00484	....	....	....	....	....	....
0.050	0.02489	0.01276	....	....	....	....	....	....
0.055	0.04071	0.02859	0.01403	....	....	....	....	....
0.060	0.05654	0.04442	0.02986	0.01208	....	....	....	....
0.065	0.07237	0.06024	0.04569	0.02790	0.00567	....	....	....
0.070	....	0.07607	0.06152	0.04373	0.02150	....	....	....
0.075	....	....	0.07735	0.05956	0.03733	0.00874	....	....
0.080	....	....	....	0.07539	0.05316	0.02457	....	....
0.085	....	....	....	0.09122	0.06899	0.04040	0.00229	....
0.090	....	....	....	....	0.08481	0.05623	0.01811	....
0.095	....	....	....	....	0.10064	0.07206	0.03394	....
0.100	....	....	....	....	....	0.08788	0.04977	....
0.105	....	....	....	....	....	0.10371	0.06560	0.01224
0.110	....	....	....	....	....	....	0.08143	0.02807
0.120	....	....	....	....	....	....	0.11308	0.05972
0.140	....	....	....	....	....	....	....	0.12304

Multiples of 3.1657

1 × 3.1657 = 3.1657
2 × 3.1657 = 6.3314
3 × 3.1657 = 9.4971
4 × 3.1657 = 12 6628
5 × 3.1657 = 15.8285
6 × 3.1657 = 18.9942
7 × 3.1657 = 22.1599
8 × 3.1657 = 25.3256
9 × 3.1657 = 28.4913

Machinery

Finish-grinding Operations on Gage

After the last heat-treatment previously referred to, as much time as possible should be allowed to elapse before the finish-grinding operation, three or four days usually being sufficient. The finish-grinding is practically the same as the rough-grinding. The gage is wrung onto an arbor and the sides are finished to the required size The full diameter is also ground to size within 0.002 inch. After the sides of the gage are ground, the hole in some cases will be found to have closed in from 0.0001 to 0.0002 inch on the ends so that they should again be lapped to size. The sides of the thread are finish-ground on a machine of the type illustrated in Fig. 7, which represents the machine used for rough-grinding as well. It will be understood, of course, that the finishing operation requires more care than the rough-grinding.

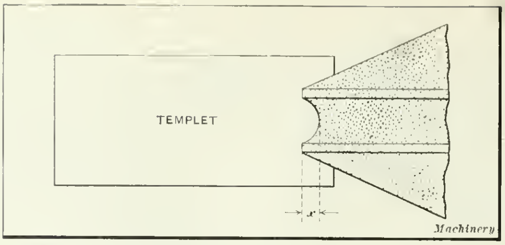

Fig. 12. Section of Wheel dressed for grinding Crest of Thread and Templet for testing Concave Groove in Wheel

One of the things that requires a little skill and experience is finishing the root of the thread. The actual root diameter is from 0.001 to 0.002 inch less than the nominal root diameter, so that at the beginning a wheel having a fairly sharp edge may be used. No attempt is made to dress the edge of the wheel to the radius of the root, since the root can be finished accurately enough for practical purposes by using a wheel which has an included angle of 55 degrees and a sharp edge or apex to begin with. As the grinding proceeds, this sharp edge naturally crumbles away and is finally rounded off sufficiently for finishing the root of the gage thread. After a wheel has removed, say, 0.001 inch, the effective diameter of the gage may be 0.003 inch over size, whereas the root diameter is perhaps only 0.001 inch over size. After another 0.001 inch has been removed, a measurement will usually show that the relation between the effective diameter and the root diameter has changed slightly. For instance, when the effective diameter is + 0.002 inch, the root diameter may be + 0.0005 inch, owing to the fact that the apex of the wheel has worn down slightly. One experienced in this work can reduce the gage by this method to the lapping size with one dressing of the grinding wheel and maintain the proper relationship required between the effective diameter and the root diameter. In the case of the particular gage selected as an example, when the effective diameter is + 0.0003 to + 0.0004 inch, the root diameter should be from 0.0012 to 0.0015 inch less than the nominal root diameter.

When beginning to grind a gage, it is well to consider the effect of expansion on the position of the wheel due to the heating of the wheel-spindle. Owing to the slight change due to this cause, it is advisable to keep the wheel running continuously when taking the finishing cuts. If it is necessary to stop the wheel for measuring or inspecting, when the wheel is again started it should be allowed to run idle long enough for the temperature of the spindle to rise to the normal working temperature before taking another cut.

Grinding Crest of Thread

After the angular sides of the thread gage are ground, the same machine is used for grinding the crest or top of the thread. By mounting the wheels as previously mentioned in connection with Fig. 6, it is possible to replace one wheel with another of different form with the maximum error not exceeding 0.0015 inch. Before grinding the crest of the thread, it is necessary to form a concave groove in the periphery of the wheel. The diamond-holder shown at *A*, Fig. 11, is first used in conjunction with the fixture illustrated in Fig. 8. The V-shaped tongue on the diamond-holder is placed into engagement with the slots in the fixture, and the sliding bar to which the diamond is attached is moved forward to bring the diamond into contact with the wheel, thus forming a slight groove in its periphery.

The diamond-holder is next removed and is replaced by the fixture shown at *B*, Fig. 11. This fixture also has a V-shaped tongue for engaging the slots in the fixture shown in Fig. 8, and is provided with projecting arms on each side, containing holes through which a wire is inserted. This wire is used in finishing the concave groove in the grinding wheel to the required form. The cross-slide of the grinding machine is adjusted in far enough to come into contact with the wire which passes through the arms of the fixture and is held taut. The radius of this wire should correspond to the radius of the crest of the thread. In this particular case the crest radius equals 0.0098 inch, so that the wire should be 0.0196 inch in diameter or slightly larger. This wire should extend at least 12 inches beyond each guide bushing in the fixture and the ends are held lightly by hand when forming the groove in the wheel. As the wheel revolves, the wire is pulled tight enough to bring it into contact with the edge of the wheel, and then the wire is moved in first one direction and then the other a number of times. A piece of thin hardened steel is next held against the edge of the wheel, thus forming it to the shape illustrated in Fig. 12. The depth x of the concave groove is measured, and if it is not deep enough the wire is again used. On the contrary, if the groove is too deep, the top of the wheel may be dressed off with an ordinary diamond. When the groove has been properly formed, it is advisable to use the fixture shown in Fig. 8 for dressing the angular sides of the wheel, so that they will not come into contact with the gage thread when grinding the crest.

When starting to grind the crest the revolving wheel is adjusted inward until it comes into contact with the revolving gage. The position of the wheel in a direction parallel to the axis of the gage is determined by noting which side the sparks come from, and the wheel-spindle slide is adjusted accordingly by turning the knurled screw *K*, Fig. 7. As those who have had experience in grinding know, the sparks indicate inaccuracy of adjustment with greater precision and refinement than an indicator, and the wheel may be adjusted by this method until it is central with the thread within 0.00015 inch.

When grinding the crest of the thread a good micrometer should be available, and it is preferable to have one of the heavy type having an anvil and spindle 5/16 inch in diameter, because such a micrometer gives a better bearing surface on the top of the gage threads. When the top of the thread has been ground until the gage is within 0.001 inch of the full diameter, it is advisable to test the radius of the crest by using a templet of the form shown in Fig. 12. This is usually a precautionary measure because if the instructions previously given have been followed there is not likely to be an error in the radius. After testing the radius with the templet, the grinding is continued until the full diameter is + 0.0004 inch. This completes the grinding of the gage, and the next operation is that of lapping in order to remove all grinding wheel

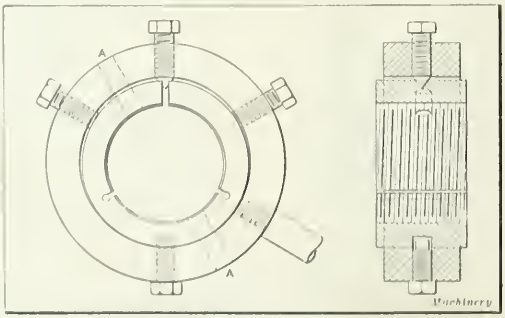

Fig. 13. Lap-holder and Lap for Use on Thread Gages

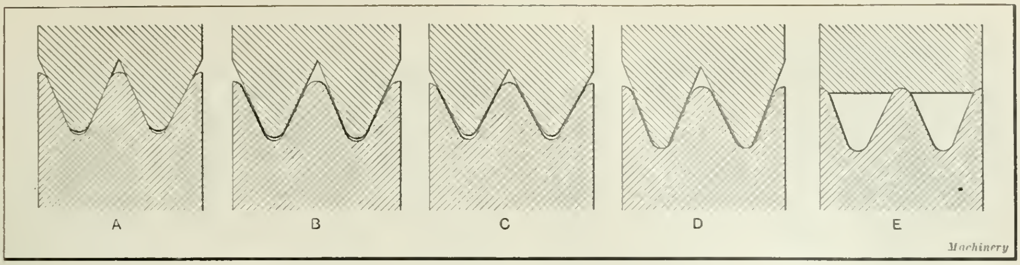

Fig. 14. Sectional Views showing Various Forms of Laps used on Thread Gages and Relation between their Form and a Standard Whitworth Thread

marks and reduce the gage to the final dimensions within the limits specified.

Laps for Thread Gages

While power-driven machines may be used for the lapping operation, lapping by hand will be described in the following, since it is regarded by the writers of this article as a better and more rapid method. When there is an unusual amount to be lapped off, the machine will remove the metal somewhat faster, but it is important to remember that the time required for actually lapping is small as compared with the time required for cleaning the work, taking measurements, etc., which can be done faster when lapping by hand.

Gray cast iron that is free-cutting and without blowholes has proved to be the best material for the laps used on thread gages. This material charges well and is less subject to changes than some other materials that are used. Cold-rolled steel and machine steel have been employed, but are not entirely satisfactory. These materials at times seem to retain the form of the thread fairly well, but there is often difficulty due to distortion. In order to obtain the best results, the lap should extend beyond the ends of the thread on the gage at least one-half inch. Occasionally, however, a short lap is required, as, for example, when a gage is slightly tapering or large either in the center or at the ends. For making corrections of this kind, laps having only three or four threads are used because one covering the entire gage could not, of course, be used to correct local errors.

A convenient form of lap-holder is shown in Fig. 13. This consists of a ring or shell containing three adjusting screws and a handle. A lap of the kind used for lapping the angular sides of the thread is shown in position in the holder. There should be five laps and holders for the use of each man working on thread gages. These five laps differ in form as illustrated by the detailed sectional views, Fig. 14. The "perfect" lap illustrated at *A* is made to the standard angle of 55 degrees and it bears on the sides only, there being clearance spaces for the root and crest of the gage thread. The lap illustrated at *B* has a slightly more acute angle than the lap shown at *A*. This is known as the "acute" or "bottom" lap and it may have an inclination of, say, 54 degrees. The obtuse lap illustrated at *C* has an angle of 55½ degrees, so that it bears on the upper part of the gage thread. The root lap *D* is made to bear on the root only, as the illustration shows, and at *E* is shown the lap used for finishing the crest or top of the gage thread. These different laps should be plainly marked so that the wrong one will not be used.

Lapping Operations on Whitworth Thread Gage

The thread gage to be lapped is placed in a holder which is securely held in a vise, and before any lapping is done it is carefully measured. The form of lap illustrated at *A*, Fig. 14, is first used. This lap is slightly charged with an abrasive mixed with vaseline to form a paste, this mixture being introduced through the holes *A* shown in Fig. 13, extending through the holder and lap. The screws of the holder should be adjusted so that the lap has a slight drag, as it is screwed over the gage. The lap, when in use, is turned forward and backward for several minutes, care being taken to see that it is always working over the entire gage surface. After removing the lap and thoroughly cleaning the gage with gasoline, the lead of the gage thread is checked by using the form of gage shown in Fig. 15. This gage consists of two circular disks ground accurately to the standard thread angle of 55 degrees and spaced a distance apart equal to some multiple of the thread gage pitch. This gage is used by simply placing the disks into mesh with the thread gage and noting whether or not it fits perfectly as determined by a "light test" or by sight.

It is also essential to test the angle of the thread, which may be done by using wires and a micrometer, the same as when measuring the effective diameter. When beginning to lap, the angle is supposed to be correct and the effective diameter of the gage about 0.0004 inch over size and the root diameter 0.0012 inch less than the nominal root diameter. Two sets of wires varying in diameter are used for testing the angle. Suppose in this case that a measurement over the large wires of 0.055 inch diameter shows that the gage is + 0.0002 inch and that the measurement is + 0.0003 inch when using the small wires having a diameter of 0.0375 inch. This shows that the angle of the gage thread is slightly obtuse or over 55 degrees. In order to correct this error, the lap shown at *B*, Fig. 14, is used. When this lap is removed, measurements may show that the gage is + 0.00015 inch over the large wires and + 0.0001 inch over the small wires, thus showing that the error in angle has been partly corrected.

Before finishing the lapping of the sides of the thread, the form of lap shown at *D*, Fig. 14, is used for reducing the root of the thread to the required size, which in this case is about 0.0015 inch less than the nominal root diameter. The lap *A* which was first used is again placed on the gage and is charged with rouge. After the lap has been given a number of turns in each direction, it is removed for testing the size of the gage, and this is repeated until the gage has been reduced to the required size. The first abrasive used, which is coarse as compared with the rouge, tends to creep up the sides of the gage thread and remove more material at the top, which accounts for the fact that the gage thread angle is sometimes a trifle wider than it should be. When rouge is used, the lap has more of a rubbing than a cutting effect and the abrading action on the side of the gage thread is more even than when using a coarser abrasive. In some cases, the gage thread is ground to an angle which is slightly less than required, in which case the obtuse form of lap shown at *C* is employed.

The time required for lapping one of these gages should not exceed two and one-half hours, and where a number of duplicate gages are being made, it is possible under favorable conditions for one

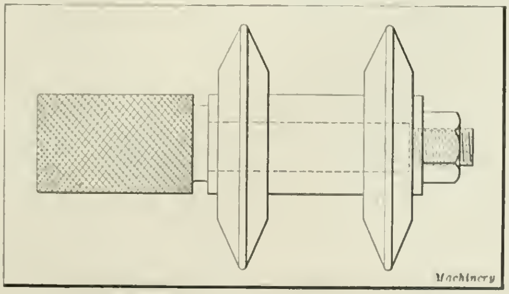

Fig. 15. Simple Form of Gage used for testing Lead of Gage Thread

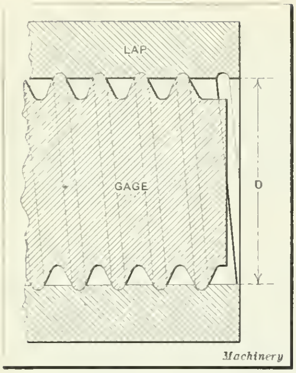

Fig. 16. Diagram illustrating Type of Lap used for lapping Crest of Gage Thread

man to lap twelve gages a day. As previously mentioned, the laps for use on the sides of the thread are made so that they will clear the crest and root. As a lap wears down, however, the clearance space decreases and it may be necessary to remove a little metal from the top of the lap thread. The lap may be tested for clearance by first placing it on a thread gage and adjusting the screws until it turns with a slight drag; the lap is then removed and a plug gage 0.001 inch smaller than the nominal core diameter is tried into the gage. If this plug passes through, the lap still has sufficient clearance, but if the gage cannot be inserted, a reamer 0.001 inch larger than the core diameter should be run through the lap.

It is not only necessary to have the gage thread of the correct angle, but the angle between each side and the axis of the gage should also be the same. A gage thread that is tilted with relation to the axis may be due to the use of a lap cut with a tool that was not set properly. The angle of the tool may be correct, but, of course, it is essential to set it so that each cutting edge has the same inclination relative to the axis of the lap. It is good practice when using a lap to reverse its position relative to the thread gage. When this is done, if the lap thread is tilted this will soon be apparent, owing to the obtuse angle given to the thread gage.

Sometimes the sides or slope of a gage thread are lapped concave instead of extending in a straight line from the crest to the root. This is usually due to the use of a lap that is too acute. Sometimes the opposite effect is produced and the sides of the thread are lapped convex instead of concave. This may be due to the use of a lap that is not properly adjusted and one that works too freely or wabbles. If the obtuse lap *C*, Fig. 14, is used too long it will, of course, increase the angle of the gage thread beyond the standard of 55 degrees, and if the root lap *D* is used too long the thread will be too deep and the angle too small.

Lapping Crest of Thread

The form of lap used for finishing the crest is shown by the sectional view, Fig. 16. This lap has a helical concave groove corresponding to the pitch of the gage thread and of the same radius, in cross-section, as the crest of the thread to be lapped. This lap is bored out to a diameter *D* equal to the full diameter of the gage thread, minus twice the vertical distance x (see Fig. 3) from the top of the thread to the point where the crest is tangent to the side of the thread. The depth of the concave groove in the lap for different pitches is given in Table 2 and also the radius of the thread crests.

When using the crest lap it should be adjusted so that it bears very lightly on the thread being lapped. Many gages have been spoiled by adjusting the lap too tightly. When lapping the angular sides of the thread, there is at least six times as much surface being lapped as when lapping the crest. Notwithstanding this fact, many mechanics apply the same amount of pressure, and the result is that the lap itself is cut instead of the work. The lap should be adjusted for this operation so that one is just able to feel the drag or pull. If used in this way, the lap will cut properly and retain its shape while lapping a number of gages. This lap should also be reversed frequently the same as when using the angle laps. If the lap for the top radius or crest is not properly made, this section of the thread may be finished slightly off center. It is important to remember that the full diameter is reduced quite rapidly when lapping the crest. The radius should be tested occasionally by using a templet gage similar to the form illustrated at *F* in Fig. 9.

TABLE 2. RADII OF CREST AND ROOT AND VERTICAL DISTANCE x (SEE FIG. 3) TO POINT OF TANGENCY

Threads per Inch	Radius of Root and Crest	Vertical Depth x of Crest	Threads per Inch	Radius of Root and Crest	Vertical Depth x of Crest
36	0.00382	0.00206	13	0.01056	0.00568
32	0.00429	0.00231	12	0.01144	0.00616
30	0.00458	0.00247	11	0.01248	0.00672
24	0.00572	0.00308	10	0.01373	0.00740
20	0.00687	0.00370	9	0.01526	0.00821
18	0.00763	0.00412	8	0.01717	0.00924
16	0.00858	0.00462	7	0.01962	0.01056
14	0.00981	0.00528	6	0.02289	0.01232

Machinery

The abrasives that have proved satisfactory for lapping thread gages are carborundum, alundum, emery, and rouge. Carborundum gives excellent results in rough-lapping, especially when there is considerable material to be removed and the lap does not have to retain an accurate form. Alundum (65F) if used for finish-lapping ground gages will produce a finish that is nearly as fine as that obtained with rouge, and the thread may be lapped to size much quicker. Emery, being tough and sharp, will cut for quite a long time without recharging and is preferred by some gage-makers. Rouge is used when a high polish is desired. Satisfactory results may be obtained by using flour emery (grades F to F4) for lapping gages after grinding and then using rouge for removing, say, 0.00005 inch. Lard oil has proved to be a good lubricant to mix with abrasives for lapping thread gages.

Timing Lapping Periods

When lapping a thread gage or any other tool or part which must be reduced by the lapping process to a given dimension within small limits, the work can be done with less chance of error and more quickly by timing the lapping period, provided the relation between the lapping time and the reduction

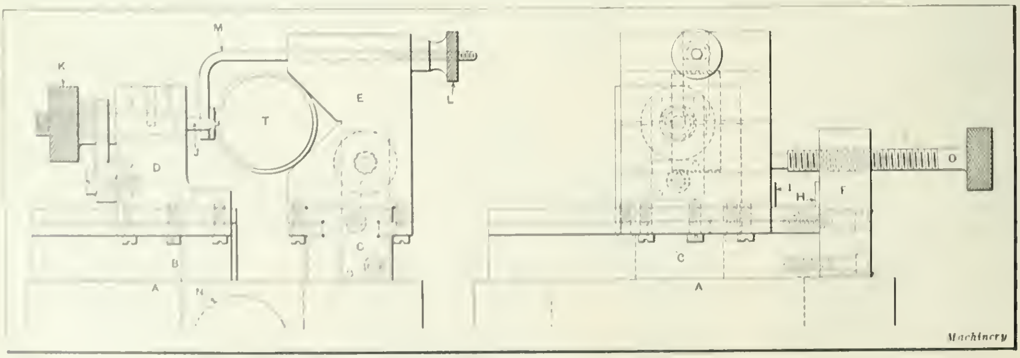

Fig. 17. Gaging Fixture for testing Lead and Angularity of Gage Thread

in size during that time has been determined previously. It is generally recognized, of course, that if a cutting tool removes a given amount of material in a given time, the same tool or one similar to it operating under corresponding conditions will approximately duplicate the amount of work done during equal periods of time. It also holds true that if a lap removes a certain amount of metal in a given time the same lap or another one like it used under similar conditions will repeat the performance. For instance, if a lap freshly charged with a certain abrasive is used continuously for, say, ten minutes, and careful measurements show a reduction of 0.0004 inch in size, it is reasonable to assume that this relation between the lapping period and the amount of metal removed may be used as a basis for determining the time required for making further reductions in size. To illustrate, suppose in this case that a lapping period of ten minutes reduced the size of the lap 0.0004 inch and that a measurement showed that there was 0.0002 inch more to be removed; in that case, the next lapping period might be five minutes in order to remove the 0.0002 inch, although it would be advisable to reduce this time somewhat in order to be on the safe side. Thus, instead of lapping continuously for five minutes, the lapping period might be reduced to four minutes, after which the part would again be measured. This simple principle as applied to lapping, eliminates largely the uncertainty connected with the lapping process, and makes it possible to reduce a precision tool, such as a thread gage, to the required size without taking so many measurements in order to avoid spoiling the work. In fact, by carefully timing the lapping periods, it is possible to reduce a thread gage to a specified dimension in three or four lapping periods. This method of procedure has in part made it possible for one toolmaker to produce from ten to twelve gages a day, when the gages have been properly ground to begin with.

Hardness Test for Thread Gages

The thread gages are tested for hardness at the root of the thread by using a high-grade knife-edge file instead of a scleroscope or Brinell hardness tester. If the gage is not as hard as it should be, the softness may readily be detected at the root of the thread because there is less carbon penetration at the root than at other sections of the thread, as indicated by the diagram, Fig. 9; consequently, if the root is sufficiently hard, it is safe to assume that the other parts of the thread are satisfactory in this respect. Each gage is tested in a number of places on the root of the thread, and if the file takes hold or cuts the gage, the latter is considered too soft and is rejected.

Lead and Angle Checking Gage

The gaging fixture shown in Fig. 17 has proved very satisfactory for testing the lead of the thread gage and also the angle of the thread, as well as its position relative to the axis. Mounted upon the base *A* of this gage there are two blocks *B* and *C* which are hardened, ground, and lapped. Block *C* carries another block *E* which can be adjusted by screw *G* and has a 90-degree notch on the side for receiving the gage *T* to be tested. In the opposite block *D* there is a spindle *J* which can be adjusted in or out by the knurled nut *K*. Spindle *J* is finished very accurately on the point to conform to the standard thread angle of 55 degrees. The arm or finger *M* which is adjusted by nut *L* is used to hold the gage in position. The gage to be tested is held in the groove of block *E* and is then adjusted until spindle *J* is in exact alignment with a thread groove near the end of the gage, by adjusting screw *G* and nut *K*, as may be required. The relation between the end of spindle *J* and the gage thread is then noted. The electric light bulb *N*, which is opposite an opening in the gaging fixture, makes it possible to see any slight difference between the contact of spindle *J* and the gage. If the contact is satisfactory, the distance between the finished surfaces *H* and *I* is then measured accurately by means of size blocks. Spindle *J* is next withdrawn far enough to clear arm *M*, and block *E* is adjusted to locate spindle *J* in line with a thread groove near the opposite end of the gage. After spindle *J* is placed in contact with the gage thread as before, the bearing between the spindle and the gage thread is again noted. If the end of the spindle and the gage thread coincide, the distance between the finished surfaces *H* and *I* is again measured and the difference between the two measurements thus taken is used in checking the lead of the gage thread. This may readily be done by simply noting the number of threads on the gage between the two places where spindle *J* was brought into contact with the gage thread. This number is then multiplied by the required pitch, thus giving a result which should correspond to the distance that surface *I* moved from surface *H* in changing spindle *J* from the first to the second position.

* * *

INCREASING WAR PRODUCTION AND SAFEGUARDING WORKERS

In view of the urgent necessity for a prompt increase in the volume of production of practically every article required for the conduct of the war, vigilance is demanded of all those in any way associated with industry, lest the safeguards with which the people of this country have sought to protect labor should be unwisely and unnecessarily broken down. It is a fair assumption that for the most part these safeguards are the mechanisms of efficiency. Industrial history proves that reasonable hours, fair working conditions, and a proper wage scale are essential to high production. During the war every attempt should be made to conserve in every possible way all our achievements in the way of social betterment.

The day's work should not exceed the customary hours in the particular establishment or the standard already attained in the industry and in the community. It should certainly not be longer than ten hours for an adult workman, and should not exceed eight hours for women and minors. No woman should be required to lift repeatedly more than twenty-five pounds in any single load. The theory under which "time and a half" is paid for overtime is a tacit recognition that it is usually unnecessary and always undesirable to have overtime. Eight hours per shift should be a maximum in continuous twenty-four-hour work, and the employment of women on night shifts should be prevented. The half holiday on Saturday is already a common custom in summer, and it is advantageous throughout the year, especially if the workday is ten hours long the remainder of the week. The working period on Saturday should not exceed five hours. An occasional shift of two or three hours on Saturday afternoons is unobjectionable if essential, but the additional hours should be regarded as overtime and paid for on that basis. One day of rest in seven should be a universal rule. The observance of national and local holidays will give opportunity for rest and relaxation which tend to make production more satisfactory.

Existing legal standards to prevent danger from fire, accident, occupational diseases, or other hazards, and to provide good light, adequate ventilation, sufficient heat, and proper sanitation should be observed as minimum requirements. Processes in which workers are exposed to excessive heat (that is, over 80 degrees), or excessive cold (that is, under 50 degrees) should be carefully supervised so as to render the temperature conditions as nearly normal as possible. When extreme temperatures are essential, workers should not only be properly clothed but should avoid sudden changes.

The need of preserving and creating methods of joint negotiations between employers and groups of employes is especially great in the light of the critical points of controversy that may arise in a time like the present. Existing channels should be preserved and new ones opened, if required, to provide easier access for discussion between an employer and his employes over controversial points. When it is necessary to employ women in work hitherto done by men, care should be taken to make sure that the task is adapted to the strength of women. The standard of wages hitherto prevailing for men in the process should not be lowered where women render equivalent service. The hours for women engaged in such processes, of course, should not be longer than those formerly worked by men. No work shall be given out to be done in rooms used for living purposes or in rooms directly connected with living rooms in any dwelling or tenement.

PRECISION SCREW MEASURING MACHINE

APPARATUS FOR MEASURING PITCH, PITCH DIAMETER, EXTERNAL DIAMETER AND ANGLE OF SCREW THREAD

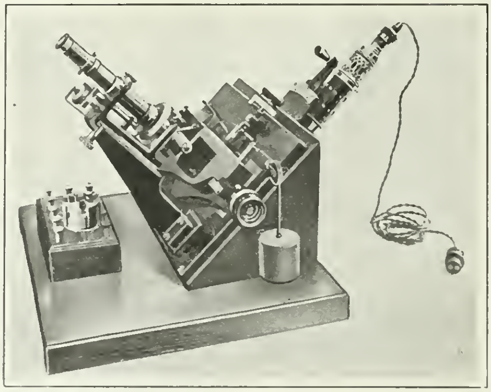

Fig. 1. Precision Screw Measuring Machine made by Cambridge Scientific Instrument Co., Ltd.

THE precision screw measuring machine to be described is of the general type which is provided with a microscope for accurately setting the screw thread to be measured in different positions and micrometer screws for determining whether or not the dimensions of the screw thread conform to required standards. A general view of this machine is shown in Fig. 1 and a side elevation in Fig. 2. The fixed microscope *A*, Fig. 2, through which the screw thread is viewed, is mounted so that it can be adjusted in a lengthwise direction for focusing and provision is also made for turning the microscope about its axis for making tests that will be referred to later. When a screw thread is to be inspected, the microscope is inclined either to the right or to the left (depending upon whether the thread is right- or left-hand) so that the axis of the microscope is in line with the screw thread instead of being perpendicular to its axis. The position of the microscope relative to the screw thread is indicated in Fig. 3. The object of this adjustment is to enable a correct view of the profile of the thread to be obtained. The angle a equals the helix angle of the thread, and the position of the microscope is indicated by an arc graduated to half degrees.

The screw to be tested is held in a self-centering split chuck. A set of these chucks is provided to take all sizes of screws within the regular capacity of the instrument. The chuck in use is held at one end of a cylindrical spindle that is supported in vees. These vees are adjustable so that the axis of the spindle may be set true. By sliding the spindle in the vees any desired part of a screw thread may be inspected, and by turning the spindle about its axis, it is possible to locate under the microscope as many different sections or profiles of the screw as may be considered desirable. This chuck spindle is turned or traversed by means of a milled screw located on the opposite side of the instrument from that shown in Fig. 1. The outer face of this milled screw head is divided into 72 divisions of 5 degrees each to indicate the angles through which the spindle is turned. Readings are taken with reference to a pointer which is delicately pivoted and has most of its weight below the point of support; consequently, this pointer is maintained by gravity in the upright position with as much accuracy as is necessary for the adjustments of the spindle. In addition to the movements which have just been referred to that enable the screw thread under test to be set in a position suitable for observation, there are two fine adjustments controlled by micrometer screws. One of these adjustments enables the screw being tested to be moved in a direction perpendicular to its axis. The micrometer screw at *B*, Fig. 2, serves to control this adjustment. In conjunction with this micrometer there is a short scale (see Fig. 1) for registering complete turns of the micrometer screw. The range of movement provided for is 15 millimeters (0.5906 inch). The micrometer screw is of ½ millimeter pitch (0.0197 inch) and the screw head is divided into 50 parts, enabling readings to be taken directly to 0.01 millimeter (0.0004 inch). The screw under test may also be traversed in the direction of its axis by means of another micrometer screw which is similar to the one just referred to and is clearly shown in Fig. 1 attached to the right-hand side of the instrument.

Before taking any measurements, the microscope must be focused properly so that the profile of the thread under observation is clearly defined. This is done by first focusing on that part of the screw thread which is nearest to the microscope. The microscope will then be in some position *A*, Fig. 3, with its axis in the same plane as the axis of the screw to be tested. When the microscope is in correct focus for this position, it is then adjusted to some position *B* so as to be in focus with the profile of the thread in a plane x–x. In order to do this, the microscope is moved downward in a direction perpendicular to the axis of the screw, a distance y equal to the radius of the screw. Since the microscope is inclined an amount a equal to the helix angle of the screw thread, the actual adjustment y of the microscope in an axial direction is equal to the radius of the screw multiplied by the secant of angle a. The microscope is first focused on the uppermost part of the thread, as previously mentioned, and is then adjusted by measurement to bring it into focus with the profile because it is easy to focus it upon the upper part of the thread by noting the clearness and sharpness of the thread as the microscope is adjusted axially in one direction or the other. If an attempt were made, however, to focus the microscope in this manner upon the profile in a plane x x, it would be difficult to determine when that particular part of the profile is in

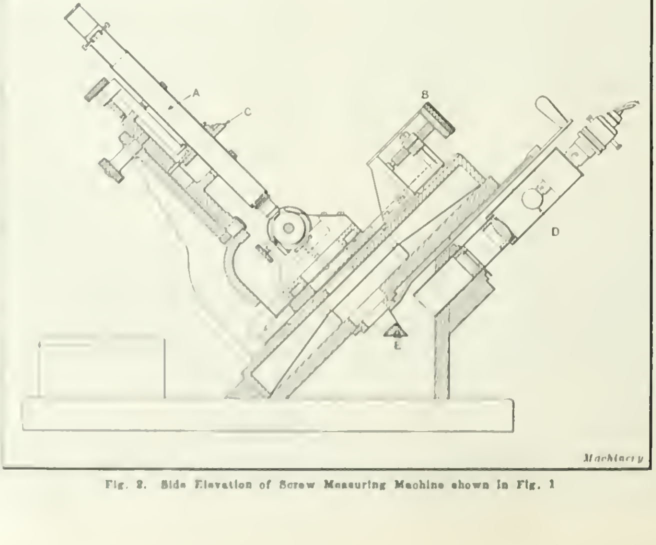

Fig. 2. Side Elevation of Screw Measuring Machine shown in Fig. 1

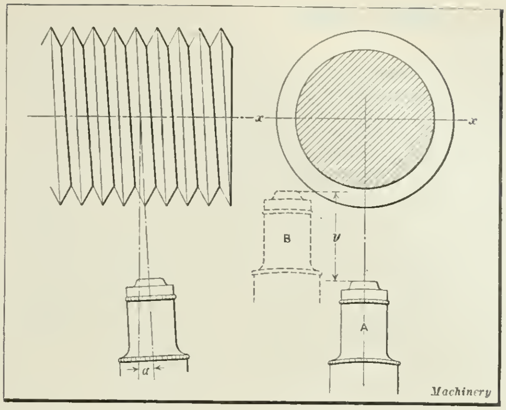

Fig. 3. Angular Position of Microscope Relative to Screw Thread and Method of focusing it

the proper focus, owing to the tangential position of the microscope.

The microscope is provided with two fine lines extending at right angles across the field as illustrated at *A*, Fig. 4. These lines are used in making accurate adjustments in connection with the tests described in the following: The two settings required for determining the external diameter of the screw thread are indicated at *B* and *C*, which show the relative positions of the screw thread and the cross-lines in the field of the microscope. When measuring the diameter, the screw is first adjusted in a direction perpendicular to its axis by means of the micrometer screw *B*, Fig. 2, until the points or tops of the threads exactly coincide with one of the cross-lines as illustrated at *B*, Fig. 4. The reading of the micrometer is then noted, after which the screw is adjusted until the points of the threads on the opposite side coincide with the cross-line as indicated at *C*. The difference between the micrometer readings for the two positions represents the external diameter of the screw.

The method of setting the screw preparatory to testing the pitch of the thread is illustrated at *D*. The intersection of the two cross-lines coincides with the slope or side of the thread. After the screw is accurately set in this position, it is traversed axially until the cross-lines again intersect the slope of the adjacent turn of the thread. The pitch, of course, is equal to the difference between the micrometer readings for the two positions. This test for pitch may be applied to different parts of the length or circumference of the screw thread, owing to the adjustments provided, so that any lack of uniformity in the pitch can be detected and measured. The cross-lines of the microscope may also be set as indicated at *E* for testing the pitch.

For measuring the angle of the thread one of the cross-lines is set to coincide with the slope of the thread as indicated at *E*, by turning the microscope about its own axis. The inclination of the cross-line to the mean position may be read directly on the graduated disk *C*, Fig. 2, which is located near the objective end of the microscope (see also Fig. 1). In order to determine the effective or pitch diameter of a screw thread, the intersection of the cross-lines is set to coincide with the thread, the same as indicated at *D*, Fig. 4, for testing the pitch. The screw is then adjusted laterally until the cross-lines intersect the slope of the thread on the opposite side, and the difference between the readings for the two positions represents the effective diameter.

While the adjustments of the screw in a lateral and an axial direction are similar to those obtained with the well-known compound slide-rest, the carriage of this instrument differs from such a slide-rest in that the upper and lower members are supported directly upon the same bed-plate, instead of the upper member being mounted on the lower one. This cast-iron bed-plate has six bearing surfaces. Three are for supporting the lower plate of the carriage and three for the upper plate. The design of the slides is strictly "geometrical" and all play or backlash is eliminated by applying such loads to the slides that the thrust against the micrometer screws is always in one direction. The weight seen at the right-hand side of the instrument in Fig. 1 is utilized for this purpose.

This instrument is equipped with an illuminating apparatus so that the profile of the screw thread under observation will be clearly defined. For ordinary work an electric lamp may be used, but to insure accuracy when measuring screws of different angles, it is necessary to use a parallel beam of light and to provide means for varying the angle of incidence of the light. For this reason, the special illuminating apparatus shown applied to the instrument in Figs. 1 and 2 is recommended. A Nernst lamp *D*, Fig. 2, in conjunction with a prism *E* illuminates the screw from below and throws a parallel beam of light up the microscope tube parallel to the optical axis. This illuminating apparatus can be adjusted to the right or left in accordance with the angle at which the microscope is inclined. This instrument was designed and constructed by the Cambridge Scientific Instrument Co., Ltd., of Cambridge, England. It was made for the small screw-gage committee of the British Association for testing the accuracy of commercially produced screw threads and taps.

* * *

TRANSPORTATION OF ARMY TRUCKS AND TRUCK PARTS

In an effort to relieve the congestion at freight terminals and at the same time test the trucks that are being built for it, the Quartermaster's Department is transporting all new army trucks under their own power, from the factories in which they are built to Baltimore, where a large repair shop has been established. It is expected that the shipment of 30,000 war trucks to the coast by this method will relieve 15,000 freight cars and also permit the transportation of 90,000 tons of other government materials to the coast from the interior storage depots. These trucks will move in trains of thirty each and will be in charge of eighty men. Twenty-nine of the first train, carrying sixty tons of spare parts, made the trip from Detroit to Baltimore in fourteen days, on three and a half of which they did not travel. They thus averaged fifty-five miles a day, though the temperature reached eight degrees below zero and large snowdrifts were encountered. This train consisted of three-ton Packards and included tank trucks, with gasoline and oil, and a kitchen truck. One of the trucks was wrecked by a railroad train just after the truck train left Detroit. Some of the trucks will undoubtedly be shipped to France from Baltimore; others will be merely assembled there for shipment from other Atlantic ports.

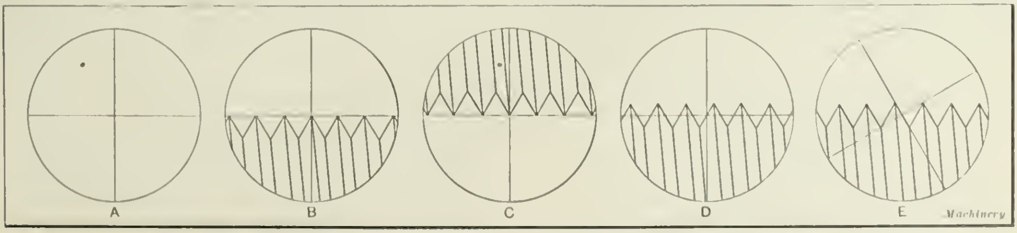

Fig. 4. Cross-lines in Field of Microscope and their Position Relative to Screw Thread for Different Measurements

PLANING COLD-DRAWN STEEL PARTS

BY DONALD A. HAMPSON[1]

Every shop man knows the tendency of cold-drawn steel to spring after a cut has been taken over the surface. If his experience has been confined to lathe work, however, he does not realize to what an extent this is the case, for in turning the bar is invariably accurately centered and the same amount is removed from all sides, so that the strains are nearly equalized and the spring is usually negligible. But on the milling machine or planer, where a cut is taken off one side, the tendency is most evident, often to the dismay of the machinist, who expected a better job. The amount of spring, or bow, in a piece that has been planed depends on the amount of stock taken off, the grade of steel, the anneal or lack of it, the length of the piece, the setting up, and whether or not the bar was straightened before being set up. If a straight bar of steel three feet long has 1/8 inch taken off one side, when released it will spring in the middle nearly 3/8 inch. The bow is always upward in the middle of the cut side. Before that piece can be used, it must be carefully straightened; and if the requirements are close and the bar must hold a piece of cigarette paper at any point, the skill required is of the highest order. Then, if a cut is taken from the other side, the straightening must be done all over again. It is possible to combat this springing on much work or to meet it fully half way, as is shown in the following examples:

The I-shaped piece shown at *A*, Fig. 1, is planed from the solid, no other construction being permitted. The maximum limit is 0.001 inch each way and from one to six pieces are required at a time; the lengths of the pieces may vary. When only one piece was ordered, the entire job took six hours, including the straightening and the setting up, though bars less than three feet long were often completed more quickly. In any case, it was work that no one liked to do, because it showed so little results for the time it demanded; besides, the bars were sold at a fixed price per inch and there was no money in them. Short lengths were planed in a vise, but most of the bars were long and were held directly on the planer table against a rib, using the regular planer equipment of posts, fingers and blocks. It was decided to make a long rib just adapted to the work, and fixtures that would be self-contained and require no fingers; the outfit was to be made so as to accommodate from one to four bars at a time. This outfit effected a saving of fifty per cent on orders for single bars, and more when the orders were larger. The saving was possible because there were fewer parts to handle and because the straightening was reduced to a minimum.

The first operation, notching the ends *B* to get tool clearance and square corners, was done in the milling machine as before. The bar *C* was then fastened against the long rib *D* by screws in the blocks *E*. There are two screws in each block and enough blocks are used on a job for a screw to bear against the bar every seven inches of its length. Slots in the under faces of the castings allow the tongues to be shifted to give a working space that will accommodate the number of bars planed and to bring the contact end of each screw at the right height. A strip *H* prevents the screws from marring the work.

Before setting up the work, the bar of drawn steel is inspected and straightened to within 0.005 or 0.006 inch, if necessary. Then one side is planed down to the milling cut, finishing it in two or three cuts. This side is then completed, but is badly bowed. Instead of straightening it, the bar is laid on blocks *F* 3/8 inch thick, and a clamp *G* is put on each end, drawing these down until all the blocks are tight. The shape of the bar before clamping is shown by the dotted line. After clamping, the second side is planed as was the first; but when released the bar is perfectly straight—commercially—so that not more than one piece out of thirty has to be touched up. The amount removed from each side being the same, the strains in the bar that are released by the cuts just balance, and the finished piece comes out better than the blank.

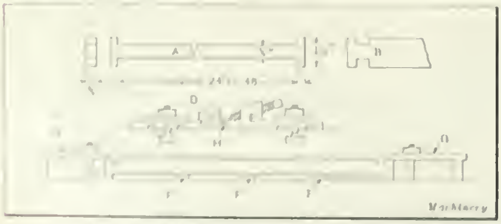

Fig. 1. Methods of planing Cold-drawn Steel Parts

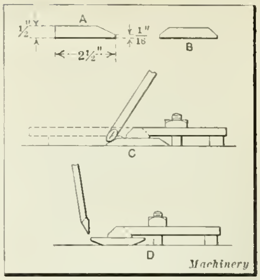

Fig. 2. Printers' Straightedges made from Cold-drawn Steel

In the printing business there is some demand for long straightedges of the form shown at *A*, Fig. 2; but as printers object to paying the price for the hardened and ground machine shop variety, they are made of cold-drawn steel. They are supposed to hold a piece of newspaper when laid flat side down or when stood on either edge on a press bed, and are from forty to seventy inches long. A cut over any one face will create a bend in the steel that can be straightened with time and patience, but the bevel cut sets up a double bend that makes it exceedingly difficult to straighten the piece within 0.01 inch. It was customary to take a light cut from both edges, releasing and resetting for each cut, but after each cut the strip would spring again. However, it was found that the users preferred straightedge *B* with two beveled edges instead of one, if they could get it for the same price. So after the piece is cut from the bar, it is inspected to see that the broad side is flat and true. Then it is clamped down as shown at *C* and one bevel cut. Before the clamps are taken off, a second set of clamps, shown by the dotted lines, is put on, to hold the piece from springing, and the second bevel is cut. There is then only one bend visible, and that one is easy to remove. To insure the narrow edges being straight, the piece is turned over, as shown at *D*, and the same clamping system employed for these cuts. Freedom from wind and a true edge are the pleasing results.

* * *

CUTTING-OFF OPERATIONS

Cutting off is a fundamental operation of manufacturing, and the importance of cutting-off machines in all kinds of manufacturing often is not fully realized. Practically every manufacturing process requires that material be cut to length and width before or after other operations are performed. In the machine shop we have hacksaws, power saws, bandsaws, cutting-off lathes, pipe machines and other tools that are used as much for cutting off as for actual shaping. Even the planer is sometimes used for cutting stock into strips, removing risers, and other cutting-off operations. It is very common to use a shaper for this purpose, and every machinist has had the job of cutting off bar stock in the lathe. The milling machine with a gang cutter makes an excellent cutting-off machine, especially for strip work. The boiler shop has power shears, circle shears and other machines for cutting boiler plates into the shapes required.

If cutting-off operations are important, then the machines used for those operations are important. The hand hacksaw and the power hacksaw are useful if not absolutely indispensable tools in metal working shops. Often lathes costing several hundred dollars are used for cutting bars to length because cheaper and simpler cutting-off machines are not provided. The power hacksaw is commonly looked upon as a cheap and inconsequential machine, but it is one of the most important in the machine shop and deserves higher regard than is commonly bestowed on it. Power hacksaws should be first-class machine tools and sold at prices commensurate with their quality. The shop manager should aim to provide these humbler essential tools that supplement the more costly ones.

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RECENT DEVELOPMENTS IN BALANCING APPARATUS[1]

IMPORTANCE OF OBTAINING PERFECT STATIC BALANCE BEFORE ATTEMPTING TO SECURE DYNAMIC BALANCE—NEW FORM OF DYNAMIC BALANCING MACHINE

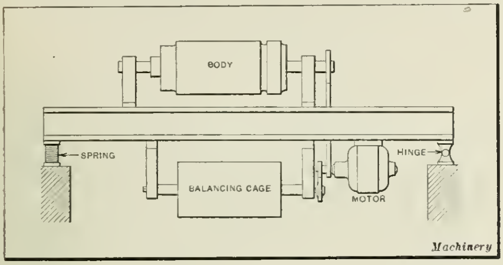

Fig. 1. Squirrel-cage Type of Dynamic Balancing Machine

A BALANCING machine developed by the writer some time ago, shown in Fig. 1, consists of a lathe bed, in the form of a beam, hinged at one end and supported by a spring at the other. The body to be tested is brought into static balance and then rotated in bearings supported by the bed. If the body is dynamically unbalanced, its rotation will cause the bed to vibrate in a vertical plane with a period of oscillation equal to the period of rotation of the body.

Suspended from the bed is a so-called squirrel cage, which consists of two circular disks that carry an even number of rods arranged to slide in holes in the disks. The cage rotates in unison with the body to be tested, so a state of unbalance in this body introduces a centrifugal couple that is neutralized by displacing the rods in the cage until an equal compensating couple has been introduced. The distances that the rods are displaced measure the amount of unbalance to be provided for and counterbalanced in the piece under test.

The improvements upon this machine are as follows: (1) The substitution for the cage of a two-point element, consisting of two disks, each with a pin projecting from its face, as shown in Fig. 2. The disk *A* is fixed to its shaft and the disk *B* is arranged to slide on the shaft through the use of a feather key *F*. When the two disks are in contact, they balance each other; but when separated, they introduce a centrifugal couple according to the weight of the pins and the distance between the disks, which can be varied while the apparatus is in motion. (2) A planetary arrangement by which the relative angular position of the body and the disks (or cage) can be varied while the machine is in operation. (3) The application of a principle whereby the disks (or cage) may be arranged to answer the problem of static balance as well as dynamic balance.

Static Balance

In the study of static balance, too much has been taken for granted. Static balance is not a trifling problem to be solved easily by placing a rotating body on parallel ways or rollers, as has commonly been supposed. While this balance can be easily found in the case of bodies of light weight or where the operating speeds are comparatively slow, there are much more difficult cases. For example, a gyroscope wheel that weighs about fifty pounds and runs at 10,000 revolutions per minute, or a turbo-rotor weighing 10,000 pounds and making 3600 revolutions per minute, cannot be balanced by placing the bodies on ways; and yet, unless static balance is perfect, no dynamic balancing machine can give reliable results.

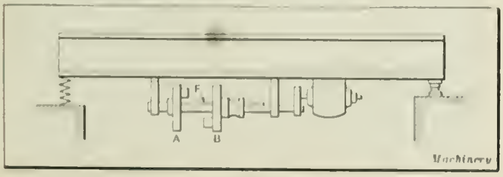

Fig. 2. Two-point Balancing Element

There is a limit to the load that can be safely borne by the journals in contact with the ways. A safe load for each journal appears to be 750 pounds per inch of width per inch diameter of journal. For instance, if the ways are 1½ inch wide and the journal diameter is 10 inches, each side will carry almost 12,000 pounds without any danger of forming permanent flat spots.

The older theories of roller friction, as proposed by Coulomb, Morin and Dupuit, do not seem to lead to very reliable results; Resal's formula is probably much more reliable, and in simplified form, steel on steel, is:

$$f = 0.056\sqrt{\frac{1}{1+\frac{79}{D}}}$$

where f = length of contact of shaft with way, in inches;
D = diameter of shaft, in inches.

The diagram in Fig. 3 has been roughly plotted to illustrate the probable sluggishness or residual unbalance that may remain in a body that has been brought into apparent balance by testing on ways. It is based on Resal's formula, and, as it is intended simply to illustrate the meaning of the formula, values have been exaggerated by plotting shafts of small diameter against weights altogether inconsistent therewith. The chart is easily read; for instance, if a rotor weighs 4000 pounds and the diameter of its shaft is 6 inches, the residual unbalance may be as great as 480 ounce-inches, or say 2½ pounds on a 12-inch radius. It is useless to put a body statically unbalanced to such an extent (or even to 50 per cent of this) on any dynamic balancing machine. Satisfactory results cannot possibly be derived from such tests. An actual case of residual unbalance, typical of many others, is of a shaft having a diameter of 2 3/32 inches, a weight of 66 pounds, and a residual unbalance of 0.844 ounce-inch. The balancing ways were made of cast iron, chilled and ground, and their width was 5/16 inch.

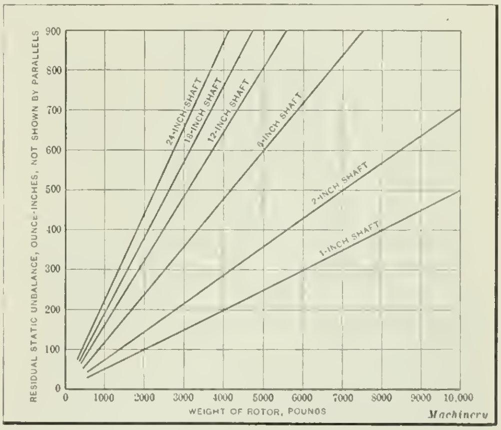

Fig. 3. Probable Residual Unbalance of Bodies balanced on Testing Ways

Considering the phenomenon of rolling friction from the standpoint of higher theories of elasticity, the following tentative formula was derived for residual unbalance:

$$M = 0.0004648P\sqrt{PD}$$

where M = residual moment, in ounce-inches;
P = weight per unit of contact length, that is, per inch of combined width of ways;
D = diameter of shaft, in inches, steel on steel.

The constant may be considered to be rather tentative, but

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[1] Abstract of a paper read before the American Society of Mechanical Engineers in New York City, December, 1917, by N. W. Akimoff, Philadelphia, Pa.

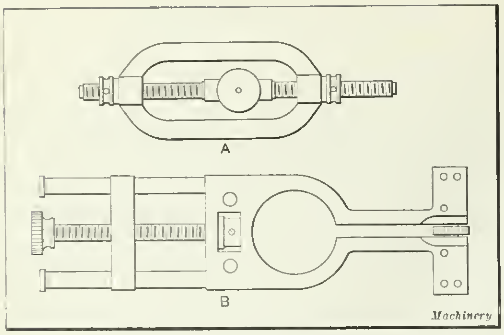


Fig. 4. Clamps used in securing Static and Dynamic Balance

with the advent of a machine capable of establishing perfect static balance it will not take long to find more reliable values for it. According to this formula, if an armature weighs 12,000 pounds and has a shaft diameter of 8 inches, the sluggishness or residual balance, when placed on ways 1 inch wide, will be:

$$M = 0.0004648 \times 6000 \sqrt{6000} \times 8 = 611 \text{ ounce-inches}$$

or over 3 pounds on a 12-inch radius. At 3600 revolutions per minute the centrifugal force due to such residual unbalance will be more than 14,000 pounds.

Use of Centrifugal Force in Balancing

The earlier machine for dynamic balancing was based on the introduction of centrifugal couples, created by the operator to offset the effect of the disturbing centrifugal couple, constituting unbalance in the rotating body. While a machine for static balancing can be based on the same principle, a long study of the subject has led to the conclusion that the whole problem of balance, static and dynamic, can be reduced to the principle of a single centrifugal force acting on a properly constrained body. Such centrifugal force can be created by the operator, within a rotating body, by such means as clamps, of which two designs are shown in Fig. 4. These clamps should be carefully made and calibrated so that the centrifugal force may be given as a function of some linear dimension, read directly, or measured by an accurate scale. One clamp *A* is easier to make and check for accuracy; while the other *B* is much handier for quick adjustment on the shaft of a rotating body.

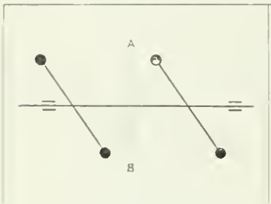


Fig. 5. Unbalanced Body with Center of Gravity lying in its Axis

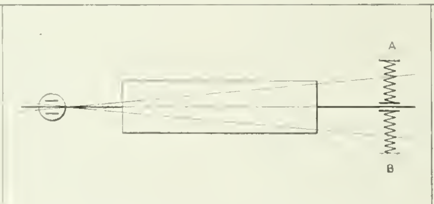


Fig. 6. Rotating Body with One Bearing pivoted and One floating between Coil Springs

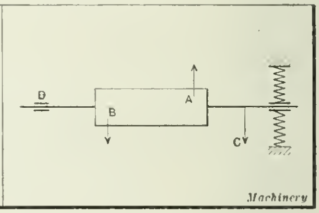


Fig. 7. Centrifugal Couple balanced by a Centrifugal Force

In order to register the effect of static unbalance of a body, or the correction introduced by means of a clamp, the body must be placed in such a condition that its oscillations are emphasized or magnified to an extent that they will be visible to the eye, otherwise its unbalance will only result in increased pressure on the bearings. Thus, in a badly unbalanced automobile engine, it is often possible to pick out a range of speeds where the engine will appear to work smoothly; and many electric motors with a badly unbalanced rotor will apparently run well, simply because their speed may be far away from that which will insure synchronism of the rotation with the oscillation of bearing supports.

Suppose a frame, suspended as shown in Fig. 8, is capable of a certain period of swinging oscillation. If the body, statically unbalanced, is operated at a speed corresponding to the period of oscillation, the oscillations of the frame will become violent, and can be readily registered by any suitable dial-gage indicator. Here the body is imposing its own period on the frame, which thus performs what are known as forced vibrations of the same period. The problem is to adjust the speed of the body so that the period of such forced oscillation will be equal to that of the natural oscillation of the frame and body, that is, at rest. Of course, a clamp *K* can always be so adjusted as to nullify the oscillations of the frame.

Dynamic Balance

As regards dynamic balance due, in a statically balanced body, only to the presence of a centrifugal couple, the theory that this centrifugal couple is due to the fact that the centers of gravity of both halves of the body, cut through its center of gravity, do not lie on the axis of rotation is radically wrong. Take, for instance, a skeleton body, as shown in Fig. 5. Its center of gravity is exactly on the axis of rotation, as also are the individual centers of gravity of each half, to the right and to the left of *AB*. Yet such a body would be manifestly out of balance, dynamically. Inversely, a body would readily be imagined to be in both static and dynamic balance, although each of its halves were statically out of balance. The only correct way to characterize dynamic balance is to say that the products of inertia, containing the axis of rotation, vanish; or, to put it practically, that there is no centrifugal couple in any axial plane.

If one end of a rotating body, statically balanced but dynamically out of balance, is constrained or pivoted while the other end is arranged to float in a bearing supported by springs so that it may move, say, in a horizontal plane, Fig. 6, the oscillations of the body will be angular, as from *A* to *B*. Under these conditions the observer will be unable to tell whether the vibrations are due to a force acting somewhere on the body or to a centrifugal couple, unless he knows beforehand that the body is in perfect static balance, under which conditions the vibratory effect can be due only to dynamic unbalance. This being the case, in view of the reaction of the constrained end, it is perfectly possible to balance the effect of a centrifugal couple by means of a centrifugal force. Thus, in Fig. 7, if the dynamic unbalance is assumed to be due to the couple *AB*, it will always be possible to select a centrifugal force *C* that will quiet the vibrating body, and because of its known distance from the bearing *D*, establish the exact value, sign and angular position of the disturbing centrifugal couple *AB*.

It is thus possible to utilize a centrifugal force to good advantage in finding both static and dynamic unbalance of

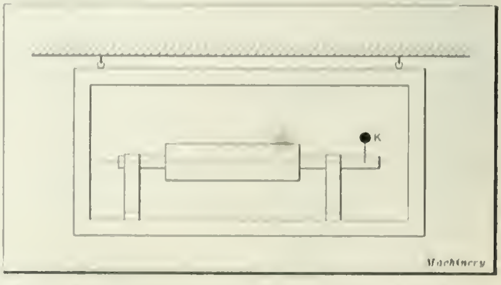


Fig. 8. Body supported in Swinging Frame for securing Static Balance

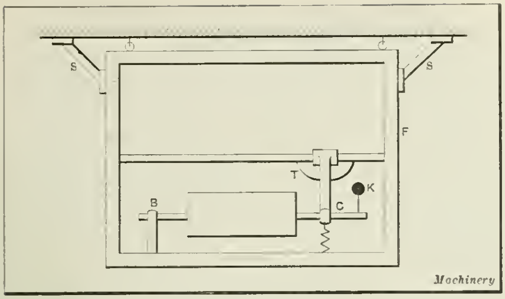


Fig. 9. Body with One Floating Bearing, supported in Rigid Frame for securing Dynamic Balance

bodies; and combining the principles illustrated in Figs. 6 and 8 gives a combination static and dynamic balancing machine.

Description of Improved Balancing Machine

A frame *F*, Fig. 9, supports the bearings *B* and *C* that carry the body. The frame has a swinging period of its own and the bearing *C* may be locked, so that it acts exactly like the right bearing *B*, or it may be allowed to float in a vertical plane, bringing into play certain resistances, springs that oppose its deflection from the neutral, vertical position. The correcting centrifugal force is indicated by *K*. Such a system is known as a system with two degrees of freedom and is capable of two kinds of motion: swinging of the frame, the bearing *C* being maintained rigid, and swinging of bearing *C*, the frame *F* being maintained rigid by brackets *S*. The most general motion consists of a combination of these two motions.

The operation of such a combination machine is very clear. In order to secure static balance, the bearing *C* is locked and the frame supports *S* are unlocked. Then, by adjusting the magnitude and direction of *K*, the body oscillations of the frame *F* are reduced to zero, thus establishing the exact value and sign of static unbalance in ounce-inch units. As soon as this has been corrected, the frame *F* is locked and the bearing *C* unlocked; then the centrifugal force *K* created by a suitable adjustment of the clamp can be made to correct the body for dynamic unbalance, as illustrated in Fig. 6. The advantage of basing the results on the centrifugal force instead of on a centrifugal couple is manifest; the former is a fundamental and the latter a derived unit, so that the former is capable of much greater accuracy in adjustment and of more direct application than the latter.

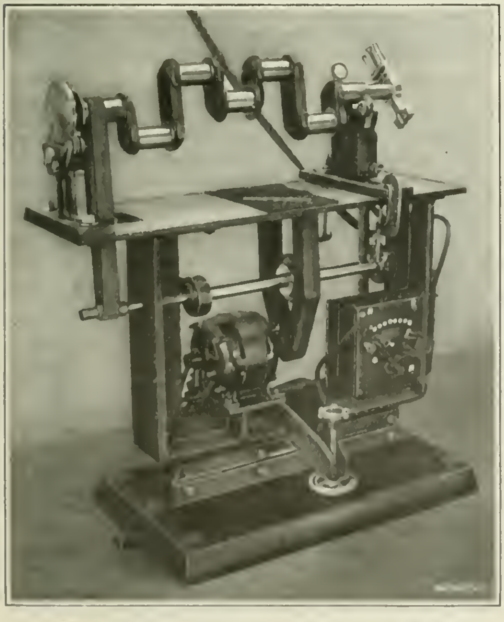


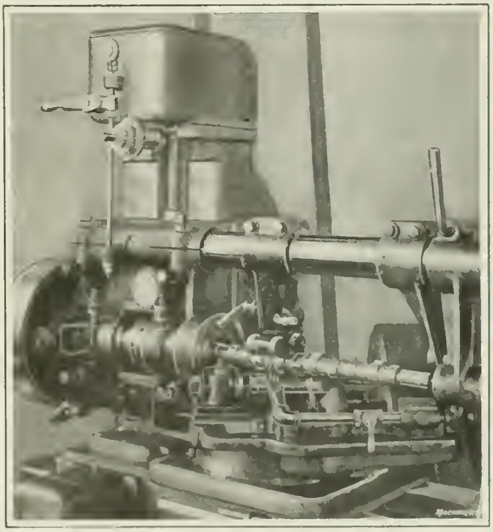
Fig. 10. Combined Static and Dynamic Balancing Machine

Fig. 10 illustrates a balancing machine built in accordance with the scheme of Fig. 9. The yielding support, on the right, and the frame are easily adjusted. The motor is of one-third horsepower capacity and operates the body, through a countershaft, by a rubber belt. The balancing clamp is on the extreme right of the crankshaft. The oscillations are read by means of ordinary Starrett dial gages, graduated in thousandths of an inch. The precision that can be secured on such a machine is almost uncanny; it enables one to see the sluggishness of the method of balancing on ways, and therefore the absolute lack of precision of dynamic balance that might be based on such results. A well-designed clamp is very easily handled and its correct position can be established in a few minutes. Its indications are capable of tabular interpretation, so that the operator has merely to carry out the simple instructions worked out beforehand. Of course, it is clear that such a machine can be built for any size of body or for any speed that may be desired.

* * *

HOBBING SPIRAL GEARS WITHOUT TRAVERSING HOB

An unusual gear-hobbing operation is shown in the accompanying illustration, which represents the cutting of a spiral gear in the center of a long camshaft on a Barber-Colman gear-hobbing machine. The bearings on each side of the gear made it impossible to cut the teeth by traversing the hob across the face of the gear in the usual manner. The gear face, however, was so narrow that it could be cut satisfactorily by simply feeding the work down onto the revolving hob. The outer end of the camshaft is supported by a center from the overhanging arm and the other end is held in a spring collet inside the spindle, the collet being opened or closed by a handwheel at the rear of the machine. The thrust of the cut is taken by a special form of steadyrest, consisting of four hardened rollers which are in contact with bearing surfaces on each side of the gear. These rollers are supported from the overhanging arm, as may be clearly seen in the illustration



Cutting Narrow Spiral Gear in Center of Camshaft without traversing Hob

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THE DAYLIGHT SAVING BILL

Practically all Europe has turned the clock forward one hour to make better use of the daylight in the early morning hours and to save artificial light at night. The "daylight saving" bill now before Congress, having a similar purpose, is of great importance at the present juncture when the shortage of coal makes it necessary to save fuel whenever possible. Statistics show that England saved 300,000 tons of coal in the summer of 1916 by turning the hands of the clock forward one hour.

It would be possible, but hardly practicable, to start work an hour earlier and accomplish the same result without moving the hands of the clock; but this simple expedient makes it easy for everyone to begin work an hour earlier, avoids any change in the railroad time-tables and other schedules and, besides saving fuel, allows an extra hour of daylight in the evening for recreation in the open air after the day's work. The objects of this bill can be accomplished with a minimum of trouble and no expense, and we hope it will become a law.

* * *

PROGRESS OF MACHINE TOOL DESIGN

The effect of the motor car on machine tool design is an interesting example of the manner in which one industry reacts on another. The first motor cars were built after the fashion of other machines, low carbon steel being used for the shafts and cast iron for the gears. Each bearing was oiled individually through its own oil cup, shafts were cut with a single spline for sliding gears, and all the mechanism was interdependent as regards manufacture and assembly. The early history of motoring was a story of breakdowns and expensive repairs. To start on a long trip was to begin an adventure quite likely to end in mishap more or less serious. The shocks and strains of road locomotion, even at moderate speeds, soon caused fatigue and failure of some of the vital parts in the engine and transmission. It was quickly realized that cast iron would not do for gears nor machine steel for shafts, that more efficient means of lubrication and separation of the mechanism into its essential units were necessary. Then came the demand for machine tools that could work heat-treated alloy steels at an economical speed. Again was the history of machine steel and cast iron re-enacted in lathes and milling machines. The reconstruction found necessary in the motor car was also necessary in the machine tool. Heat-treated steel gears and shafts, compact and strong gear-shifting devices, multiple splines, separation of the feed mechanism into demountable units, automatic lubrication of bearings and other features of modern motor cars are being incorporated more and more in the latest types of machine tools, especially the milling machine. The result is a long-lived machine that operates with less friction than its predecessor and seldom breaks down. A break is less serious also, as the defective part can be removed and replaced without tearing down the whole machine. The next important step in machine tool improvement will be the general use of ball and roller bearings and the standardization of design so as to permit of the more general manufacture of interchangeable parts.

* * *

COOPERATION WITH THE TOOL ENGINEER

To design a machine that will work well and that will be also practical to manufacture comprises two distinct problems. No machine or apparatus should be perfected to the state where it is to be manufactured without the cooperation of the tool engineer, who should be given opportunity to study the design and modify it so as to reduce the cost of manufacture and provide for its efficient and rapid handling in the shop. The addition of a lug, the thickening of a frame, the change of location of a bolt hole or any one of many other modifications may mean all the difference between a slow, expensive job and one that can be turned out quickly at a minimum of cost. The machine designer is usually quite jealous of his design and slow to let anyone tinker with his pet ideas, but he should recognize the fact that it is one thing to design a machine to secure the maximum mechanical efficiency, and quite another to design it to secure the maximum manufacturing efficiency.

* * *

ELIMINATE UNNECESSARY WORK IN WAR TIME

It is unfortunately true that a great deal of unnecessary work is frequently done in the large industrial plants, which represents a loss both in peace and war times. This loss is theoretically individual under normal conditions, but under present conditions it affects the entire nation and should be eliminated wherever possible. In machine building, time should not be spent on unnecessary finish or unimportant refinement of measurements. Jigs and fixtures should never be finished on any surfaces where finish is not absolutely required in order that the work for which they are used may be properly performed.

It requires courage to change customs and ignore precedents, but during these critical times customs and precedents must go when they involve useless labor. Systems should be pruned of all unnecessary red tape, and forms and reports divested of all information except what is of actual value for future reference. Care should especially be taken to see that only necessary information is required and placed on record, because procuring information that is not to be used is a waste. Inspections will often prevent the collection of data that will never be referred to, although there may not be many cases like the one cited by an efficiency engineer who recently found in one large plant a highly developed cost system requiring the time of four men to compile, the data for which was filed in cabinets that had never been opened except to add other data.

Unnecessary correspondence should be avoided. Many communications require no answer, and the sender expects none except in reply to an inquiry or in the case of important letters which may be considered as forming part of an agreement. Even such correspondence may be considerably reduced.

The difficulty of obtaining efficient help of all kinds under war conditions makes this an opportune time to examine the work of every individual in your organization so as to determine what part, if any, can be economically dispensed with. In the shop the same thing may be true. Foremen and workmen, unless they are carefully looked after, are likely to continue unnecessary finish and refinement on their work, which should be dispensed with.

THE DESIGNING ENGINEER

BY JOSEPH W. WUNSCH[1]

It is the intention to review here the most common troubles encountered by the designing engineer. He is frequently confronted by problems in which duty, conscience, and common practice do not quite coincide; some solutions of these problems are suggested. What do you imagine are the thoughts of a designing engineer when an inventor or manufacturer steps into his office, pulls out some patent letters, and after saying what that invention does and others don't do, finally asks for just a "few rough sketches" for the machinist, to make the first machine? The man does not care to have assembly drawings at all. He does, however, expect, possibly within a few days, drawings warranted to be without error, and that will insure the correct working of the machine.

Conscientiously, the engineer may tell his visitor that a perfect set of drawings of a special machine, made within a few days, is impossible of accomplishment; and as to guarantees, if his last month's rent is paid, the engineer may have the courage to tell the man that they are not customary, unless especially paid for. After studying the invention, the engineer may also decide that the necessary drawings will cost approximately $500. His visitor is dumbfounded. He can hardly understand why they should be so costly, especially as the patent drawing, with all frills and fancies, costs only $5 and there is lots of room for argument between $5 and $500.

A large number of manufacturers, including many machine builders, do not appreciate creative designing work. At any rate, that may fairly be concluded from their attitude when they have to pay for such services. As a rule, they consider bills rendered for designing service too high, no matter how modest those charges may be. If the manufacturer takes this stand, it is hardly fair to expect the amateur inventor to be more reasonable. One of the common sources of disagreement between the designer and his client is the latter's inability to differentiate between designing a new machine and a standard machine. Another source of disagreement, even a more serious one, is the fact that the client expects the drawings to be entirely devoid of error, and the working of the first machine, upon assembly, to be guaranteed. Given sufficient time, these expectations might be realized, but is the client willing to pay the premium for such insurance? A conscientious and complete design of a new machine usually requires more labor, expressed in time, than the building of the machine in the shop. In fact, assuming no ulterior motives on the part of the designer, the cost of building the machine in the shop is, to a certain point, inversely proportional to the time spent on the design in the drawing-room; and it is cheaper to find mistakes there than in the shop.

The ethical codes of various engineering societies show that the engineer is constantly striving to establish a code of conduct similar to that of the older profession of medicine. There is a close analogy between the problems that confront the physician and engineer, which may be classified in the departments of research, original creative work, and routine work. The field of general practice in both professions is so broad that specialists must frequently be consulted. Incidentally, attention may be called to the quackery from which most professions have to suffer, and this is particularly true of the engineering profession. While the physician is protected by the state and his organizations, the engineer has practically no equivalent support. It is true that he may often easily acquire superficial recognition when he affixes to his name a number of letters, which, translated into the language of the layman, means that he is a member of various societies because he is able to pay his dues.

Another serious problem of rather frequent occurrence resolves itself into the question: Should an engineer give his client what he asks for or what he needs? When an inventor lays his ideas before an engineer and asks him to develop them into a machine, should the engineer inform the inventor that his ideas are not practical, thereby incurring his wrath and utter contempt, or should he design a costly machine that is finally to land in the junk heap? Or should an engineer gratify the request of the small-shop man, who says that all he needs is a "couple of sketches," to build his machine? He says that he cannot afford to pay for assembly drawings, and that they are useless anyway. If an engineer doesn't do as he is asked, he loses the job, and if he does, he will sooner or later hear of violent curses and sneers, by the fraternity of "practical men," on the engineering profession in general, and this engineer in particular. That is the ultimate stage in the evolution of the sketch-built machine, despite the story of the machine that Sammy and his boss built, without drawings, even without sketches. It was put together and worked without a hitch. The writer likes this story, it is a perfect shop story. It can be molded, tempered, and adjusted. It can be modified to suit any shop, machine or condition, with the added advantage that it may be kept in stock for repeated use.

In general, drawings should be accurate, legible, and in appropriate form for the purpose intended. To show shade lines and other unnecessary adornments on a shop drawing, is a waste of time; and to show two projections in a drawing where at least three are necessary, is worse practice. There seems to exist a general lack of appreciation of the value of proper assembly drawings and a sufficient number of detail drawings. The opinion apparently prevails that it is more efficient for the designer to hang around the shop as the work advances. In a majority of cases, the need of such supervision is merely the consequence of incomplete and inaccurate designs; it should not be at all necessary for the designer to supervise the execution of the work in the shop. When building a standard type of machine, his presence should not be required even when putting the machine into operation.

The natural development of a new type of machine may be properly divided into three stages, which are: the creative and experimental, the development, and the standardization. A perfect product cannot be approached if any function in any of these stages is neglected. The few records of first drawings that are extant and accessible are immensely interesting and instructive. Designs of machines in the process of development are indeed rare, and owe their existence to lucky accidents. In our literature, permanent and otherwise, first drawings are not considered at all. Drawings therein are of the final product and may be properly called postmortem designs, inasmuch as the valuable matter of the stage of development is withheld from the reader. Designs of special machinery, which often represent months and even years of designing, embodied in a beautifully proportioned machine of the most ingenious mechanisms, are usually buried in the blueprint bin of the machine shop constructing the required number of machines, and never see the light of day. The inestimable value of such a design as a text on machine design is thus lost forever. Only in rare cases can the publication of such first drawings be of any harm to the designer or owner of the machine. Does it harm a physician to acquaint his colleagues with details of an interesting case even if the report ends "the patient died?" This brings to mind the great number of machines that never reach the market and of which no information at all is extant. These designs are often mines of valuable data and experience and their utility to the designer of new machinery can hardly be estimated.

* * *

According to the *Engineering News-Record*, conserving the food supply of the country by turning city garbage into alcohol instead of using grain or potatoes for the purpose is a promising possibility established by carefully conducted experiments reported from the garbage-reduction plant of Columbus, Ohio. The experiments show that one ton of Columbus green garbage will yield 4.8 gallons of 95 per cent alcohol of satisfactory quality. Estimates indicate that a $36,000 plant would produce from the 20,000 tons of garbage treated annually at the reduction works a total of 96,000 gallons of alcohol, giving a profit of 42 cents per gallon at war-time prices, or 30.5 cents under normal conditions. A year's garbage, the tests indicate, would yield as much alcohol as could be produced from 33,600 bushels of shelled corn, 39,500 bushels of wheat, or 110,000 bushels of potatoes.

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MODERN DRILLING PRACTICE—2

SINGLE-PURPOSE CLUSTER TYPE MULTIPLE-SPINDLE DRILLING MACHINES—STATION TYPE MACHINES—APPLICATIONS OF INVERTED DRILLING PRACTICE FOR DEEP-HOLE WORK

BY EDWARD K. HAMMOND[1]

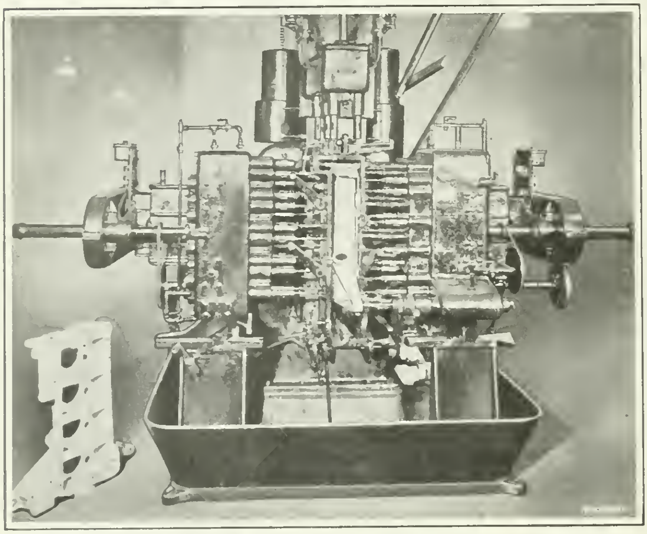

Fig. 22. Foote-Burt Three-way Multiple-spindle Drilling Machine for drilling Eighty-four Holes in Automobile Crankcase at One Setting

IN addition to the universal multiple-spindle machines described in the January installment, there is a very important group of cluster type multiple-spindle drilling machines which are designed and built to meet the requirements of specific manufacturing operations. In these machines the spindles are not usually made adjustable, because they are intended for one given class of work and each spindle is properly located to drill the particular hole in the work for which that spindle has been provided. Fig. 22 shows a three-way multiple-spindle drilling machine built by the Foote-Burt Co. for use in simultaneously drilling all of the screw holes in the upper half of a Willys-Overland crankcase. The material is aluminum, and this machine provides for drilling eighty-four holes at a single setting of the work. An idea of the remarkable rate of production secured through the possibility of simultaneously drilling such a large number of holes will be gathered from the fact that 480 crankcases are drilled in an eight-hour working day. This machine is so designed that the different sizes of drills are driven at approximately the correct speed and feed.

Special-purpose multiple-spindle drilling machines of the cluster type are built for a great variety of work, although the automobile industry represents the most important field in which these machines are employed. The reason for this is that it would not pay to invest in an expensive machine of this kind unless the volume of work to be drilled were sufficiently great so that it would be found profitable to build special machines for handling the work. Among the parts which are frequently drilled on special-purpose multiple-spindle drilling machines, the following may be mentioned: cylinder blocks, transmission cases, flywheels, crank-cases, camshafts, differential frames, wheel [illegible] [illegible] [illegible] etc.

Drilling, Reaming and Counterboring Rifle Floor-plates

Fig. 23 shows two Langelier multiple drilling machines used in couples for drilling, reaming and counterboring four holes in the floor-plate of a foreign rifle. The operations are performed without removing the work from the jig. The drilling is done with the machine at the left in two operations, and the reaming and counterboring with the machine at the right in two operations. Fig. 24 shows the floor-plate. Three of the holes are drilled, reamed and counterbored; the fourth is only drilled. The holes are drilled half way through from each side, the meeting of holes not being important, as the floor-plate is afterward slotted as shown by the dotted lines. To produce the greatest possible output from these machines, an operator is required for each machine, while a third loads and unloads the jigs. A set of three jigs is used. Thus the machines are continually at work. Fig. 26 shows the lay-out of spindles in the drilling head for the two drilling operations. This head is in the machine to the left in Fig. 23. The group of four spindles that carry the 5.1-millimeter and the three No. 17 drills is used for the first operation with the cover side of the jig down. The four that carry the 5.1-millimeter and the three 1/8-inch drills are used for the second operation with the cover side up. The 1/8-inch holes are not reamed. The jig is then carried to the second machine. Fig. 27 shows the lay-out of spindles in the drilling head in the machine to the right in Fig. 23, which is used for reaming and counterboring. The group of three spindles carrying the 0.178-inch reamers do the reaming with the cover side of the jig down. The group of spindles carrying the two 0.275-inch and one 0.315-inch counterbores do the counterboring with the cover side of the jig down.

Fig. 25 is a partial side elevation showing the drill head with its sub-jig attached and the jig on the table of the

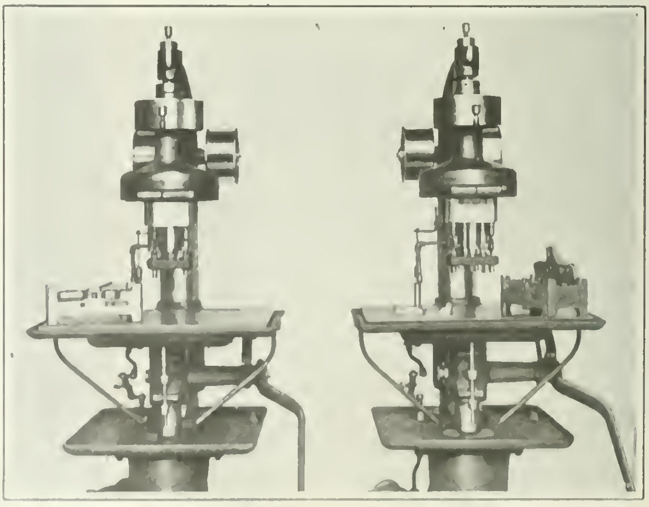

Fig. 23. Langelier Multiple Drilling Machines used in Couples for drilling, reaming and counterboring Holes in Floor-plate of Rifle Receivers

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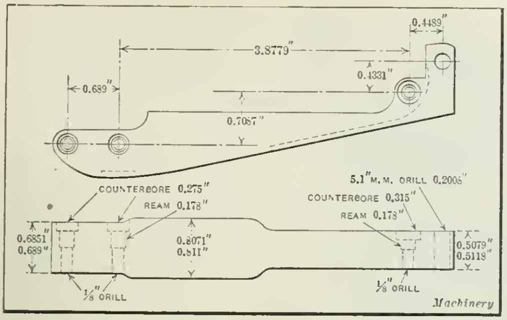

Fig. 24. Rifle Receiver Floor-plate which is drilled, reamed and counterbored in Machines shown in Fig. 23

machine in position for the first drilling operation. The sub-jigs on the two machines are the same in principle. The bushings in the sub-jig guide the tools, and the bushings in the jig guide the sub-jig. By this method, each of the drills, reamers or counterbores has its own guide bushing, and the use of interchangeable slip bushings in the jig is avoided. The sub-jig is attached to the drill head under the compression of a spring. When the sub-jig comes in contact with the work jig, it is forced upward while the drilling, reaming or counterboring takes place. The sub-jigs can be quickly removed by unscrewing two tapering thumb-pins so as to provide free access to the tools if required. All the spindles are provided with adjusting screw collets so as to compensate for grinding of tools, also for individual adjustment for depth of holes. The jigs are of the swing cover type, compensating means and stops being incorporated for accurately locating and holding the work while it is operated upon. The machines are of the round column and base type. The table has a working surface of 21 inches by 14 inches, which is ample for the handling of the jigs. It is trunnioned into a supporting arm that is clamped to the column and can be adjusted to the required working position. The trunnion of the table has a rack which meshes with a pinion shaft having bearings in the supporting arm and to which is attached the long feed hand lever. A single feed stop is provided for the table for both operations.

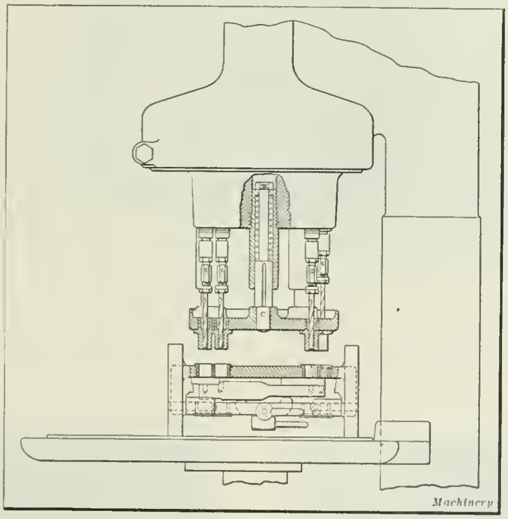

Fig. 25. Partial Side Elevation of Drill Head used on Machine at Left in Fig. 23, showing Sub-jig and Jig in Position for First Drilling Operation

Station Type Multiple-spindle Drilling Machines

In Fig. 21 in the January installment there was shown an illustration of a battery of Baush multiple-spindle drilling machines used in conjunction with a traveling jig which carried the work from one machine to another in order that advantage could be taken of the possibility of performing a number of groups of operations without the necessity of resetting the work. When the importance of the savings that are possible through the use of such an arrangement has been fully appreciated, it will be apparent that a still further benefit would be secured by the combination of different groups of spindles in a single machine that would provide for saving time by avoiding the necessity of frequent resetting of the work, and at the same time economizing floor space through having the entire outfit contained in a single unit. This is the idea that has been successfully accomplished through development of the "station type" of multiple-spindle drilling machines which are built by the Baush Machine Tool Co. Machines of this type were first constructed for the use of the Ford Motor Co. in drilling all of the holes that are required in flywheel castings. The complete machine for doing this work is shown in Fig. 28, and Figs. 29 to 31, inclusive, show, respectively, the loading station where the work is set up on the machine, a view of two multiple-spindle drill heads, and a view of heads equipped with tools for the performance of drilling and reaming operations.

In operating the machine, each flywheel is placed on a supporting block and secured by means of an expanding center. The loading station on the machine is illustrated in Fig. 29, and in this view the wrench used for expanding the center on which the flywheel is held will be clearly seen in position. The counterbore in the wheel is used to locate the work under each jig, this result being obtained by a tapered leader which enters the counterbore as the jig at each station on the machine comes down to the working position. In addition to this counterbore, there is a flat dowel in the supporting block that registers between two jaws on the extreme outside portion of the jig, thus securing the wheel against rotation. The feed is accomplished by means of a barrel cam which is of the correct form to give a quick approach and the desired rate of feed and return. By employing different cams suitable rates of feed can be employed for the tools in different heads. The table is rotated by a mechanism which also lifts it, thus allowing the weight to be carried on a center pintle, while it is in motion, and the provision of ball bearings in this connection makes it possible for the table to be easily moved. A hardened steel locking bolt is provided, which is actuated by a cam and comes into play just before the table is lowered to its working position, where the bolt locks the table in place.

When in the working position, the table rests on a circular rail which is slightly smaller than its outside diameter, this rail being carried up inside a flange at the periphery of the table to protect the bearing from chips. One central oiling system is provided which delivers lubricant to all bearings, the pump taking the oil from a tank in the base and circulating it through a system of piping provided with return connections. There are eighty-one drilling, counterboring and reaming operations to be performed on the Ford flywheel, and with this machine it is found possible to perform all of these operations in fifty-four seconds. Each machine has a capacity for drilling 500 flywheels in an eight-hour working day, the

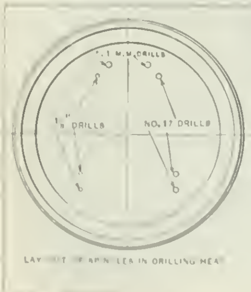

Fig. 26. Lay-out of Spindles in Drilling Head

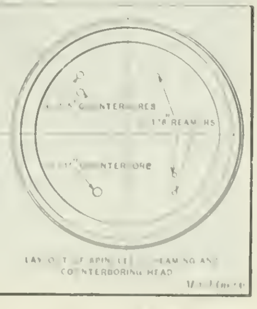

Fig. 27. Lay-out of Spindles in Reaming and Counterboring Head

actual rate of production being 510 flywheels in 450 minutes. The operations consist of drilling sixteen 21/64-inch holes in the inner circle through 1⅛ inch of metal, and sixteen 1/4-inch holes in the outer circle half way through the same thickness of metal; second, counterboring the sixteen holes in the inner circle to a diameter of 0.386 by 3/16 inch deep, and drilling the holes in the outer circle through the remaining metal, a 0.204-inch drill being used for this purpose which cuts through 7/16 inch; third, counterboring three half round faces 0.936 inch in diameter by 3/8 inch deep in the hub of the wheel; fourth, drilling four holes 0.386 by 5/8 inch deep, two holes 27/64 by 5/8 inch deep, and three holes 21/32 by 7/8 inch deep; fifth, reaming three holes 0.675 inch in diameter by 7/8 inch deep and two holes 0.436 inch in diameter by 5/8 inch deep.

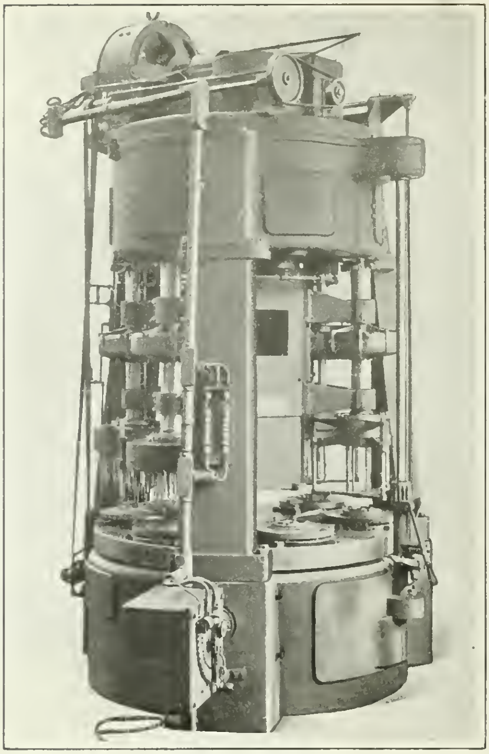
Fig. 28. Baush Station Type Multiple-spindle Drilling Machine built for performing Eighty-one Drilling, Counterboring and Reaming Operations on Ford Flywheels

While the discussion of the work of this machine is presented in connection with its application in machining flywheels of Ford motor cars, it must not be thought that this is a single-purpose machine, because there are a great many classes of work that could be handled on an equipment of this type with beneficial results. Not only is the use of this machine responsible for saving a lot of space in the shop, but it will be apparent that its use also presents the possibility of drilling holes on centers that would be too close for an ordinary multiple-spindle drilling machine. Where the center distance is so close that it would be impossible to arrange spindles in a cluster head to provide for drilling them with a machine of this type, one hole may be drilled by one head and the next hole by a following head, so that the question of distance from center to center becomes relatively unimportant. The multiple head feature also makes it possible for heavy and light drills to be grouped together in different heads, so that each size may be operated at suitable rates of cutting speed and feed. Different standard spindle clusters may be furnished to meet the requirements of different classes of work, and these heads may be readily removed to enable different ones to be substituted. The regular adjustable drill heads built by the Baush Machine Tool Co. can also be used to adapt the machine for more or less general classes of multiple drilling. A switch and starter are located beside the loading station, which enable the operator to control the motor with his left hand, while the feed mechanism is governed by a small lever at the right-hand side of the operating position. By means of this lever it is possible to stop all the feed motions of the machine instantly, including the indexing of the table.

Application of Inverted Drilling Principle for Deep Hole Work

A deep hole is usually defined as a hole the depth of which is equal to at least five times the diameter, although some

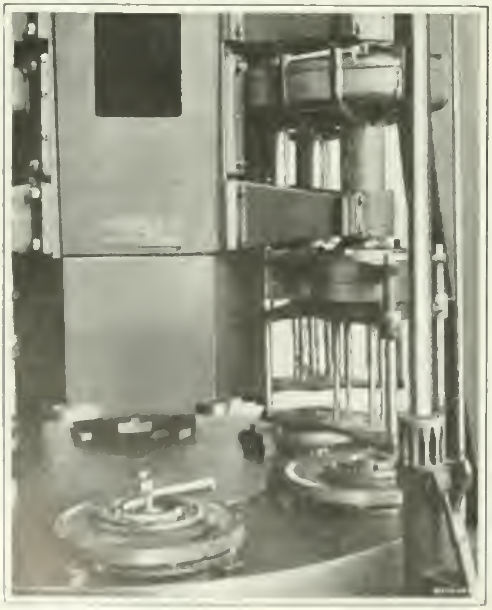
Fig. 29. View of Loading Station of Drilling Machine shown in Fig. 28

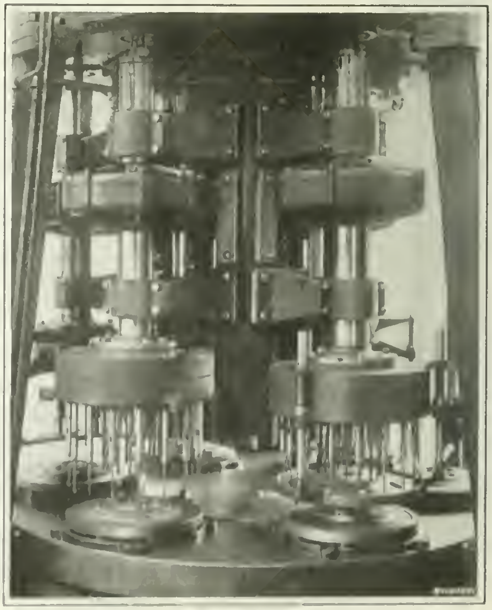
Fig. 30. Close View of Multiple-spindle Drill Heads

authorities define it as one in which the depth is equal to four diameters. In deep hole drilling, special precautions must be taken for two reasons: In the first place, trouble is likely to be experienced through breaking of the drill as a result of chips clogging the drill in the hole; and, secondly, further trouble may result through failure to obtain the desired cooling and lubricating action on account of having the chips prevent lubricant from reaching the cutting point of the drill. Numerous expedients are employed, but to provide for preventing trouble from chips clogging the drill in the hole, it is quite general practice to back the drill out of the hole at frequent intervals in order that the chips may be cleared from the drill. This also guards against an accumulation of chips preventing lubricant from reaching the cutting point. A better way to assure efficient lubrication of drills used in deep holes is to use oil-tube tools which are furnished with ducts that carry the oil or cutting compound direct to the point of the drill where its action is required. Recently it has become quite general practice to adopt the use of inverted drills for deep hole work, because it has been found that where an inverted drill operates from below the work, it is a much easier matter for the chips to clear themselves from the hole. Where this inverted drilling is employed, it is not often necessary to resort to the practice of backing the drill out of the hole at frequent intervals, in the manner which has just been mentioned. The following examples of inverted drilling will clearly show the benefits of this method for drilling deep holes.

The station type drilling machine shown in Fig. 32 was designed and built by the Baush Machine Tool Co. for drilling the bolts and receivers of military rifles. At first sight, this machine may appear similar to the preceding type for drilling automobile flywheels, but as a matter of fact there are noteworthy points of difference. On the preceding type of machine the drills are carried in multiple heads and the work is mounted on an indexing table supported by the base of the machine. In the present case, it will be seen that the work is supported in fixtures carried by the spindles of an indexing turret, while the tools are carried on a fixed spider. In both cases the drive is from above, but in the case of the present machine the work revolves and the tools remain stationary. Advantage is taken of the inverted drilling principle, which is beneficial in clearing chips from the work. Feeding the drills to the work is accomplished by raising the spider on which the drills are carried. The drills increase progressively in length in order to obtain the required depth of hole, and it will, of course, be evident that for each indexing of the work one finished part is produced. The use of various lengths of drills serve the same purpose as backing out the drill at the required intervals, which is the practice in deep hole drilling operations where a single drill is employed. On this machine the drills used are of the oil-tube type, which provide for delivering oil direct to the cutting point of the drill. Drive is provided by an electric motor at the top of the machine, from which power is transmitted to the spindles which carry the work-holding fixtures by means of a central gear meshing with pinions on each of the spindles. Feed motion is furnished by a barrel cam, which provides for raising or lowering the spider that carries the drills. Indexing is accomplished by rotating the turret that carries the work-spindles; and the release of the locking bolt that secures this turret in place, during the performance of each drilling operation, is accomplished by means of an edge cam carried at the bottom of the feed cam.

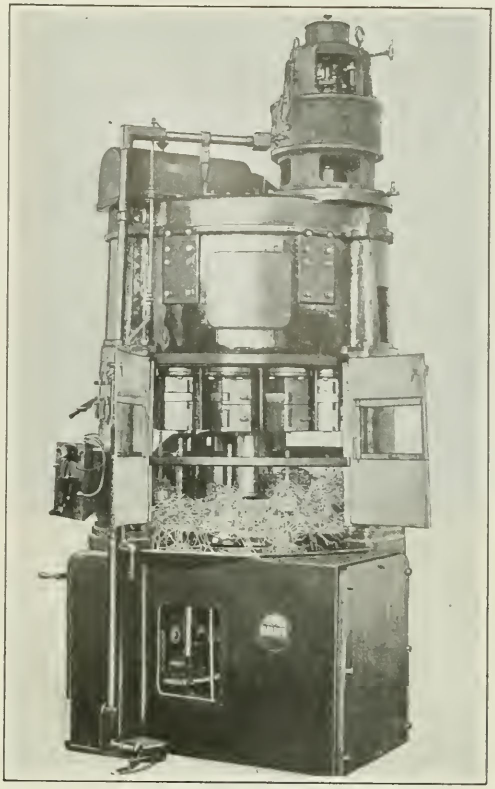

Fig. 32. Baush Station Type Drilling Machine for drilling Rifle Bolts and Receivers

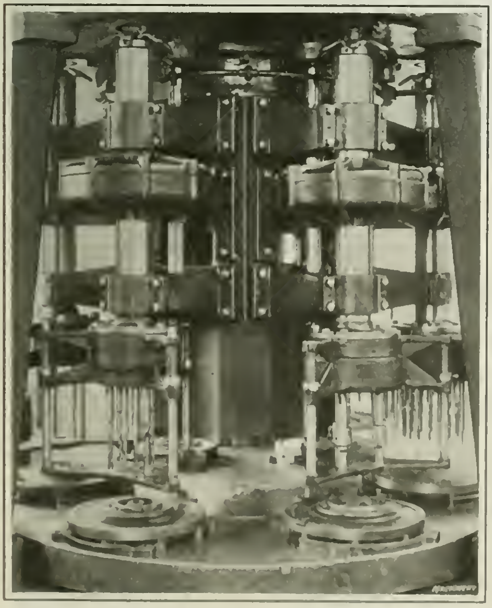

Fig. 31. Drill Heads equipped with Tools for Drilling and Reaming Operations

Fig. 33 shows a four-spindle gang drilling machine built by the Rockford Drilling Machine Co., which is equipped with two-jaw chucks mounted on the spindles so that work may be rotated by the spindles and fed down onto inverted drills which are held stationary on the table of the machine. The principle will be clearly understood by reference to the illustration. As in preceding cases, the advantage of this method of drilling is that the chips are cleared more easily from the deep holes than would be the case with the usual relation of the work and drill. The work consists of yoke forgings for universal joints, and these pieces are fed down over the drills so that, after the drilling operation has been completed, the end of the forging is faced by the stationary tool *A*, which will be seen in the holder at the base of each drill. The work to be drilled is a drop-forging containing 0.15 to 0.25 per cent of carbon, 0.30 to 0.60 per cent of man-

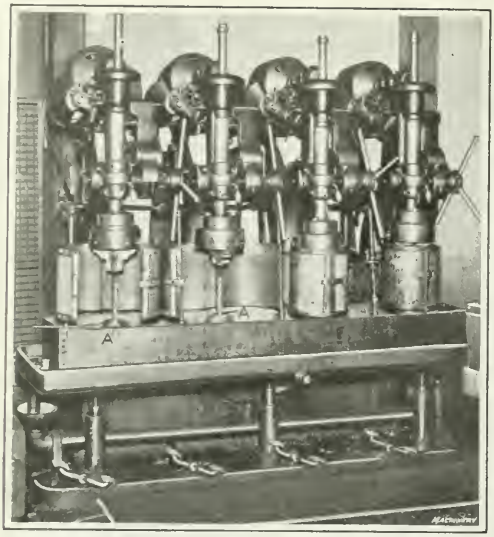

Fig. 33. Rockford Gang Drilling Machine employing Principle of Inverted Drilling

ganese, phosphorus below 0.045 per cent and sulphur below 0.05 per cent. The holes to be drilled are 7/8 inch in diameter by 1 3/8 inch deep and approximately 1000 pieces are drilled on this four-spindle machine in a ten-hour working day. Fig. 34 shows a detailed view of the fixture provided for handling a somewhat similar job, although in this case, after being drilled, the work is turned on the outside and then threaded. As in the previous case the drill is held stationary on the machine table and a chuck carried on the drilling machine spindle provides for rotating the work and feeding it down onto the drill. After the drilling operation has been completed, the fixture is indexed to bring the cup turning tool, or hollow-mill, into the operating position to provide for turning the outside of the work; and after this operation has been completed, the fixture is again indexed to bring the Geometric self-opening threading die into position for threading.

Machining High-explosive Shell Blanks on the Drill Press

Fig. 35 shows an interesting installation of drilling machines built by the Barnes Drill Co. for machining 18-pound high-explosive shells, and Fig. 37 shows a close view of the tool equipment on this machine. Selection of this type of equipment was decided upon at the factory where the machines are used, due to inability to secure reasonable deliveries on the types of machine tools that would ordinarily be selected for the performance of machining operations of this kind. A battery of eight of these self-oiling 22-inch machines was installed, and the results obtained have been entirely satisfactory. It will be apparent that the shell to be machined is held in a fixture *A* secured to the drilling machine spindle, while the tools required for the performance of successive operations are carried on an indexing fixture mounted on the machine table. With this arrangement the work is revolved and fed down onto a stationary inverted tool, so that advantage may be taken of the greater ease with which chips clear themselves from an inverted hole of this kind. After each operation has been completed, the tool-holding fixture is indexed to bring the next tool into the operating position. The first operation is to spot-drill and rough-form the nose of the shell with tools held in holder *C*. It will be seen that a guiding ring is provided for the work so that it cannot spring away from the cut. The operation is performed at 92 R.P.M. with a feed of 0.013 inch per revolution. The spotting is done with a short twist drill, and rough-forming of the nose with three turning tools, which are stepped so that they cut to different depths, leaving an irregular surface.

The second operation is to drill the hole in the shell to the required depth, for this purpose drill *D* is used, which is 1 13/16 inch in diameter. The drilling operation is performed at 145 R.P.M., with a feed of 0.013 inch per revolution. The third operation is to rough-ream the hole with reamer *E*, which is formed at the end to finish the bottom of the shell cavity to the required shape. The operation is performed at 37 R.P.M., with a feed of 0.093 inch per revolution. The fourth

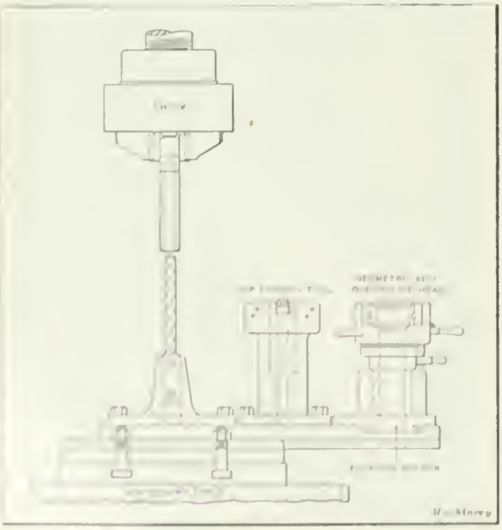

Fig. 34. Fixture for drilling, turning and threading Work

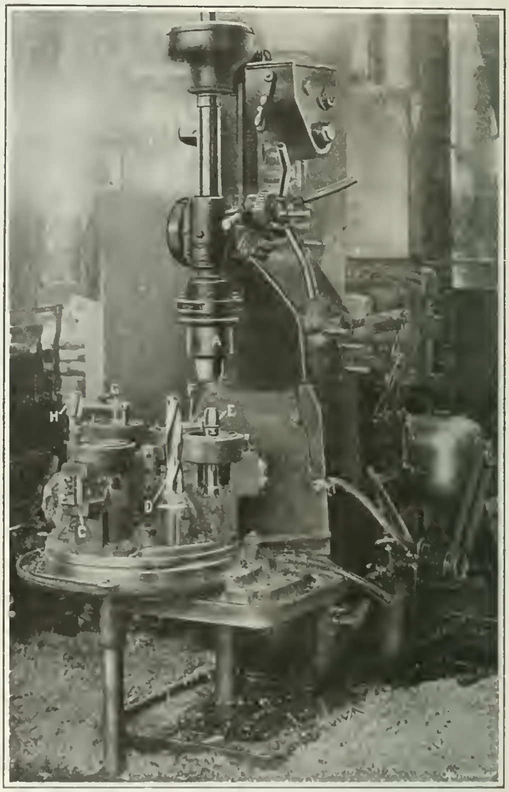

Fig. 35. Drilling Machine built by Barnes Drill Co. for machining 18-pound High-explosive Shells

operation is to finish-form the nose with a form cutter located in holder *F*, which is bronze lined. The spindle runs at 45 R.P.M., and is fed down by hand. The fifth operation is to cut the step and bevel on the nose of the shell. For this operation the tool is supported by a bronze lined tool-holder *G* and the machine is operated at the same speed and feed as for the fourth operation. The sixth and final operation is to finish-ream the hole in the shell with reamer *H*. Great care is required in the performance of this operation, as specifications for the shells require that when a light is dropped into the hole the surface will show a uniform polish in all places. The finish-reaming operation is performed with the spindle rotating at 37 R.P.M., with a down feed of 0.093 inch per revolution.

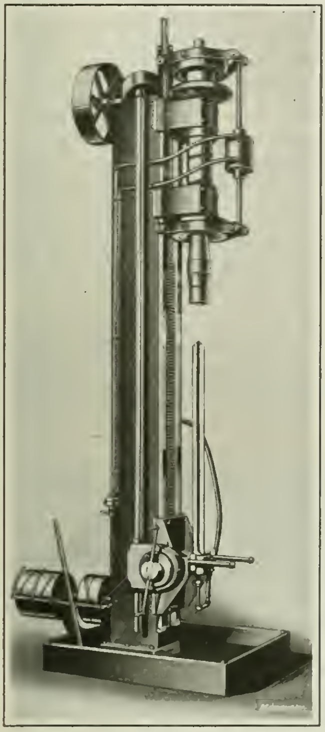

Fig. 36. Stecher Deep-hole Drilling Machine

Drilling Lathe Spindles

The deep-hole drilling machine shown in Fig. 36 was built originally by the Charles Stecher Co. for drilling holes in the solid forgings from which machine tool spindles are made, and the first machine was used for drilling the spindles of the Stecher screw machines. Several machines of this design were subsequently sold to other machine tool builders for the same service. Recently this machine has been enlarged and its design has been altered to adapt it for drilling recoil cylinders, axles for gun carriages, and gun barrels and jackets for the smaller guns. The largest machines built to date have a bore through the spindle 8 inches in diameter and a feed of 96 inches. These dimensions can easily be increased. This machine is used for roughing out the first hole from the solid forging and on finishing operations where wood-packed reamers are used. For roughing out holes from the solid, an ordinary drill point is used, inserted in a bar slightly smaller in diameter than the bore, and the bar is fluted for chip clearance. The vertical feature allows the chips to clear freely without the use of high pressure on the cutting compound, and it is not necessary to give special consideration to this problem, which is the chief source of trouble in drilling deep holes in a horizontal position. Drilling artillery axles in these machines with a drill point 3.185 inches in diameter, using 0.012 inch feed and driving the spindle at 48 revolutions per minute, the work is drilled to a depth of 57 inches without trouble from chips clogging, and as the work revolves, the hole is straight and concentric to the bottom.

The spindle is equipped with an air chuck at each end, controlled by an operating valve which is conveniently reached from the floor. The work can be lowered through the spindle with an overhead tackle, but where head room is limited the work can be placed on a carriage and raised through the spindle from below. An operator and helper can operate a number of these machines, depending on the nature of the work accomplished. Where wood-packed reamers are used, the reamer is drawn down through the work by a draw-rod and is guided and held against turning by a rigid bushing above the spindle; or the work can be changed from the rougher to a special machine designed for reaming, which is constructed with the hollow spindle, in which the work is rotated, at the base end of the column and the drill carriage above, feeding the reamer down through the work and washing the chips ahead. By revolving the work, the best results are obtained, and the vertical lay-out permits the use of simple tooling, with consequent low tooling cost. The design of these machines permits of grouping the equipment, which is the ideal arrangement for handling four or five machines by one operator and helper without decreasing their production.

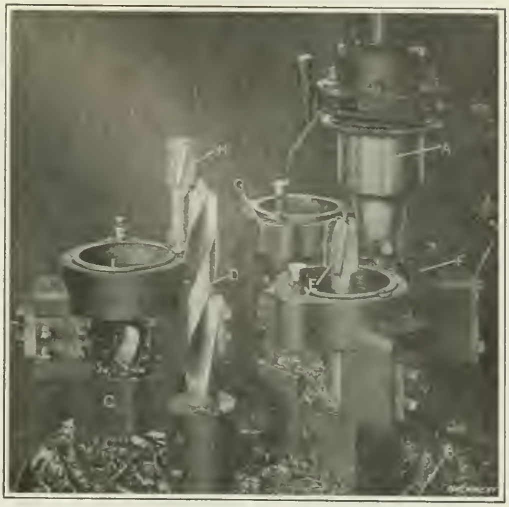

Fig. 37. Close View of Tool Equipment of Machine shown in Fig. 35

Horizontal Deep-hole Drilling Machine

The machine shown in Fig. 38 was designed for the special purpose of drilling the long small hole through the length of the steel block shown in Fig. 39, which is a part of a machine gun. The making of this part is started in the block form and the hole is put in first, as it is the most difficult to locate

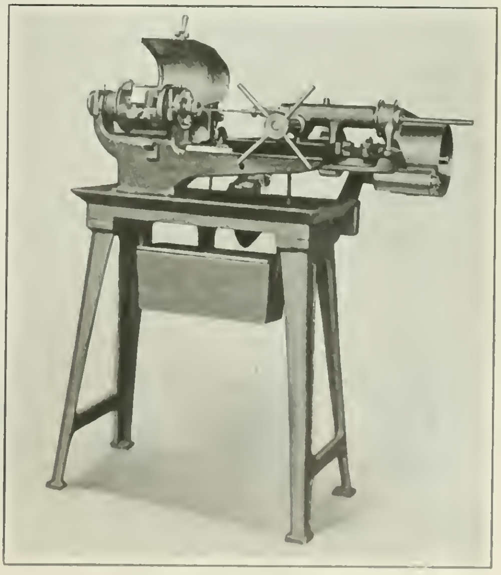

Fig. 38. Horizontal Deep-hole Drilling Machine

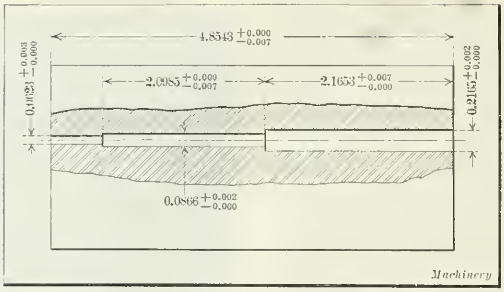

Fig. 39. Gun Part drilled in Machine shown in Fig. 38

accurately. All the subsequent machining is gaged from the finished hole. The drilling of this hole is difficult, on account of its small diameter as compared with its length. The test for straightness of hole was the free fit of a hard ground arbor sized to 0.0005 inch less than the low diameter limits given in Fig. 39. To pass inspection, the pin had to drop through of its weight to the full length of the hole. The limits for this hole diameter are 0.002 and 0.003 inch, and for depth, ± 0.007 inch. The leading feature of this machine is that both the work and tools revolve, the proper speed for each being determined from experimental tests. A set of seven tools, Fig. 40, is used to produce the hole. The large portion of the hole requires a spotting tool *A*, drill *B* and reamer *C*, the reamer having a spotting tool on its end to start the middle hole. The middle hole requires a drill *D* and reamer *E*, the reamer also having a spotting tool on its end to start the small hole. The small hole is drilled with drill *F* and reamed with reamer *G*. Each individual tool is fitted with a knurled taper socket lock shank that permits the tools to be quickly interchanged and locked firmly in place on the tailstock spindle.

The tailstock has two drilling positions, the outward position being used for the three operations on the large hole and the inner position for the operations on the middle and small holes. The tailstock is moved by a toggle lever motion that is self-locking in both positions. The tailstock spindle runs on ball bearings mounted in a feed sleeve that is actuated through a rack and pinion. The headstock has the work placed inside and the cover closed so as to lock it in place while revolving. To avoid any possible flying out of the block in case the cover should accidentally open, a guard is provided that surrounds the spindle on all sides. In Fig. 38 the guard is shown open, but when closed it is locked by a snap-catch. After a block has been completely drilled, it is necessary to bring the headstock spindle to a dead stop so as to permit the operator to open the swing cover, remove the block and put in a blank block. Rotation of the headstock and tailstock spindles is stopped by throwing the friction drive plates on the countershaft out of contact. This is done by the operator by a foot-pedal and long link connection. To bring the headstock spindle to a quick stop, toggle joint shoe brakes that act on a pulley on the jackshaft are automatically put into action when the guard is opened and released when it is shut. To the front end of the inner bearing of the headstock, there is screwed a stationary cover which supports the guide bushings required for the tools, and which also acts on a reservoir for forcing the cutting oil to the tools.

* * *

According to figures recently published, about 6,000,000 shells were used in the operations that resulted in the capture of Messines. Reckoning these at the average weight of slightly over 100 pounds, this represents a consumption of about 300,000 tons of steel.

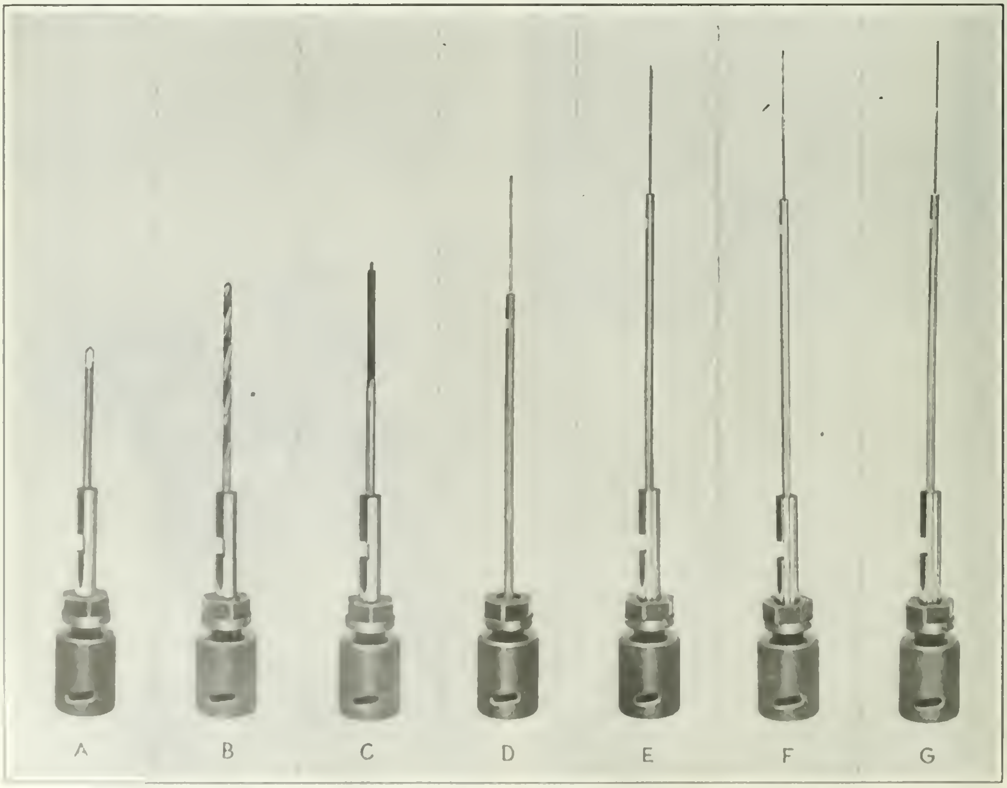

Fig. 40. Tools used in Machine shown in Fig. 38 to produce Hole in Part shown in Fig. 39

INCREASED EMPLOYMENT OF WOMEN IN THE INDUSTRIES

A REVIEW OF THE PROBLEMS INVOLVED IN THE SUBSTITUTION OF WOMEN WORKERS TO MEET THE PRESENT LABOR SCARCITY

DURING the present year probably not less than a million men, most of them formerly engaged in gainful occupations, have become a part of the armed forces of the United States. Many others have left their regular occupations and are more or less indirectly in the war in munition factories, in shipbuilding and repair plants, and in other industries necessary for the conduct of the war. It is not known how many more men will eventually be called into the Army and Navy, or how many may be required in the manufacture of ships, munitions and other war materials, but it is not likely that this number will be small. The result is a labor scarcity, with indications of worse conditions.

Investigation Made by Merchants' Association of New York

The following paragraphs consist of an abstract of a report prepared by the Industrial Bureau of the Merchants Association of New York, by Alfred L. Smith, manager of the bureau, which is based upon an investigation of present conditions and relates to the present substitution of women in the industries and the methods now in vogue, rather than to the possible extent of their substitution in case the industrial situation becomes more critical. The report summarizes the opinions of employers who have made such substitution, so that other employers interested in the possibility of increasing their labor force in this manner may obtain a comprehensive idea of what has already been done and the chief problems which have arisen. The report is based upon correspondence and interviews with a number of employers who have substituted women workers for men extensively, upon data received from manufacturers' associations, upon reports of investigators who have studied the conditions in various factories, and upon information obtained from 160 replies to a series of questions sent to large employers of labor.

The investigation on the substitution of women for men workers in the industries was made with the idea of answering five questions, as follows:

1. To what extent are women being substituted for men workers at the present time?
2. To what extent do employers expect that such substitution will be necessary in the future?
3. In general, on what types of work, not now ordinarily performed by women, are they satisfactory?
4. Are the wages paid women the same as those paid men in the same or similar positions, provided production is the same in both quantity and quality?
5. What problems, if any, arise from the employment of women in positions ordinarily filled by men?

Extent to which Women Have Been Substituted for Men

Careful investigations have failed to reveal that there has yet been a substitution of women workers on a large scale. For instance, of 160 employers who reported concerning the substitution of women workers in their factories, only thirty-five are as yet using women workers more extensively than formerly. Of these, only nine have substituted any large number of women in positions formerly filled by men exclusively; fifteen, while using women more extensively than in the past, are doing so only in positions which have always been filled by women to some extent; and the remaining eleven are substituting women to only a slight extent.

Probability of Increased Substitution of Women During Period of War

Employers do not agree upon the extent to which women will have to be substituted. Many employers are making plans to substitute more women employes and to fill future increases in their labor force as much as possible through the employment of women. Others, who have not yet employed women, report that they see no other course open to them if conditions become much worse. On the other hand, many employers do not expect to hire any women, in some cases because they expect that the required number of men can be obtained, and in other cases because they feel that women are unsuitable for their particular work. The indications are, however, that during the next year there will be a rapidly increasing tendency to employ women.

Type of Work Satisfactorily Performed by Women

In addition to the many occupations in which women have customarily engaged, as well as those occupations taken up by them in recent years with success, they are today entering a surprisingly great variety of new occupations, on account of the situation caused by the war. Nevertheless, the type of occupation in which women can give satisfaction is rather definitely limited. In general, the woman worker is either excluded from or at a disadvantage in occupations requiring strength, endurance, control over others—particularly men—willingness to work under particularly disagreeable conditions, long period of apprenticeship, and natural mechanical ability. It is generally considered impracticable to employ women where it is necessary to lift heavy weights.

On the other hand, the female worker has advantages in many occupations usually considered distinctly male. On all kinds of light work requiring manual dexterity, quickness of hand, eye or brain, which can be accomplished after a comparatively short period of instruction, a woman generally learns more quickly than a man, and eventually turns out more and better work.

Obviously, women cannot be substituted for skilled mechanics; neither has the average woman the natural mechanical ability of the man, so that operations of a mechanical nature which a man easily performs, women often find difficult. Women are also likely to prove unsatisfactory, or at least not as satisfactory as men, on mechanical work where tools or machine parts have to be changed frequently. Nevertheless, they are performing satisfactorily a great many of the operations ordinarily performed by skilled mechanics. One manufacturer states: "We have found in our short experience that women can be taught to perform quite a number of the operations of our work so long as the work is not heavy, but they can only perform the operations that have been taught them. They, of course, have to be taught these various operations, because they are not skilled mechanics. Skilled mechanics do not have to be taught how to perform these operations, because they learn to do all kinds of mechanical work when they serve their time, and all they need is to be given the machines with which to do the work and the blueprint to show them what is required."

Employers have stated that women substitutes have proved to be superior to the men whose places they have taken in picking and sorting materials, in operating automatic machinery, in light assembling, in winding coils, as drill hands, and as inspectors. They are proving successful as operators of lathes and similar machine tools, machinery oilers and cleaners, timekeepers, and inspectors. Undoubtedly, they are filling many other occupations satisfactorily, but these give an idea of the kind of employment which is evidently most suited to women.

In Great Britain, France and Italy, women form a very important element in many occupations in which there has yet been no need for them in this country. In European countries women have been used in any position they can fill at all, rather than in only those positions which they can fill as well as men. This has resulted in radical changes in machine operation and factory management, and often in long, careful and especially adapted training for women in industrial occupations.

Wages Usually Paid to Women

One of the perplexing problems of the manufacturer substituting women employes is that of proper wages. Should a women be paid the same wages as the man whose place she is filling? In theory, there seems to be a unanimity of opinion that if women can fill a position they are entitled to the usual wage for that position. Nearly all employers who report that they are substituting women, also report that the same wages are paid women as were formerly paid men. The committee on standards of working conditions of the Detroit Executives' Club recommended in a report that women be given equal pay for equal work; and that while learning they be paid the day rate paid men for the same work or operation.

Reasons Given for Paying Women Less than Men

Some concerns pay women less than men, irrespective of the fact that the woman may accomplish as much as the man. In some instances, this is because the employers consider that, because the average man is married and has greater expenses than the average woman, he should rightly receive larger earnings. Others claim that wages for women should be determined entirely by the law of supply and demand; and that, therefore, if the supply of female labor is so large that women will accept lower wages, a lower wage should be paid.

One important employer does not believe that it is right to argue that a higher wage should be fixed for men because they have a family to support, whereas the majority of women have only themselves to support. He states: "The hesitancy of the average honest employer in paying a woman exactly the same rate as a man is on account of not knowing what the future may bring forth, and he, therefore, prefers to start women at a somewhat lower rate than men in order that he may experiment on their relative value. As time goes on, however, it is reasonable to assume that the difference in the wage rate between a man and a woman doing the same work will be comparatively little." This same employer thinks that the wages for women in "war industries" may rightly be determined in a different manner than in factories producing standard products. In a manufacturing plant used exclusively for the manufacture of war materials during the war time, the wage rate for men and women should be the same, if they do exactly the same work and can produce equal amounts, and the finished product is as good in one case as in the other. There seems to be no reason for any difference in the rates, as the manufacture of such products will be discontinued after the war, and the considerations that must be given to the question of permanent employment need not be entered into as thoroughly as in the cases where the manufacturer is producing a standard line of commercial goods that will be continued after the war is over, where consideration must be given to competition with other manufacturers in the United States and foreign countries.

Difficulty of Determining Relative Efficiency

Granting that women are entitled to the same wages as men if they do the same work, there remains the practical problem of determining whether or not the woman employe does turn out equal work. This is a problem for each factory, and even for each type of work upon which women are being substituted. In order to produce equal work, a woman must not only produce as much, but she must maintain quality, and do this with the same cost to the employer per unit of product for supervision, machine operation, helpers and overhead. In cases where the women substitutes are paid by the piece at the usual rate, real wages are actually higher, from the standpoint of the employer, if the women do not turn out the average number of pieces per day, for the reason that more employes are then necessary to maintain production, thereby necessitating more machinery, more supervision, more manufacturing space and more overhead expense.

It is in many cases impossible, or at least very difficult, to determine what should be the piece rate for substituted female labor in factories, if it is attempted to make the labor cost per unit of product the same for work done by women as for that done by men. On operations for which women are well adapted, labor costs may be lower, but on many operations on which women require more time, extra machine appliances and extra helpers, produce a poorer article or spoil more work, they are found to be more expensive than men. In factories where bonus payments are made for certain tasks accomplished, the increase in cost of female labor is sometimes more or less accurately offset by a lower bonus rate, although the wage rate is maintained.

Difference in Value of Men and Women Workers

Some employers treat women and men employes as entirely distinct in the matter of wage payments, and the wage schedules are determined as entirely independent of each other. One large employer of both men and women reports as follows:

> We have always considered the two groups, male and female, as distinct. The doctrine of "equal pay for equal work" does not apply. There are inherent differences between male and female workers which affect their value to industry and which must be taken into consideration in connection with the question of equal wages. Among the many differences are: (1) The field of work is much larger for men than for women. (2) The average life in industry for men is many times longer than for women. (3) Steadiness is considered greater for men than for women. (4) The attitude toward the work is different.

Another large employer gives a similar idea, as follows:

> In establishing rates of pay to women employes consideration must necessarily be given to the particular work which they are to do, because in the employment of an unskilled boy or man, or in the employment of a so-called handy man, the average manufacturer, while expecting to spend considerable money in training men to do a given job, does so in anticipation of the employe's remaining permanently and continuing to learn other operations or details from observation while employed on the less important work, and as time goes on he can be advanced to the more important work without much waste of time or loss of material; while in the case of the employment of women, an employer will naturally assume that the work on which a woman can be employed is limited, and she, therefore, does not become an asset in the same way as in the employment of boys and men. The average woman is also liable to marry and leave.

A third employer writes:

> In fact, in every case men and women should be paid, in so far as it is possible to do so, according to a number of different factors; length of service, ability to perform various different tasks desired by the employer; quantity of product produced upon the individual employment; and quality of product. Our records prove that sickness claims on the part of a woman are much greater than those of men, and that their relative absences from employment are greater.

Problems Arising from the Substitution of Women

Employers report many problems arising from the substitution of female labor. The substitution frequently requires many changes, such as shorter hours, rest-room facilities, a welfare superintendent, seats at machines, and luncheon room with facilities for heating food, making coffee, etc. Often radical changes in factory organization and revolutionary changes in production methods are required. The causes of problems reported most frequently by employers in this investigation are as follows:

1. Laws regulating the hours, time and conditions of labor. These prevent women from working under the ordinary conditions existing in many plants.
2. The greater liability of women for accidents due to style of dress, as well as to physical causes. Frequently women are required to wear sleeve holders, and caps to cover the hair. Additional safety appliances must be installed on machines. This is of prime importance if female labor is to be satisfactory, as one accident might affect the morale of all the female machine operators.
3. The necessity of further specialization of labor, particularly where women operate machines. Women are machine operators and not mechanics, and therefore special occupations need to be created for men as helpers, machine repairers and adjusters. In some cases the usual operations are divided and women do the lightest part of a process formerly entirely performed by men, and to the men is left only the heavier part of the operation.
4. The necessity for special machinery or machine parts adapted to operation by women.
5. The necessity for substituting mechanical appliances, as conveying machinery, to minimize physical exertion.

Handling of Women Workers

Some employers find women employes much more difficult to handle than men. They say that they are likely to be more excitable, especially in positions to which they are unaccustomed; and it is claimed that they are often more unreasonable. One employer states that they are greater agitators.

Friction is likely to result in cases where women come into contact with men as co-workers, and particularly when they are in any way in authority over men or boys. Women workers are likely to regard their employment as temporary and, therefore, often lack the same degree of seriousness and earnestness toward their work that men ordinarily have. On the other hand, several large employers report exactly the opposite to be true. Women substituted for unskilled male labor of the lowest grade are likely to be of a better type than the men formerly occupying the positions.

Specific Recommendations for Working Conditions

Employers who are confronted with the problem of substituting female labor will find the recommendations of the committee on standards of working conditions of the Detroit Executives' Club of value. This committee recommends the following working conditions as essential: Separate entrances to be provided for women if practicable; if not, that women be allowed to report for work fifteen minutes later than men and leave fifteen minutes earlier. That separate workshops be provided if possible; if not, that there be both a man and a woman supervisor stationed in the mixed departments. That rest rooms and toilets adjoining workshops be provided with a matron in charge. That a sufficient number of drinking fountains be installed in each department. That the period for lunch be at least forty-five minutes. That, if possible, a restaurant be operated on the premises; if not, at least a counter should be maintained where a box-lunch with hot coffee and tea and milk can be purchased at cost. That provision be made for rest periods during working hours, their frequency and duration depending on the nature of the work. That seats be provided wherever possible to avoid injury to women by standing all day at their work. That sickness insurance be provided to care for workers absent because of sickness. That workers on monotonous and tedious operations, to avoid undue fatigue, be transferred from time to time as seems advisable. That there shall be provision for first-aid attention to all workers. That there be first-class supervision of working conditions, with particular reference to safety, sanitation, ventilation and lighting. That some person be delegated to act as "welfare supervisor" for the plant, to whom women shall have access and whose duty it shall be to have a general oversight over welfare conditions. This position might be given to some woman already in the employ of the company, in addition to her other duties, but, if possible, a trained person should be secured for this work.

Supply of Female Labor

A discussion of this kind is usually thought to presuppose the existence of a great reservoir of female labor which can at any time be called upon. Large employers of women have reported, however, that there has recently been no great surplus of female labor; and, in fact, it is becoming difficult to obtain women workers. The manufacturer who substitutes female labor for male will undoubtedly obtain most of his new workers from other factories rather than from a surplus reservoir of unemployed women; and this condition is likely to continue unless a great many more men are called into the Army and Navy or into the war industries than is expected from present indications, in which case, both economic conditions and patriotism will cause women to enter industry as they have in European countries.

If the supply of male labor further decreases, employers will have to solve more than the problem of properly adjusting the labor conditions, so that women can be employed efficiently. The necessary supply of female labor must first be found, and preferably be found so that women and girls will not be taken from other gainful occupations where they are already of great importance to the welfare of the country in this time of need, otherwise the introduction of women into positions usually occupied by men in industry is likely to result in almost as much harm to industries already employing women as in benefit to industries introducing women into employment. All these problems will have to be carefully weighed, and a solution arrived at, because few employers will be in a position to entirely sidestep this issue.

INSPECTION OF BRONZE AND BRASS[1]

In brass and bronze castings, the defect that most commonly occurs is caused by the inclusion of oxide in the metal of the casting. As the admixture of oxide is indicated most distinctly by the greatly reduced elongation and the lowered ultimate strength, the tensile test should be specified for all important brass and bronze castings no matter whether a certain strength and elongation are of mechanical value or not. If a tensile test is impracticable, oxidation in the metal may be discovered by bending a machined specimen; small cracks opening on the outside of the bend indicate the presence of oxide; if the oxidation is extreme, it is shown by the abnormal color of the surface of the fracture. In foundries where tensile or hydrostatic tests are not made, the metal is generally allowed to become considerably oxidized in the crucible, because this defect does not show on the surface of the casting. To specify bronze castings merely by the mixture is therefore useless.

The presence of included dross is more difficult to discover. If a hydrostatic test cannot be made, it is practically impossible to find such defects, unless they happen to come to the surface of the casting; even a hydrostatic test does not always reveal such defects, because there may be considerable thickness of good metal along one or both of the surfaces of the casting. The best insurance against this kind of defects is correct molding. Minor leaks in hydraulic casting may be stopped by peening, but the fact that the casting leaked at a certain point generally indicates that the metal was defective. It is commonly believed that certain brass and bronze mixtures are normally porous and premit water to pass through them under high pressure. This belief is erroneous, at least up to a pressure of 1000 pounds per square inch. If water passes through the walls of a casting, even in minute quantities under smaller pressures, the metal is not clean or the casting is porous from some other accidental condition.

The presence of initial stress in wrought brass may be detected most quickly by cutting a longitudinal slit in the end of the piece. If the initial stress is of sufficient magnitude to be objectionable, the two halves of the piece will curve outward sufficiently to be detected by an ordinary micrometer; and if the stress is great, the curvature may even be visible. Extruded brass rods sometimes contain piping. The presence of this defect may be discovered by nicking the end of a rod and breaking it off.

Another source of defects in brass work is caused by overheating by men unfamiliar with the properties of brass. This overheating produces an interior oxidation, thus greatly reducing the strength of the material and the ductility. Defects of this kind are likely to be very troublesome, because they are difficult to discover by surface inspection and tests cannot be made on finished material.

* * *

Geared turbines were developed mainly for use on board ship in order to reduce the high speed at which a steam turbine will work economically to the speed at which the propeller is most efficient. Recently, however, geared turbines have been applied also for stationary purposes, an example being the installation made in the Northwestern Consolidated Milling Co., Minneapolis, Minn., where a 1700-horsepower Westinghouse high-pressure condensing turbine operating at 3000 revolutions per minute is geared to a flour mill shaft operating at 140 revolutions per minute, single reduction gearing being used, the reduction being approximately 21 to 1. It is estimated that the efficiency of this gearing is 98 per cent, and as the load is practically constant, a geared turbine drive is more efficient than an electrical arrangement with generators and motors would be. Another advantage in favor of the geared drive is that it occupies a very small space. In this particular case, the turbine and gearing are installed in practically the floor space occupied by the driving pulley alone of the reciprocating engine which was formerly used. The old engine required altogether four times the floor space that the new installation occupies.

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[1] Abstract of a paper read by Ernst Jonson before the American Institute of Metals in Cleveland, Ohio, September, 1916

AUTOMATIC CONTROL AND MEASUREMENT OF HIGH TEMPERATURES[1]

IMPROVEMENTS IN SENSITIVENESS AND RELIABILITY OF MEASURING INSTRUMENTS AND IN CONTROL DEVICES

PROBABLY no employe has caused the average works manager more sleepless nights than the furnace man, on whom rests the responsibility for the uniformity of the product. Through years of practice, an old furnace man is able to judge the temperature fairly accurately; but we can pardon the works manager for thinking, "Suppose John dies, gets sick, or quits." For this reason much study has been given to both the perfection of pyrometers and the automatic control of temperature. It has, however, been only recently that real results have been accomplished in automatic temperature control.

First of all, it was necessary to perfect the temperature-measuring instruments, so that they could be relied on to indicate uniformly the actual furnace temperature. It was then necessary to apply to the pyrometers attachments that would throw the switches on the electric furnaces, or open or close the valves on gas or oil furnaces. For industrial service, an instrument actuated by the expansion of nitrogen gas is the most satisfactory for temperature measurements up to 800 degrees F. or 425 degrees C. The gas is in a bulb of copper, which is inserted in the heat and is connected, by capillary tubing, to an indicating or recording gage containing a helical expansive spring. The expansion of the gas exerts a pressure in the capillary tubing which is conveyed to the spring in the instrument, and the pointer attached directly to this spring moves across the scale or chart. The capacity of the bulb must be fifty times as great as the capacity of the capillary tubing and springs, so as to reduce to a minimum errors due to atmospheric changes in temperature along the capillary tubing or at the instrument. In consequence, this instrument is not desirable for use where the gage must be placed more than 100 feet from the bulb.

For use at moderate temperatures where the measuring instrument must be placed at a considerable distance and for temperatures above the range of the gas-expansion instrument, the thermo-electric pyrometer has been almost universally adopted in the United States. A thermo-couple of base metals, usually formed of one wire that is 90 per cent nickel and 10 per cent chromium and a wire that is 98 per cent nickel and 2 per cent aluminum, is preferred for temperatures up to 1800 degrees F. or 1000 degrees C. For temperatures above this, and as high as 2800 degrees F. or 1500 degrees C., thermo-electric pyrometers using a platinum rhodium thermo-couple are the most satisfactory. For higher temperatures still, a radiation type of pyrometer is available. This consists of a thermo-couple in the focus of a reflector at the rear end of a tube that is pointed at the door or opening of the furnace.

For measuring the voltage produced by a thermo-couple, whether of base metal, platinum rhodium, or the radiation type, millivoltmeters of 1000 ohms resistance are available. This high resistance is desirable to practically eliminate the errors due to changes in the resistance of the line or wiring connecting the thermo-couples and the instrument, and also to nullify the effects of any changes in the resistance of the thermo-couples due to heating. Changes in resistance may be due to actual changes in length or changes in atmospheric temperature, which, in turn, affect the resistance of the line or wiring. This high resistance has been secured by reducing the weight of the moving element to a minimum.

In one case the total weight of the moving element, including pointer and springs, is 526 milligrams. This extreme lightness is secured by the use of an enameled aluminum alloy wire. As the enamel coating is much thinner than the silk insulation formerly used, more turns can be secured on a coil of a given width. Likewise the weight has been reduced 66 2/3 per cent as compared with copper wire, which was formerly used for these moving elements. The aluminum wire is 0.003 inch in diameter and its drawing has been quite a mechanical problem. The aluminum pointer tubing has an inside diameter of 0.008 inch and an outside diameter of 0.012 inch, or a total thickness for the wall of the tubing of 0.002 inch. Probably the weight of the tubing could be reduced by using magnesium, but so far magnesium has not been satisfactorily drawn.

It will be understood that the electrical system described can be used either to indicate or record the temperature. By the introduction of suitable switching mechanism, a record of the temperature of quite a number of thermo-couples can be made on the same record sheet. These temperature records are distinguished by the use of different colors for each record line, using numbers corresponding to each thermo-couple, or changing the form of line produced on the chart for identification.

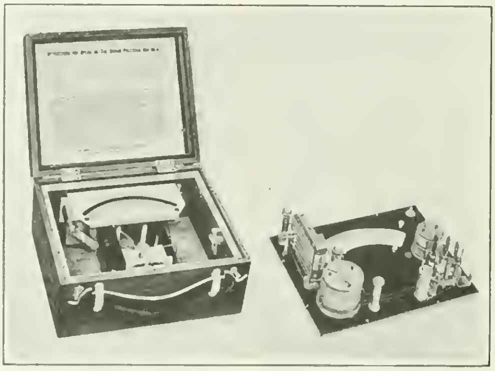

Fig. 1. Brown Precision Heatmeter

Brown Heatmeter

For greater precision in temperature measurements than is secured with the high-resistance millivoltmeter, the Brown heatmeter, shown in Fig. 1, has been developed. This instrument is suitable for either temperature measurement or automatic control of temperature. The idea in its development has been the elimination of all the bad features or drawbacks found in using a millivoltmeter for temperature measurement.

Among the possible sources of error in the use of a millivoltmeter (even one of high resistance) are changes in the resistance of the circuit comprising the thermo-couple and the leads or wiring, due to changes in length or atmospheric changes in temperature. Errors can also be caused by atmospheric changes in the temperature of the meter itself and by changes in the actual indication of the instrument, due to spring fatigue, abuse or sticking.

Briefly, the operation of the heatmeter is as follows: With the standard high-resistance millivoltmeter there are furnished an ordinary dry cell about 1¼ inch in diameter by 2½ inches long, and rheostats to reduce the voltage of the dry cell to a range of 0 to 60 millivolts, the maximum voltage produced by the thermo-couples. First, the voltage developed by the thermo-couple is opposed to the reduced voltage of the dry cell; when the pointer stands on zero, the voltage from each source is equal. Second, the voltage of the thermo-couple is cut out and the voltage of the dry-cell circuit is read by direct deflection. This eliminates the line resistance entirely, as in a potentiometer, and indicates the actual temperature developed by the thermo-couple at the moment of reading the instrument, but fluctuations in temperature of the thermo-couple will not be indicated, as the voltage from the dry cell is being read. Third, the thermo-couple is connected to the meter instead of the dry-cell circuit to see if the indications are the same.

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[1] Abstract of a paper presented by Richard P. Brown, of The Brown Instrument Co., of Philadelphia, Pa., and read before the Faraday Society, of London, England, November, 1917.

By switching back and forth quickly, the voltage from the thermo-couple circuit or from the dry-cell circuit can be noted. If excessive line resistance has caused the indications of the millivoltmeter to be lowered, as compared with the dry-cell circuit, a rheostat is operated to bring up the indications of the thermo-couple circuit to that shown when the voltage of the dry-cell circuit was read. Leaving the instrument indicating on the thermo-couple circuit eliminates the errors that might be due to line resistance or changes in temperature of the line, and a direct-reading millivoltmeter indicating the correct temperatures is obtained.

The temperature coefficient of the meter has been eliminated by furnishing a copper resistor in the meter equivalent to the copper or aluminum of the coil; hence in balancing the voltage from the dry cell against that of the thermo-couple errors due to the temperature coefficient of the meter itself are automatically eliminated. To obviate errors due to sticking of the pointer, abuse of the instrument, spring fatigue, etc., the instrument, when desired, is supplied with a standard cell with suitable resistors and can be checked in the same manner as the meter can be tested by the potentiometer method. Where the instrument is supplied with a standard cell, the temperature of the instrument should always be between 5 and 40 degrees C. or 40 and 105 degrees F. In fact, any standard cells used in instruments will be injured if the temperature rises or falls beyond these limits.

Automatic Temperature Control

Attempts have been made to operate switches and valves electrically by permitting the pointer of the pyrometer to come in contact with adjustable contact arms on each side of the pointer. Unfortunately, the millivoltmeter used with the thermo-electric pyrometer has an exceedingly weak control for the pointer; in fact, the pointer may be easily blown across the scale. In consequence, simply permitting the pointer of such a pyrometer to move into contact is not sufficiently positive to be satisfactory for automatic control work.

An automatic-control pyrometer recently developed, shown in Fig. 2, operates in the following manner: A thermo-couple, formed of a nickel-chromium alloy, is installed in the electric furnace, the temperature of which is being controlled, and actuates a high-resistance millivoltmeter. Below the pointer, and adjustable throughout the whole scale range, is a table carrying two contact pieces that are separated by a piece of insulating material 1/32 inch thick. The depressor arm, which is driven by a small electric motor, or by a clock if preferred, depresses the pointer at regular intervals, usually every ten seconds, causing the two contact pieces to be forced together.

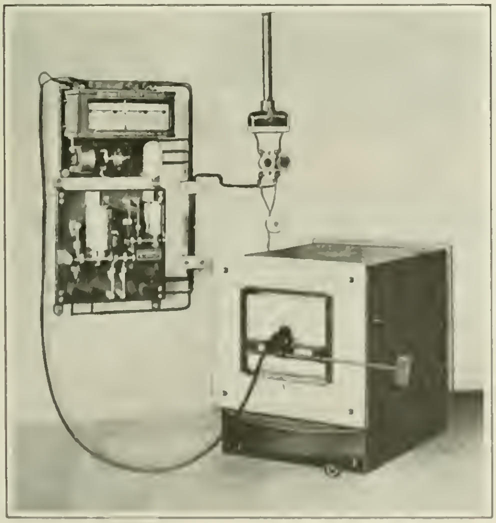


Fig. 2. Automatic Control Instrument attached to Electric Furnace

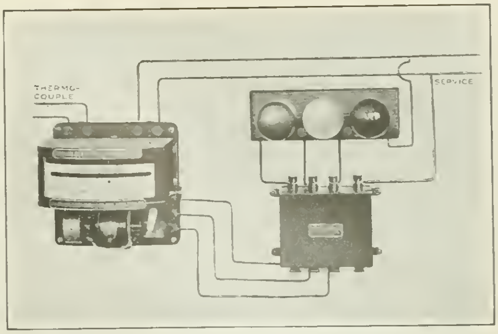


Fig. 3. Automatic Signaling Lighting Equipment

Assume that it is desired to maintain a temperature of exactly 1400 degrees F. The knob on the left of the instrument is turned until the index in front of the scale stands at 1400 degrees F., at which the thin insulating material will then separate the high and low contacts. The switch connecting the furnace in the line is closed and the pointer slowly rises across the scale as the temperature of the furnace rises. As the switch is already closed, when the pointer is depressed on the low contact the switch remains closed and no change occurs until the pointer passes over the insulating piece, when a switch, indirectly operated by a solenoid and relay, is instantly actuated and the circuit opened. The temperature of the furnace then falls until the pointer is again depressed on the low contact and the circuit is again closed. This operation continues as long as the furnace is to be operated.

When the switch opens or closes the main circuit, the current is either full on or full off, and the fluctuations are continuous within narrow limits of 10 to 20 degrees F. This continuous rising and falling of temperature can be largely reduced and closer control can be procured by the use of two rheostats in the furnace line. The solenoid-operated automatic switch is then used simply to cut in and out of circuit the second rheostat. Assuming that it is desirable to maintain 1400 degrees F. in the electric furnace, irrespective of fluctuations of voltage, the two rheostats are set so that with only one in the circuit the temperature will rise to approximately 1500 degrees F; with the second rheostat in the circuit the temperature drops to 1300 degrees F. When the solenoid-operated switch is used to cut in and out the second rheostat, the temperature is controlled only between 1500 and 1300 degrees F., and there are no rapid surges in temperature, maximum control being secured.

The same form of switch can be used to operate a valve to control a gas or an oil furnace. It has been found desirable to use an automatic valve in a by-pass to control part of the gas or oil supply, for this plan eliminates the maximum fluctuations caused by the complete opening and closing of the switch or valve. For instance, if a 2-inch pipe supplies the gas to the furnace, it is customary to by-pass this and use a ½-inch automatic valve, which gives approximately 25 per cent control. This is sufficient to control the usual fluctuations in gas supply and secure satisfactory control.

Temperature Signaling Pyrometer

In addition to an instrument to control furnace temperatures automatically, there has been a demand for an instrument to signal by lights whether the temperature is too high, correct, or too low in any particular furnace. It has been common practice for plants having a number of heat-treating furnaces to maintain an operator at a central pyrometer, and by colored electric lights at the furnace to signal whether the temperatures are right or not. Usually, three lights are placed above each furnace, red, white and green; the red light burns when the temperature is too low, the white light when the temperature is within certain limits, for example, 20 degrees F. of the correct temperature, and the green light when the temperature is too high. The fireman who operates the furnace is guided entirely by the lights.

Recently there has been developed an instrument, shown in Fig. 3, that automatically signals whether the temperature is correct or not by lights, and in this way the operator at the instrument is eliminated. The same form of instrument is used for this purpose as to control the furnace temperatures automatically, and the pointer is depressed at intervals of every ten seconds onto contacts corresponding to the red, white and green lights. No special battery or other source of current than an ordinary service line is required to operate these lights.

The supply may be 110 or 220 volts, either alternating or direct current, but the current that lights the lamps does not flow through the instrument; it is made and broken by an auxiliary device containing the necessary mechanism. A high resistor is in series with the circuit connected with the pyrometer, which reduces the current flowing through the contactors within the instrument to less than 0.07 ampere. This prevents sparking at the contactors and errors due to the heating effect of a current of higher amperage. The lamps may be any reasonable distance from the pyrometer; in fact, they are operative at a mile or more if desired. The various thermocouples in each furnace are connected successively to the instrument through switching mechanism, and at the same time a switching mechanism connects the various sets of lights at each furnace. There has been constructed an instrument of this type to take care of the signal lights at twelve furnaces.

This form of equipment gives the fireman or operator of the furnace an indication by lights that he can easily understand, and he adjusts the valves or fires the furnaces accordingly. It is a simple method to instruct a man to keep the white lights burning and to explain what the red and green lights mean, and a less experienced workman is required to control the furnaces in this manner than where it is necessary to read temperatures on a pyrometer scale.

The extensive use of pyrometers to measure or record high temperatures will serve to eliminate guesswork as to the temperature; reduce fuel consumption, through the maintenance of the correct temperature and not excessively high temperatures; reduce time for heating the product, due to the maintenance of the correct temperature; and increase the efficiency in operating a plant. Instruments to control the temperature automatically, when properly constructed and applied, will eliminate the personal element entirely. The maintenance of the correct temperature in the furnace is automatic, and this is one step further, and, in consequence, an improvement over temperature control through pyrometers. The next few years will see further improvements in pyrometers and temperature control. There will always be room for improvement, and the cooperation of the industrial works and the pyrometer manufacturers will hasten the development of practical instruments for the measurement and control of high temperatures.

* * *

UNITED STATES PUBLIC SERVICE RESERVE

A special bureau organized under the direction of the Department of Labor, known as the United States Public Service Reserve, has been created to obtain information relating to the labor resources of the country available for various classes of work required in connection with the war. The object of the Public Service Reserve is to provide an agency where all men who are willing to work at their own trade to help win the war may place themselves on record, notifying the bureau of their readiness to serve and of their capacity for service. This record, when once placed on file, will be available to all branches of the government concerned with the war. It is especially intended for men who are willing and ready, when the call comes, to give up jobs which are not vitally important in war times to take up work in which the country needs them. Men who list themselves with the Public Service Reserve are carefully indexed according to their qualifications, so that they may be located at once when men of their skill or ability are needed. They are then promptly notified that they are required for undertaking work in a civilian capacity, either for the government or for employers working on government war contracts.

Men of draft age who are likely to be called soon are not wanted in the Public Service Reserve. It is intended mainly for the men who do not expect to do military service. Enrollment in the Reserve is no ground for exemption from military duties. However, it gives to the man who wants to serve his country the assurance that when he has enlisted in the Reserve he has done his full present duty, and he can continue to work at his present task with a good conscience until called upon to serve his country elsewhere.

The Public Service Reserve is needed because millions of Americans must engage in industries essential to the war if the war is to be won and won quickly. An ever-increasing number of men will be needed for building ships and airplanes, for making munitions and equipment for the Army and Navy, and for other purposes in connection with the war. In order that these men may be called quickly when needed, the government must know in advance who are available and where they are, and must have a great volunteer reserve of men who stand ready to work for good wages under reasonable conditions in the industries essential to war.

All classes of men are requested to join the Public Service Reserve, if they are in a position to change to such work as may be designated when required to do so. Professional men, engineers, machinists, toolmakers and all other classes of skilled mechanics are required. In fact, every man who wishes to serve is asked to register, no matter what his qualifications; but only men who are really ready and able to respond when the opportunity for service requires them should enroll. The files of the Reserve must not be swamped with records of men who are merely expressing patriotism, but who, when the call comes, would not be able to respond immediately.

Most of the positions offered will be well compensated. No obligation exists to respond to a call when it comes, but it is, of course, expected that most of those who have joined will know in advance that they will be able to take up whatever work is required of them. Should they, however, be prevented from doing so by unforeseen circumstances, they have a full right not to respond to the call. Hence, enrolling in the Reserve places only a moral, but no legal, obligation upon the man who so joins. Applications for membership may be obtained from the Department of Labor, United States Public Service Reserve, 1712 I St., Washington, D. C.

It should be particularly pointed out in this connection that in asking a man of engineering or mechanical experience to enroll in the Public Service Reserve, a rare combination of opportunities are open to him which are not open to the average patriotic American. The engineer or mechanical man can serve the country in his most effective capacity and at the same time keep in touch with his own profession or trade, with the result that his patriotic service will not have diminished his ability in his chosen life work at the time when peace returns, but the added experience will prove helpful to him. His earning capacity is not diminished because of his willingness to serve the government where he is most required, and in most cases he will be able to perform his service to the country without leaving the United States.

* * *

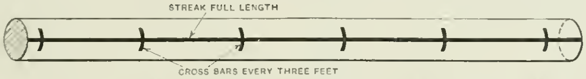
A twin-six V-type gasoline engine has been designed for motor boats by C. D. Holmes, who designed a motor used by the Life Saving Service. The engine weighs 3400 pounds, is eight feet, four inches long and three feet, ten inches high. Its especially high crankcase increases the accessibility of the parts as well as the rigidity and strength of the mechanism. All working parts are enclosed; but each part is accessible by covered handholes, through which the working parts can be taken without removing the motor from its base. At 1000 revolutions per minute, this engine will develop 300 horsepower, without any strain whatever, and it can be speeded up to 1400 revolutions, developing 400 horsepower, with little evidence of extra effort. One horsepower is produced for every nine pounds of engine, while the ratio of engines now in use is about 1 to 20. Production of parts of the engines has already been commenced, but none of the engines will be offered for private or commercial use during the period of the war.

IDENTIFICATION MARKS FOR STEEL

Every metal-working concern buys a variety of steel in bars, and many use some means of identifying the various kinds, especially tool steel. A common method is to paint the ends of the bars when received in the store-room, but the serious objection to this is the fact that the identification mark may be lost when the bar is cut up. Workmen are not always careful to remove the desired stock from the same end of the bar, and it often happens that the paint markings are removed from both ends of the bar.

The plan of steel marking shown in the identification chart, used in modified form by the Rockford Drilling Machine Co., Rockford, Ill., was worked out by the superintendent, E. K. Morgan, and it eliminates the trouble of losing the identifying mark when both ends of a bar are cut off. When the steel is received in the store-room, the stock-keeper lays a number of bars side by side on horses, and with a brush paints a streak on each of the bars lengthwise. Then, with the brush bearing the same or another color, he paints marks across the bars at intervals of about three feet. By using red, yellow, green, black, blue and white length marks and the same color cross marks, and no cross marks, forty-two kinds of steel are provided for. It will be noticed in the chart that high-speed steel has red cross marks; tool steel, yellow cross marks; machine steel, green cross marks; and so on. If the stock has no cross marks, it is some kind of screw stock.

IDENTIFICATION OF DIFFERENT GRADES OF STEEL



STREAK	RED	YELLOW	GREEN	BLACK	BLUE	WHITE	NO MARK
BARS	High-speed	Tool Steel	Mach. Steel	Finished Steel	Nickel Steel	Special Steel	Screw Stock
Blue	Blue Chip	0.80 Carbon	0.15 Carbon	0.15—0.25 C. Turned and Gr.	3.50 Ni.— 0.15 C.	Low Ni. Chr.— Oil-treated	
White	Novo	0.90 Carbon	0.25 Carbon	0.25—0.35 C. Turned and Gr.			
Yellow		1.00 Carbon	0.35 Carbon	0.35—0.45 C. Turned and Gr.			
Green		1.10 Carbon	0.45 Carbon				
Black		1.20 Carbon					
Red	Red Cut Superior	Non-Shrinking		Drill Rod	3.50 Ni.— 0.45 C.		

Machinery

The plan is one that can be used generally by machine shops, and may be applied with many variations. It would be desirable to have it worked out to a near standard form and generally adopted. Then workmen going from one plant to another would know instantly that steel marked lengthwise with red was high-speed; yellow, tool steel; green, machine steel; and so on.

* * *

Wood patterns must be protected from moisture of the molding sand or they will swell and warp out of shape. Shellac serves the purpose of excluding moisture satisfactorily when only a few castings are required, but if many are needed, it is customary to use metal patterns, preferably aluminum, because of its lightness. But aluminum now is scarce and high-priced and substitutes are being used. The fact has been recognized that wood patterns may be waterproofed by plating them with copper or aluminum by the Schoop process. The plated pattern is made practically moisture-proof, and in the case of thin sections is considerably strengthened by the thin metal coating. The plated pattern has practically all the advantages of a metal pattern, being smooth, light and strong. There is a limitation to the metal protective coating, however. Large patterns are likely to swell with changes of temperature sufficiently to crack the coating and permit the ingress of moisture, which still more increases the width of the cracks.

THE AMERICANIZATION OF IMMIGRANT LABOR IN OUR INDUSTRIES

On account of the war it has become of greater importance than ever to create facilities for the education of immigrant labor in the English language and in American ideals. Employers in whose works great numbers of foreign-born men or women are employed could do no greater service to the country at the present time than by creating facilities for the Americanization of these immigrants. The city of Cleveland has taken active steps toward the installation of an organized system for the education of non-English-speaking aliens. An Americanization information bureau has been installed which gives to aliens, free of charge, information in all languages regarding the draft, proclamations and regulations affecting aliens, naturalization, Liberty bonds, Red Cross work, and other war measures. The bureau, with the authorization of the draft boards, acts without charge as notary public for all immigrants filing exemption claims and sees that affidavits are properly filled out. War information centers have been established in 350 places throughout the city, which receive regularly from the bureau official information regarding war matters and Americanization. All industrial plants employing more than twenty-five non-English-speaking aliens, that have had their English-speaking force disorganized by the army or navy recruiting and the draft, have been circularized and visited, and plans are pending to train their alien labor, in or near the plants, in English and civics. An Americanization institute to train teachers of immigrant classes was opened, with an attendance of 450 drawn from the alumni of the Western Reserve University, the Normal School, the Training School, and the College Club.

In Detroit similar measures are advocated, and it is certainly highly important, because, if the United States is to win the war, foreign-born men and women must of necessity constitute an important source of the labor supply and must be made entirely dependable and reliable. They must understand the English language and become citizens in order to have a stake in the country and take an interest in it. They need American standards of living for physical efficiency. In the present crisis many of our industries absolutely necessary in the conduct of the war are largely manned by immigrants. Industrial difficulties with these men due to the misunderstandings that arise because they are not Americanized may cause national difficulties of great magnitude. Hence manufacturers in both large and small industrial centers where foreign labor is employed should exert every effort toward making these men good American citizens.

* * *

U-boats are now said to be made without periscopes. A lens on each side of the boat is used in conjunction with other lenses and reflectors. With this device, however, the boats must navigate nearer the surface than when periscopes are used.

STRESSES IN TURBINE WHEELS

METHODS AND VALUES BY WHICH STRESSES IN TURBINE WHEELS MAY BE DETERMINED

BY WILLIAM KNIGHT[1]

An accurate analysis of the stresses in a turbine wheel due to the centrifugal forces of the wheel itself and to the centrifugal forces of the blades fitted at the periphery is a rather complicated analytical problem. Formulas for obtaining stresses under these conditions refer to some particular shape of disk, and how the difference between the actual shape and the shape assumed in the calculations will affect the results is left to the designer to estimate and to allow for in his design. This is because a strictly accurate determination of the stresses in a rotating disk of varying thickness, with a hub at the bore and a rim of irregular section at the periphery and carrying blades attached to the rim, is very difficult to obtain.

By assuming that the outline of the disk is a hyperbola and that the effect of the blades is equivalent to their centrifugal force uniformly distributed at the periphery of this disk, it is possible to derive a formula for determining the radial and the tangential stresses produced by the centrifugal force of the disk and the blades at any point between the bore and the periphery. Such a formula gives only an approximate solution of the problem, because it does not take into consideration the variation of the actual shape of the disk from the hyperbolic shape assumed (especially at the periphery and at the hub, where the outline of the disk departs the most from the hyperbola), and yet it is not easily applied. A long and tedious process of calculation involving the probability of making errors is required for solving the formulas, and this must be repeated several times, when designing a disk, before the proportions that will secure the most efficient design can be determined. To save the time required for making these calculations and eliminate the probability of making errors, the accompanying tables have been prepared.

At any point of a rotating disk, there is a radial and a tangential stress produced by the centrifugal forces of the disk and of the blades. The tangential stress at any point, due to the centrifugal force of the disk, added to the tangential force at the same point due to the centrifugal force of the blades, will give the total tangential stress at that point due to the centrifugal force of both the disk and the blades. In the same way, the total radial stress at any point is obtained by adding the radial stresses produced at that point by the centrifugal force of the disk and of the blades. The radial stress produced by the centrifugal force of the disk is zero at the periphery and at the bore, and reaches its maximum value in the middle portion of the disk.

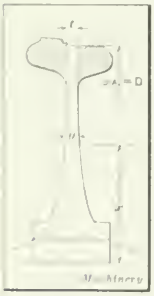


Diagram Illustrating Stress in Turbine Wheels

The radial stress produced by the centrifugal force of the blades only, assumed as being uniformly distributed at the periphery of the disk, varies from zero at the bore to a maximum at the periphery. The tangential stress produced by the centrifugal force of the disk, and the tangential stress produced by the centrifugal force of the blades, reach a maximum either at the bore or at the periphery, depending on the shape and the proportions of the disk. For instance, the larger the ratio of the bore diameter to the diameter at the periphery, the more pronounced is the tendency of the stress at the bore to become larger than the tangential stress at the periphery.

A disk of hyperbolic profile is such that the thickness y at any point distant x from the center is equal to

$$y = \frac{c}{x^a} \qquad (1)$$

where a can be positive, negative, or zero. If $a = 0$, $y = c$ for any value of x, which is the case of a disk of uniform thickness. If a is positive, the thickness of the disk is larger at the bore than at the periphery, which is the case with all turbine wheels. Values of a between 0 and 2 cover a wide range of wheel shapes commonly used in turbine design. If a is negative, the thickness of the disk increases from the bore to the periphery, which is a very unusual design.

If the section of a turbine wheel is laid out and it is desired to find the values of c and a that, substituted in Formula (1), will give values of y for various values of x, which will more closely approach the thickness of the wheel at different points, as laid out, Formula (2) may be applied:

$$a = \frac{\log y_1 - \log y_2}{\log x_2 - \log x_1} \qquad (2)$$

in which y_1 and y_2 are the thicknesses of the wheel at two points distant x_1 and x_2 from the center. Having found the value of a, $c = y_1 x_1^a = y_2 x_2^a$. Substituting the values of c and x thus found in Formula (1), all the points of a hyperbola that will coincide with the outline of the wheel, at least at x_1 and x_2, can be found. Then the outline of the wheel can be slightly modified so as to make it follow the hyperbolic profile as far as possible, or a hyperbola that will fit more closely to the outline of the wheel as laid out may be found.

It is well to note that the value chosen for a must be such as to give a hyperbola that will follow, as closely as possible, the profile of the outer portion of the disk. A variation of the hyperbola from the outline of the disk as laid out, in points near the bore, will have only a small influence in the calculation of stresses; but any variation in points near the periphery will have a decided influence in the stresses calculated. Consequently, the addition of metal at the hub will not increase the stress at the bore (which is the point where, in general, the tangential stress is a maximum) and will add strength to the wheel at its weakest point; an addition of metal at the periphery will considerably increase the tangential stress at the bore of the wheel.

Having found the value of a giving a hyperbola that will more closely approach the outline of the wheel, the values of T and R can be obtained from Tables 1 to 5 and Tables 6 to 10, respectively, for values of $a = 0$, $a = 0.5$, $a = 1$, $a = 1.5$ and $a = 2$ and plotted on cross-section paper against different values of a. Joining with a curve the five points thus obtained for T and R, the values of T and R for any intermediate value of a between $a = 0$ and $a = 2$ are easily found. All the tables give numerical values for corresponding values of m and m_o, where

$$m = \frac{\text{Diameter at any point}}{\text{Outside diameter of disk}}$$

$$m_o = \frac{\text{Diameter at bore}}{\text{Outside diameter of disk}}$$

The tangential and radial stresses at any point of a rotating disk for any value of a between 0 and 2 may be obtained by plotting five values of T and R for the corresponding values of m and m_o. The tangential and the radial stresses of the disk only, at any point, as determined by m and m_o, are:

$$T_t = ST \qquad (3)$$

$$T_r = SR \qquad (4)$$

where T and R = factors obtained from the tables;

S = tangential stress of a thin ring rotating at same peripheral speed as disk.

For cast iron, $S = 0.0972V^2$ pounds per square inch

For steel, $S = 0.105V^2$ pounds per square inch

where V = peripheral speed of disk, in feet per second.

With the metric system,

For cast iron, $S = 0.0735V^2$ kilograms per square centimeter

For steel, $S = 0.0791V^2$ kilograms per square centimeter

where V = peripheral speed of disk, in meters per second.

The tangential and the radial stresses at any point of the disk due to the centrifugal force of the blades and the rim

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TABLE 1. VALUES OF T FOR $a = 0$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.815	0.493	0.434	0.408	0.369	0.337	0.304	0.266	0.225	0.181
0.2	.....	0.823	0.584	0.488	0.432	0.385	0.343	0.299	0.254	0.206
0.3	.....	.....	0.830	0.636	0.533	0.461	0.404	0.347	0.299	0.246
0.4	.....	.....	.....	0.841	0.675	0.568	0.490	0.434	0.362	0.303
0.5	.....	.....	.....	.....	0.858	0.706	0.602	0.517	0.444	0.375
0.6	.....	.....	.....	.....	.....	0.876	0.739	0.634	0.545	0.467
0.7	.....	.....	.....	.....	.....	.....	0.897	0.766	0.660	0.570
0.8	.....	.....	.....	.....	.....	.....	.....	0.927	0.803	0.697
0.9	.....	.....	.....	.....	.....	.....	.....	.....	0.959	0.837
1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.000

Machinery

TABLE 2. VALUES OF T FOR $a = 0.5$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.500	0.323	0.304	0.299	0.290	0.284	0.255	0.226	0.191	0.145
0.2	.....	0.617	0.445	0.392	0.349	0.320	0.291	0.255	0.217	0.175
0.3	.....	.....	0.706	0.550	0.465	0.418	0.364	0.317	0.270	0.220
0.4	.....	.....	.....	0.763	0.619	0.527	0.450	0.397	0.335	0.270
0.5	.....	.....	.....	.....	0.818	0.662	0.575	0.493	0.425	0.355
0.6	.....	.....	.....	.....	.....	0.853	0.733	0.630	0.550	0.475
0.7	.....	.....	.....	.....	.....	.....	0.905	0.765	0.659	0.570
0.8	.....	.....	.....	.....	.....	.....	.....	0.934	0.811	0.700
0.9	.....	.....	.....	.....	.....	.....	.....	.....	0.968	0.840
1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.000

Machinery

TABLE 3. VALUES OF T FOR $a = 1$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.295	0.201	0.205	0.216	0.229	0.229	0.207	0.189	0.159	0.120
0.2	.....	0.463	0.349	0.305	0.286	0.271	0.244	0.220	0.187	0.155
0.3	.....	.....	0.584	0.438	0.379	0.346	0.303	0.268	0.231	0.185
0.4	.....	.....	.....	0.680	0.536	0.463	0.399	0.350	0.304	0.250
0.5	.....	.....	.....	.....	0.759	0.620	0.530	0.455	0.395	0.330
0.6	.....	.....	.....	.....	.....	0.819	0.690	0.586	0.512	0.445
0.7	.....	.....	.....	.....	.....	.....	0.865	0.739	0.637	0.550
0.8	.....	.....	.....	.....	.....	.....	.....	0.909	0.788	0.690
0.9	.....	.....	.....	.....	.....	.....	.....	.....	0.950	0.835
1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.000

Machinery

TABLE 4. VALUES OF T FOR $a = 1.5$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.174	0.125	0.140	0.158	0.172	0.178	0.173	0.158	0.133	0.101
0.2	.....	0.351	0.255	0.229	0.224	0.216	0.204	0.182	0.157	0.121
0.3	.....	.....	0.490	0.356	0.312	0.284	0.259	0.228	0.196	0.167
0.4	.....	.....	.....	0.610	0.480	0.417	0.363	0.311	0.269	0.223
0.5	.....	.....	.....	.....	0.708	0.584	0.498	0.421	0.367	0.308
0.6	.....	.....	.....	.....	.....	0.792	0.664	0.558	0.489	0.419
0.7	.....	.....	.....	.....	.....	.....	0.860	0.720	0.634	0.545
0.8	.....	.....	.....	.....	.....	.....	.....	0.905	0.775	0.673
0.9	.....	.....	.....	.....	.....	.....	.....	.....	0.950	0.830
1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.000

Machinery

TABLE 5. VALUES OF T FOR $a = 2$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.070	0.080	0.097	0.118	0.135	0.145	0.149	0.131	0.122	0.082
0.2	.....	0.262	0.192	0.180	0.181	0.180	0.177	0.157	0.148	0.105
0.3	.....	.....	0.414	0.321	0.278	0.256	0.239	0.213	0.191	0.152
0.4	.....	.....	.....	0.550	0.443	0.376	0.336	0.292	0.257	0.203
0.5	.....	.....	.....	.....	0.668	0.550	0.465	0.401	0.353	0.291
0.6	.....	.....	.....	.....	.....	0.760	0.643	0.553	0.478	0.399
0.7	.....	.....	.....	.....	.....	.....	0.850	0.735	0.646	0.545
0.8	.....	.....	.....	.....	.....	.....	.....	0.903	0.785	0.675
0.9	.....	.....	.....	.....	.....	.....	.....	.....	0.950	0.840
1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.000

Machinery

TABLE 6. VALUES OF R FOR $a = 0$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	.....	0.294	0.330	0.322	0.294	0.254	0.204	0.145	0.0775	.....
0.2	.....	.....	0.206	0.257	0.257	0.232	0.192	0.138	0.0785	.....
0.3	.....	.....	.....	0.151	0.198	0.196	0.170	0.126	0.0694	.....
0.4	.....	.....	.....	.....	0.111	0.144	0.141	0.110	0.0625	.....
0.5	.....	.....	.....	.....	.....	0.079	0.103	0.091	0.0543	.....
0.6	.....	.....	.....	.....	.....	.....	0.057	0.066	0.0441	.....
0.7	.....	.....	.....	.....	.....	.....	.....	0.035	0.0305	.....
0.8	.....	.....	.....	.....	.....	.....	.....	.....	0.0175	.....
0.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Machinery

TABLE 7. VALUES OF R FOR $a = 0.5$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	.....	0.212	0.264	0.278	0.267	0.252	0.202	0.145	0.079	.....
0.2	.....	.....	0.169	0.225	0.235	0.232	0.188	0.137	0.076	.....
0.3	.....	.....	.....	0.135	0.183	0.202	0.174	0.132	0.075	.....
0.4	.....	.....	.....	.....	0.099	0.150	0.139	0.107	0.063	.....
0.5	.....	.....	.....	.....	.....	0.088	0.101	0.088	0.053	.....
0.6	.....	.....	.....	.....	.....	.....	0.038	0.060	0.042	.....
0.7	.....	.....	.....	.....	.....	.....	.....	0.034	0.031	.....
0.8	.....	.....	.....	.....	.....	.....	.....	.....	0.021	.....
0.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Machinery

TABLE 8. VALUES OF R FOR $a = 1$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	.....	0.146	0.204	0.227	0.235	0.231	0.187	0.141	0.078	.....
0.2	.....	.....	0.126	0.183	0.209	0.214	0.176	0.133	0.076	.....
0.3	.....	.....	.....	0.116	0.166	0.188	0.161	0.122	0.072	.....
0.4	.....	.....	.....	.....	0.097	0.145	0.134	0.109	0.068	.....
0.5	.....	.....	.....	.....	.....	0.085	0.095	0.088	0.058	.....
0.6	.....	.....	.....	.....	.....	.....	0.051	0.061	0.046	.....
0.7	.....	.....	.....	.....	.....	.....	.....	0.031	0.030	.....
0.8	.....	.....	.....	.....	.....	.....	.....	.....	0.016	.....
0.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Machinery

TABLE 9. VALUES OF R FOR $a = 1.5$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	.....	0.101	0.154	0.189	0.194	0.198	0.178	0.140	0.087	.....
0.2	.....	.....	0.104	0.161	0.180	0.187	0.173	0.133	0.079	.....
0.3	.....	.....	.....	0.095	0.142	0.156	0.149	0.118	0.067	.....
0.4	.....	.....	.....	.....	0.057	0.113	0.123	0.101	0.060	.....
0.5	.....	.....	.....	.....	.....	0.061	0.088	0.082	0.053	.....
0.6	.....	.....	.....	.....	.....	.....	0.051	0.060	0.040	.....
0.7	.....	.....	.....	.....	.....	.....	.....	0.035	0.031	.....
0.8	.....	.....	.....	.....	.....	.....	.....	.....	0.022	.....
0.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Machinery

TABLE 10. VALUES OF R FOR $a = 2$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	.....	0.069	0.118	0.153	0.174	0.178	0.164	0.124	0.069	.....
0.2	.....	.....	0.084	0.130	0.160	0.166	0.156	0.120	0.069	.....
0.3	.....	.....	.....	0.083	0.127	0.149	0.144	0.110	0.069	.....
0.4	.....	.....	.....	.....	0.074	0.118	0.128	0.100	0.065	.....
0.5	.....	.....	.....	.....	.....	0.059	0.088	0.080	0.052	.....
0.6	.....	.....	.....	.....	.....	.....	0.038	0.051	0.031	.....
0.7	.....	.....	.....	.....	.....	.....	.....	0.017	0.018	.....
0.8	.....	.....	.....	.....	.....	.....	.....	.....	0.004	.....
0.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Machinery

T_{1t} and T_{1r} is obtained as follows: The shaded portion of the rim shown in Fig. 1 is equivalent to two continuous rings attached at the sides of the disk near the periphery. These two rings, if they were free, that is, not attached to the disk, would expand a good deal more than they do when integral with the wheel disk. This means that a part of the centrifugal force of the shaded section of the rim is carried by the disk, and the remainder is self-supporting. A good approximation, in average cases, is to assume that two-thirds of the weight of the shaded portion of the rim is concentrated at the periphery of the disk. Calling this two-thirds weight W, the total weight of the blades, in pounds, attached at the periphery of the wheel W_1, the diameter at the center of gravity of the blades in feet D_1, and the number of revolutions per minute N,

TABLE 11. VALUES OF T_1 FOR $\alpha = 0$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	2.020	1.263	1.122	1.073	1.051	1.038	1.031	1.026	1.022	1.020
0.2	.....	2.080	1.505	1.300	1.207	1.156	1.125	1.105	1.091	1.082
0.3	.....	.....	2.200	1.720	1.496	1.375	1.302	1.255	1.222	1.199
0.4	.....	.....	.....	2.380	1.955	1.720	1.580	1.489	1.426	1.381
0.5	.....	.....	.....	.....	2.680	2.270	2.020	1.860	1.750	1.670
0.6	.....	.....	.....	.....	.....	3.120	2.800	2.440	2.250	2.120
0.7	.....	.....	.....	.....	.....	.....	3.920	3.460	3.140	2.920
0.8	.....	.....	.....	.....	.....	.....	.....	5.560	4.980	4.560
0.9	.....	.....	.....	.....	.....	.....	.....	.....	10.560	9.540
1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	∞

Machinery

TABLE 12. VALUES OF T_1 FOR $\alpha = 0.5$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.985	0.644	0.630	0.657	0.691	0.722	0.757	0.788	0.820	0.849
0.2	.....	1.275	0.933	0.844	0.820	0.819	0.838	0.853	0.878	0.900
0.3	.....	.....	1.540	1.205	1.071	1.012	0.988	0.984	0.988	1.020
0.4	.....	.....	.....	1.735	1.500	1.335	1.248	1.195	1.172	1.162
0.5	.....	.....	.....	.....	2.190	1.860	1.670	1.550	1.485	1.446
0.6	.....	.....	.....	.....	.....	2.580	2.410	2.170	2.025	1.925
0.7	.....	.....	.....	.....	.....	.....	3.550	3.120	2.850	2.660
0.8	.....	.....	.....	.....	.....	.....	.....	5.190	4.630	4.280
0.9	.....	.....	.....	.....	.....	.....	.....	.....	10.140	9.190
1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	∞

Machinery

TABLE 13. VALUES OF T_1 FOR $\alpha = 1$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.456	0.322	0.353	0.408	0.470	0.539	0.600	0.654	0.703	0.781
0.2	.....	0.764	0.571	0.540	0.559	0.604	0.650	0.694	0.735	0.797
0.3	.....	.....	1.058	0.835	0.759	0.749	0.760	0.782	0.807	0.882
0.4	.....	.....	.....	1.315	1.180	0.982	0.940	0.924	0.923	1.023
0.5	.....	.....	.....	.....	1.750	1.500	1.400	1.304	1.252	1.290
0.6	.....	.....	.....	.....	.....	2.250	2.000	1.846	1.711	1.715
0.7	.....	.....	.....	.....	.....	.....	3.186	2.846	2.576	2.490
0.8	.....	.....	.....	.....	.....	.....	.....	4.926	4.346	4.100
0.9	.....	.....	.....	.....	.....	.....	.....	.....	9.760	9.000
1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	∞

Machinery

TABLE 14. VALUES OF T_1 FOR $\alpha = 1.5$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.192	0.148	0.186	0.243	0.310	0.373	0.446	0.518	0.596	0.673
0.2	.....	0.440	0.332	0.341	0.374	0.423	0.485	0.552	0.626	0.698
0.3	.....	.....	0.713	0.571	0.542	0.556	0.587	0.633	0.698	0.764
0.4	.....	.....	.....	1.006	0.973	0.750	0.710	0.751	0.855	0.898
0.5	.....	.....	.....	.....	1.469	1.251	1.152	1.100	1.110	1.131
0.6	.....	.....	.....	.....	.....	1.930	1.775	1.613	1.565	1.535
0.7	.....	.....	.....	.....	.....	.....	2.930	2.556	2.400	2.280
0.8	.....	.....	.....	.....	.....	.....	.....	4.600	4.100	3.850
0.9	.....	.....	.....	.....	.....	.....	.....	.....	9.670	8.710
1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	∞

Machinery

TABLE 15. VALUES OF T_1 FOR $\alpha = 2$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.077	0.066	0.099	0.147	0.206	0.272	0.349	0.429	0.522	0.616
0.2	.....	0.240	0.188	0.204	0.246	0.303	0.373	0.451	0.539	0.633
0.3	.....	.....	0.466	0.380	0.371	0.398	0.451	0.514	0.596	0.684
0.4	.....	.....	.....	0.768	0.645	0.607	0.617	0.654	0.717	0.791
0.5	.....	.....	.....	.....	1.172	1.012	0.940	0.925	0.952	1.000
0.6	.....	.....	.....	.....	.....	1.710	1.526	1.395	1.355	1.365
0.7	.....	.....	.....	.....	.....	.....	2.716	2.425	2.170	2.090
0.8	.....	.....	.....	.....	.....	.....	.....	4.344	3.910	3.650
0.9	.....	.....	.....	.....	.....	.....	.....	.....	9.250	8.420
1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	∞

Machinery

TABLE 16. VALUES OF R_1 FOR $\alpha = 0$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	.....	0.660	0.900	0.950	0.970	0.985	0.990	0.995	0.999	1.000
0.2	.....	.....	0.580	0.780	0.880	0.930	0.960	0.980	0.990	1.000
0.3	.....	.....	.....	0.480	0.710	0.825	0.895	0.945	0.980	1.000
0.4	.....	.....	.....	.....	0.380	0.660	0.800	0.890	0.960	1.000
0.5	.....	.....	.....	.....	.....	0.410	0.655	0.815	0.925	1.000
0.6	.....	.....	.....	.....	.....	.....	0.415	0.685	0.870	1.000
0.7	.....	.....	.....	.....	.....	.....	.....	0.460	0.775	1.000
0.8	.....	.....	.....	.....	.....	.....	.....	.....	0.585	1.000
0.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.000
1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Machinery

TABLE 17. VALUES OF R_1 FOR $\alpha = 0.5$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	.....	0.450	0.601	0.698	0.767	0.841	0.878	0.920	0.962	1.000
0.2	.....	.....	0.406	0.594	0.709	0.814	0.863	0.915	0.969	1.000
0.3	.....	.....	.....	0.375	0.580	0.735	0.813	0.890	0.948	1.000
0.4	.....	.....	.....	.....	0.357	0.600	0.728	0.837	0.933	1.000
0.5	.....	.....	.....	.....	.....	0.385	0.605	0.770	0.903	1.000
0.6	.....	.....	.....	.....	.....	.....	0.375	0.645	0.855	1.000
0.7	.....	.....	.....	.....	.....	.....	.....	0.440	0.760	1.000
0.8	.....	.....	.....	.....	.....	.....	.....	.....	0.580	1.000
0.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.000
1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Machinery

TABLE 18. VALUES OF R_1 FOR $\alpha = 1$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	.....	0.249	0.383	0.490	0.589	0.692	0.763	0.845	0.926	1.000
0.2	.....	.....	0.264	0.421	0.548	0.665	0.746	0.833	0.921	1.000
0.3	.....	.....	.....	0.270	0.453	0.605	0.706	0.812	0.912	1.000
0.4	.....	.....	.....	.....	0.283	0.499	0.636	0.775	0.893	1.000
0.5	.....	.....	.....	.....	.....	0.325	0.525	0.711	0.870	1.000
0.6	.....	.....	.....	.....	.....	.....	0.335	0.597	0.813	1.000
0.7	.....	.....	.....	.....	.....	.....	.....	0.410	0.735	1.000
0.8	.....	.....	.....	.....	.....	.....	.....	.....	0.660	1.000
0.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.000
1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Machinery

TABLE 19. VALUES OF R_1 FOR $\alpha = 1.5$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	.....	0.121	0.234	0.335	0.440	0.557	[illegible]	0.767	0.881	1.000
0.2	.....	.....	0.179	[illegible]	0.417	0.532	0.646	0.764	0.883	1.000
0.3	.....	.....	.....	0.197	[illegible]	0.490	0.619	0.747	0.870	1.000
0.4	.....	.....	.....	.....	[illegible]	0.407	[illegible]	0.717	0.860	1.000
0.5	.....	.....	.....	.....	.....	0.267	0.470	0.603	0.829	1.000
0.6	.....	.....	.....	.....	.....	.....	0.310	0.570	0.787	1.000
0.7	.....	.....	.....	.....	.....	.....	.....	0.403	0.713	1.000
0.8	.....	.....	.....	.....	.....	.....	.....	.....	0.636	1.000
0.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.000
1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Machinery

TABLE 20. VALUES OF R_1 FOR $\alpha = 2$

Values of m_0	Values of m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	.....	0.067	0.139	0.226	0.326	0.437	0.561	0.696	0.842	1.000
0.2	.....	.....	0.106	0.204	0.312	0.427	0.566	0.692	0.837	1.000
0.3	.....	.....	.....	0.141	0.270	0.398	0.538	0.680	0.836	1.000
0.4	.....	.....	.....	.....	0.178	0.338	0.498	0.657	0.820	1.000
0.5	.....	.....	.....	.....	.....	0.217	0.417	0.608	0.803	1.000
0.6	.....	.....	.....	.....	.....	.....	0.270	0.519	0.757	1.000
0.7	.....	.....	.....	.....	.....	.....	.....	0.357	0.688	1.000
0.8	.....	.....	.....	.....	.....	.....	.....	.....	0.610	1.000
0.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.000
1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Machinery

[illegible] centrifugal force F (pounds) at disk periphery is,

$$F = 0.00017N^2 (WD + W_1D_1)$$

If W is expressed in kilograms and D in meters, the centrifugal force F, in kilograms, is

$$F = 0.00056N^2 (WD + W_1D_1)$$

If the centrifugal force of the projecting masses, per square inch of section at the periphery of the disk, is S_1,

$$S_1 = \frac{F}{\pi Dt} \qquad (5)$$

the values of D and t being shown in the illustration.

The tangential and the radial stresses at any point of a disk, as determined by m and m_0, are:

$$T_t = S_1T_1 \qquad (6)$$

$$T_{1r} = S_1R_1 \qquad (7)$$

The values of T_1 and R_1 may be obtained from Tables 11 to 15 and Tables 16 to 20, respectively, for values of a between 0 and 2, in the same way as described for T and R.

From the foregoing it is possible to conclude that, in similar disks, where the values of a and m_0 are the same, and for the same peripheral speed and the same value of S_1, the stresses in the disks at points determined by the same value of m are exactly the same in a very large wheel and in a very small wheel. This point may be useful to keep in mind in carrying on experiments on small models of large wheels.

* * *

DECREASING THE LABOR TURNOVER

In a paper read before the American Society of Mechanical Engineers at the annual convention, December, 1917, Richard B. Gregg called attention to many interesting factors of value to employers in determining the causes for a large labor turnover, and pointed out that the percentage could be greatly decreased. There is, of course, a certain amount of labor turnover which is unavoidable and normal. A factory will always be losing employes from old age or death, marriage, changes of residence, or domestic conditions wholly uninfluenced by the character of the work or trade. This normal labor turnover will vary according to local conditions, but is probably about 20 per cent of the total working force. A turnover in excess of this percentage may be considered as an indication that some abnormal conditions are present, and the management should immediately take steps to determine the causes.

Determining Causes of Excessive Labor Turnover

The first thing to do is to examine the pay-roll and keep a record of the number of people hired and of those leaving or discharged in the entire factory for a given period, say one year. By comparing the total number of those leaving the company's employ with the total number of workers in the factory, the labor turnover, expressed as a percentage, may be obtained. In a thorough analysis it is also well to obtain the percentage of turnover for each department, or for each group working under one foreman. These percentages, when recorded, will usually point quite clearly to defects in the organization, unsuitable working conditions, or other factors which tend to increase the turnover.

In carrying the analysis further, it is well to group those who leave according to their actual earnings, which will show the significance of the wage factor as a cause for leaving. In one case, such an analysis made it possible to ascertain that in one department, where the turnover was unusually high, the reason was that the men were receiving fifty cents a week less than men doing similar work elsewhere in the same town. The wages were raised fifty cents and the men did not leave their jobs as in the past. Usually, the largest percentages of shifting labor will be found in the low-paid groups.

A further aid in determining the causes of a high percentage of labor turnover is to make inquiries from the foremen and from the men who leave. Too much reliance should not be placed upon information obtained in this way, however, as it is very likely to be distorted by personal opinions. It is a valuable aid, however, in determining some of the underlying causes. Sometimes these are very simple, as in the case of a machine-building concern which learned that most of the men who left resided a considerable distance from the plant. By giving preference to applicants living near the plant, the turnover was gradually greatly reduced. Usually, however, there is a complex set of causes.

Cost of Losing a Worker

The cost of losing an old worker and hiring and training a new one is high. It may be roughly divided into overhead cost and operating cost. Among the overhead costs are: (1) More rapid depreciation of machinery, because of ignorance or lack of skill of new workers. (2) Extra floor space and extra machines to provide against idleness of a certain amount of machinery due to shifting labor.

Among the operating costs the following may be mentioned: (1) Time spent by the foreman or superintendent in discharging a worker. (2) Time spent by the foreman or other workers in training the new employe. (3) Time spent by clerks on additional pay-roll or other records. (4) Time machinery is idle when a new worker cannot be obtained immediately. (5) Idle machinery or temporary stoppages due to ignorance or lack of skill of new worker. (6) Repairs to machines or renewals of tools broken for the same reason. (7) Waste or damaged material due to ignorance or lack of skill of new worker. (8) Difficulties in subsequent processes due to poor work by new employes in previous processes. (9) Lower production while new employe is working up to his best skill. (10) Additional accident cost due to higher rate of accidents among new employes.

Those who have made the most careful studies of this question find that it costs about $10 to replace an ordinary laborer and as much as $300, and perhaps more, to replace a skilled worker. Mr. Alexander, of the General Electric Co., estimates the losses in a group of twelve metal-working factories in a single year to have been not less than $831,000. In another case, the annual loss from a high labor turnover in a plant employing 2000 men was estimated at $20,000. It should be remembered, moreover, that none of these estimates include the losses to the employes themselves or to the community. The subject is, therefore, one of the greatest importance, and it is to be expected that more and more attention will be given to it in the future. Just as about ten years ago industrial managers began to realize the enormous waste due to accidents, and set out to take steps to prevent the waste incident thereto, so it is probable that during the next decade attention will be paid to the enormous waste incident to the constant shifting of labor.

* * *

THE NEW ZEPPELINS

The Zeppelins that came to an untimely (?) end in France a few months ago were 643 feet in length, had a total height of 114 feet, and consisted of eighteen balloons enclosed inside an aluminum framework, these balloons containing over one million cubic feet of hydrogen. The total lifting capacity was 55 tons. As the aluminum structure weighs between ten and twelve tons and the five motors, each of 240 horsepower, together with the weight of the cars, balloons, etc., weigh several tons, the actual carrying capacity of the complete Zeppelin may be estimated at about thirty-five tons. This weight is mainly made up of the weight of the crew, fuel, ballast, provisions and other necessary appliances required for the journey, leaving about 2½ tons for explosives. These Zeppelins are built with a view to flying at a height of between 16,000 and 20,000 feet. At such an altitude their designers apparently considered them reasonably safe from both shells and heavier-than-air craft, but as a matter of fact there appears to be some slight error in these calculations, since one Zeppelin was brought down from a height of over 16,000 feet. The Zeppelins with all their motors working at full power can travel at more than sixty miles an hour. Three of the motors are in the forward and in the two middle cars, while the stern car carries two motors, each car carrying only one propeller. As a rule, only four motors are used, the fifth being held in reserve. The commander is in the forward car with the greater part of the crew. The total crew for short raids consists of twenty men, and for long raids, of eighteen men.

* * *

BONUS FOR PUNCTUALITY AND ATTENDANCE

A method has been adopted by the Cincinnati Planer Co., Cincinnati, Ohio, for encouraging employes to secure a perfect record for punctuality and attendance. Eleven of the employes of the company who were never late or absent during the twelve months from December 1, 1916, to December 1, 1917, were awarded a 5 per cent bonus on their yearly earnings, this 5 per cent being in addition to the regular 5 per cent on the earnings provided for by the company's Christmas fund. The eleven men who were thus awarded were Charles Marschel, George Hoemschemeyer, C. Corum, J. Murphy, J. Eisenbrey, N. Doggendorf, Charles Tope, E. Oder, J. Byrum, John Behrens and J. L. Ballman.

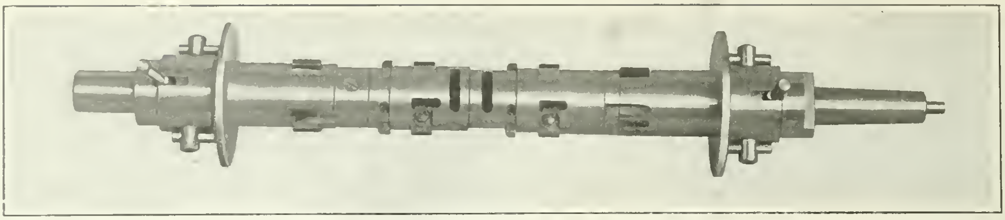


Fig. 1. Murchey Combination Boring, Reaming, Chamfering and Tapping Tool

COMBINATION TOOLS AND THEIR APPLICATION

TOOLS FOR PERFORMING A SERIES OF OPERATIONS AT ONE SETTING OF THE WORK

In many lines of manufacturing, competition has become so keen that a great deal of time may often be profitably spent in planning methods of performing machining operations and designing special tools with the view of making what may appear to be only slight savings in the cost of production. Nevertheless, there are many factories where these very small savings represent the difference between manufacturing the piece at a profit and at a loss; and when these savings per piece are multiplied by the yearly production of a large plant, the importance of careful planning of the methods of machining and pains taken with the designing of tools at once becomes apparent.

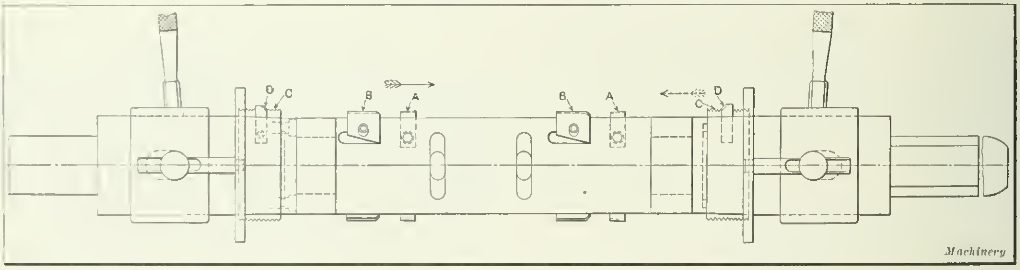


Fig. 2. Detail View of Combination Tool shown in Fig. 1

It is a matter of general knowledge among experienced mechanics that the time involved in setting up a piece of work ready for the performance of a machining operation often takes longer than the actual machine work that is required on the piece, and when there is a sequence of operations to be performed, this item of setting-up time may become a serious limiting factor. With the idea of overcoming this limitation imposed upon the rate of production on pieces where a series of operations has to be performed, the Murchey Machine & Tool Co., 34 Porter St., Detroit, Mich., has developed a number of interesting tools which provide for the performance of a series of operations, including boring, reaming, facing, chamfering, turning, threading and tapping, at a single setting of the work. With the view of explaining how these tools operate, a description is given of four typical tools and of the work done by them. While these are representative examples of the combinations of operations, for the performance of which a single tool may be designed, the tools shown do not represent by any means all of the combinations which are possible.

In Figs. 1 and 2 there is shown a combination boring, reaming, chamfering and tapping tool developed for the purpose of machining automobile differential gear housings of the type shown in Fig. 3. The tool consists of two sets of cutters, comprising boring, reaming and chamfering bits and a collapsing tap, carried in a single bar. In this case the use of this combination tool is not only the means of increasing the rate of production by enabling all of the operations to be performed at a single setting of the work, but, in addition, performance of the boring, reaming, chamfering and tapping operations in each of the two holes in the work with a single tool is the means of assuring accurate alignment between the two holes, which is a matter of the utmost importance. After the tool has been set up, each hole in the work is located to the right of the boring and reaming cutters *A* and *B*; then, as the tool is fed to the right, cutters *A* bore the two holes in the work and these holes are then reamed by cutters *B*. This movement of the tool to the right is continued until one of the holes has been tapped and chamfered by cutters *C* and *D*; and when this

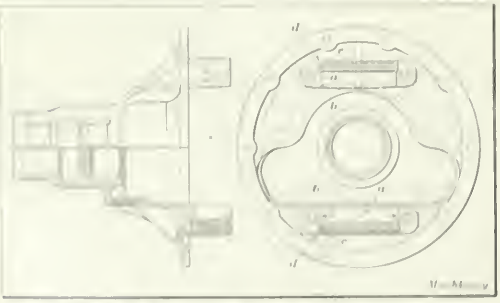


Fig. 3. Automobile Differential Gear Housings machined by Tools shown in Figs. 1 and 2

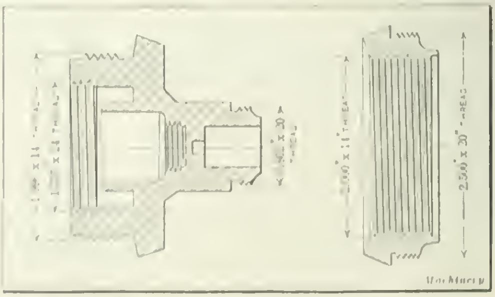


Fig. 4. Work threaded by Combination Threading Die and Tap shown in Fig. 5

result has been accomplished, the direction of movement of the tool is reversed in order that the other pair of cutters *C* and *D* may tap and chamfer the other hole in the work. In Fig. 3, *a*, *b*, *c* and *d* indicate the work done by the cutters *A*, *B*, *C* and *D* in Fig. 2.

In Fig. 5 is shown a combination tool which provides for boring and reaming one hole, reaming and tapping a second hole, and chamfering and facing the surface at the top of the tapped hole. This tool consists of a combination of the required boring, reaming, chamfering and facing cutters and a collapsing tap. The work is an automobile differential case. In this illustration the tool is shown in operation, so that a brief description will suffice to explain the way in which it works. In each case it will be seen that capital and small letters are employed to indicate the cutting tool and the portion of the work on which it operates, respectively. The order of operations is as follows: Cutter *A* bores hole *a* to a diameter of 4.351 inches; cutter *B* reams hole *b* to a diameter of 4.371 inches; cutter *C* reams hole c to a diameter of 4.5625 inches; cutter *D* cuts a 45-degree chamfer *d* at the top of hole *c;* and cutter *E* faces surface *e*. During the time that these operations are being performed, the chasers of the tap are collapsed; the tool is next drawn back and the tap expanded, after which it is again fed into the work to provide for tapping hole *c*. Collar *F* engages a trip on the fixture to provide for automatically collapsing the tap. A little thought will suffice to show the great increase in production which is made possible through being able to perform all of these operations at a single setting of the work.

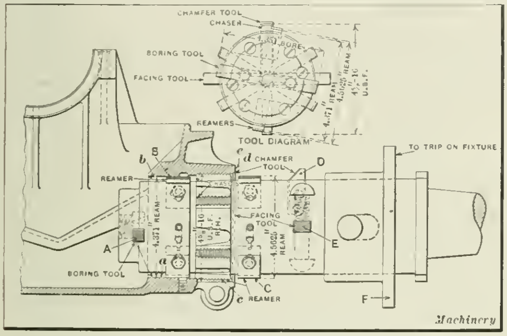


Fig. 5. Combination Boring, Reaming, Chamfering, Facing and Tapping Tool for machining Automobile Differential Case

So far, we have been concerned only with the performance of internal machining operations, but the combination tools made by the Murchey Machine & Tool Co. are not in any sense restricted to this class of service. Fig. 6 shows the combination of a set of turning and facing cutters and a self-opening threading die, which is used for machining the piece shown in Fig. 7. The operation of machining this piece is divided into two parts; first, the tool is fed over the piece with threading die chasers *A* collapsed, so that the four combination turning and facing tools *B* may turn section *b* on the work and face surface *c*. The form of these combination turning and facing tools will be best understood by referring to the cross-sectional view of the tool on the line X–X. After the first part of the operation has been completed, the tool is withdrawn from the work and the threading chasers *A* expanded, after which the tool is again moved forward to provide for cutting threads *b*. This automatic die is of the type provided with an inside trip which is operated by having trip-points *C* engaged with surface c on the work.

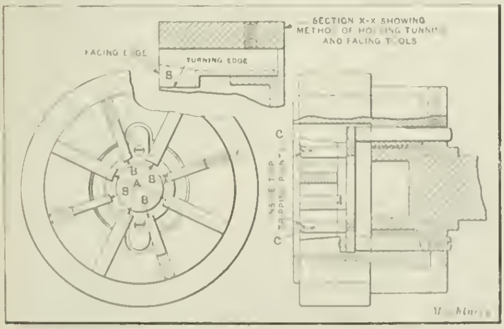

SECTION X-X SHOWING METHOD OF HOLDING TURNING AND FACING TOOLS
FACING EDGE
TURNING EDGE
B
C
B
A
B
B
B
TRIPPING POINTS
C
Machinery

Fig. 6. Combination Turning, Facing and Threading Tool for machining Piece shown in Fig. 7

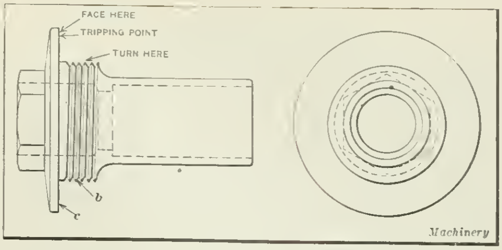


Fig. 7. Piece which is turned, faced and threaded by Tool shown in Fig. 6

In the manufacture of fuses for shrapnel and high-explosive shells, the necessity has arisen for machining various parts on which there is an internal and an external thread. To provide for handling this work in the most expeditious manner, it is obviously desirable to perform the internal and external threading operations simultaneously. Fig. 8 shows a combination threading die and tap which the Murchey Machine & Tool Co. has developed to meet the requirements of this work, and in Fig. 4 are shown two examples of the kinds of work for which this tool is adapted. The tool consists of a combination sizing tap and threading die, and both the tap and the die are furnished with means of adjustment to control the size of the work. To provide for handling work where the pitches of the internal and external thread are not the same, the tap is made free to move longitudinally in order to compensate for the difference in rate at which the tap and the die must be advanced while performing their respective operations. Although this type of tool was especially developed to meet the requirements of firms engaged in the production of fuse parts, it will be apparent that there are a variety of other threaded parts on which it could be used with excellent results. E. K. H.

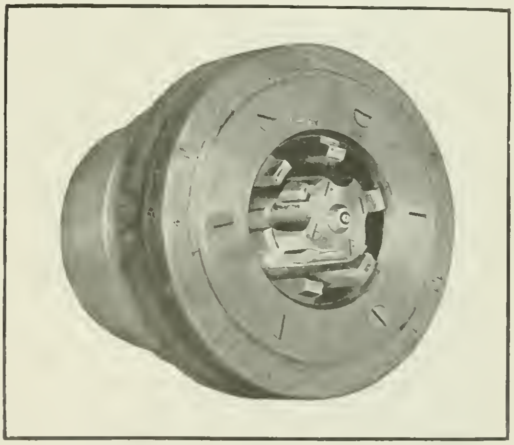


Fig. 8. Combination Threading Die and Tap for threading Work shown in Fig. 4

• • •

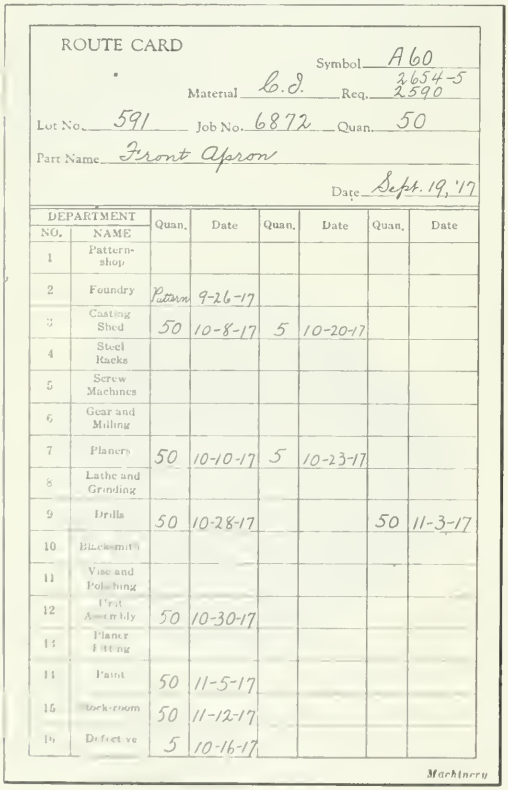
The magnitude of the operations to be undertaken by the American forces in France is indicated by the fact that the government has purchased 150,000 tons of eighty-pound rails for use overseas, which is equivalent to 600 miles of double-track line.

CARD INDEX PRODUCTION SYSTEM

BY LEWIS JOHNSON[1]

There are two objections to most routing systems: First, they are written upon large sheets of paper, usually about fifteen by twenty-four inches, which makes them extremely unhandy; and, second, no provision is made for parts made up later on an order to replace spoiled work or defective castings or for parts that are sent twice to the same department for different operations or on which there is some intermediate operation in another department.

The routing card shown in Fig. 1 takes care of all these contingencies. It measures only four by six and one-half inches and is very flexible, yet the writer has never seen its use suggested in any text-book. The card gives the part number and name of the pieces and the material from which they are to be made, the requisition number upon which it was ordered, the lot and job numbers upon which the pieces are to be used, and the date the order was made out. It also states if this material is special, and each department bears a number. To illustrate its purpose, the card is filled out for a piece that has not been manufactured before. This case will especially apply to any concern building special machinery, but the quantity of pieces made on an order would be probably smaller. The card shows that the pattern shop delivered the pattern to the foundry store house on September 26, that fifty castings were finished and in the shed on October 8, and were delivered to the planer department on October 10. A receipt, shown in Fig. 2, is given by each department for all material it receives. On the planer operation, five castings were found to be defective, so a green rush tag was issued for castings to replace them. These were ordered from the foundry on requisition No. 2654, were delivered to the casting shed on October 20, and sent to the planer department on October 23, where they were planed and sent forward, with the other forty-five pieces, to the drilling department on October 28, and from there to the unit assembly department. On November 3 the work was returned to the drilling department for further drilling, and was then sent to the painting department on November 5, and finally to the stock-room on November 12. If, in the stock-room, some of the pieces failed to pass the final test and could not be used, another green tag would have been made out for the rest, and the replacement carried through as before.



ROUTE CARD

Symbol A 60

Material C. I. Req. 2654-5 / 2590

Lot No. 591 Job No. 6872 Quan. 50

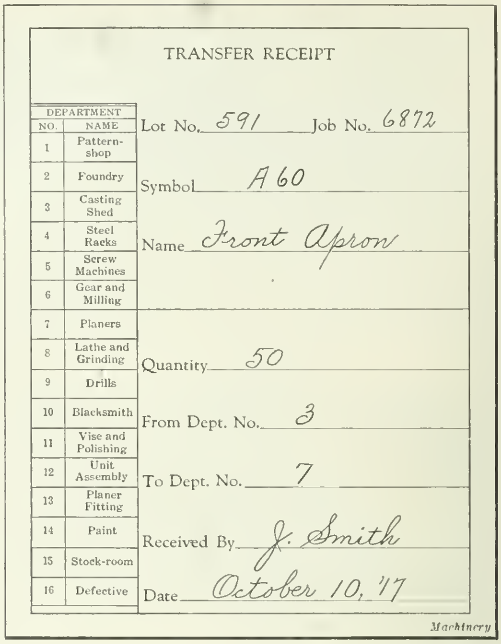
Part Name Front Apron

Date Sept. 19, '17

DEPARTMENT NO.	DEPARTMENT NAME	Quan.	Date	Quan.	Date	Quan.	Date
1	Pattern-shop						
2	Foundry	Pattern	9-26-17				
3	Casting Shed	50	10-8-17	5	10-20-17		
4	Steel Racks						
5	Screw Machines						
6	Gear and Milling						
7	Planers	50	10-10-17	5	10-23-17		
8	Lathe and Grinding						
9	Drills	50	10-28-17			50	11-3-17
10	Blacksmith						
11	Vise and Polishing						
12	Unit Assembly	50	10-30-17				
13	Planer Fitting						
14	Paint	50	11-5-17				
15	Stock-room	50	11-12-17				
16	Defective	5	10-16-17				

Machinery

Fig. 1. Routing Card



TRANSFER RECEIPT

DEPARTMENT NO.	DEPARTMENT NAME
1	Pattern-shop
2	Foundry
3	Casting Shed
4	Steel Racks
5	Screw Machines
6	Gear and Milling
7	Planers
8	Lathe and Grinding
9	Drills
10	Blacksmith
11	Vise and Polishing
12	Unit Assembly
13	Planer Fitting
14	Paint
15	Stock-room
16	Defective

Lot No. 591 Job No. 6872

Symbol A 60

Name Front Apron

Quantity 50

From Dept. No. 3

To Dept. No. 7

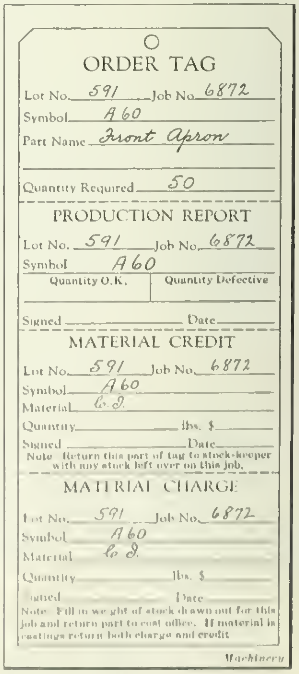
Received By J. Smith

Date October 10, '17

Machinery

Fig. 2. Transfer Receipt

The classification chart, Fig. 4, shows how these cards may be sorted into special groups; of course, in each group the cards run with the symbols in numerical order, and are filed with the cards constituting each order for machines separately. Group 1 contains route cards for all orders for parts made from castings, the patterns for which are not yet completed. As the patterns are made and delivered to the foundry store-house, an entry is made on that particular card and the card placed in Group 2; thus Group 1 grows smaller and smaller. At regular intervals, a shortage slip is made out and delivered to the pattern-shop boss, so he can tell where to concentrate the energies of his force. This also insures that patterns for such pieces as are made from special material or



ORDER TAG

Lot No. 591 Job No. 6872

Symbol A 60

Part Name Front Apron

Quantity Required 50

PRODUCTION REPORT

Lot No. 591 Job No. 6872

Symbol A 60

Quantity O.K.	Quantity Defective

Signed Date

MATERIAL CREDIT

Lot No. 591 Job No. 6872

Symbol A 60

Material C. I.

Quantity lbs. $

Signed Date

Note Return this part of tag to stock-keeper with any stock left over on this job.

MATERIAL CHARGE

Lot No. 591 Job No. 6872

Symbol A 60

Material C. I.

Quantity lbs. $

Signed Date

Note Fill in weight of stock drawn out for this job and return part to cost office. If material is castings return both charge and credit

Machinery

Fig. 3. Order Tag

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[1] [illegible] Manager, Hamilton Machine Tool Co., Hamilton, Ohio

cast outside the plant are made ahead of the rest of the patterns and sent out to the foundries. As the castings are made in the foundry, they are sent through the castings shed, and when there are enough to satisfy the order they are sent to the machine department. When the receipt for this transaction comes into the office, the entry is made on the card, which is in Group 2, and the card is filed in Group 3. As all castings are finished, Group 2 will be finally eliminated, and, if necessary, shortage slips can be made out from time to time on the foundry. There are now left only Groups 3, 4 and 5, and as the parts are finished and sent to the stock-room ready for assembling, Groups 3 and 4 are assimilated by Group 5, which is the only group that remains at the end. Of course, where any parts have proved defective or been spoiled, rush tags have been made out to replace those parts. These rush tags bear the same lot and job number as the original order, and the work is pushed through to the stock-room, so that the order is soon completed and ready for assembling.

The transfer receipt, shown in Fig. 2, is four by five and one-half inches and is furnished in duplicate in pads of fifty each. One copy is then sent to the production office and the other to the foreman from whom the material has just been received.

CLASSIFICATION FOR ROUTE CARDS. .	
Group 5	Orders for pieces which have been completed and are in finished stock-room awaiting assembly.
Group 4	Orders for pieces made from steel in process of manufacture.
Group 3	Orders for pieces made from castings which have been completed by foundry and are now in process of machining.
Group 2	Orders for pieces made from castings the patterns for which are completed and in foundry.
Group 1	Orders for pieces made from castings the patterns for which are not yet completed.

Machinery

Fig. 4. Classification Chart

The order tag, shown in Fig. 3, is made out in the production department, attached to the blueprint and sent to the raw stock-room. If the parts are made from castings, the weight is filled in and the two lower parts detached and sent to the office. The two upper parts, with the blueprint and castings, are sent to the machine department. If the parts are made from steel pieces sawed from the bar, a similar procedure is followed. In the case of screw machine parts, the bar of steel or brass is weighed and the weight filled in on the lowest part of the tag, which is detached and sent to the office. The rest of the tag, with the blueprint and bar stock, is sent to the machining department. When the job is finished, the part headed Material Credit is returned with the surplus stock to the raw stock-room, where the weight is filled in and the slip is sent to the cost office. If there is no stock left over, the slip is so marked and returned to the raw stock-room and thence to the cost office. The two upper parts of the tag, with the blueprint, remain with the job through all the machine operations to the finished stock-room. After being inspected, the second part of the tag is detached and sent to the cost office, while the top part of the tag remains with the pieces as a means of identification. A similarly printed tag, but colored green and headed rush, is used as an order for those pieces that are being made to replace defective or spoiled pieces and which follows exactly the same routine enumerated above.

The advantage of this system is that most of the clerical work is performed in the office, and as a good mechanic is seldom either an expert chirographer or bookkeeper, this eliminates the chances for error and also reduces to a minimum the number of forms required, thereby simplifying the working system. On the route card, no provision is made for the cost record figures, but the reverse side of the card may be used for this purpose. This card was designed and intended to fit one particular shop. Many forms fail in their purpose simply because they have been copied piecemeal from some form that is doing excellent duty in the first plant but which fails to fit the conditions in the second plant. Care must be taken with the receipt form and with the numbering of the departments to have everything clearly defined and nothing ambiguous, so that the entries on the route cards may be made correctly by a junior clerk (the writer has found girls much more careful and thorough for this class of work than boys); this leaves the production man's time open for more important work.

* * *

METHODS OF WAGE PAYMENT

In the Pittsburg district, increases in wages during 1917 were made in a number of different ways, including the payment of bonuses, straight increase in time rates, and increases by means of premium, piece-work and tonnage rates. Twenty-nine per cent of the employers pay a bonus in addition to the regular wages. Twenty-two per cent use the premium plan in which a certain time is set for the completion of an operation, and if the workman completes the task in less than the time set, he is paid a certain percentage, usually one-half, of the saving thus effected. Twenty-nine per cent of the employers use the piece-work plan for all wage payments. In some cases even common laborers, truckers and loaders are paid by the ton or piece for all the work done. In 10 per cent of the cases a bonus is paid upon the tonnage output and the number of hours worked, this being an incentive to put forth the best efforts and to discourage absence from work. In 10 per cent of the cases, straight wage increases have been paid without the use of bonus, premium or piece-work plans. Bonuses are frequently paid in separate envelopes and on separate days from the regular pay days. In some cases the bonuses are paid at the same time as the regular wage payments, but are marked on the outside of the envelope in red ink as "Bonus." Generally the bonus is from 10 to 20 per cent of the regular wages. In some cases, a 5 per cent bonus is paid after two months' employment, and then an increase of 1 per cent is made for every two months of employment until 10 per cent is reached. In other cases the additional percentage is continued until 20 per cent is reached. Some firms also have paid an additional bonus of 8 per cent based upon punctuality and attendance to business. Absence from work without permission forfeits the bonus, but absence on account of sickness or other unavoidable causes does not deprive the employe of his share. It has been noted that the payment of a certain percentage of the regular wages in the form of bonuses under these conditions has resulted in regular attendance at work, so that there has been a marked decrease in the days and hours lost.

In the Pittsburg district, the customary allowance for over-time is time and one-half, except on Sundays and legal holidays, when double time is paid. Over-time commences after fifty-four hours for the week have been completed. Over-time and long hours are the rule rather than the exception, and from the present outlook this will continue to be the condition throughout the duration of the war.

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Norway's first reinforced-concrete ship was launched in three weeks from the time work on it was begun. As the forms can be used for all other ships of this size, it is expected that all later ships will be ready for launching in one-half this time. It is thought, too, that the ships of 1000 tons that are being planned can be launched in six weeks after work is begun.

THREAD-CUTTING ATTACHMENTS[1]

STANDARD AND SPECIAL MECHANISMS AND ATTACHMENTS FOR ENGINE LATHES, TURRET LATHES, DRILLING AND BORING MACHINES

BY FRANKLIN D. JONES[2]

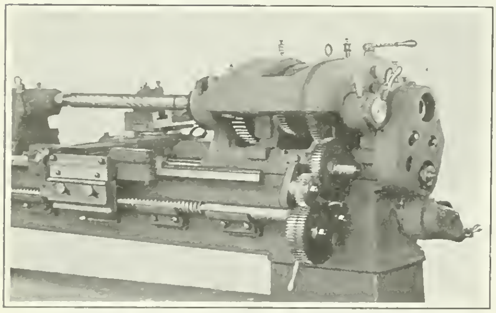

Fig. 1. Attachment for cutting Threads of Coarse Pitch or Large Lead

A SPECIAL mechanism or some form of attachment may be used in connection with thread-cutting operations either in engine lathes, turret lathes, or other classes of machine tools which may or may not be employed ordinarily for work of this kind. An attachment is sometimes applied to an engine lathe for cutting a screw thread of unusually large lead or for other special operations, such as cutting threads which differ slightly in pitch from the standard pitch. Thread-cutting attachments are also applied to some turret lathes, so that threads may be cut by means of a single-point tool or chaser whenever a tap or die cannot be used to advantage.

Attachments for Cutting Screws of Large Lead

When a lathe is used for cutting a screw thread of exceptionally large lead, or steep pitch, the change-gear mechanism may be subjected to excessive stresses if the power for traversing the carriage along the bed is transmitted from the lathe spindle to the lead-screw in the usual manner. This is due to the unusual distance that the carriage must move along the bed per revolution of the work in order to obtain a large lead. For instance, if the lead is such that the lead-screw must be revolved quite rapidly to move the carriage and tool a distance equal to the lead of the thread, each time the spindle makes one revolution, the teeth, especially on the first gear of the train, may be broken as a result of the excessive stress. One method of avoiding trouble of this kind is to apply power directly to the lead-screw, instead of to the spindle; motion is then transmitted from the high-speed member of the gear train to the low-speed member, as the lead-screw drives the spindle, and the load on the gear teeth is reduced. Another method of overcoming this difficulty is by driving the lead-screw from the gear on the cone pulley, a special "attachment" or gearing being used to transmit the motion. On one design of lathe arranged in this way, the cone pulley has a velocity ten times that of the spindle when the back-gears are engaged; consequently, by using the rapidly revolving cone gear as the driver in the train of gearing connecting with the lead-screw, the stress on the teeth is reduced proportionately. If we assume that the lead of a screw to be cut is 3½ inches, and that there are 4 threads per inch on the lathe lead-screw, the ratio of the spindle speed to that of the lead-screw is 14 to 1. By driving directly from the cone gear, however, the ratio will be changed to 14 to 10, because the cone pulley revolves ten times as fast as the spindle; therefore, the power necessary for traversing the carriage is easily transmitted through the gearing, and without overstressing the teeth. The gearing on a coarse threading attachment of this kind may be arranged as follows: A double sliding gear on the reversing shaft [illegible] of the headstock can be engaged either with the regular driving gear on the spindle or with a small gear at the end of the cone pulley. For cutting threads of large lead, the sliding gear is engaged with the cone gear and the back-gears are thrown into mesh. The sliding gear will then make ten revolutions to one of the spindle; consequently, if the lathe were geared to cut one thread per inch, it would cut a thread groove having a lead of ten inches when driving through the sliding gear and cone pinion. An attachment of this kind may be used for cutting oil-grooves in cylindrical parts and for similar operations, as well as for cutting screws of large lead.

Special Lead-screw for Cutting Threads of Coarse Pitch

A rear view of a Lodge & Shipley lathe having a special lead-screw for cutting threads of large lead is shown in Fig. 1. This auxiliary lead screw extends along the rear side of the bed, and when in use the back-gearing of the headstock is engaged; the drive is then from the large back-gear, through the change-gearing shown, to the special lead-screw. A long half-nut at the back of the carriage engages the threads of the lead-screw and is so arranged that it may be raised or lowered by a cam operated by a handwheel at the front of the apron. The lead-screw is supported on the under side by a number of long shoes attached to the lathe bed. This lathe is equipped with the regular quick-change gear mechanism and a lead-screw at the front for ordinary thread-cutting operations with leads ranging from 1/32 inch to 2 inches. The coarse-pitch threading attachment is used for leads varying from 2 to 15 inches.

Cutting Threads so that Pitch is Slightly Greater or Less than Standard

It is sometimes necessary to cut a screw thread having a pitch which is slightly greater or less than standard. A very small increase of pitch may be required in order to allow for shrinkage of the steel in hardening, or if a screw is to be fitted into a hardened part having an internal thread, it may be necessary to make the pitch of the screw thread less than standard on account of shrinkage in the nut or other part which is to receive the screw. A slight increase in pitch may easily be obtained by means of a taper attachment, but cutting a pitch less than standard is more difficult.

When a taper attachment is used to increase the pitch slightly it is set at an angle and the part to be threaded is located at the same angle by adjusting the tailstock center; consequently, the thread tool will cut a straight thread or one of uniform diameter throughout its length, but as the tool point moves along an angular path relative to the movement of the carriage, it travels farther than the carriage. The result is that the pitch of the thread cut by the tool is a little greater than the pitch for which the lathe is geared. The amount that the pitch is increased depends upon the angle between the axis of the work (or the angle to which the taper attachment is set) and a line representing the movement

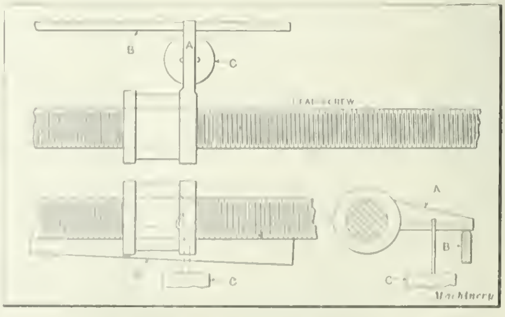

Fig. 2. One Type of Attachment for obtaining Slight Variations in Pitch or for correcting Lead-screw Errors

of the carriage. The cosine of the angle to which the work and taper attachment should be set for obtaining a given increase in pitch equals the standard pitch (obtained with the regular gearing) divided by the increased pitch necessary to compensate for shrinkage.

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[1] For additional information on this subject, see "Thread Milling," January, 1918, and articles there referred to.

[2] Associate Editor of MACHINERY

If a screw thread must be cut having a pitch slightly less than standard, special equipment is required. One method is to provide special gears which give a somewhat greater reduction of pitch than is necessary. The taper attachment is then used, as previously explained, to increase the pitch so that it is below the standard just the right amount. For instance, if the required pitch is 0.198 inch instead of the standard of 0.200 inch (five threads per inch) gears having 83 and 84 teeth, respectively, could be used to form a compound train of gearing and reduce the 0.200-inch pitch obtained with the regular change-gears. This reduction would equal 83/84 of 0.200 inch, or 0.1976 inch. In order to increase the pitch of 0.1976 inch to 0.198 inch, the taper attachment and work are set at an angle the cosine of which equals 0.1976 divided by 0.198 equals 0.9979, which is the cosine of 3 degrees, 40 minutes. As this example indicates, the pitch for which the lathe is geared is divided by the pitch required, to obtain the cosine of the angle.

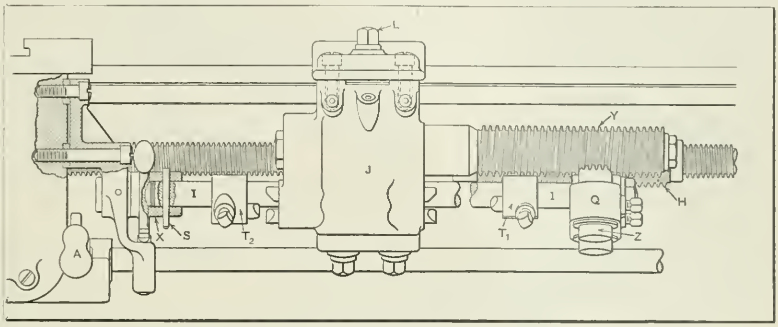

Fig. 4. Quick-threading Attachment for Engine Lathe

Special Attachment for Obtaining Slight Variations in Pitch

Lathes that are used extensively for precision screw cutting are sometimes equipped with special compensating attachments for varying the pitch. These attachments may be used in some cases to cut screw threads which differ slightly from the standard pitch, as when an allowance must be made for shrinkage, or the attachment may be used to compensate for slight inaccuracies in the lead-screw in order to cut threads to a given pitch within as close limits as possible. Most of these attachments are designed to vary the pitch either by imparting a turning movement to the nut engaging the lead-screw, or by shifting the lead-screw itself in a lengthwise direction. The diagram Fig. 2 illustrates how slight variations may be obtained by turning the lead-screw nut or as a result of a differential motion between the lead-screw and the nut connecting with the tool carriage. A nut of special form is mounted in a bracket attached to the carriage so that it is free to turn. Projecting from this nut there is an arm *A*, the end of which is held firmly against the edge of a compensating strip *B* by weight *C*. The strip *B* can be set in an inclined position, so that when arm *A* is traversed along it, the nut is turned in one direction or the other, thus increasing or decreasing the pitch of the thread cut by the lathe, by advancing or retarding the movement of the carriage.

The diagram Fig. 3 illustrates a type of compensating attachment which operates by moving the lead-screw axially. The lead-screw bearing at one end is in the form of an externally threaded sleeve *A*, which is screwed into an outer stationary sleeve *B*. The lead-screw is free to rotate in sleeve *A*, but it cannot move in a lengthwise direction relative to *A* except when the latter is screwed in or out of sleeve *B*. The turning movement of sleeve *A* for varying the pitch is derived from a pinion attached to *A* which meshes with a rack *C* having at its lower end a block engaging a slot in plate *D*. This plate *D* is attached to a slide *E*, which is connected to the lathe carriage by a rod *F*; consequently, slide *E* and plate *D* move with the carriage, and when slot *D* is in an angular position the resulting vertical movement of rack *C* turns sleeve *A* and shifts the lead-screw, thus varying the pitch of the thread cut by the lathe.

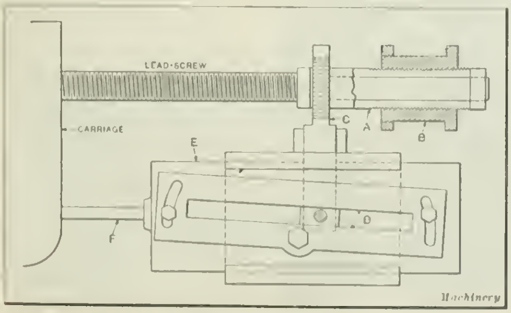

Fig. 3. Another Form of Attachment for obtaining Slight Variations in Pitch

Translating Gears for Metric Pitches

Lathes used for cutting threads based on either the English or metric systems of measurements may be provided with translating gears. There are two gears having 50 and 127 teeth, respectively. The numbers of teeth in these gears represent the relation between the English and metric systems of measurement; thus 1 inch is equivalent to 2.54 centimeters, and $\frac{1 \times 50}{2.54 \times 50} = \frac{50}{127}$. When these gears are in the train of gearing connecting the lathe spindle and lead-screw, the lathe may be geared for cutting a given number of threads per centimeter by using, in addition to the translating gears, the same gears that would be employed for cutting a similar number of threads per inch. For example, if a metric thread is to be cut having a pitch of 2 millimeters, or 5 threads to the centimeter, and translating gears are used, change-gears for cutting 5 threads per inch could be employed. In this case, 5 threads to the centimeter will actually be cut and not 5 threads to the inch, because the translating gears are used in conjunction with the regular gears, thus forming a compound train of gearing. If the gears for cutting 5 threads per inch should have 36 and 30 teeth, respectively, on the stud and lead-screw, the compound train of gearing for cutting 5 threads per centimeter would consist of driving gears having 50 and 36 teeth and driven gears having 127 and 30 teeth. The positions of either the driving or the driven gears could be transposed, if necessary, in order to make the gears mesh together properly.

Quick-threading Attachment for Engine Lathe

The Hendey quick-threading attachment shown in Figs. 4 and 5 is intended especially for cutting comparatively short threads on duplicate parts varying from one to three inches in length, although it may be used for lengths up to six inches. Thread cutting can be done rapidly with the attachment owing to the high speed at which the carriage is returned from the end of the cut to the starting point. This rapid-return movement is effected by a quick-return sleeve having a multiple thread of coarse pitch. This return sleeve, as well as the thread chasing sleeve from which the forward movement is derived, rotates constantly when the attachment is in use. The length of the travel in either direction is governed by automatic trip dogs. The chasing sleeve *Y* and the quick-return sleeve H are geared together and rotate at the same speed as the lead-screw. The nuts Z and Z_1, attached to rocker Q, may be engaged with the sleeves. Rocker Q is connected with the apron by means of push-shaft I through the handle indicated at X. When the split nut in the apron is disengaged, rotation of the lead-screw will move the carriage in one direction when nut Z is engaged with the chasing sleeve Y, and the rapid-return movement is obtained when nut Z_1 and sleeve H are in engagement. The dogs T_1 and T_2 determine the limits of travel by striking stop-pins on bracket J, which throws the handle X and rocker Q to the neutral position, in which position neither nut is in engagement.

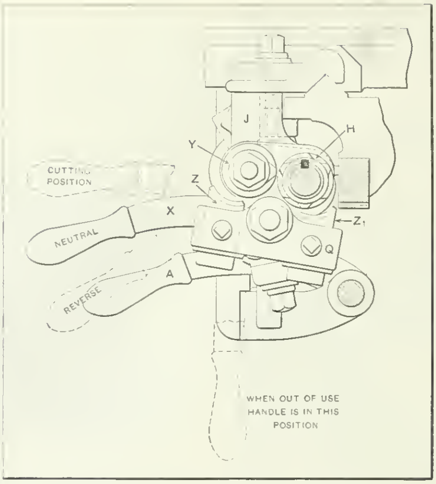

Fig. 5. End View of Quick-threading Attachment shown in Fig. 4

If a right-hand thread is to be cut, the change-gears in the gear-box of the lathe are set for whatever pitch may be required, and the regular reverse handle A is thrown downward and left in that position. The attachment should be clamped tightly to the bed by means of clamp screw L at a point which will allow of the desired amount of travel. Handle X is placed in the neutral position and the two dogs T_1 and T_2, marked "R" (which signifies right-hand), are placed on shaft I. The latter is then connected with X by the taper pin S. The dogs are set by running the carriage by hand to the point where it is to stop, and then sliding the corresponding dog along shaft I until it engages the stop-pin. Assuming that the first cut is to be taken with the carriage at the tailstock end and that the lathe is in motion, throw handle X up to the cutting position (see Fig. 5), keeping the pressure on the handle until nut Z engages the thread on sleeve Y. The carriage will then travel along until the dog T_1 throws the rocker Q and handle X to the neutral position. After withdrawing the threading tool, handle X should be thrown down to the reverse position with a rapid movement, thus causing the carriage to return rapidly to the starting point; then dog T_2 throws nut Z_1 out of engagement with sleeve H, and the carriage stops. This cycle of movements is repeated for each successive cut until the thread is completed. When cutting left-hand threads, the dogs marked "L" (left-hand) are substituted for those marked "R" and the regular reverse handle A is placed in the upper position. The operation of the attachment is the same for a left-hand thread as for one of the opposite hand, except that the quick-return movement is toward the lathe headstock. When using this attachment, the operating handle X should be thrown quickly from the neutral to the engaging positions, pressure being kept on the handle until the nuts are in engagement.

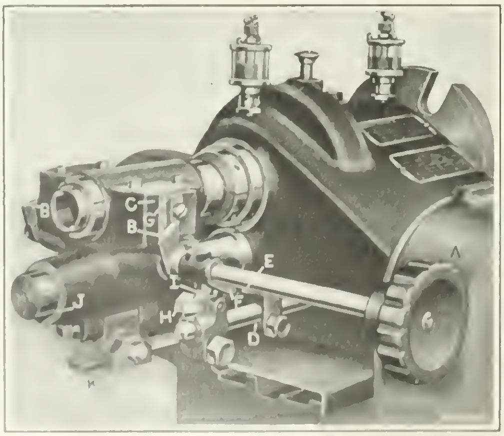

Fig. 6. Screw-cutting Attachment for Lathe of Manufacturing Type

Regulating Pitch of Thread when Using Quick-threading Attachment

It is important to understand the relation between the pitch of the thread to be cut and the pitch for which the regular change-gear mechanism of the lathe is set when using the quick thread attachment shown in Figs. 4 and 5. On Hendey lathes up to and including 20 inches swing, the lead-screw has 6 threads per inch, and, as previously mentioned, the chasing sleeve of the threading attachment revolves at the same speed as the lead-screw; therefore, it is evident that, when the lathe gear-box is set for 6 threads per inch, the pitch of the thread cut by the attachment will be the same as that of the chasing sleeve on the attachment. If the gear-box were set for 12 threads per inch, a thread of one-half the pitch of the chasing sleeve would be cut, and so on, it being possible to cut any number of threads per inch listed on the index plate of the gear-box, which is divisible by 6. For example, suppose that the chasing sleeve of the attachment has 4 threads per inch; then, with the gear-box handle set at 6 threads per inch, a 4-pitch thread will be cut; with the handle at 12, an 8-pitch thread; with the handle at 18, a 12-pitch thread; with the handle at 24, a 16-pitch thread; with the handle at 36, a 24-pitch thread, etc. When the gear-box handle is set at intermediate positions or for pitches not divisible by 6, the thread cannot be "picked up" again when the second cut is started, because the chasing sleeve is always in motion. When cutting threads which are finer than those on the chasing sleeve, it is evident that the lead-screw and attachment must rotate at a reduced speed, which reduces the speed of the return travel; therefore, it is advisable to use a chasing sleeve having a pitch as near as possible to the one that is to be cut.

Thread-cutting Attachment for Lathe of Manufacturing Type

An attachment for cutting screw threads rapidly on a lathe of the manufacturing type (see Fig. 6) is so arranged that the carriage is moved along the bed by the direct action of a short lead-screw and without the use of gearing between the lead-screw and the spindle. The lead-screw is in the form of an externally threaded sleeve and is mounted on an extension of the spindle. When a cut is being taken, the lead-screw is engaged by two segment-shaped nuts. One nut is shown at C and the other is on the opposite side of the lead-screw. These nuts, by traversing bracket J and the pull-rod K, transmit motion to the carriage.

In order to adjust the attachment, the carriage is located in the position it should occupy at the beginning of the cut. The right-hand carriage stop is then placed against it and fastened. The bracket J should be located next to the headstock and should be attached to pull-rod K, which, in turn, is secured to the carriage by means of a grip screw. With the carriage in this position, handwheel A is turned to the left, thus locating the two arms B in the position shown, which engages the nuts with the lead-screw. Stop D is next set so that finger E will contact with finger F. The wheel A is now turned to the right for disengaging the nuts from the lead-screw and the carriage is moved forward to the position it occupies at the end of the cut. After wheel A is turned to the right as far as it will go, or until the square corner of arm B comes into contact with the left-hand side of block G, trip-latch H is set so that it engages trip-finger I

When cutting a thread the carriage is located in the starting position by the stop at the right-hand side. When the tool has been fed in for taking a cut, wheel *A* is turned to the left, thus engaging the nuts and lead-screw. The carriage moves forward until the nuts are automatically disengaged by the engagement of finger *I* with latch *H*. The tool is then withdrawn and the carriage returned by hand to the starting position. This cycle of operations is repeated until the thread is finished. The manufacturing lathe to which this attachment is applied is made by the Porter-Cable Machine Co., Syracuse, N. Y.

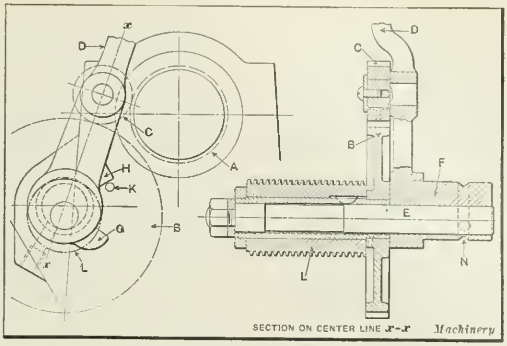

Fig. 7. Leader Driving and Reverse Mechanism

Thread-chasing Attachment

The lathes of the Fox or monitor type, which are used so extensively in the manufacture of brass fittings, have a thread-chasing attachment that affords a rapid means of cutting screw threads. The chasing attachment shown on the universal turret lathe in Figs. 8 and 9 (built by the Acme Machine Tool Co., Cincinnati, Ohio) will serve to illustrate the important features common to attachments of this kind. The attachment has a round bar *A* extending along the rear of the bed. This bar is mounted in bearings so that it is free to move in an endwise direction. Attached to one end of the bar there is an arm *B* which carries the follower *G*. The follower has several arms or sections which are threaded like the segment of a nut. These segment-shaped ends have threads of different pitches to match the pitch of the thread on whatever leader *C* is being used. When the chasing attachment is in use, the follower is placed in engagement with this leader *C*, which is simply a short lead-screw and is connected through gearing with the machine spindle. As the leader rotates, an endwise movement is imparted to the chasing bar *A* and to the thread-chasing tool which is carried by a toolpost on slide *H*, which, in turn, is supported by arm *F* attached at the rear to bar *A*. The leader is sometimes applied directly to the spindle, in which case its pitch must coincide with the pitch of the thread to be cut. Ordinarily, however, it is mounted on a shaft and is geared to the spindle in the ratio of 2 to 1, the leader revolving at one-half the spindle speed. When the leader is driven through gearing, the relation between the pitch of its thread and the pitch of the thread on the work depends upon the gear ratio. In any case where gearing is used, the leader revolves slower than the spindle in order to increase its pitch and make the threads coarser and more durable. If the ratio of the gearing were 2 to 1, the pitch of the thread on the leader would be double the pitch of the thread to be cut.

The slide which carries the chasing tool is operated by crank *E*, which serves to adjust the tool in accordance with the diameter of the work. The slide is located for cutting threads on duplicate parts by a stop-screw *K*. The arm *F* has an extension which rests upon a swiveling plate *D* at the front of the bed. The upper edge of this plate is in a horizontal position, except when cutting taper threads. When arm *F* is shifted by the handle *L* at the end of the extension, the chaser bar is turned in its bearings and the follower and leader are disengaged; at the same time the tool is withdrawn from the work. The tool-slide is prevented from swinging farther back than is necessary by a finger *N*, which engages a projection on the bed. The part to be threaded may either be held in some form of chuck, on a special arbor inserted in the spindle, or between centers, the outer center being carried in a hole in the turret. The tool-rest is clamped along bar *A* at the rear, in whatever position is necessary for locating the tool relative to the part to be threaded.

Method of Using Thread-chasing Attachment

When an attachment of the type illustrated in Figs. 8 and 9 is in use, the tool or chaser, which is held in an inverted position, is traversed by the leader, until the end of the cut is reached; the follower is then disengaged from the leader and the tool returned for another cut, which is taken as soon as the tool is fed downward by handle *E*. These cuts may be taken rapidly and a thread finished in a surprisingly short time. The action of the chaser bar may be controlled entirely by hand or may be partly regulated by adjustable stops on bar *A* and a return spring. One method of using stops is as follows: When the chaser has moved forward the required distance, a stop on the bar makes contact with a fixed stop (which may be one of the bearings in which the shaft slides and oscillates), and the angular flanks of the leader thread force the follower out of engagement and cause the chaser or cutter to withdraw from the work. Then a coiled spring or weight acting on the bar causes it to return to the starting position, which is also regulated by an adjustable stop. This operation is repeated until the thread is finished. The method of using a stop on the machine shown in Figs. 8 and 9 is as follows: The stop *P* is set so that a spring (not shown) will return the chaser just beyond the end of the piece to be threaded, and the follower *G* is so located relative to the leader *C* that it runs off the thread of the leader when the required length of thread has been chased.

The followers of chasing attachments have teeth formed on them by means of a hob. This hob may be placed on the leader spindle temporarily, or cutting teeth may be formed at one end of the leader, thus combining the leader and hob in one unit. When there is a star-shaped follower having teeth of several different pitches (as shown at *G*, Fig. 9), the follower is, of course, turned to locate in the working position, whichever end corresponds to the pitch of the leader being used. The leaders for thread-chasing lathes should be made of tool steel (not necessarily hardened) and the followers of a fairly soft material, such as brass.

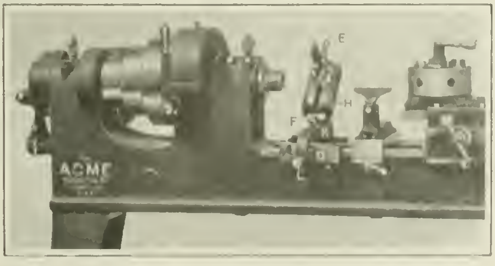

Fig. 8. Front View of Universal Turret or Monitor Lathe equipped with Thread-chasing Attachment

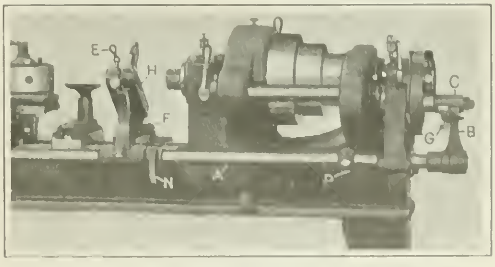

Fig. 9. Rear View of Universal Turret Lathe equipped with Thread-chasing Attachment

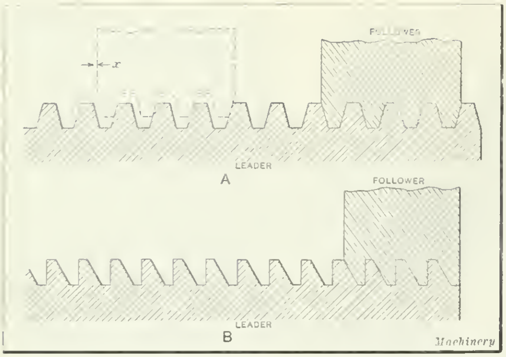

Fig. 10. (A) Action of Follower when using Rigid Follower Arm while chasing Taper Threads. (B) Form of Leader Thread intended to prevent Loss of Pitch when chasing Taper Threads

Cutting Left-hand Threads with Chasing Attachment

The gearing connecting the spindle and leader of a thread-chasing attachment of the Fox type is commonly provided with an intermediate or idler gear which can be engaged in order to permit cutting left-hand threads. This idler gear is mounted on a swinging plate, and when cutting right-hand threads, the drive is direct from the spindle gear to the gear which drives the leader. When it is necessary to cut left-hand threads, the idler is pushed over in mesh with the spindle gear, and at the same time the leader is disengaged from the gear on the spindle, so that the motion is transmitted through the idler. This reverses the motion of the leader and the movement of the chaser on the cutting stroke. It is the practice in some brass-working shops to reverse the lathe spindle for chasing left-hand threads so that the leader will continue to revolve in the same direction and the chaser will move toward the headstock of the machine when cutting a left-hand thread, the same as for a right-hand thread.

The leader driving and reversing mechanism of the universal monitor lathe built by the Dreses Machine Tool Co., Cincinnati, Ohio, is shown in Fig. 7. Gear *A* is on the main spindle and gear *B* drives the leader. For chasing right-hand screw threads, motion is transmitted directly from gear *A* to gear *B*, but for left-hand threads lever *D* is shifted to the position shown in the illustration. The drive is then through gears *A*, *C* and *B*. Lever *D* with its boss *F* swivels in a bearing formed in the headstock and is held in place by a setscrew and plug engaging the annular groove *N*. Lever *D* also carries the small intermediate gear *C*. Stud *E*, which supports the leader *L* and the large gear *B*, is located eccentrically in boss *F*, so that by swinging lever *D* in one direction or the other, the direct drive or the drive through the intermediate gear is obtained. The lugs *G* and *H* on lever *D* engage a fixed pin *K* attached to the headstock, which limits the movement of the lever and brings the gears into proper mesh.

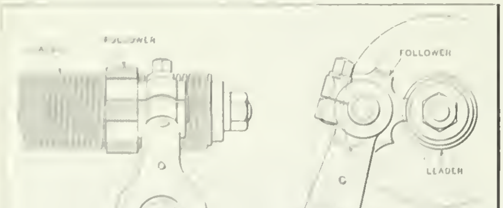

Fig. 11. Flexible or Yielding Follower Arm for holding Follower in Contact with Straight Leader when Chasing Taper Threads

Application of Chasing Attachment to Tapering Work

When a chasing attachment of the type illustrated in Figs. 8 and 9 is applied to the cutting of tapering screw threads, the plate *D* is tilted at an angle, so that as arm *F* is traversed along the plate, it will be elevated, thus causing the tool to cut a tapering thread. The inclination of this plate depends upon the relative lengths of the two arms of the chasing lever, the distance from the cutting teeth of the chaser to the center of bar *A* representing one arm and the distance from plate *D* to bar *A* representing the other arm.

If the arm *B* to which the follower is attached were rigidly connected to bar *A* when chasing a tapered thread, the follower would move away from the leader as the chasing tool and arm *F* were elevated by the inclined plate *D*, while traversing from the small to the large end of the tapering part being threaded. Any such movement of the follower relative to the leader would cause the chaser bar to lag behind and result in a loss in pitch, as illustrated diagrammatically at *A* in Fig. 10. The follower, which is shown in full mesh at the starting point, would gradually move outward on the angular side of the leader thread and there would be a loss in pitch, as indicated by dimension x. For many classes of brass work, the error in pitch resulting from this action of the follower might be of little consequence, especially when mating parts are chased in the same way. The chasing attachment shown in Figs. 8 and 9, and many other chasing attachments now in use, have a flexible or yielding follower arm which makes it possible to chase all taper threads satisfactorily and without loss of pitch.

In order to overcome the loss of pitch due to the relative movement between a rigid follower and a parallel or straight leader, the form of leader thread illustrated at *B* in Fig. 10 has been employed. As will be seen, one side of the thread is perpendicular to the axis of the leader. One of the disadvantages of this form of thread is that the bearing between the follower teeth and the leader thread decreases as the follower moves outward, due to the difference between the helix angles of the surfaces in contact. In some cases this difficulty has been partly overcome by allowing the follower to swivel on a stud located at right angles to the axis of the leader.

Instead of using parallel leaders for chasing taper threads, taper leaders have been employed in conjunction with an inclined plate for guiding the chasing arm. When using a taper leader, it is necessary to consider the bearing contact with the follower, which cannot be made to fit the leader thread at all points. For instance, if the follower is fitted to the small end of the leader, the angle of its teeth will be greater than if it were made to fit the large end of the leader. The contact on the driving side will be at one point only on each thread or tooth, except at the small end. If the follower is fitted to the large end of a tapering leader, a better bearing will be obtained, although, in any case, a relatively small amount of follower surface will be in contact with the leader.

Flexible or Spring-supported Follower Arm for Chasing Taper Threads

The difficulties previously referred to in connection with taper work have been overcome by using a flexible or spring-supported follower arm. The yielding follower arm or holder of a Dreses universal monitor lathe is illustrated in Fig. 11. This holder consists principally of a short lever *A*, which is clamped to the chasing bar *B*, and a yoke-shaped arm *C*, to the upper end of which the star-shaped follower is attached. Interposed between lever *A* and arm *C* is a spiral spring *D*, which bears against one side of lever *A* and rests in a pocket formed in arm *C*. When chasing a tapered thread, this spring connection holds the follower into engagement with the leader while the chasing tool travels from the large to the small end of the tapering screw thread.

If the chasing tool must run close to a shoulder, the guide plate (corresponding to plate *D*, Fig. 8) may be provided with a rather abrupt tapering shoulder for elevating the chasing tool quickly at the end of the cut.

Thread-cutting Mechanism of Gisholt Turret Lathe

While most thread cutting in the turret lathe is done by means of taps or dies, special sizes or pitches are often required which can be cut to better advantage by using either a single-point tool or a chaser. The Gisholt turret lathe is so arranged that the carriage can be traversed by the lead-screw when a single-point tool or chaser is to be used. The lead-screw is driven through change-gears which provide for cutting thirty-two different leads or pitches, ranging from 4 to 56 threads per inch. These same gears also furnish sixty-four feed changes, the necessary reduction of movement for feeding being obtained by shifting a pull-pin which changes the ratio of the gearing through which motion is transmitted from the change-gears to the lead-screw.

The arrangement of the mechanism on the carriage which makes it possible to readily "catch the thread" each time a cut is taken is shown in Fig. 12. The view at *A* illustrates the old type, and that at *B*, the new type. These two designs differ somewhat, but are the same in principle. The lead-screw nut has a number of equally spaced notches in flange *f*, and when the carriage is being traversed by the lead-screw, the end of pull-pin *p* engages one of these notches. When the tool reaches the end of its cut, pull-pin *p* is withdrawn and the carriage is returned by hand for taking another cut. The different notches in the lead-screw nut serve the same purpose as the graduated thread indicator on an ordinary engine lathe in that they are used for engaging the carriage and lead-screw at the right time, so that the tool will follow the original cut or thread groove. The number of notches in any lead-screw nut depends upon the pitch of the lead-screw on that particular machine. The lead-screw nuts with pitches of 3, 4 and 5 inches have notches so located that they represent inches of carriage travel, there being three notches in the lead-screw nut of 3-inch pitch, four notches in the nut of 4-inch pitch, and so on. The lead-screw nuts having pitches of 3½ and 4½ inches, which are found on two sizes of Gisholt turret lathes, have notches representing ½ inch of carriage travel.

When cutting threads of even pitch, such as four, six or eight threads per inch, the pull-pin *p* may be engaged with any notch on the lead-screw nut, regardless of the pitch of the lead-screw, and the tool will follow the original cut. The reason why any notch may be engaged when the number of threads per inch is even is illustrated by the diagram *A*, Fig. 13, which shows a screw having four threads per inch. Thus, if the movement of the tool is 1 inch, as represented by positions *a* and *b*, or any whole number of inches, it will still remain in alignment with the thread groove. The alignment would also be maintained for half-inch movements, as indicated by positions *a* and *c*. If there were an odd number of threads per inch, as indicated at *B*, it would be necessary to engage the pull-pin with notches representing an inch of carriage travel, as illustrated by positions *d* and *e*. This requires two notches, or any number evenly divided by 2 on those machines where one notch represents one-half inch of carriage travel, whereas on the other machines any notch will catch the thread. A movement equivalent to ½ inch, 1½ inch, etc., would locate the tool on line with the top of the thread, as illustrated at *f*. If there were 5½ threads per inch to be cut, the pull-pin should be engaged only with notches representing two inches of travel, or 11 threads on the screw, because a movement of one inch would align the tool with the top of the thread. Diagram *C* shows a screw having 5¾ threads per inch. In this case, the movement should be equivalent to 4 inches, or 23 threads. If the notches represent inches of carriage travel, the engagement of the pull-pin with the lead-screw nut should be at points either four notches apart or any number evenly divided by 4. On the other hand, if the notches represent half inches of carriage travel, engagement at points eight notches apart, or any number evenly divided by 8, will catch the full thread. The various positions of the tools in diagram *C* clearly show why the movement must be equivalent to four inches, or some multiple of 4, in order to again locate the tool in alignment with the thread groove.

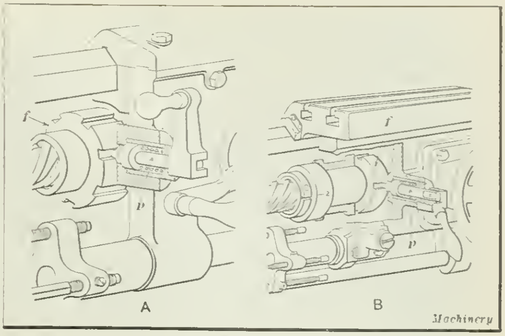

Fig. 12. Thread-cutting Mechanism of Gisholt Turret Lathe

Thread-chasing Attachment of Hartness Flat Turret Lathe

The screw-cutting or screw-chasing attachment shown in Fig. 14 is applied to the Hartness flat turret lathe, built by the Jones & Lamson Machine Co., Springfield, Vt. This attachment is semi-automatic in operation, the cutter or chaser advancing and returning automatically while the operator regulates the depth of cut by feeding the cross-sliding headstock the required amount for each stroke of the thread-chasing tool. The attachment is driven from the bevel gear *A* on the main spindle through spiral gears and spline shaft *B*; this shaft transmits motion through bevel gears *C* and *D* to vertical shaft *E*, the lower end of which carries a spiral gear *F* that meshes with spiral gear *G*, keyed to the special lead-screw *H*. The cutter-bar *J* has a threaded plug or sectional nut *K* engaging the lead-screw. When the tool has been fed forward the required amount, the adjustable collar *L* on the extension end of the lead-screw strikes plug *M* with its projecting end, thus rocking shaft *N* and allowing nut *K* to drop down on a flat part of the shaft and out of engagement with the lead-screw. At the same time, the rocking of shaft *N*, through the eccentric pin *O*, withdraws the tool from the work. On the lower end of shaft *E* there is a spur gear *R* driven by friction resulting from the pressure of spring *S*. This spur gear is constantly in engagement with rack teeth cut on the cutter-bar *J*. As soon as nut *K* is withdrawn, the cutter-bar is returned rapidly by the rack and pinion motion until a pin in collar *T* engages pin *U*, thus again turning shaft *N* to its former position, which reengages nut *K* with the lead-screw *H*, and then the cutting stroke is repeated. The small lever *W* may be used for disengaging the nut and withdrawing the tool by hand. With this arrangement, the main spindle ro-

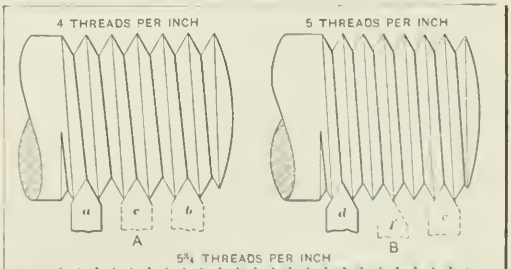

Fig. 13. Relation between Position of Tool and Screw Threads having Even, Odd, and Fractional Numbers of Threads per Inch

tates continuously in one direction. A separate lead-screw and nut is required for each different pitch, which must correspond to the pitch on the work. For taper threading operations the attachment is swiveled on its base. The chaser type of cutter, or one having several teeth, is used for U. S. standard threads, V-threads and Whitworth threads, but single-point cutters are recommended for square and Acme threads, as well as for all threads that must extend close to a shoulder. The connections at both the headstock and turret end swivel about vertical axes and the spline transmission shaft *B* slides through the headstock connection, so that lateral feeding movements of the headstock or the indexing of the turret does not interfere with the connection to the thread-chasing attachment. This attachment is adapted for internal and external thread-cutting operations. It is shown in Fig. 15 cutting an external thread.

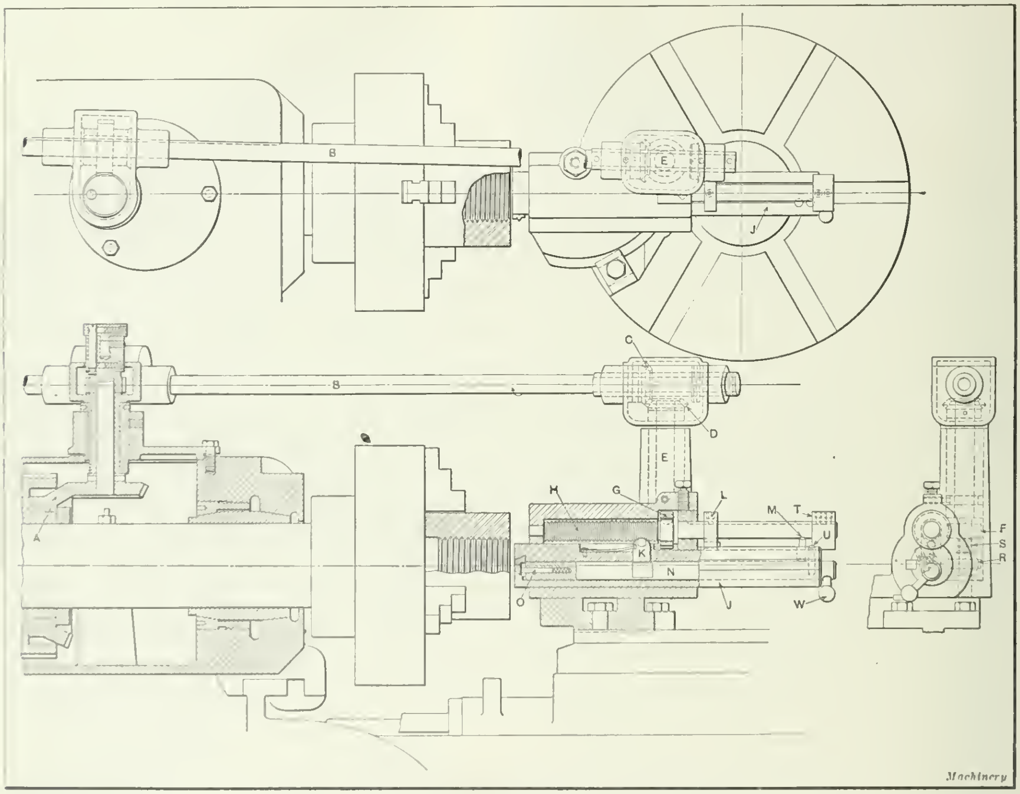

Fig. 14. Thread-chasing Attachment of Hartness Flat Turret Lathe

Thread-chasing Attachment of Acme Flat Turret Lathe

The thread-chasing attachment of an Acme flat turret lathe, built by the Acme Machine Tool Co., Cincinnati, Ohio, is applied to the machine illustrated in Fig. 16. This chasing attachment may be used for either right- or left-hand threads on internal and external work. It is intended especially for cutting threads on parts which are either too large in diameter or required in too small a quantity to warrant the purchase of special taps and dies. An example of external thread cutting is shown in this particular illustration. A single-point cutter is carried by a 2-inch bar, which is rigidly held in a holder clamped on to the flat turret. The action of the carriage when cutting a thread is controlled by a leader shown on the front end of the machine. The pitch of the thread which is cut corresponds to the pitch of the thread on this leader. The brass follower which engages the leader is moved into or out of engagement by the hand-lever shown. This lever is pivoted on a bracket which is bolted to the end of the carriage apron. The controlling lever is arranged to disengage automatically at the end of a cut. In order to chase left-hand threads with this attachment, it is simply necessary to shift the feed reverse lever on the gear-box at the front of the headstock.

Attachment for Cutting Threads on Drilling Machine

A drilling machine is sometimes used for cutting internal threads with a single-point tool when the part will not swing in the lathe and the use of a tap is not practicable. A lead-screw of whatever length may be needed is attached to the end of the cutter-bar, or the latter is extended to form a lead-screw as shown at *A*, Fig. 17. This lead-screw engages some form of nut that is bolted to the baseplate of the machine. The thread on the lead-screw corresponds, as to lead, with the thread to be cut, and, as the spindle revolves, the cutter forms a thread, as it is drawn down through the work by the direct action of the lead-screw. The spindle may be returned to the starting position by reversing it, assuming that the machine has a tapping attachment or other means for reversing the rotation. When performing an operation of this kind, the drill press spindle must be free to move vertically. With a makeshift arrangement of this kind intended for a special operation, the cutter would not require a special device for feeding it outward, as it could be reset for each cut without much trouble.

Thread Cutting on Vertical Boring Mill with Single-point Tool

The vertical boring mill is used quite frequently for cutting screw threads in order to finish a part complete at one setting of the work and avoid a second operation. Taps are often used for threading holes of small or medium size, but occasionally it is necessary to use either a single-point tool or a chaser for cutting a thread which is not standard or which is too large in diameter for tapping. When a single-point tool or chaser is employed, the cutter-bar must be traversed for

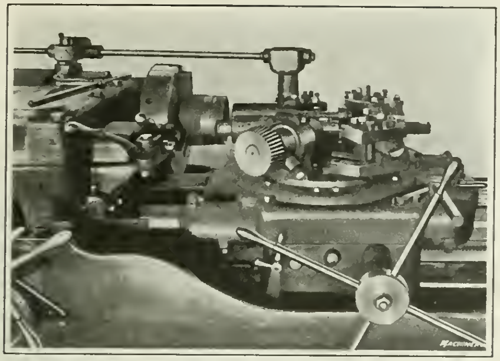

Fig. 15. Thread-chasing Attachment shown in Fig. 14 cutting an External Thread

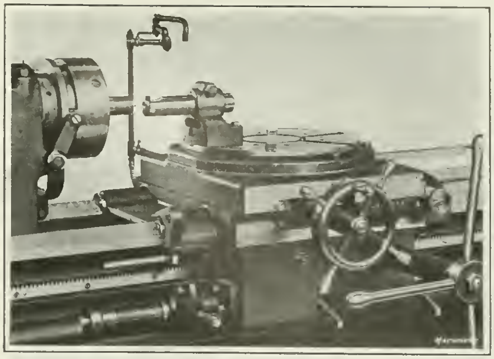

Fig. 16. Flat Turret Lathe built by Acme Machine Tool Co. equipped with Thread-chasing Attachment

controlling the lead of the thread. This traversing movement is usually obtained by means of special change-gears, which are inserted in the feeding mechanism at one end of the cross-rail. The change-gears are used to transmit motion to the cross-rail feed shaft, and they are selected with reference to the lead of the thread to be cut, the same as the change-gears of a lathe. Whatever special equipment may be needed for holding such gearing in position is supplied by most boring mill manufacturers. This is a simple and inexpensive arrangement, as motion is transmitted to the regular down-feed mechanism of the boring-bar or tool-slide through these extra gears. Some boring mill manufacturers supply this type of thread-chasing attachment for ordinary threading operations, such as the cutting of threads in large pipe flanges, etc., but for more accurate work a special lead-screw is used to control the motion of the tool-slide. A different lead-screw may be used for each pitch or lead of thread that is cut, or variations may be obtained by driving a lead-screw through change-gearing, the same as on an engine lathe.

A simple method of applying a lead-screw to a vertical boring mill is shown by diagram *B*, Fig. 17. This is not recommended for general application, but has been used to advantage when a machine was not equipped with a regular thread-cutting mechanism and it was particularly desirable to cut the thread in the boring mill. Some form of lead-screw is attached to the end of the tool-slide, and a nut which engages the lead-screw is fastened in the central hole in the machine table. The thread tool is held preferably in a holder provided with some simple means of adjusting it when taking successive cuts. As the machine table revolves, the lead-screw and tool-slide, which should be free to move vertically, are drawn downward, thus cutting a thread corresponding to the pitch of the lead-screw.

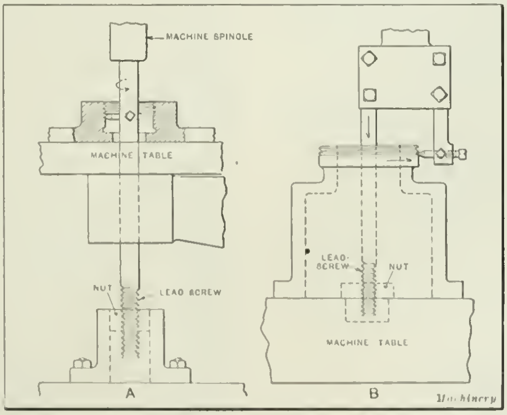

Fig. 17. (A) Method of cutting Threads on Drilling Machine with Single-point Tool. (B) Makeshift Arrangement for cutting Threads on Vertical Boring Mill

One design of vertical boring mill has a central boring-bar with an independent rotary drive. With such a machine, a lead-screw for threading operations may be applied directly to the upper end of the bar. The split nut for engaging the lead-screw may be mounted on a stationary arm or yoke, which, in turn, is held in position by shafts or studs far enough above the end of the bar to permit moving the latter to its highest vertical position. The nuts are opened or closed by a vertical shaft having a lever at its lower end within reach of the operator. With this arrangement, the boring-bar revolves and the work remains stationary while the thread is being cut. If much thread cutting is to be done with an attachment of this kind, provision should be made for adjusting the tool radially by applying some form of independent slide at the end of the boring-bar. Threading attachments of this kind are not in common use, because comparatively few boring mills are equipped with an auxiliary boring-bar, such as is found on some of the larger machines for performing high-speed boring independently of the table rotation.

* * *

REPORTS BY EMPLOYERS ON WAR INCOME TAX

Employers of labor in any capacity are required by the War Revenue Act of October 3, 1917, to report to the Internal Revenue Collector of their district the names and addresses of all employes, past and present, to whom they have paid a wage or salary of $800 or more since January 1, 1917. The object of this provision of the law for collecting information at the source is to give the Revenue Department as absolute a check as possible on all persons subject to the war income tax. It should be understood that the expression "employe" means, in this case, all persons employed or who have rendered service in any capacity. Attention should also be called to the fact that employes who are not now in the employ of a firm must be reported if, during 1917, at any time, they were employed and received a total salary, wage, fee or remuneration of $800 or more.

* * *

BLACK FINISH ON STEEL

A good black finish can be produced on steel by the following method: Prepare a saturated solution of caustic soda and add a small amount of saltpeter, say a small handful to a five-gallon solution. Boil the solution for a short time and allow it to cool over night. The clear liquid should only be used, and this should be brought to the boiling point in an iron kettle. The articles should be wired as for plating and immersed in the blackening solution. The articles will take on a gray color at once with black underneath and should be left in the solution until the gray finish disappears and a beautiful black remains. Rinse the articles in cold water, dry in sawdust and oil with linseed oil, and wipe clean. The resulting finish will be a fine blue black that wears well, and is suitable for shears, razors, etc.—*Metal Industry*

THE VALUE OF MANUFACTURING PROPERTY[1]

DIFFERENT APPRAISAL METHODS AND ITEMS THAT COMPRISE THE REPRODUCTION COST METHOD

BY CHARLES W. MCKAY[2]

PERHAPS no subject has attracted such universal attention, during the past decade, as the appraisement of public utility plants. These appraisements have been subjected to the most searching scrutiny by the legal, engineering, and accounting professions, for public-utility corporations are almost universally subject to regulatory measures inaugurated by federal or state public-utility commissions. But in the industrial field, appraisal work has been confined largely to the valuation of the purely physical assets of manufacturing companies. Although it is only natural that progress in the public-utility field should be reflected, to some extent at least, in what may be termed the private-utility field, the established precedent in industrial-plant appraisement has been largely confined to a consideration of the purely physical assets. In other words, industrial appraisers have depended largely on the appraisement of the so-called "inventoriable property," or that part of the property which can be actually seen and counted in the field. Public-utility appraisers, on the other hand, have long recognized the fact that many elements of cost enter into the appraisement of the property of a utility corporation besides the cost of the inventoriable property. These costs include what are usually termed the "collateral costs"; they may be divided into the four general classes: Cost of general and legal organizations; cost of engineering and general supervision during construction; taxes and insurance on property during the construction period; interest on investment during construction.

Every student of industrial problems realizes that the value of the purely tangible, or inventoriable, property is only one of the elements component to the total value of industrial property. In a paper read before the American Society of Mechanical Engineers, Professor Gantt says: "The following factors are important elements in determining the value of an industrial property: Cost of product, capacity of plant, part of plant operated, and expense of maintenance of idle portion." Or, stated in a different way, the reproduction cost of the tangible and the intangible property, the depreciated value of the property, the cost of producing and marketing the plant output, and the production capacity of the plant are all factors that deserve the most careful consideration in attempting to place a value upon the property of an industrial organization.

The accompanying summary, which is taken from a recent reproduction-cost appraisal, will convey a general idea of the relation of the so-called "collateral costs" to the other elements component to the total value of the physical property of an industrial company. It will be noted that besides the cost of the inventoriable property there have been included in the direct construction costs, omissions and contingencies, purchasing expense during construction, and tools and tool expense during construction.

Summary of Physical Property

Direct construction costs—	Reproduction Cost	Present Value
Land		
Buildings		
Machine tools—lathes, boring mills, etc....		
Auxiliary equipment—chucks, etc..........		
Electrical equipment—motors, rheostats, etc		
Belting		
Shafting		
Small tools and dies......................		
Patterns and drawings.....................		
Stock and supplies		
Furniture and fixtures		
Total inventoriable property		
Omissions and contingencies		
Purchasing expense during construction....		
Tools and tool expense during construction		
Total direct construction costs...........		

Collateral construction costs—	Reproduction Cost	Present Value
General and legal expense during construction		
Engineering and general supervision during construction		
Taxes and insurance during construction...		
Interest on investment during construction		
Total collateral construction costs.......		
Total cost physical property.............		

Reproduction Method of Appraisal

To one unfamiliar with the foregoing method of appraisement, the collateral construction costs and the allowances for omissions, contingencies, etc., may seem to be an effort to inflate property values. But after a little consideration even the most practical industrial men will agree that these items are a real part of the cost of constructing any industrial property. While in the reproduction-cost method all these items will be estimated by a method necessarily based somewhat upon assumptions, if the actual cost of original construction could be ascertained it would be found that actual expenditures had been made for just such items as those included in these items. The reproduction method was developed by those who were seeking for an accurate determination of property values as a basis for cost studies and the determination of an equitable sales price for the product. The book values did not always represent real values; nor could the latter be determined by finding the actual cash outlay, for many industrial companies were not very particular as to the segregation of operating and capital expenditures. When operating employes were used for the installation and erection of new machinery, the cost of labor was frequently charged to operation and not to new construction. As a result, the cost shown on the books included only the cost of the machine and possibly the freight; no allowance was made for the labor costs involved in building the foundations and erecting the machinery.

Relation between Cost of Inventoriable Property and Collateral Costs

The accompanying summary shows that the inventoriable property includes only the actual visible assets as inventoried in the field, and subsequently priced at current market prices, including both cost of material and labor of installation. The close connection between the collateral costs and the cost of the inventoriable property may be made clearer by making the complete appraisement of one item of inventoriable property, say a Corliss engine. The reproduction cost of this engine, as included in the appraisement of the strictly physical property, will be computed somewhat as follows:

Cost of engine f.o.b. point of manufacture.......	$
Cost of freight from point of manufacture to plant location	
Cost of transporting and erecting engine on foundations	
Cost of material and labor of constructing foundations	
Cost of direct supervision, actual cost of time of foreman who superintends erecting and erection operations	
Total reproduction cost of engine...........	$

It is at this point that appraisers of the old school of industrial evaluation stop; they further contend that this cost represents the total reproduction cost of the property under consideration. But, before the engine is bought the purchasing agent, the designing engineer, and possibly the plant executives will decide upon the type of engine required to perform the service in the plant under consideration. Subsequently, various engine companies will submit competitive bids from which the purchasing agent, together with his immediate superiors, will decide which is the most favorable and award the contract. There are two elements of expense involved in this operation, purchasing and engineering.

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[1] For previous articles on this and allied subjects published in MACHINERY, see [illegible] Capacity a Measure of Value of an Industrial Plant," April, [illegible] "The Valuation of Machine Tools," May, 1915.

[2] [illegible] Monadnock Block, Chicago, Ill.

After the engine has been received, the expense of installation may materially exceed any cost estimate made by an appraisal engineer in evaluating the property. For instance, in excavating for the foundations, quicksand or some other unstable soil may be encountered, but an estimate made by an appraisal engineer who does not know of the unusual subsurface conditions will be based entirely on normal conditions; hence, the item of contingencies. In the construction of every industrial plant certain unusual conditions are encountered so that conservative engineering practice is to make an allowance of from 1 to 2 per cent of the cost of reproduction for contingencies.

Again in the installation and erection of an engine, certain tools, like hand tools and pneumatic tools, may be required. While, considered alone, this item is of relatively small importance, in the erection of a large industrial property it may amount to an appreciable sum.

General and Legal Expense

The item general and legal expense during construction includes the general expense of the executive and administrative organization up to the time the property becomes an operating entity. This item includes the salaries and expenses of the general executives, bookkeepers, timekeepers, and pay-masters, and the retainer for legal counsel required for the organization of the company. Any practical industrial executive will realize that the construction of a new industrial property necessarily involves an appreciable expenditure for engineering and general supervision during construction. Plans must be prepared for the general lay-out of the buildings, for the transportation facilities, and for the distribution of the machinery in the buildings themselves. Many industrial organizations retain the engineer employed in a consulting capacity prior to the construction period throughout the entire construction period to supervise the work of building the plant and, in many cases, as a plant engineer for the operating company. Nevertheless, the salary and expenses of the chief engineer and his assistants, up to the time the property actually begins to operate, is a capital and not an administrative charge.

Taxes and Insurance During Construction

Taxes and insurance on real estate and equipment up to the time the plant actually begins to operate are unquestionably charges against the capital account. Both taxes and insurance may be computed on a percentage basis, by applying a predetermined percentage to the reproduction cost of the taxable and insurable property, or they may be determined, perhaps a little more accurately, by analyzing the taxable and insurable items and estimating the actual costs of taxes and insurance by applying prevalent insurance and tax rates.

Interest During Construction

The construction of an industrial property costs money in two ways: The real estate, machinery, and equipment represent an appreciable monetary outlay and the money used for the purchase of land, construction of buildings and construction and installation of machinery and equipment must be paid for at the current market rate for borrowed money. Interest on the investment in an industrial property, up to the time the plant begins to operate, is undeniably a part of the construction cost.

At the beginning of the construction period there are no tangible assets that can be mortgaged to raise money. The promoters, therefore, must borrow such funds as they may require for immediate use on short-term notes. Subsequently, as tangible assets are brought into being, these short-term notes may be replaced by permanent mortgages or bonds on the property. In a similar manner, additional funds for carrying on the project may be raised.

The cost of interest during construction may be computed by estimating the probable length of time that interest on the investment in the various portions of the plant, such as buildings, machinery, equipment, etc., will have to be carried as a capital rather than an operating expenditure and by applying prevalent interest rates to the various sums involved for the time periods estimated. A simpler way, though, consists of estimating the average investment tied up in plant construction during the entire construction period and applying thereto the interest rate prevalent at the time of the appraisal. The total to which this rate is applied will, of course, include all the direct and collateral construction costs.

Conclusion

From the foregoing it will be apparent that there are many costs involved in the construction of a modern industrial property besides the actual cost of the inventoriable property. While these costs are really a part of the cost of the inventoriable property, for obvious reasons they cannot be included directly in the unit costs as generally applied to the inventory in determining the reproduction cost of a plant.

Many industrial executives deceive themselves by assuming that the inventory and appraisement of that part of the property that can actually be seen and counted in the field represents the entire investment in physical property. They entirely overlook the fact that many other elements of cost are really part and parcel of the cost, but cannot be included in the unit costs as applied to the inventoriable property. Undoubtedly there may be reasons why some industrial executives wish to limit the value of the physical property carried on the books, but on the other hand industrial executives are constantly confronted with problems that can be solved only by one having an accurate knowledge of total plant investment, as represented by the reproduction cost, and by the present value of physical property, as represented by reproduction cost less accrued depreciation.

Among the possible uses of total reproduction cost, including collateral costs, are:

1. The determination of total investment as a factor to be considered in the determination of a proper sales price for the plant output.

2. The determination of the total value of the physical property as a basis for capitalization; that is, the issuance of securities.

3. The determination of total value, both on a reproduction cost and a reproduction cost less depreciation basis, for the purpose of ascertaining the real value of the physical property in the event of a proposed sale or in the event of a proposed consolidation of the property under consideration with other similar properties.

4. The determination of invested capital for computing war profit taxes.

Whether or not industrial corporations deem it advisable to include all these elements of collateral cost in the value of the property as carried on the books, any student of industrial problems will realize that it is most important to have a clear and complete record of total physical property value available for ready reference in solving such problems as those just enumerated.

* * *

ENGINEERING STUDENTS EXEMPT FROM DRAFT

The order of the secretary of war exempting engineering students from the selective draft for military service is a step that should have been taken immediately at the beginning of the war, but it is well that it has been taken as soon as it has. The exemption privilege is limited to those students to whom the engineering school issues a certificate, properly attested by the president of the school, reading as follows:

> 'I hereby certify that .... is a regular student of the ...... class in good standing, as a candidate for an engineering degree at .... and that in the judgment of the faculty of this school, based upon his academic record, supplemented by his relations with fellow students and by observation of his instructors, he may fairly be regarded as deserving a place in the first third qualitatively of the young men graduating from this institution during the past ten years.

Hence, it is evident that the mere attendance at an engineering school does not exempt a student from being drafted for military service; the regulations governing the exemption require also that his record as regards his engineering studies be of a high character.

TOOLING A FOREIGN CAR IN AMERICA—2

TOOLING THE REAR AXLE HOUSING

BY THOMAS ORCHARD[1]

In this car, the rear axle housing, which, with the operations required, is shown on page 410 in the January number, is made in two parts. As most of the operations are performed with these parts assembled, it is necessary first to mill the surfaces of the joint and then drill the eight holes in each flange, reaming two for locating points in order that the assembling can be done as quickly as possible. The drill jig used for this purpose is similar to the one described in the preceding installment, but a different method of indexing is employed.

The fixture, shown in Fig. 1, consists of a plate, on each end of which are two wheels *A*. In order that these wheels may rotate, steel shafts are pressed in them but are a running fit in the supports *B* at each end of the fixture. These supports are made of cast iron and are, in turn, tongued and bolted to a base *C* on which the entire fixture rests. The wheels ride on cast-iron shoes *D*, which are screwed and doweled to the base of the supports. During the rotation of the wheels, the friction produced by the rubbing of the wheels against the shoes prevents the fixture from being damaged should the operator lose control while indexing; at the same time it relieves the shaft at each end of a certain amount of the weight.

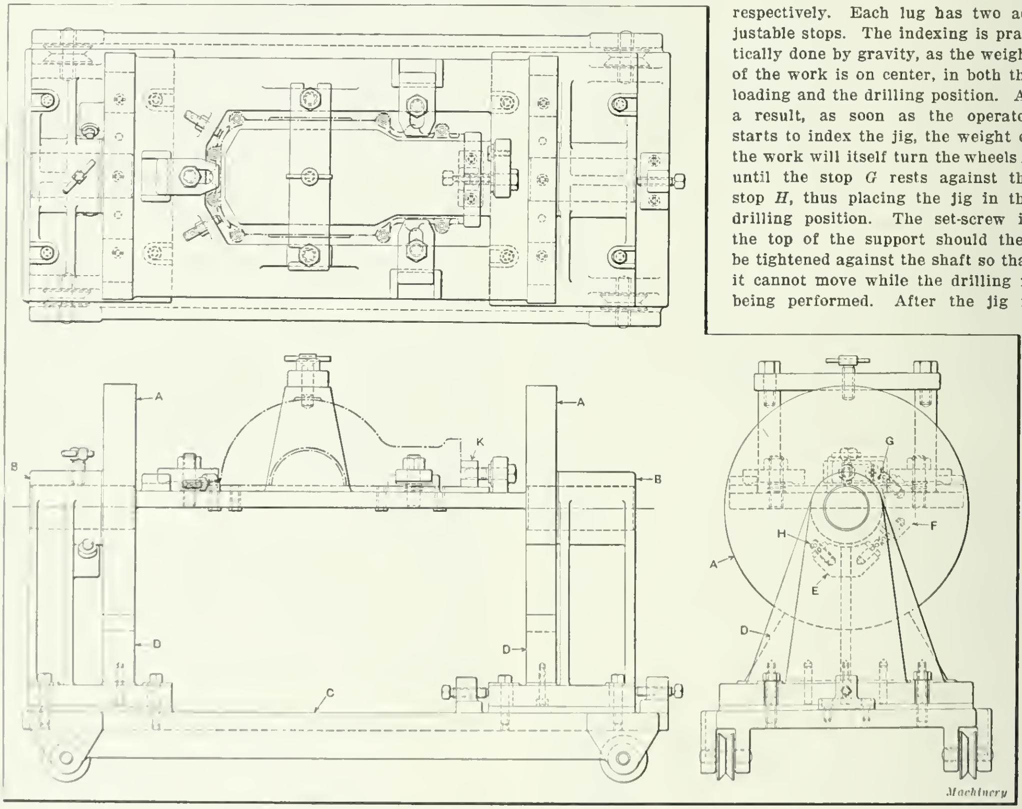

Fig. 1. Trunnion Jig for drilling Flange Holes

After the joint of each half of the housing has been milled, the parts are ready to be placed in the fixture, which should be in the position shown. The clamp across the center of the jig is removed and the work set on the finished pad and moved to the left until the flange comes against the two stops, which may be adjusted to suit the run of the castings. The work is next squared up by screwing in the clamp at the right-hand end of the work. After this has been done, the top clamp is replaced and the set-screw brought down against the boss on the top of the housing. The three sliding clamps are then brought into place and hold the work down at their respective locations against the flange.

The fixture may now be indexed 180 degrees in order to place the work in the proper position for drilling. The method of indexing is very simple. Lugs *E* and *F* are cast on one support and the outside of one wheel, respectively. Each lug has two adjustable stops. The indexing is practically done by gravity, as the weight of the work is on center, in both the loading and the drilling position. As a result, as soon as the operator starts to index the jig, the weight of the work will itself turn the wheels *A* until the stop *G* rests against the stop *H*, thus placing the jig in the drilling position. The set-screw in the top of the support should then be tightened against the shaft so that it cannot move while the drilling is being performed. After the jig is loaded and indexed for drilling, it is run along a track that passes under a No. 14 "Natco" multiple-spindle drilling machine and the eight holes in the flange are drilled at one operation.

Quick-clamping Device

A quick-clamping device is designed for clamping and squaring up the work at *K*. This clamp, illustrated in Fig. 2, is operated by a screw *L* and a hinged clip *M*, the screw being notched at *N* to receive the clip. To release the clamp, the clip is swung back until it assumes the position shown in the lower view. The clamp may then be brought back until it touches the face of the lug at *P*. This method is reversed when squaring up and clamping the work, except that a quarter turn is given to the screw after the clip is in place so as to exert the necessary clamping pressure on the work.

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[1] Address: New Britain Machine Co., New Britain, Conn.

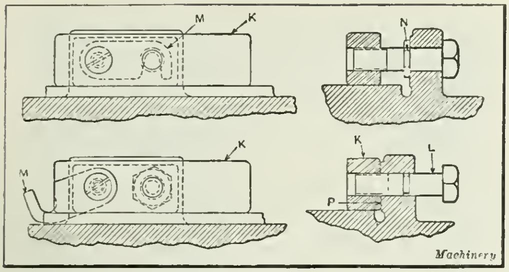

Fig. 2. Device for quickly clamping and squaring up Work

Ninth Operation on Housing

The ninth operation on the rear axle housing is turning out and sizing the recess on both sides of the housing to receive the rear axle tube, after both halves of the housing have been bolted together. This operation is performed on a No. 7A Potter & Johnston turret lathe. Fig. 3 shows the tools required and the method of setting up.

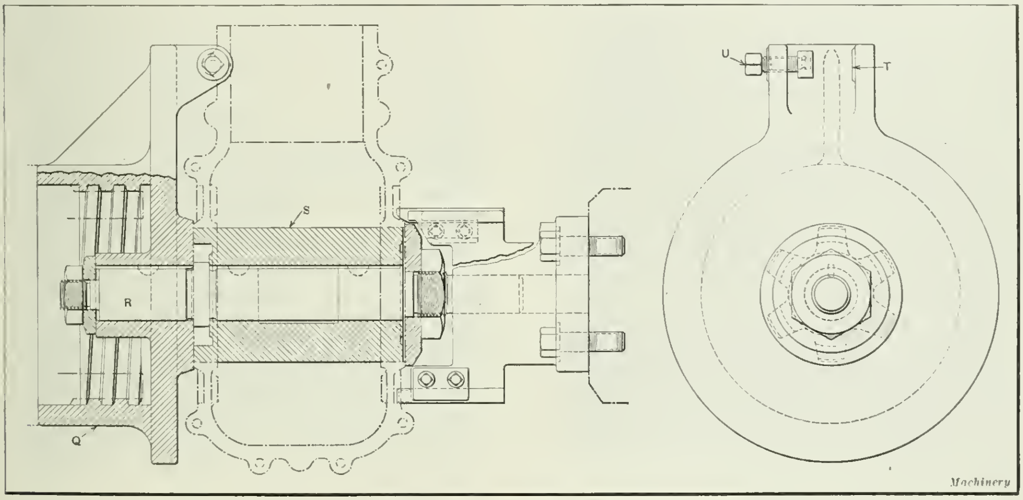

Fig. 3. Fixture for recessing Both Sides of Housing

This fixture consists of a faceplate *Q* screwed onto the spindle of the turret lathe. This faceplate serves as a base for the rest of the holding mechanism and also to drive the work. A shaft *R* is pressed and keyed into the faceplate and held in position by a nut and washer. A spider *S*, keyed to the shaft, serves to locate the work, a U-washer and nut holding the work in position after it has been slipped over the spider. The work is driven by clamping the flange against surface *T* by means of clamp screw *U*.

After the work has been clamped in position, the turret head is brought forward to perform the recessing. The tools are held in a tool-holder or head bolted to the turret head; there are three tool-holders with the tool set-ups necessary to complete the recessing properly. The construction of the tool-holder and the method of holding the tools are shown in Fig. 4. On the first operation, three tools are used; *V*, *W* and *X* in Fig. 5 show the relative position of these tools as they perform their work.

The tool-holder for the second recessing operation contains two tools, which finish the radius and carry the recess to the proper depth. These two tools are alike and are wide enough so that they may be alternately nicked in order to break up the chips. In the third operation, the tool brings the outside diameter of the recess to the finished size. After one side of the housing has been completely recessed, the work is slipped off the arbor, turned, and then replaced so that the opposite side is in position for recessing.

* * *

The *Gazette de Lausanne* for November 18, 1917, published a telegram from Berne, Switzerland, according to which a member of the Krupp Co., of Essen, Germany, has attempted to form an organization which, if it succeeds, would have a sinister influence upon Swiss journalism. Briefly, the organization is to sign advertising contracts on behalf of the German industries with a considerable number of Swiss trade and general journals. It is also stated that the object of the proposed organization is to purchase the business of Swiss firms that have suffered through the war. Their business would thereafter be continued by Germans, but under the former Swiss names. Through these Swiss firms, Germany would purchase, after the war, raw materials and goods which could not be obtained directly, and would sell under a Swiss label the products of German industry.

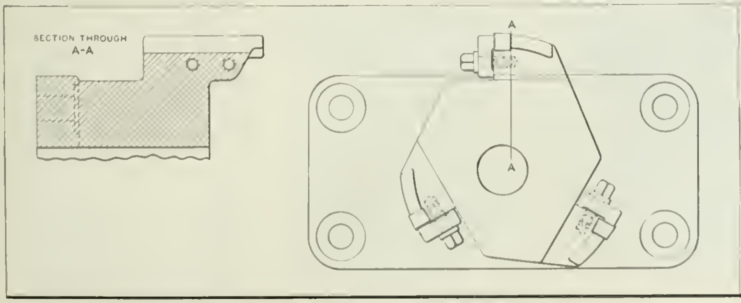

Fig. 4. Tool-holder used when recessing Housing

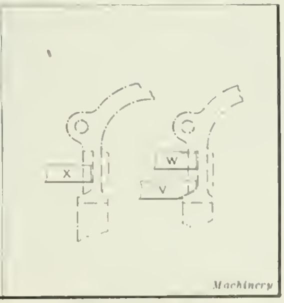

Fig. 5. Tools for recessing Housing

DEFECTIVE FIRE ESCAPES

BY CHESLA C. SHERLOCK [1]

Employers are more or less familiar with the law requiring the maintenance of proper fire escapes, and they know their liability to the state or municipality in case they fail to comply with the various statutes and ordinances. Recently, however, the question has been raised as to whether an employer is liable to an individual in an action for damages for a failure to provide proper fire escapes, as contemplated by the statutes and ordinances. Employers have been compelled to take certain measures to protect the individuals in the community from the fire hazard while on the premises used or occupied by the employer; though this regulation does not limit itself to employers, it applies to all owners of buildings, and in some instances to tenants. The term employer is here used in a loose sense, as it is the purpose to limit the discussion to cases between employer and employe.

The theory upon which the state has compelled obedience to its safety acts has been that it is a valid exercise of the police power of a state to make such requirement of employers. It can be seen, then, that to bring up a situation where an employe or other third person is attempting to profit individually from the employer's failure to comply with a statute that involves a question concerning the community at large is unique, to say the least. It is not common to permit an individual to bring an action in damages for a breach of duty owed to the community at large and not to the individual in particular. In a recent case involving this point, the Supreme Court of Nebraska was of the opinion that the violation of any statutory or valid municipal regulation established for the purpose of protecting persons or property from injury is sufficient to prove such a breach of duty as will sustain a private action for negligence, if the other elements of actionable negligence concur. The mere fact that the statute or ordinance in question does not, in terms, impose a civil liability for its violation does not affect such evidence of its violation as may go to show negligence.

The general liability of an occupant of a building has had more attention from the courts than the point just mentioned. Many courts hold to the opinion that a tenant has a right to assume that the landlord will comply with the provisions of the statute relating to fire escapes and that the tenant is under no legal obligation to perform that duty in the failure of the landlord to act. One court has said that a tenant is under no obligation to act even though he discovers that the landlord has violated the provisions of the statute, for he has a right to assume that the landlord will not continue in his breach of the statutory duty. The mere length of time of occupancy, in the opinion of the New Jersey court, unaccompanied by some affirmative act or circumstance on the tenant's part showing an intent to relieve the landlord from the consequences that might result to the tenant from the landlord's failure to perform the statutory duty imposed upon him of erecting fire escapes, cannot relieve the landlord from responding in damages in case a fire breaks out and the tenant suffers injury by reason of the absence of fire escapes.

In a Minnesota case, where a statute required one noncombustible ladder or stairway for each twenty persons, or fraction thereof, that the building accommodated above the first story, but did not state how far down the ladder should extend, it was held to be a question for the jury whether there was negligence on the part of the landlord in not bringing the ladder down closer to the ground than twenty feet, so as to afford a reasonably safe escape from the building. In a Kentucky case, it was held that the mere fact that the building in question was erected before the enactment of the ordinance does not relieve the landlord from liability for failure to comply with its provisions, since it applies to buildings erected before as well as after its enactment.

The New York courts have plainly said that an employer who fails to equip his building with fire escapes as required by statute is liable for the death of an employe due to such failure, regardless of the question of his negligence in other respects. The Illinois courts have said that where the occupant of a building fails to comply with the law requiring metal fire escapes that he is liable in an action for negligence to anyone lawfully in the building at the time the fire breaks out and injured because of the inadequate means of escape.

The Indiana court has gone a step farther and said that the failure of the owner of a building used for factory purposes to comply with a mandatory statute requiring the erection of fire escapes was the proximate cause of the injury of a person who jumped from the third-story window in an effort to escape from the burning building. In Pennsylvania, the court said that the owner of a building failing in his statutory duty to provide an adequate means of escape in case of fire cannot claim that injuries sustained by one in escaping from the building were due to want of familiarity with the means of escape that had been provided. It is not the lack of familiarity with the means of escape, but the inadequacy of the means, that is the proximate cause of the injury in such case.

In another Illinois case, it was held that the mere construction of a fire escape pursuant to a statute does not relieve the owner of the building from further responsibility to his employes, or establish the fact that the fire escape is a reasonable and sufficient means of escape, as the statute prescribes no method of construction. The mere fact that the owner of a building has had no notice from a state or municipal officer to construct fire escapes is not a sufficient excuse to relieve him from the penalties provided by law for a failure to perform this duty.

* * *

STANDARDIZATION NECESSARY IN WAR TIME

A great many airplane engines have been developed both in the United States and Great Britain during the past year—more so probably in Great Britain than in the United States. It has been proposed in England, therefore, that a halt should be called by the government to the multiplication of designs of air engines, and that all plants having facilities for work along these lines should concentrate on the production of a limited number of standard types. Progress might be maintained by encouraging promising experimental work in one or two factories especially intended for the purpose. Nobody but a practical engineer realizes the enormous amount of time, money and skilled labor that may be uselessly expended at the present time in making jigs, gages and special tools for the production of engines or other new developments that may have no justification for their existence. The engines of captive airplanes of German design show that they have traveled far along the road of standardization, and the present policy of the American War Department indicates that the value of standardization is fully realized here, the Liberty motor and the commercial motor trucks being the two most notable examples. The present is no time for hit-and-miss experimenting, but for productive work along certain conservative lines. Speed of production is the main object, and although there may be opportunity for improvements here and there, it is better to accept a good reliable engine that meets the main requirements than to waste time on attempts to perfect details that will only delay victory and peace.

* * *

Nothing shows the rise and decline of the popularity of the bicycle more than the census of 1914, which has just been published. The industry reached its zenith in 1899, when there were 312 establishments, which had 19,760 employes, who received $29,783,600 in wages and produced goods worth $31,915,900. In 1889, there were but 27 establishments, and the total value of their output was $2,568,300. During the five-year period ending with 1904, the industry declined very rapidly; but the increasing popularity of the motorcycle has since caused the industry to grow. Although the number of establishments has steadily decreased, there was over 100 per cent increase in the number of employes in the ten years ending 1914; wages were increased over 300 per cent, and the value of the output nearly 450 per cent. Still, the bicycle has not entirely disappeared from the markets, for, in 1914, 398,899 were manufactured and only 62,793 motorcycles.

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[1] Address: [illegible] Des Moines, Iowa

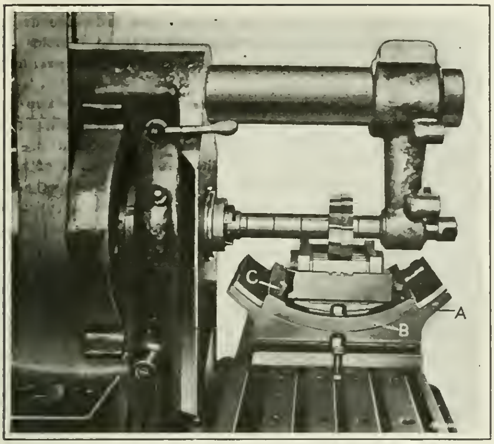

Fig. 1. Milling Steps D and E of Belt Shifter shown in Fig. 5

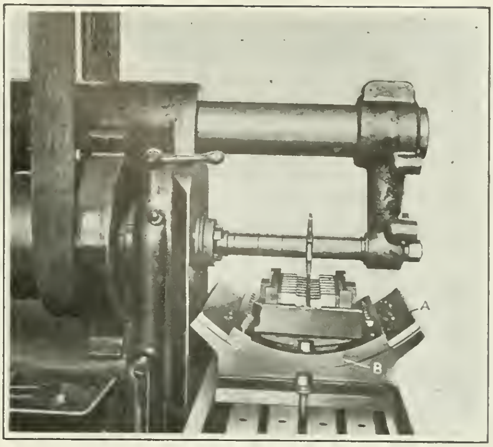

Fig. 2. Milling Central Slot in Belt Shifter

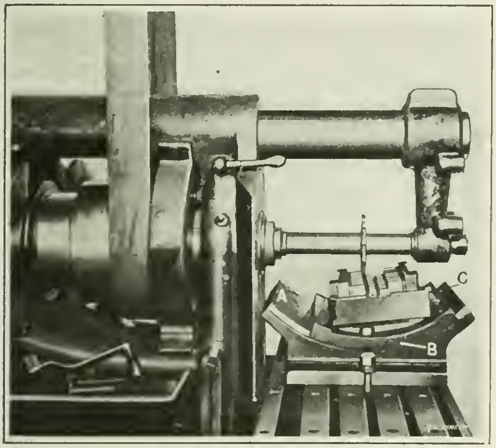

Fig. 3. Position of Fixture for cutting Angular Side of End Slot

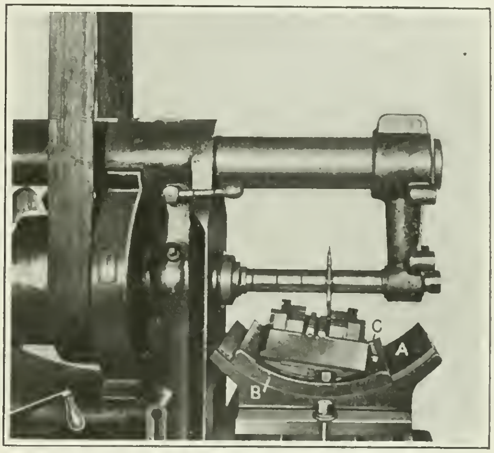

Fig. 4. Fixture moved so that Other End Slot may be cut

EXPORT LICENSES FOR SWITZERLAND

The War Trade Board announces that a trade agreement has been drawn up between the War Trade Board and the Swiss government, covering the issuance of licenses for shipments to Switzerland, and announces the following rules:

Applicants must first procure an S. S. S. permit and show the number of same on their application.

Applications should be sent by the applicants to the Legation of Switzerland, 2013 Hillyer Place, Washington, D. C., who will check up the S. S. S. permit number with their records; and upon their endorsing the application, it will be forwarded by the Legation of Switzerland to the War Trade Board.

Licenses, when granted by the War Trade Board, will be sent to the Legation of Switzerland, who will, in turn, notify the applicant and deliver the license.

Should applicants be refused by the War Trade Board, the Swiss Legation and the applicant will both be notified.

Licenses will not be given until information is lodged with the Swiss consul in New York or with the Swiss Legation in Washington as to the steamer on which the commodities are to go.

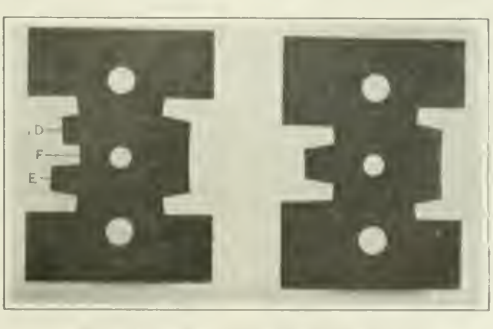

Fig. 5. Belt Shifter Parts on which Fixture is used

SIMPLE BUT EFFICIENT MILLING FIXTURE

BY J. P. BROPHY [1]

Occasionally in every line of manufacture we have a piece that is simple to look upon but difficult to machine. Figs. 5 and 6 show a part of a belt shifter used on an automatic machine, the makers of which use eight different shaped pieces of this kind. The stock is flat and one-half inch thick. If the sides of the slots were perpendicular, the manufacture of these pieces would be a simple job, but the sides are not perpendicular, and the angles they form with the bottom differ with each different shaped piece. As a result, these pieces are difficult to manufacture without the proper form of fixture.

The fixture shown in Figs. 1 to 4 consists of two parts *A* and *B*, which are clamped together, when in the proper position, by bolts passing through holes in the lower casting *A* and slots in the upper casting *B*. A tongue planed in the bottom of the base *A* fits a slot in the milling machine table, to which

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[1] Vice-president and General Manager, Cleveland Automatic Machine Co., Cleveland, Ohio

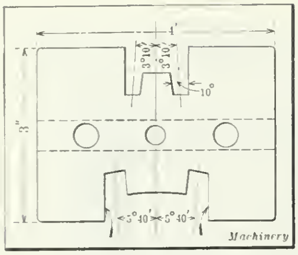

Fig. 6. Angles at which Slots were cut in Belt Shifter

the base is bolted. The upper part *B* is turned to fit the lower part so that no gib is required. The parts to be milled are held in place by a setscrew, which is not shown. Each shape has its own number, and these numbers are stamped upon the top surface of the base *A*. The upper part of the fixture can move in either direction from the center, so by placing the locating pin *C* in the proper hole, as shown by the number, the fixture can be quickly set for machining any shape. Fig. 1 shows the different size cutters milling projections *D* and *E*, Fig. 5; in Fig. 2, the central slot *F*, Fig. 5, is being cut; Figs. 3 and 4 show how the angular slots may be finished. This style of fixture can be used for all kinds of angles, as holes can be placed where desired from zero to its full capacity.

* * *

AUTOMOTIVE ENGINEERING AND THE GREAT WAR[1]

In the last analysis, war as fought today is substantially the matching of great engineering enterprises. In the long run, the side with the best engineering genius will win the contest. The organization of the motor transport service required by modern armies is a problem worthy of the best engineering talent, for the unusually severe service conditions make the problems of keeping a fleet of army trucks in operation far more serious than those encountered in normal peace service. Great difficulty has been caused through lack of standardization of motor trucks in use by the Allies. It was left to the American engineers to solve the problem of standardization; and as a result of the years of preparation and experience along standardization lines by the Society of Automotive Engineers, the government now has in process of production a truck that is not only rugged and finished, but can be rapidly produced and is simple and easy to repair. In every possible case, the standards created by the society have been used in the design of this United States war truck.

The work of the society has not, however, ended with the completion of the design. The organization within the quartermaster corps that will handle such matters as the production, inspection, and the operation of military trucks is largely made up of automotive engineers, practically all of whom are members of the S. A. E. who have entered the service. In addition, the engineer corps will use a large number of trucks for handling the materials; in all probability these trucks will be identical, as far as the chassis is concerned, with those now being provided through the quartermaster corps. Other branches requiring special motor-propelled equipment are the ordnance department, the signal corps, and the medical corps. Light, high speed trucks to act as airplane tenders will be used by the signal corps, and the medical corps will use somewhat similar chassis for ambulances.

In the ordnance department another group of automotive engineers, S. A. E. members for the most part familiar with design of tractors, is working on the problem of motorizing the equipment. Heavy ordnance, which heretofore it would have been difficult to move successfully, is now drawn over ground almost impassable otherwise. In addition, a large number of four wheel drive trucks will be provided for the handling of ammunition; these vehicles are comparatively modern developments suitable for operation over rough ground and under conditions where the ordinary type of road vehicle would find it difficult to secure the necessary foothold. So far as known, the government has made no announcement as to its plans for the development of tanks. It is by no means to be doubted, however, when the troops of this country are ready for service, that they will be provided with equipment of this character second to none in use by the Allies. The ordnance department is working upon the development of these vehicles; the work is in the hands of competent automotive engineers, many of them S. A. E. members.

The motorcycle used for war purposes is made in two- and three-wheel vehicles for dispatch work and for transporting machine guns. Here again the society has rendered effective assistance to the government in the standardization of parts, the secretary of war having delegated officers in the quartermaster corps to confer with a society committee on problems relating to the development, standardization, and use of the motorcycle.

The development of the Liberty engine is properly credited to engineers who are members of the Society of Automotive Engineers and whose work has been greatly facilitated by the present and past activities of the society. Due credit must be given to the Allied Governments for data, but this engine is strictly an American product designed for rapid production, standardization, and interchangeability of parts. The aviation engine is a high-strung piece of apparatus, one that must develop a great power with minimum weight. The engine operates under full load and at high temperature practically all the time, so that its depreciation is relatively rapid. This greatly increases the service problem and new parts must be supplied frequently in order to keep the maximum number of machines in operation. The society is justly proud of the work its members have done in connection with the production, inspection, and upkeep of aeronautic apparatus.

The submarine problem may possibly be solved by the adoption of one of the large designs of seaplanes now being perfected. The flying boat no longer is a matter for speculation. It has proved possible to build a machine with the seaworthy qualities of a small yacht and at the same time able to take the air, for the purpose of locating and destroying submarines. The seaplane, however, is not the only type of craft used in attacking the submarine developed by the automotive engineers. Several hundred submarine chasers have been used for months on the British coast with the result that submarines seldom attempt navigation less than one hundred miles off shore. The design and construction of engines used in many of these submarine chasers constitute another of the problems that automotive engineers have handled with marked success.

The development of small stationary or semi-portable units for the operation of the wireless set, the searchlight, pumps, isolated electric lighting plants, and machine tools in portable repair shops is another of the details handled by automotive engineers. While many of the types of automotive apparatus are as useful in industrial activities as in what may be termed direct military operations, for instance, the trucks used for handling materials in our great munition plants, the development and production of the farm tractor is equal in importance to any direct military activities. The farm tractor is playing a tremendous part in the production of food, which will, after all, be the determining factor in winning the war. In any branch of the service, whether here or with our men in France, where automotive apparatus is made or used, there will be found the automotive engineer striving to do his part, always willing to cooperate with his fellow-men, and always looking for more work to do.

* * *

MECHANICAL ENGINEERING IN THE BUILDING OF THE PANAMA CANAL

In his address before the American Society of Mechanical Engineers at the occasion when honorary membership in the society was conferred upon him, Major-General George W. Goethals called attention to the work performed by mechanical engineers in the construction of the machinery required for the carrying out of the great civil engineering work represented by the canal. He also mentioned that the satisfactory working of the canal since its completion is in a great measure due to the machinery of the locks, the dredging equipment, and various other appliances which are the work of mechanical engineers. Hence, while the canal is looked upon mainly as a civil engineering feat, it nevertheless is also a tribute to the skill of the mechanical engineer.

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[1] [illegible] of a paper read before the Engineering Society of Buffalo, in [illegible] George W. Dunham, president of the Society of Automotive Engineers [illegible] of the Board for Motorizing Field Artillery of the U. S. A.

POSSIBILITIES OF DOUBLE HEAT-TREATMENT OF STEEL[1]

The time has arrived in America when we are obliged to lay more emphasis than ever on the question of quality and higher standards for steel for special work. We have nearly reached our limit of quality in cheap steel, as far as chemical and mechanical manufacture is concerned, but in the field of heat-treatment there is a great deal that can be done and without much expense. Most steel workers have had tools burst when quenching and are familiar with the hollow that frequently forms down the entire center of a tool due to the stresses in cooling. Casehardened articles are particularly liable to these stresses. It is the same way with armor plate, which is casehardened to perhaps as high as 2.5 per cent carbon on the surface but is down as low as 0.25 per cent in the back; this naturally causes all sorts of stresses, particularly in curved plates. One famous English metallurgist heats his armor plate to about 1000 degrees C., cools it very slowly to about 700 degrees, and quenches it; then in order to get it fibrous he reheats it to about 650 degrees C. and quenches it.

That heat-treatment changes the molecular structure of steel is shown by the fact that any steel heated to about 775 degrees C. will lose its magnetism, and magnetism is usually admitted to be a molecular change. Yet the magnet steel invented by Sir Robert Hadfield, which contains about 2.75 per cent silicon and has as little of any other ingredient than iron as possible, when subjected to a double heat-treatment is changed to the most magnetic substance we know; it is even more magnetic than chemically pure iron. One of the most important results of heat-treatment is to change the size of grain for the reason that, every other condition of the steel being the same, if the grain size is small, the steel will be strong and tough, while if the grain size of the same steel is large, the steel will be weak. The object of almost all double heat-treatments is to produce a small size of grain in steel, for the highest strength and ductility is invariably accompanied by the smallest grain size.

The large size of the ferrite grains produced in one of the heat zones has given rise to many double heat-treatments, but it has not been understood as a rule. The only way to do the thing is to heat to between 700 and 900 degrees C., depending on the carbon content of the steel, and quench as rapidly as possible; then heat to just below 700 degrees C. and quench again. This is a common double heat-treatment for all steels of medium carbon that are to be of high quality, because in these medium-carbon steels the ferrite forms a large portion of the mass, and if that can be obtained in small grains, a good quality of steel is cheaply obtained from a steel that would otherwise be much inferior. Steel containing approximately 0.30 to 0.35 per cent carbon and 0.10 to 0.15 per cent vanadium without chromium or nickel is commonly heated to 900 degrees C., quenched, heated to, say, 600 degrees and quenched. If it is desired to have the steel a little stronger and not quite so ductile, the second heat should come to 500, 400, or even 350 degrees, depending on the amount of strength desired. Vanadium also has the effect of making the absorption of the ferrite in steel take place very slowly; consequently it is necessary not only to heat slowly to 900 degrees, but to hold the metal there for some minutes in order that all the ferrite will be absorbed. Some advise heating above 950 degrees, cooling to 875 degrees, and quenching. Exactly the same result is obtained by heating a little more slowly to exactly 900 degrees, or else heating to 950 degrees and maintaining that heat a while.

Axles are heated to about 720 or 730 degrees, quenched, heated just below 700 degrees, and quenched again. Axles containing chromium and vanadium are heated a good deal higher, quenched in oil, and heated above 700 degrees, which heat is maintained for about twenty minutes and then allowed to cool slowly. The chromium has so strong a tendency to retain the carbon dissolved in the steel that if the steel is quenched it will be too brittle.

Casehardened gears are cooled to atmospheric temperature, then heated to between 700 and 900 degrees C., depending on the carbon content, quenched, heated above 700 degrees, and quenched. As the core of the gear contains only a small amount of carbon, so that it is rich in ferrite, the first quenching toughens the core by bringing it rapidly through the ferrite range, thus preventing the ferrite grains from increasing in size. The first quenching gives a tough core and a brittle case, and the second quenching gives the fine grain case. As this is quite brittle, it is usually annealed by heating to about 200 degrees C.

One reason the double heat-treatment has been neglected is that when steel is heated up to the austenite range, an enormous size of grain is produced. Steel heated up to this point has been known as burnt and as overheated steel, but it is possible to remove any bad effects of that treatment. The steel is heated to this high temperature and quenched, and then all the bad crystallization is removed by heating, say, to 1100 degrees C., quenching, heating to 800 degrees and quenching, and finally heating to 700 degrees and quenching. If ordinary commercial, Bessemer, low-carbon steel is heated to 1400 degrees C., quenched in water, heated to 750 degrees, and quenched in water, its strength will be increased from two to four times without decreasing the ductility more than 25 per cent. If a little more elaborate process is used, a steel over 200,000 pounds per square inch tensile strength with a good degree of ductility will be obtained at only a slightly greater cost than ordinary Bessemer bars or rods.

Vanadium keeps the cementite from segregating into coarse grains, and to some extent keeps the austenite from coarsening in this range. It is for that reason that vanadium has been used in high-speed steel, for these steels may then be heated to a very high temperature without acquiring such a coarse grain. The result has been an increase of 60 to 100 per cent in the service of the steel. Nickel has a similar effect, and 12.5 per cent nickel steel will stand considerable overheating in the austenite range, without coming to as much harm as straight carbon steel. When the steel contains 25 per cent nickel, it can be heated to almost any point without getting coarse crystallization. Vanadium exerts its influence chiefly on the cementite, and nickel chiefly on the ferrite. Most of the nickel dissolves in the ferrite in steel, whereas most of the vanadium dissolves in the cementite, so that a small amount of nickel is exceedingly advantageous in steels to be heat-treated in the ferrite range where the ferrite is to be kept small. Manganese has the same effect as vanadium and nickel in keeping the grains of austenite small. Nickel-vanadium steel, manganese-vanadium steel, chromium-vanadium steel give many combinations that afford an almost endless line of possibilities.

By cooling steel to liquid-air temperatures, Sir Robert Hadfield has made bars of manganese steel and 25 per cent nickel steel that are strongly magnetic on one end and as non-magnetic as lead on the other. All these steels are normally non-magnetic, but by cooling to the temperature of liquid air that end becomes magnetic. This opens a line of possibilities with heat-treatment that as yet have scarcely been touched.

* * *

STRENGTH OF PIPE JOINTS AS AFFECTED BY TYPE OF THREAD

The Research Department of the National Tube Co. has conducted an investigation with a view to developing a pipe joint having greater resistance to impact and vibration than the present joints. The different joints tested were regular Briggs pipe thread joints, and a joint in which the pipe had a thread with a round bottom and top and the coupling had a regular Briggs pipe thread. According to the *American Drop Forger*, these tests made it possible to draw the following conclusions: (1) The round thread is superior to the Briggs thread in tensile strength of joint, in impact resistance, in the amount that threaded pipe may be bent, and in resistance of the joint to vibration. (2) Annealed joints are more resistant to shock, bending and vibration than unannealed, and equally strong in tensile strength. (3) Steel joints are superior in every way to those made from wrought iron.

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[1] Abstract of an address delivered, in October, 1917, before the Steel Treating Research Society of Detroit, by Prof. Bradley Stoughton, secretary of American Institute of Mining Engineers

THE THIRD LIBERTY LOAN

HE ALSO FIGHTS WHO HELPS THE FIGHTER FIGHT—BUY LIBERTY BONDS

THE third Liberty loan will without doubt exceed in amount the combined total of the two preceding Liberty loans. The probable date of offering will be March 1, but the details have not yet been decided upon, and are subject to such change as the rapidly changing conditions of the war may warrant. No loan of such proportions can be successfully absorbed unless the entire nation responds and every citizen prides himself on the practice of self-denial, so that he may subscribe to the limit of his ability. All Americans must be prepared to spend less on themselves, if they are to do their full share for their government in this hour of need. Luxuries and extravagance must go completely out of fashion; necessities only should be purchased, and no one should hire others to do for him the things which he can do himself.

Complete Readjustment Inevitable

As a belligerent, this country has outgrown the idea of "business as usual." There is not enough labor, transportation, coal or other raw materials to go around if those industries which are not essential to the conduct of the war are continued at normal productiveness. The expansion of the essential war industries is only possible if other industries are gradually absorbed, the same as they have been in England and France. Every unessential industry which continues in operation bids against the nation.

Everyone must feel that he personally places himself behind his government—that the country depends on *him*. Each must do his share. The war requires putting men in the field and keeping them fed and clothed. It requires the production of ships, shells, guns and rifles, motor trucks, saddlery, airplanes, hospital supplies, food, and a great variety of goods, the production of which calls for vast industrial plants from one end of the country to the other, manned by millions of men and women who serve their country as effectively as our soldiers and sailors.

If the American people continue to require all the pleasant and comfortable luxuries which they consumed before the war, they are making it necessary for thousands of factories and shops, employing millions of men and women, to produce articles that do not help to bring peace a day nearer, when they might be devoting themselves to the production of the necessary things which will help to make the Allies victorious. Both things cannot go on together. We have pledged the honor of our country and our people to fight this war to our last dollar and to our last man, if necessary. America does not break her word. The necessities of the war must be produced and must be produced quickly. The key to the situation, therefore, rests in the hand of the average man and woman, who can, by refraining from everything not absolutely necessary to health and efficiency, release strong arms to the production of materials of war and the support of our army and navy. This is the philosophy of labor and materials. This is the lesson which must be immediately brought home to the people of America.

Fallacies which Need Correction

There is a widespread assumption that money is a miraculous worker and can, in some mysterious way, produce. Money produces nothing—it is labor and materials which are required, and money is only needed by the government to buy labor and materials; hence it is the production of the things that are needed in the conduct of the war that must be increased, and the production and use of the things with which we can do without for a time that should be discontinued. Labor and materials are the only things that count in the conduct of the war, and they cannot be bought if they do not exist. Every unessential industry which burns coal deprives an essential industry of the supply available for a necessary purpose. Every dollar spent on luxury bids against the United States when the nation buys war materials.

It has been believed that some virtue attaches to the keeping of money in circulation by freely expending it. This is a fallacy. Money is kept in circulation in a useless and injurious way at the present time if spent for non-essentials or luxuries; but it is kept in useful circulation if invested in Liberty bonds to be employed for a successful prosecution of the war. Money spent in the buying of Liberty bonds gets as wide and immediate a circulation as if spent on theater tickets and it goes to support the industries which produce those things which the government needs.

Importance of Present Savings

The war is fought entirely on present savings, labor, and materials; hence the imperative necessity for thrift, not only on the part of those who have never before put aside anything, but also on the part of those who normally would be spending the income from past savings. In either case, it is the duty in the present situation to practice self-denial in the matter of consumption, in order that more may be turned over to the government in the form of Liberty bond investments. Briefly, it is every citizen's double duty to produce more and consume less. To inspire the average citizen with zeal in this twofold effort, and to justify his mind in this unaccustomed sacrifice for the common good, it is highly necessary that he should realize that with every dollar put into Liberty bonds he stands back of the fighters at the front.

In a month or so, the subscription lists will open for the new big war loan. Begin to prepare for it immediately. This loan will probably be so much greater than either of the two preceding bond issues that, in order to meet the demand, every man and women must place at the disposal of the government every dollar that they can spare. All must feel that they and the United States are one in this fight against autocracy and for a world made free for democracy.

* * *

GERMAN SHIPS IN AMERICAN HARBORS REPAIRED

All the damage done to the 109 German ships in American harbors by their crews prior to their seizure by the United States Government when war was declared is now repaired, and these ships are all in service, adding more than 500,000 gross tonnage to the transport and cargo fleets in the war service in the United States. There is evidence that a German central authority gave an order for the destruction of the vital machinery of these ships, effective on or about February 1, 1917, or simultaneously with the date set for the unrestricted submarine warfare, the object being to effect such vital damage to the machinery of all German ships in American ports that they should not be able to put to sea for from eighteen months to two years. There is documentary proof that those who carried out these orders believed that the damage was irreparable. This purpose, however, was defeated in a signal fashion, for in less than eight months all the ships were in service. This is all the more remarkable when it is considered that the campaign of destruction was carried on for more than two months, and that the Germans were convinced that they were doing a thorough job.

Instead of obtaining new machinery, which would have greatly delayed the placing of the ships in service, in nearly all cases it was possible to make the required repairs by means of electric and oxy-acetylene welding. The work of placing the vessels in seaworthy condition also involved an extremely thorough examination of every part of the vessels, as many instances of cleverly concealed injuries were found. Indications show that there was a plan to burn the ships under certain conditions, and it is believed that the German crews were seized and interned somewhat in advance of their expectations. Altogether, the problem presented by the German ships in our harbors has been well handled.

LETTERS ON PRACTICAL SUBJECTS

WE PAY ONLY FOR ARTICLES PUBLISHED EXCLUSIVELY IN MACHINERY

CAM CUTTING ATTACHMENT FOR MILLING MACHINE

When the designer of the cam cutting attachment shown in Fig. 3 was asked what he would call it, he said "just riggin." In the midst of all standardization with special tools that reduce the effort and error of production to a minimum, amid the humdrum life of jigs, fixtures and gages, there exists in the heart of every true mechanic a good deal of love for "just riggin." For him life takes on a new zest when the "Big Boss" comes with a tale of woe of a broken machine or something else that has smashed the everlasting sameness of the usual operation on the regular machine. One of these jobs came up at a machine tool plant when a cam with a 7/16-inch rise, as shown in Fig. 1, had to be cut. The usual method of doing this when the rise of the cam is less than the smallest lead of the machine is shown in Fig. 2. A milling machine with a vertical attachment is used, the end-mill being turned parallel to the axis of the dividing head spindle. The sine of the angle *A*, at which the dividing head is elevated, is equal to rise of cam divided by lead for which milling machine is geared. This gives a mathematical relation between the forward motion of the table, the revolution of the dividing head spindle and the angle at which it is set, which gives the lead desired.

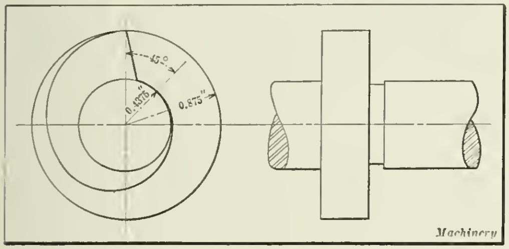


Fig. 1. Cam to be machined

However, in this case a milling machine with a vertical attachment was not available, and it was necessary to interpose sufficient gearing to reduce the smallest lead from 1.55 inch to 7/16 inch. To do this the dividing head was set at right angles to the travel of the table, the dividing head spindle being parallel to the axis of the milling cutter. A pair of bevel gears was used to connect the revolving motion of the dividing head with the table traverse motion; these were 1 to 1 gears taken from stock. To secure the reduction, the gears at the end of the table were assembled as shown in Fig. 3. The bevel and reducing gears were held in place by means of two special castings which were bolted to the table of the milling machine. The crank shown attached to the bevel gear at the dividing head was used to revolve the work and move the table. The resulting cam was as accurate and workmanlike in every particular as though the regular method and machine had been used.

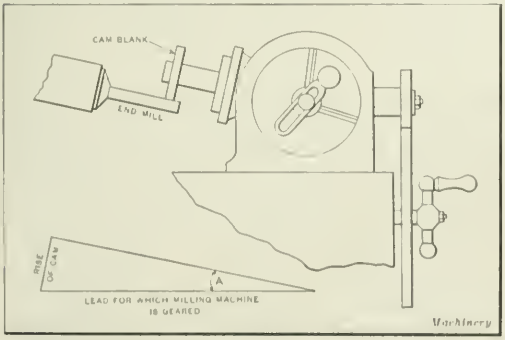


Fig. 2. Usual Method of setting Milling Machine for Operation

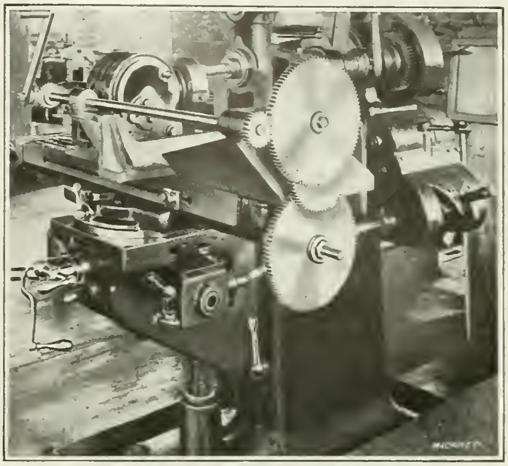
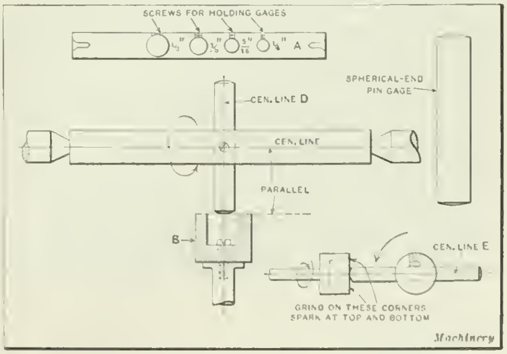


Fig. 3. Special Attachment used for cutting Cam

Cincinnati, Ohio — D. M. Perrill

GRINDING SPHERICAL-END PIN GAGES

Pin gages are preferred to plug gages by many mechanics, especially for large holes that must be round and straight. Taper and out-of-round errors can be easily detected with the pin gage. Except for adjusting micrometers, pin gages of the type here illustrated are seldom used for shop work, due, perhaps, to the difficulty experienced in grinding the ends perfectly spherical. Most mechanics just file the ends to a sharp point and let it go at that, making a fair gage but rather unsatisfactory for permanent use. Quick and satisfactory results can be obtained by the following method and with but one special tool:



Method of grinding Spherical-end Pin Gages

The arbor *A* is made of tool steel and has several holes drilled and reamed through the center to take the various diameters of stock used for making the different lengths of gages, screws being provided to hold the gages from slipping

The grinding wheel is nothing more than a cup-wheel *B* mounted on a toolpost grinder and used in a lathe. After roughing the gage and hardening the ends, the gage is placed in the proper hole in the arbor *A*, placing the arbor on the centers of the lathe as illustrated and adjusting the wheel as nearly as possible by the eye to agree with center lines *D* and *E* and having the face of the wheel parallel with the arbor. By rotating the gage slowly by hand past the wheel and noting the sparks, it is easy to see if the wheel is too high or too low. When the wheel just sparks on the top and bottom, the wheel is right for center line *E*. Center line *D* must be determined by measuring the pin gage and adjusting the lathe carriage sidewise until the contact points of the micrometer, when swung back and forth parallel with the arbor, strike at all points on the gage. The wheel revolving in the direction indicated by the arrow and the work being swung up and down past the wheel by hand, generates a sphere. The accuracy depends on the alignment of the wheel face to the center of the arbor and the center lines of the wheel to the center of the arbor and the center of the gage.

Care should be taken to see that the wheel cuts only at the inside edge of the wheel and that the screw which holds the wheel in place does not project far enough to strike the work when swung past the wheel. If care is taken in grinding, little or no lapping is required.

Derby, Conn. GEORGE SLIDER

The principle of this method of grinding spherical-end pin gages is geometrically correct, but it may be somewhat difficult to see without some explanation. The inner edge of the cutting face of the cup-wheel lies in a plane that intersects an imaginary sphere whose center is at the intersection of the axes of the wheel-spindle and the work-arbor, and whose diameter is equal to the length of the pin gage being ground. The cup-wheel characteristic in this case is that it grinds with the inner edge only. The end of the pin gage ground in the manner described lies within the section of the spherical surface intercepted by the plane coinciding with the end of the cup-wheel, and because of the characteristic of the wheel referred to, it must have a spherical end when finished. If the cup-wheel had an internal diameter equal to the length of the pin being ground, it would have to be moved toward the work until its grinding plane would intersect the axis of the arbor in which the pin is mounted, which, of course, is impossible; but when considered as being in this extreme position, the spherical generating action becomes somewhat clearer.—EDITOR

EFFICIENCY POINTS IN BORING FIXTURES

Special emphasis should be placed on the superiority of the inserted tongue over one made integral with the fixture, as described in the December number of MACHINERY, page 343. Some may question the statement that the inserted tongue design is the cheaper to make, for the integral tongue looks cheaper to the fellow who never made one and to the shop man who regards the word "cheap" as synonymous with shoddy. The table slots on any reputable make of planer, milling machine or boring machine are practically exact to some standard size. Stock sizes of cold-drawn steel will usually fit the slots closely enough for all practical purposes, and any operator of a planer or milling machine will admit that it is much easier to cut a slot to fit a piece of steel that he can use as a gage than to try to form a tongue on the base of a fixture that will fit a slot on some machine. The principal difficulty is usually the impossibility of using a micrometer on the tongue, unless it projects from the base much farther than it should.

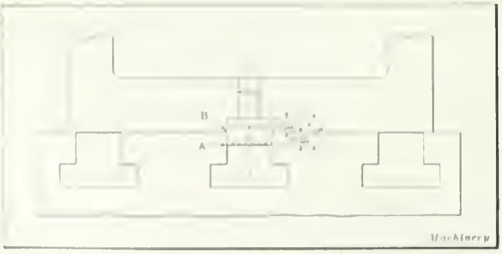


Fig. 1. Satisfactory Method of Inserting Tongue in Fixture

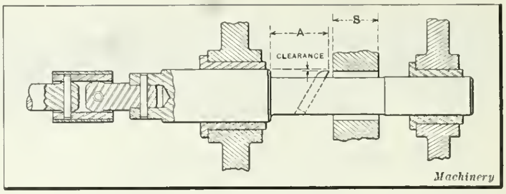


Fig. 2. Boring-bar that may be removed from Fixture without disturbing Setting of Cutters

The natural tendency of designers is to have the tongue enter too far into the slot; the use of ½-inch stock, ¼ inch in the fixture base and ¼ inch in the table slot, is ample for any case, while ⅜-inch stock, as shown in Fig. 1, will usually give complete satisfaction. Any machine table that has seen much service will have slots narrower at the bottom than at the top. Edges like *A* and *B* should be beveled. The bevel at *A* will soon be there anyway as the result of filing off burrs raised by inevitable bumps the tongue will receive. If a square corner is left at *B*, it is a very careful man who will keep the corner free from embedded chips, which, of course, will cause stresses in the fixture when it is clamped down. When beveled as shown, the corner is easily kept clean.

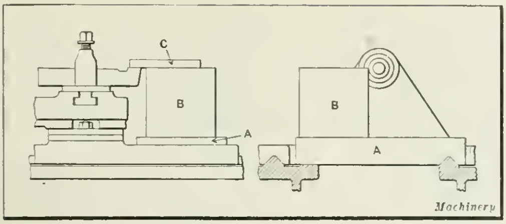
There are doubtless advantages to the design of guide bushings that do not fit on the diameter but are held in location by dowel-pins through the flange or head, and it seems that they should be very satisfactory for light boring, such as finish-boring a hole that had been drilled slightly under size so that the cut would be light and of practically uniform depth. For boring cored holes, however, the flange of the bushing should be rather thick, the dowels of large size and hardened, and the screws set up quite tightly to prevent the bushing from working loose within a short time. One good reason is given for using single-point boring tools in certain cases, but these tools are often better for another reason. The first cut with a single-point tool through a hole cored off center may not be quite truly round, but its center will be more nearly in the correct location than if a double-edge cutter had been used. In case of the springing of the bar in boring an eccentrically cored hole, the double-end cutter not only springs from the heavy side, but into the light side, enough perhaps to prevent the finishing cutter from finishing the entire perpihery of the hole.

Boring bars should always, if possible, be designed so that they may be removed from the fixture without disturbing the setting of the cutters. Fig. 2 shows a method of accomplishing this without the necessity of having an extra loose bushing on the bearing of the bar. This method, of course, would be hardly practicable except on a part having but one hole to be bored as shown. All that is necessary is to have a clearance between the liner bushing and the point of the cutter; also to have length *A* somewhat greater than *B*, so that the tool may pass well through the work before the bar comes against the part being bored. The hole for the pin at the extreme left-hand end should be slightly tapered or bell-mouthed from each end to permit alignment.

Anderson, Ind. LEROY M. CURRY

METHODS OF SETTING THREADING TOOL

The writer would like to suggest another method of using the threading tool setting gage described in the October number of MACHINERY, page 155. Instead of clamping the tool lightly and advancing it gently into the sixty-degree groove of the gage, the tool should be clamped rather firmly at the exact height of the lathe centers and advanced into the groove until one of the cutting edges is within a few thousandths inch of the side of the groove. A white, strongly lighted surface beneath the gage and the tool must be provided in order to set the cutting edge of the tool parallel with the side of the groove quickly and accurately. This is done by noting the shape of the line of light shown between the tool and gage when the



Method of setting Tool correctly

tool is nearly in contact with the gage, and tapping the back end of the tool with a hammer until parallelism has been secured. The tool must be withdrawn from the groove before it is tapped, and each advance into the gage groove must be carefully made to avoid damage to the tool or gage by actual contact between them. When the tool has been correctly set, it is clamped tight. If the tool has been formed accurately to the angle, setting correctly on one side is enough; but as nothing is exact, it is best to try both sides of the tool. It will be seen that in using this method the bottom of the gage groove is not used. This relieves the maker of the gage from forming that part, which is the most difficult. Many toolmakers fail to realize the need for the whole of the cutting edge or edges of a threading tool to be radial to the work. It is not uncommon to see great pains taken to set the point of the tool at the height of the center line of the work while the cutting edge is not radial. A good method of setting the tool is to provide a plate *A* and block *B* as illustrated. The top surface of the plate must be parallel with the cross-slide, and the block height must be such as to bring its top surface exactly in the plane of the centers. The top surface of the plate should be slightly higher than the cross-slide to allow the block to be extended over to the tool point and the test of tool height to be made by extending a scale *C* from the block to all parts of the cutting edge of the tool. The required height of the block may be obtained by careful measurement from a cylinder of known diameter, between the lathe centers, to the top of the plate, and adding half the diameter of the cylinder.

Wilkinsburg, Pa. William S. Rowell

USE OF FLY CUTTERS

When visiting various machine shops during the past few years, the writer has noticed an almost total absence of fly cutters. In fact, many of the younger machinists have never seen one in use, so it might be well to state, therefore, that this is a machining tool that was used quite extensively by our fathers to obtain finished surfaces. Perhaps one reason why the tool was so commonly used was that many of the special tools were made in the various shops where they were employed, with the result that the cheapest tool that would perform the work was made. A different procedure, however, is followed today. When the part is to be finish-machined by a form milling cutter, say, it is usually made by a shop specializing in the manufacture of milling cutters. The cutter is made of a cylindrical shape and with the conventional number of cutting edges, or teeth. The writer has no objection to these tools; but when only a few parts are to be machined, a cheaper tool is to be preferred, if equal results can be obtained.

The fly cutter is made of carbon or high-speed steel, as desired, and of a flat section, say ¼ to ⅜ inch in thickness. Its shape is easily obtained and the cutting rake of about 10 to 12 degrees formed on the cutting edge. The tool is then hardened to suit the material being machined. The inner edge or that opposite the cutting surface, is best machined with a notch the width of the holder and about ¾ inch deep, and the shank of the holder should be made to suit the spindle of the machine; the cutter is then held in the holder by either a pin or a set-screw.

One objection that has been made to the fly cutter is that it tends to pull the work into it. The writer has used this tool on both milling and drilling machines and, when ordinary care is used, has experienced no such trouble. On the other hand, almost any shape can be machined with this tool, but the conventional type of cutter cannot be made for intricate and complicated contours of surfaces. Another advantage of the fly cutter is the ease with which the tool may be sharpened by grinding or stoning. It is simply necessary to remove the cutter from the holder and grind on the flat side; no tool grinder is necessary. This advantage is of especial value to the small shop that has no tool grinder, but sends out its cylindrical tools when they must be ground.

The value of fly cutters is shown by the following example: Some time ago the blades of a steam turbine, when received, did not have the correct contour. As there were ten sets of blades and each set was of a different shape, ten milling cutters were needed to make the necessary changes. A firm that made the conventional type of cutter asked $280 for the set and required from a month to six weeks' time. As the turbine was an experimental one, this price and the time required were considered prohibitive; so ten fly cutters were made and a milling machine holder was changed to receive them. These cutters were made in two days and cost only $20. The blades were held in a vise on the milling machine table and no trouble was experienced during the machining operation. The surface produced was equal to any obtained with an ordinary milling cutter and the time required was no longer. It seems that there is a greater field of usefulness for the fly cutter than has been realized. It may be advantageously used in solving many machining problems of surfaces on both the milling and the drilling machines.

Providence, R. I. Robert Mawson

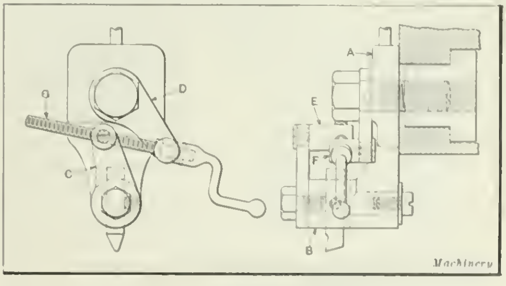
REASON FOR SUPERIORITY OF GUN TAP

Referring to the article relating to thread cutting in the October number of Machinery, it may be of interest to note that the reason why the so-called "gun tap" cuts better than an ordinary tap is that, on account of the angle at which the teeth at the end of the tap are chamfered off, the face of the teeth is at right angles to the direction of the helix of the screw thread. Hence the tap will naturally cut better than an ordinary tap with straight flutes. The relation is exactly the same as in a hob for cutting gears. It is well known that the cutting action is better when the flutes are at right angles to the direction of the helix of the hob thread.

Geneva, Switzerland A. Bollinckx

AN ARC-FORMING TOOL

The illustration shows an arc-forming tool for use on a shaper. *A* is a slotting tool-holder, made of tool steel and hardened. Piece *B*, also of tool steel, has a shank that has a bearing in *A*. The portion of *B* containing the tool bit should be an even diameter so that it will be convenient to set the tool bit for any given radius. Arm *C* is made of cold-rolled steel and is fastened to *B* by a cap-screw. Arm *D* is also made of cold-rolled steel and is held on *A* by the bolt that secures the entire tool to the shaper. Piece *E* is tapped to allow screw *G* to pass through it, and piece *F* is drilled and counterbored to form a bearing for this screw. *E* and *F* turn on their axes when *G* is revolved. This fixture can be made to suit almost any radius. If *G* should be too short to cut the entire arc, *C* can be loosened and brought back with *G*, and



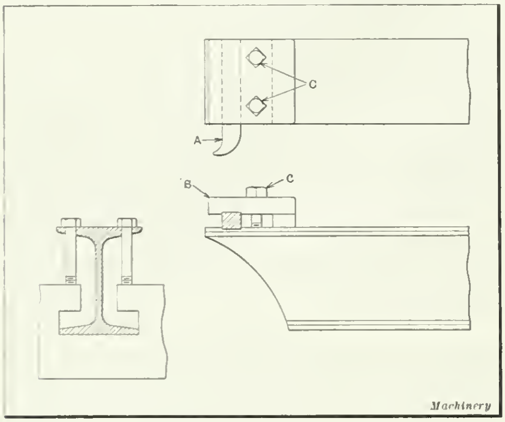
Tool for cutting Arcs on Shaper

the same cut can then be continued. The screw could be placed in a vertical position if so desired.

Schenectady, N. Y. P. Vuille

I-BEAM BORING BAR

The writer had to bore out six-inch diameter counterbores on an engine lathe, and in order to clear a projection on the casting being machined, the boring-bar overhung twelve inches from the cross-slide of the lathe. The illustration shows the boring-bar used, which was a three-inch I-beam, and the methods of fastening the tool and beam. The edges of the lower flange of the beam were trimmed off to allow the beam to slide freely in the toolpost slot. Four holes were drilled in the top flange of the beam, and corresponding holes were drilled and tapped in the cross-slide for the bolts used in clamping down the beam. The cutting tool *A* was held in position by block *B* and the beam, which had milled grooves to prevent the tool from pivoting; hence it was not necessary for bolts *C* to be drawn so tight as when there is no allowance for this feature. This boring-bar was especially stiff, considering the amount of overhang, and worked satisfactorily.



I-beam Boring-bar used on Engine Lathe

Worcester, Mass. C. Anderson

CIRCULAR CUTTING TOOLS

In the manufacture of circular tools for automatic screw machines, particularly where cut-off tools having a rounded profile are required, the holder and tools illustrated will be of value. In addition to being made at small cost, they can be used for a considerable time by regrinding the faces. The holder can be made of soft steel and pack-hardened, and the tools of ordinary or high-speed steel, the best results being obtained if the tools are ground after hardening. In Fig. 1 are shown tools for cutting arcs of various radii, *A* being used for radii from 3/16 to 1/2 inch, and *B* for radii from 3/32 to 3/16 inch. Tool *B* should have an offset of 1/16 inch when the radius is 3/16 inch, the offset increasing as the radius decreases, to allow the work to clear the tool-holder.

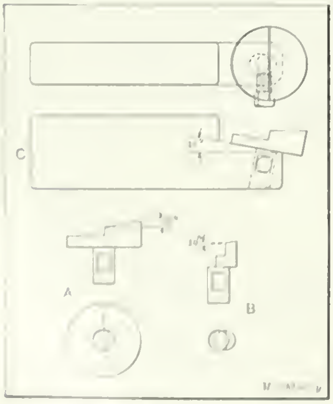


Fig. 1. Arc-forming Tools and Holder

In Fig. 2 is shown a tool and holder for cutting angles. When a tool is required that is wider than the diameter of the hole in the holder, larger stock may be used and a suitable shank turned on it. The tool-holder shown in Fig. 1 could also be used for this tool if a hole were drilled in the end *C*.

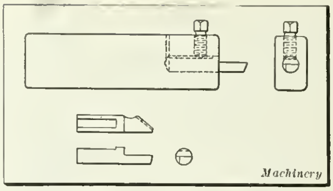


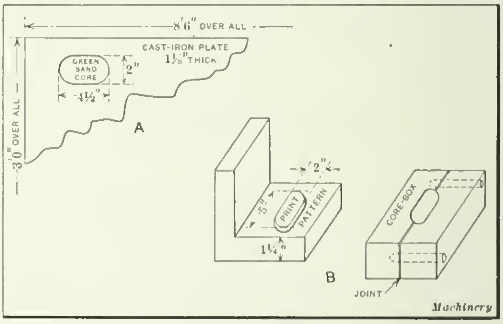
Fig. 2. Angle-forming Tool and Holder

New Haven, Conn. Frederick W. Randall

EXAMPLES OF POOR PRACTICE IN PATTERNMAKING

In the making of a great many patterns much labor and time are wasted, and the finished pattern often does not answer the requirements of the foundry. The reason for this is that the patternmaker does not know what these requirements are. Without a knowledge of molding practice it is impossible for a patternmaker to plan his work and predetermine the operations of the molder; he has to resort to guessing. An example of guesswork patternmaking was brought to my attention by the boss molder in a large jobbing foundry. The first casting was a plate, 3 feet wide by 8 feet, 6 inches long and 1⅛ inch thick; in it were cast eight holes of the shape and dimensions shown at *A*. These holes were made in the pattern to be molded in green sand. The work of cutting the holes in the pattern was labor and time wasted, and molding them in green sand was contrary to good molding practice.

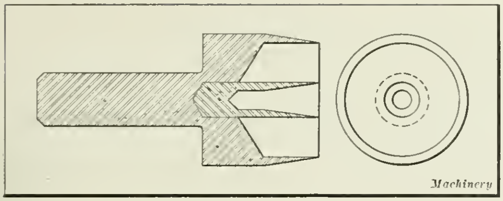
The practical method is to core these holes. Core-prints and a core-box are quickly made, and the cores can be made in a few minutes. To repair one green sand core that has been torn up or lifted with the pattern requires more time and labor than setting the eight dry sand cores in the mold, and with dry sand cores, cleaner holes correct in size are produced in the casting.



Examples of Poor Practice in Patternmaking

Another pattern made by the same patternmaker is shown at *B*. This small pattern is easily molded and lifted from the mold. The oblong hole is produced with a core, and for this a core-print and core-box were made. The core-box was made in two parts as shown. Now, if cutting the eight holes in the plate to be molded in green sand was considered by the patternmaker to be practical patternmaking, why make the small pattern to be molded with a dry sand core? Again, if the large plate, which is unhandy for the molder to handle, can be lifted without disturbing the green sand cores, then what is the sense of making this small pattern, that is so easily handled, to be molded with a dry sand core? What was the object of making the core-box split through the middle?

Kenosha, Wis. M. E. Duggan



Tool for cutting Rubber Washers

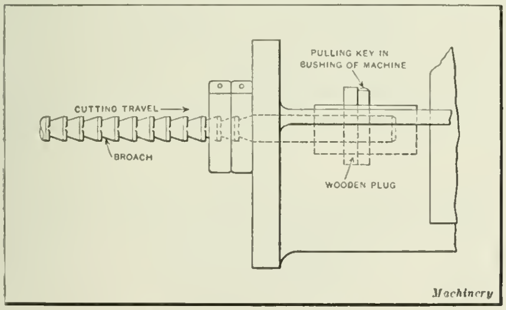
CUTTER FOR SOFT COMPOSITION WASHERS

The writer was employed where it was often necessary to make washers from rubber, etc., and a cutter like the one shown in the accompanying illustration was used so that the washers could be cut out on a drill press. The cutters were made from hard brass and drilled. The bevel is on the inside of the cutter that forms the hole in the washer, and this cutter is soldered or held in place by a small brass screw. This tool is quickly made and produces accurate washers. A wooden board should be placed beneath the composition, and the stop on the drill-press spindle set for the proper depth.

New York City E. J. Higgins

SAVING A BROACH

When a straight oval hole was being broached through light drop-forgings, two at a time, the broach frequently broke because too much stock had been left. As a result, the operator had to stay at home until the broach could be welded and the teeth recut. The broach used is 46 inches long and has 107 teeth, which are slightly tapered except the last ten, these being made straight for finishing. The work is done on a Lapointe machine. After the broach is run out to the end of its travel, the forgings are inserted over it and pushed onto the work-holding bushing, being located by engaging with pins. As the slot in the broach is 1 inch by ¼ inch, a key that was much stronger than the broach was, at first, used; therefore, the operator substituted for it a wooden plug and a piece of ⅜-inch drill rod, which was filed down on two sides to ¼ inch. Since then, whenever too much stock is left on the forgings, the drill rod breaks and not the broach, so that it is only necessary to remove one forging from the broach and the other is easily broached. Since making this change, there have been no broken broaches and 20,000 pieces were broached before it became necessary to discard the tool, because its teeth had worn down so much that the hole in the forging was too small.



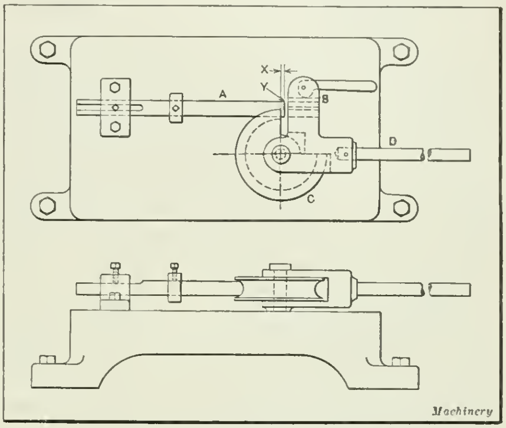
Safe Method of fastening Broach in Machine

New Haven, Conn. Eric Lee

TUBE-BENDING DEVICE

The accompanying illustration shows a device for bending brass or steel tubing without wrinkling the inside of the bent portion. As is well known, when bending tubes by the old method of filling the tube with lead, rosin or sand to keep it from collapsing, the bent portion leaves much to be desired as regards smoothness and appearance, and if plated and polished, the wrinkles become more noticeable. In analyzing the problem, it became apparent that the trick consisted merely in stretching the outside portion of the bend a sufficient amount to keep the inside from crumbling. The illustration shows the fixture that was designed. Arbor *A* is a snug working fit inside of the tube to be bent. The arbor is equipped with an adjustable collar to maintain the proper length from the end of the tube to the bent portion. Clamp *B* holds the tube in place.

The tube is inserted on the arbor and clamped in position. Sheave *C* is then turned by handle *D*, and the tube will be drawn off the arbor and stretched over the sharp edge *Y*. The distance *X* must be determined by experiments and will increase with the hardness of the material being bent. In the experience of the writer, this dimension was 5/32 inch for seamless brass tubing, 1 inch inside diameter and No. 20 gage, annealed. For the same size of steel tubing, also annealed, *X* was 9/32 inch. The device will make a bend of any number of degrees up to a U-bend, and also compound bends. The arbor *A* should be made of hardened tool steel. Lard oil should be used as a lubricant for the arbor.

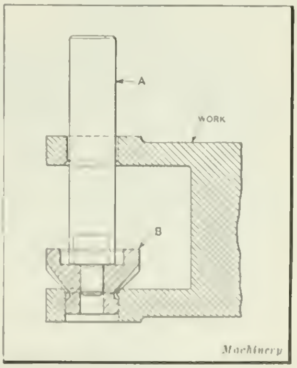


Fixture for bending Brass or Steel Tubing

Oak Park, Ill. H. W. Jespersen

INSIDE COUNTERSINKING

The illustration shows a device that was used on a machine gun part for countersinking two reamed holes from the inside. The driving bar *A* is held in place by a chuck on the drill press spindle; it is slightly smaller in diameter than the holes to be countersunk, and has two flat surfaces at one end. The cutter *B* is placed over the hole to be countersunk and bar *A* is brought down into it, the flat surfaces loosely fitting into an elongated hole in the top of the cutter. When the drill press is started, the revolving of bar *A* causes cutter *B* to revolve, and the hole is countersunk to the desired depth. The shank on the cutter is a good fit in the reamed hole, and this centralizes it during the operation. The work is then reversed and the countersinking operation performed on the other hole.



Device for countersinking Holes from Inside

A. C. Bartman, Jr.
Hartford, Conn.

DIES FOR STAMP COVER

In Fig. 1 is shown a stamp cover for which the writer designed and built the dies; these are of simple construction and perform the work very satisfactorily. The cover is made in two operations. Fig. 2 shows the combination die for the first operation, in which the blank is drawn and trimmed to the form shown at *A*, Fig. 3. In this operation, the blanks, which have been cut in a shear, are fed against stop *H*, Fig. 2. Then, when the ram comes down, the metal is held between *A* and *B* while the knock-out pad *E* draws the 0.07-inch channel on block *C*. Spring *G* must be strong enough to hold the metal securely during the remainder of the operation. When the draw is completed, blocks *A* trim the blank on block *D* as indicated by the arrows. The rubber pad *F* must be stiff enough to hold *B* tightly against blocks *A* so as to prevent wrinkling of the stock.

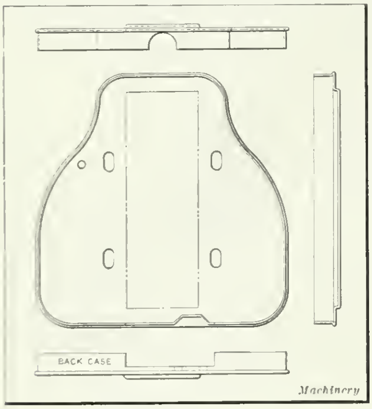


Fig. 1. Stamp Cover made in Dies shown in Figs. 2 and 4

Fig. 4 shows the die that performs the second operation, pressing the cover into the form shown at *B*, Fig. 3. When making plate *D*, the four pieces are roughed out within 0.02 inch all over, then hardened and ground in a surface grinder, the wheel of which has been trimmed with a radial fixture to the convex shape of the required radius.

New York City CHARLES HARDY

RIFLE CHAMBER REAMER

In the manufacture of rifles, the chamber reamer is a tool of prime importance. It must be as precise in its measurements as it is possible to make it; otherwise a quick, easy ejection, which is essential in a rifle, will be lacking. If the chamber should be reamed below its specified dimensions, the shell would jam and would not eject; if the chamber should be reamed too large, the shell would expand on explosion, and again the ejection would suffer. The reamer is made of high-grade tool steel. It differs from barrel reamers primarily in its shape, which, in the finishing reamer, is the shape of the cartridge. There are several different grades of chamber reamers, ranging from the first roughing reamer to the hand finishing reamer. The first roughing reamer is shorter than the finishing reamers and does not take a chip from the entire length of the chamber, but merely cuts from the large or rear end, as it is there that the greatest amount of stock must be removed. It is this roughing reamer that cuts the biggest chip, and it has but four flutes, the edges of which are cut across with a thread tool. There are about three of these cuts to the inch, and they serve to break up the chips, thereby feeding them out more rapidly. The finishing reamers have preferably a greater number of flutes, probably six or eight in number, and this increased number of flutes insures a smoother surface. An absolutely smooth surface is required, as a rough, uneven chamber would cause the shell to swell when exploded, and this, as before stated, would oppose a free ejection.

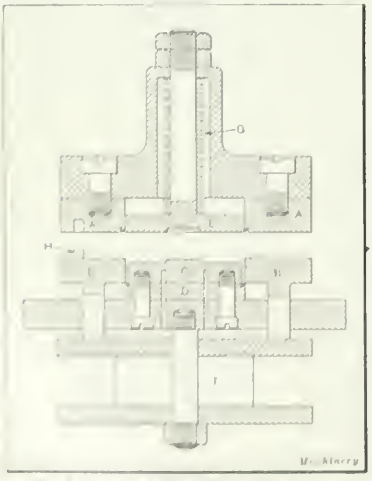


Fig. 2. First Punch and Die used in making Stamp Cover

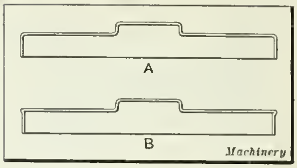


Fig. 3. Stages in making Stamp Cover

The total amount of stock removed by the chamber reaming in a 0.315-inch caliber rifle is 0.2362 inch. The first rough reaming takes away 0.2312 inch, and the remaining 0.005 inch is removed by the roughing and finishing operations that follow. By this may be seen the great difference in the size of the chips of the first rough-reaming and the following reamings. During the chamber reaming process the rifle barrel may be in either an upright or a horizontal position. In either case, the oil-flow that cools the tool enters the muzzle end of the barrel and is forced through to the other end. Although simple, the chamber reaming operation is very important; and as the success of the operation depends upon accurately made tools, it will be seen that the chamber reamer is an instrument of great importance in the manufacture of rifle barrels.

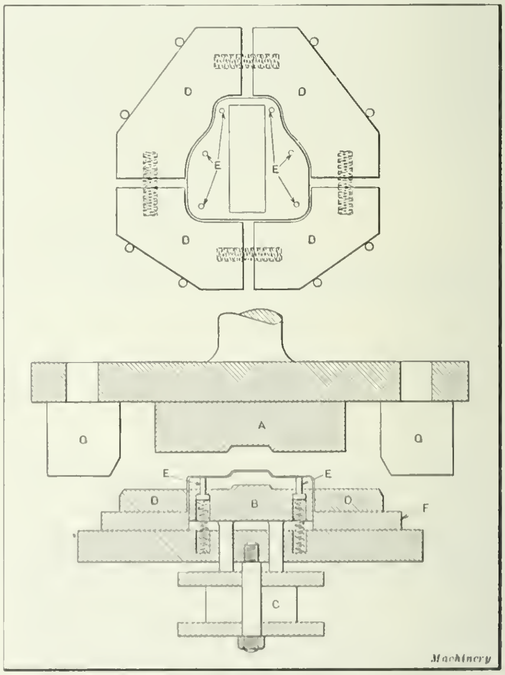
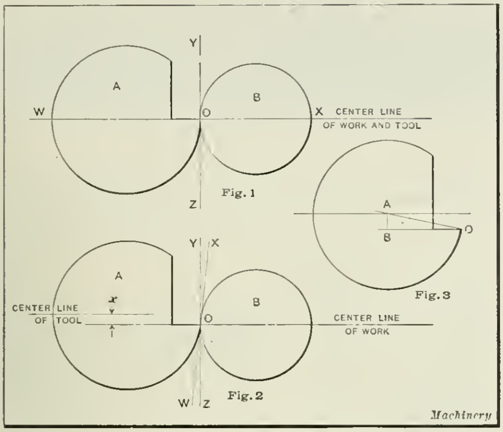


Fig. 4. Punch and Die used to complete Stamp Cover

West Haven, Conn. HARRY W. CHARD

CLEARANCE OF CIRCULAR FORMING CUTTERS

I agree with Mr. Miller, in the December number, that a great deal of time is wasted in developing the curves of forming cutters of the circular type. In this connection it is of



Figs. 1 to 3. Diagrams showing Clearance of Circular Forming Cutters

interest to consider the importance of clearance, and for the purpose of making clear what I have to say, I will review the situation.

If an exact outline is to be obtained by the use of a circular forming cutter, the cutter must be formed to give the exact outline on its cutting edge and not on the diametral section. To illustrate this rule, in Fig. 1 let A be a forming cutter that has been formed to give an exact outline on its diametral section, and B the work. The cutter and the work are set at the same height, that is with the cutting edge of the cutter on the line WX passing through their centers. The work produced will be the correct shape, but the tool can cut only while it remains absolutely sharp because the cutter is given no clearance angle, since tangents to the work and to the cutter at point O coincide in the line YZ. The cutting edge, however, is strongest in this position and becomes weaker as the clearance angle increases, because of lack of metal directly beneath the cutting edge. This angle of clearance may range from 3 to 15 degrees, depending on the work and the material of which the cutter is made. In Fig. 2, the forming cutter A has been formed to give an exact outline on its cutting edge, which is a distance x below the center of the tool and is set in line with the center of the work B. This distance x is dependent on the clearance angle WOZ, which is formed by the intersection of the line YZ drawn tangent to the work and the line WX drawn tangent to the tool at O. In the accompanying table are given the values of x and the clearance angle for forming tools of given diameters. In the table the distance x is obtained by multiplying the radius of the cutter by the sine of the angle AOB, Fig. 3, or what is the same thing, the clearance angle.

CLEARANCE ANGLES AND VALUES OF x OF FORMING TOOLS

Clearance Angle, Degrees	Diameter of Cutter, Inches				
	2	2.5	3	3.5	4
	Value of x, Inches				
3	0.052	0.065	0.078	0.091	0.102
4	0.069	0.087	0.103	6.110	0.138
5	0.087	0.109	0.130	0.150	0.174
6	0.104	0.130	0.156	0.182	0.208
7	0.122	0.152	0.183	0.212	0.244
8	0.139	0.173	0.208	0.241	0.278
9	0.156	0.195	0.234	0.273	0.312
10	0.174	0.217	0.261	0.303	0.348
11	0.191	0.239	0.286	0.335	0.382
12	0.208	0.252	0.312	0.365	0.416
13	0.225	0.281	0.337	0.393	0.450
14	0.242	0.302	0.363	0.422	0.484
15	0.259	0.323	0.388	0.451	0.518

Machinery

Moline, Ill. C. C. Hermann

PROBLEM IN TRIGONOMETRY

Another comment on the "Problem in Trigonometry," on page 245 of the November number, is as follows: In any triangle, the product of two sides is equal to the product of the diameter of the circumscribed circle by the altitude upon the third side. Thus:

$$BC = \sqrt{4.25^2 + 7.25^2} = 8.4038 \text{ inches}$$

$$AB = \sqrt{3.125^2 + 7.25^2} = 7.8948 \text{ inches}$$

$$\text{Diameter of circumscribed circle} = \frac{8.4038 \times 7.8948}{7.25} = 9.1512$$

inches

$$DC = \frac{9.1512}{2} = 4.5756 \text{ inches}$$

Indianapolis, Ind. Robert W. Smith

The geometrical construction given on page 245 of the November number of Machinery, for finding the center of a common gear for three pinions is simple and direct, but much of the accompanying computation is unnecessary. If the point of intersection of the vertical line through C and the horizontal line through B is denoted by H, as the point E bisects the line BC, the line EG is one-half of HC, or equal to 3 5/8 inches, and GC is one-half of BH, or equal to 2 1/8 inches. The triangles DEF and CBH are similar and their corresponding sides are proportional. Hence $\frac{EF}{DF} = \frac{BH}{CH}$; or $EF = \frac{BH \times DF}{CH}$. Now, $DF = BH - GC - 9/16$; or $DF = 4\,1/4 - 2\,1/8 - 9/16 = 1\,9/16$. Therefore, $EF = \frac{4\,1/4 \times 1\,9/16}{7\,1/4} = 0.916$; whence $X = 3\,5/8 - 0.916 = 2.709$.

Ampere, N. J. A. A. Nims

A simpler and more accurate solution of the problem stated on page 245 of the November number of Machinery is possible if analytical geometry is used.

Slope m' of $BC = -\frac{7\frac{1}{4}}{4\frac{1}{4}}$

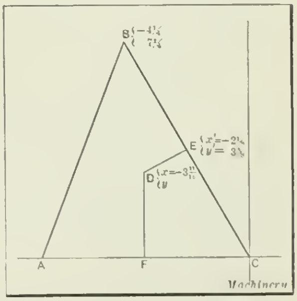
Slope m of $DE = \frac{4\frac{1}{4}}{7\frac{1}{4}}$

Equation of line DE, $(y' - y) = m(x' - x)$

$(3\,5/8 - y) = \frac{4\,1/4}{7\,1/4}(-2\,1/8 + 3\,11/16)$, from which $y = 2.709$

Hence $y = DF = 2.709$

The above example illustrates how simple many problems may be made by using the principles of analytical geometry.


$B\begin{cases}-4\frac{1}{4}\\ 7\frac{1}{4}\end{cases}$
$E\begin{cases}x'=-2\frac{1}{8}\\ y'=3\frac{5}{8}\end{cases}$
$D\begin{cases}x=-3\frac{11}{16}\\ y\end{cases}$
A
F
C
Machinery

Problem solved by Analytical Geometry

Newark, N. J. Ormonde Boggert

RIGHT- AND LEFT-HAND TOOLS

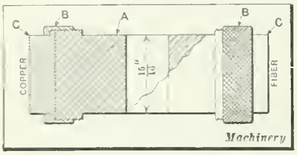
In the December number of Machinery, R. L. decides that a tool gets its name of "right-hand" or "left-hand" from the side the cutting edge or inclination is on rather than from the side of the work it cuts. The writer thinks that a right-hand lathe tool would generally be considered a left-hand tool if used in a planer or shaper, as the tool is commonly fed from right to left, when the operator stands facing the front of the machine. Consequently, the tool gets its name from the direction of cut in the machine rather than from its own inclination or side of cut. To cut a right-hand thread the tool will be inclined to the left, but it would be hardly correct to speak of cutting a right-hand thread with a left-hand tool. In the case of a side tool for the lathe, a right-hand tool (as commonly called) will work on the right-hand end of the work, and a right-hand planer or shaper tool also will work on the right-hand side or end of the work.

East Bridgewater, Mass. Percy S. Thomas

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

REMOVABLE HEAD HAMMER



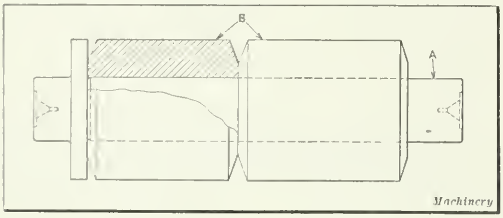
Soft Hammer with Removable Head

The advantages of the soft hammer here illustrated are that heads of any material may be used for various classes of work, and that the heads may be replaced when they become worn. The body *A* is made of soft steel, and has a hole in the center for a wooden handle; it is threaded at the ends for the knurled nuts *B* which hold the heads *C* in place.

Ambridge, Pa. AUGUST J. LEJEUNE

THREADING-TOOL SETTING ARBOR

The illustration shows a threading-tool setting gage that is similar to the one described in the October number of MACHINERY, except that it is hardened and ground. The advantage of this is that the V-point may be made sharper and the tool will not scratch or mar the gaging surface. The arbor body *A* may be made of tool steel, hardened and ground, or of cold-rolled steel, pack-hardened and ground. Bushings *B* are lapped to a snug fit on the arbor and are ground square on the ends, the bevels being ground while on the arbor. One end may be used for U. S. standard threads, while the other may be made for either Whitworth or metric threads. The end grinding of the bushings is done with the bushings projecting over the end of the arbor.

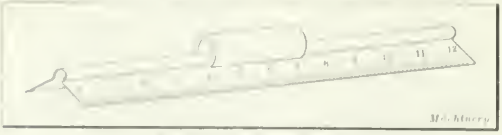


Gage for setting Threading Tools

Watertown, N. Y. HERBERT V. COULSTON

HANDLE FOR DRAFTSMAN'S SCALE

The scale shown in the illustration is familiar to all draftsmen or engineers. The handle is made from either brass or light-gage steel tubing, about ⅝ inch diameter and 2¼ inches long. The tubing is slotted the entire length by a hacksaw, and is snapped over the ridge of the scale into place.



Handle for Draftsman's Scale

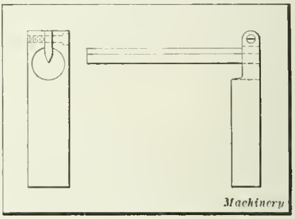
Flint, Mich. C. C. [illegible]

JIG LOCATING SYSTEM

The writer suggests the following method of locating jigs, etc. The special tools, jigs and gages are separated into convenient groups, and each group is given a number. This number is stamped within a circle on each piece of the group and on the proper storage rack. Where the use of a jig or gage is required, the group number is placed inside of a circle on the drawing, and when the workman studies the drawing he sees the group number and can easily locate the proper tool.

Los Angeles, Cal. R. H. WELCOME

DIEMAKER'S SQUARE



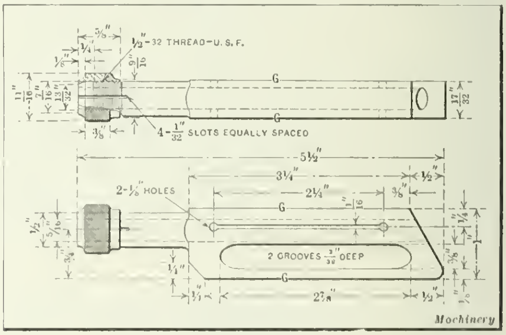
Handy Diemaker's Square

In filing the angular clearance on small dies, the square shown in the accompanying illustration permits the light to enter through the space cut from the inside of the beam, while the hole serves for a line of vision and allows the blade to be clamped at the necessary angles.

New York City E. J. HIGGINS

TOOLMAKER'S BORING TOOL-HOLDER

The illustration shows a tool-holder that is superior to the old style of V-holders, most of which have a set-screw projecting over the tool that prevents using it close to a faceplate when the work is held by U-straps. The boring tool is made of 5/16-inch drill rod and is clamped by the toolpost screw. The knurled nut at the end prevents unnecessary spring by means of the taper and slots that are shown.

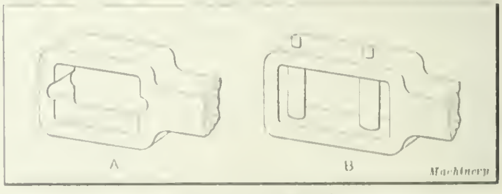


Handy Boring Tool-holder for Toolmakers

Frankford, Pa. CHARLES W. CARVETTE

DURABLE BELT SHIFTER

Several belt shifters became worn at the sides, as shown at *A* in the illustration, and gave trouble by curling the edge of the belt when shifting. At *B* is shown the change that was made in the design. Two rollers are used for guides; these revolve when the belt touches them, and thus eliminate wear on the shifter and on the edge of the belt.



Change made in Shifter Design

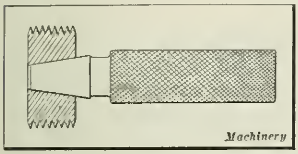
Concord, N. H. CHARLES H. WILLEY

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

ENLARGING WORN THREAD PLUG GAGES

In the January number of MACHINERY, D. D. inquires if there is any way of enlarging a thread plug gage that has worn small. This can be easily accomplished by designing the plugs as shown in the accompanying illustration. The taper plug is made of soft steel and is forced into the thread ring. After hardening the ring, the soft taper plug is forced into place by a screw press to enlarge the threads (which usually contract in hardening) for lapping. This plug may also be forced farther into the ring when the threads are worn small.



Method of enlarging Worn Thread Plug Gages

A CONSTANT READER

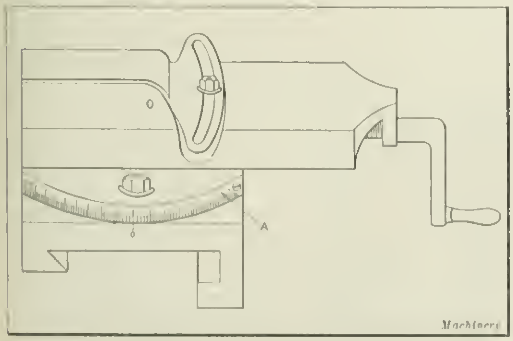
THREADING TAPS

C. E. C.—Is the following method of sharpening and lubricating taps in general use? It seems to be opposed to the teaching of the Pratt & Whitney Co. that resharpening should be done entirely on the face of the tap. The method has been used on taps working in soft steel, with a water solution of soluble oil, and on sizes from 5/16 to 3 inches, with fine threads. The taps are threaded with the cutting end about 0.002 inch large, fluted and relieved with a three-cornered Swiss file to within about 1/32 inch of the cutting edge. When hardened and drawn in oil, they are placed between centers in the universal grinder and the chamfer ground to include four threads on the smaller sizes and six on the larger. As this gives no clearance on these ends, the clearance is obtained by feeding the tap in from 0.005 to 0.008 inch on the cross-feed handle and turning the tap by hand until all but 1/32 inch of the previously ground surface has been removed, the piece being taken from the centers between each flute. The larger sizes are lubricated by having a 1/4-inch hole drilled entirely through them. The releasing holder is connected to the pump, so that the solution is forced through this hole ahead of the tap, returning through the flutes.

This question is submitted to the readers for discussion.

GRADUATING A PLANER HEAD

In the January number of MACHINERY, a correspondent asks how a planer head may be graduated in a shop that has no special appliances. The writer would suggest that the diameter of the part to be graduated in the accompanying illustration be multiplied by 3.1416, and this product divided by 360; the result will be the distance apart the graduations should be. These graduations may then be marked on a thin narrow strip *A* of cold-rolled steel, which is afterward fastened to the head as shown. For instance, if the diameter should be, or could be made to be, 14 21/64 inches, a flexible scale graduated to 1/8 inch will do the trick, as 14 21/64 × 3.1416 ÷ 360 = 0.125.



Method of graduating a Planer Head

Somerville, Mass. JOHN R. BECKETT

PROBLEM IN GEOMETRY

A. B. C.—Prove that in any triangle the product of two sides is equal to the product of the diameter of the circumscribed circle and the altitude upon the third side.

A.—Referring to the illustration, it is desired to prove that AB = diameter × H.

The area of the triangle $= \dfrac{AB \sin a}{2}$

Therefore, we will prove that

$$\frac{AB \sin a}{2} = \frac{DH \sin a}{2}, \text{ or } RH \sin a$$

If an angle at the circumference of a circle, between two chords, is subtended by the same arc as the angle at the center, between the two radii, then the angle at the center equals two times the angle at the circumference, so $\beta = 2a$.

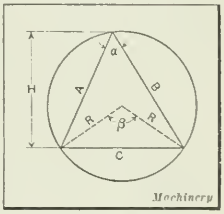


Diagram illustrating Problem in Geometry

The area of a triangle equals one-half the base times the altitude.

$$1/2\,C = R \sin a$$
$$\text{Area} = R \sin aH$$

Thus: $$\frac{AB \sin a}{2} = RH \sin a$$

CROWNING OF LOOSE PULLEYS

F. M.—(1) Is it customary to make drop-face or reduced-diameter loose pulleys with a crowned face? (2) Are cone step pulleys made with crowned face?

A.—(1) A number of replies have been received to this question. In the opinion of the Hall & Brown Woodworking Machine Co., St. Louis, Mo., all pulleys where the belt is to run in a fixed position for a period of time should be crowned, as this will hold the belt in position better. A belt running on a loose pulley having a straight face is likely to run against the edge of the tight pulley, and even to climb onto the pulley in spite of the fact that the loose pulley is made with a reduced diameter. The Defiance Machine Works, Defiance, Ohio, state that it is their practice to crown all loose pulleys. The American Woodworking Machinery Co., Rochester, N. Y., follows the same practice, but also advises that it has discontinued the use of loose pulleys with reduced diameters on account of the effect upon the belt, which is stretched on the side running against the flange between the loose and tight pulley. The only advantage of the reduced-face pulley is on countershafts which are placed quite close to the lineshaft and where a short tight belt is used. When the belt is shifted from the tight to the loose pulley some of the strain is taken off the loose pulley bearing, thus giving it longer life, if that pulley is made with a reduced diameter. The H. B. Smith Machine Co., Smithville, N. J., states that in this company's practice loose pulleys with reduced diameter are made with a straight face. The Bentel & Margedant Co., Hamilton, Ohio, also makes it a practice to provide drop-face loose pulleys with a straight face, but crown slightly loose pulleys that are of the same diameter as the tight pulley. The J. A. Fay & Egan Co., Cincinnati, Ohio, states that drop-face loose pulleys are provided with a crowned face, in the company's practice, because unless so made the edge of the belt runs against the bevel flange and has a tendency to climb onto the tight pulley and start the machine without the operator's knowledge. The company, however, discourages the use of drop-face loose pulleys, because they are very hard on the belts. The elimination of the drop-face loose pulley, also known as the "bevel-flange pulley," would mean considerable economy on account of the belt cost.

(2) Cone step pulleys are crowned the same as other pulleys of corresponding size.

FINDING THE AMOUNT OF METALS IN AN ALLOY

O. O. T.—We have an alloy that is known to contain copper, tin and zinc, and, by careful weighing, it has been found that a cubic inch weighs 0.285 pound. Is there any way by which we can find the proportions of copper, zinc and tin without making an analysis?

A.—Problems of this kind belong to the class called indeterminate; they are so called because they are capable of an indefinite number of solutions. However, by imposing certain restrictions, a satisfactory solution may usually be obtained. In the present case, it is assumed that the density of the alloy is directly proportional to the densities and amounts of the metals composing it. By this is meant that there is not a chemical combination, as in the case of carbon and iron in steel, the density of steel being greater than iron, although the density of carbon is less than iron. It is also assumed that the number of parts of each metal is integral and less than 10. With these assumptions granted, the easiest way to solve problems of this kind is by the arithmetical process known as alligation alternate. Referring to page 1245 of MACHINERY'S HANDBOOK, it is found that the weight of one cubic inch of copper is 0.3184; of zinc, 0.2476; and of tin, 0.2632. Taking the weight of a cubic inch of the alloy as 0.2850, and dropping the decimal points, arrange these quantities as shown herewith. Subtract (algebraically) each number from the mean number 2850 and write the results, as shown, in the same rows as the corresponding subtrahends; note that two of these remainders are positive and the other is negative. Multiply these remainders by such numbers (to be found by trial) as will make the sum zero, or approximately zero. In this case, the multipliers are 3, 1 and 4, and their sum is 8. It is, therefore, assumed that in eight parts of the alloy there are three parts zinc, one part tin and four parts copper. Expressed in percentages, the alloy contains copper, 50 per cent; zinc, 37½ per cent; tin, 12½ per cent.

$$2850\left\{\begin{array}{l|rcl} 2476 & 374 \times 3 & = & 1122 \\ 2632 & 218 \times 1 & = & 218 \\ 3184 & -334 \times 4 & = & \end{array}\right. \quad \begin{array}{r} \left.\begin{array}{r}\\ \end{array}\right\} 1340 \\ -1336 \\ \hline 4 \end{array}$$

$$\begin{array}{r} \hline 8 \end{array}$$

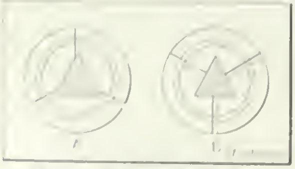
$$\text{Proof: } \frac{0.2476 \times 3 + 0.2632 \times 1 + 0.3184 \times 4}{8} = 0.28495,$$

which is very nearly 0.285 and coincides with it when reduced to three significant figures.

J. J.

WHICH WAY IS CHEAPER?

The proper way to make the chuck shown in the December number on page 318 under the head "Which Way is Cheaper?" would be to slit as shown at *A*. Cutting the slits as shown at *A* will permit the broach to be made with flats at the corners of the width of the saw used to cut the slits. This not only means a stronger broach, but makes a better spring chuck.



Two Ways of Slitting Spring Chucks

[illegible] JOHN SHAND

By slitting as shown at *A* in the illustration in the December number not only is the risk of cracking in hardening eliminated, but accurate chucking on burred stock is secured; the latter fact is often overlooked by makers of hexagon and triangular collets. On soft stock where the chucking pressure is great enough to indent the stock, the method shown at *B* will be of greater advantage. Assuming the stock to be soft steel or brass, collets slit as shown at *A* will undoubtedly give more accurate results.

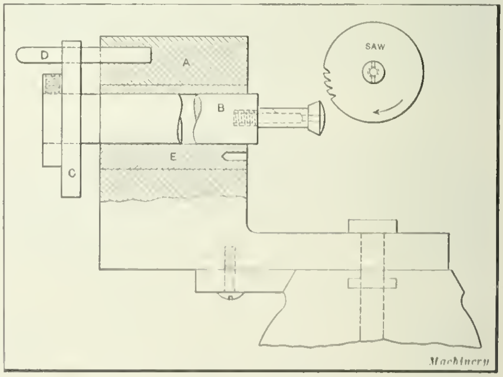
A quick way of slitting collets in three parts is to draw out of mesh the worm in a regular index head, and index from the jaws of the three-jaw chuck. This method means no extra equipment. It has been used by the writer on various collet and bushing jobs with good results.

Toronto, Ontario, Canada A. F. OWEN

In the December number of MACHINERY R. G. shows two spring chucks for triangular stock and asks which is the cheaper method of slitting. If he is making these chucks on order and the only requirement is that the chuck shall have three slots in the stock-holding end, there would probably be little, if any, difference in the cost of the two methods. However, if he is in any way responsible for the satisfactory performance of these chucks, he should by all means use the method shown at *A*. A chuck split as shown at *B* must have a relief groove in each corner, as the triangular stock will have occasional dents and burrs on the sharp corners. The cutting of these relief grooves will mean an extra cost, whereas the other method eliminates the sharp corners entirely. No matter if the stock being operated on is slightly misshapen, that is, not a true equilateral triangle, the chuck shown at *A* will grip it with all three prongs, while only a slight difference between the shape of the stock and the triangular hole of chuck *B* will result in but two jaws, or prongs, doing all the gripping.

Anderson, Ind. LEROY M. CURRY

In the December number of MACHINERY, R. G. asks which is the cheaper and better method of slitting taper spring chucks. The chuck shown at *A* in the illustration in the December number is slit correctly, as it allows the corners of the stock to protrude into the slots and holds the work by the flat sides; as dirt and chips will collect in the corners of the chuck shown at *B*, this chuck cannot grip the work properly; but one method is as cheap as the other.

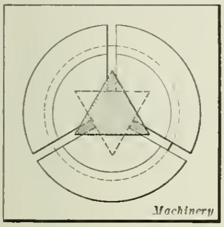


Slitting Fixture for Taper Spring Chucks

The best slitting fixture for spring chucks where the quantity of work to be produced warrants the expense of manufacture is shown in the accompanying illustration. The fixture is fastened to the bed of a bench lathe in place of the slide-rest. The saw is held in the head of the bench lathe. The casting *A* is drilled and reamed for the chuck holder *B*, on the end of which is a cast iron index plate *C*, having three holes that fit over a pin *D*. Vertical adjustment is provided by an eccentric bushing *E*. As R. G. does not show a side view of the chuck, it is impossible to show a proper holder, but the wire chuck shown will perhaps suggest some similar scheme of holding the work. This method of sawing by pushing the work against the saw will be found more sensitive than a screw feed, as the least catching of the saw will be felt at once and the work can be withdrawn before the saw is broken. A stiff bristle brush, such as a toothbrush, dipped in cutting oil, should be rubbed constantly across the teeth of the saw.

Jersey City, N. J. W. H. DUNBRACK

It is clearly seen in the accompanying illustration, where method *A* is shown in full lines, and method *B* in dotted lines, that the first is the cheaper. In the first case there is not as much stock to be removed when milling the slits as by the other method. Also, the slits are not as deep, so the time and the power necessary for removing the stock shown in shaded lines are saved, with the resulting reduction in the cost. Of course, the operations in each case are the same, namely, after the piece has been finished on the outside and broached, it is slit on the milling machine. While method *A* is the cheaper, method *B* is preferable, as the slits should always come on the sides of the stock.



Two Methods of slitting Taper Chucks

Cincinnati, Ohio TAFT S. ARMANDROFF

INSPECTION LIMITS FOR TAPS AND DRILLS

Q. R.—What are the generally used limits for taps and drills as sold in the open market?

A.—There is no universal agreement among manufacturers of taps and drills as regards the limits to be used for these tools. All taps are made over size both on the outside diameter and the pitch diameter, the size that would pass inspection being somewhere between standard nominal size and the over-size limit adopted. In Table 1 are given these over-size limits for hand taps and tapper taps. This table places on record the average limits used by two tap manufacturers and may be assumed as representing good practice. As the outside diameter is not vital to the size of thread cut by the tap, this being determined by the pitch diameter, the dimensions given in the table for outside diameter limits need not be so strictly adhered to (provided the diameter is always larger than nominal) as those for pitch diameter limits. The over-size dimension on the outside diameter provides for clearance and wear, and, in fact, many makers permit much larger limits than those given.

The permissible error in lead (in ordinary single-threaded taps the lead equals the pitch) should be ± 0.002 inch in 1 inch length of thread. Taps on the market, however, indicate that this limit is not adhered to by all makers, as taps of several makes that have been measured have proved to have a lead error of as much as 0.006 inch. Only a few makers seem even to attempt to limit the lead error to 0.002 inch.

On taps where great accuracy is required, as, for example, for hob taps used for finishing threading dies, the limits should be made from 0.00025 to 0.0005 inch less than the limits given for hand taps in Table 1 for the finer pitches, and about 0.001 inch less than the limits given for the coarser pitches. This also applies to taps made to the Society of Automotive Engineers' standard (S. A. E. standard). The limits in the table are given for "number of threads per inch," which has been found to be rational and much better than when an attempt is made to give the limits for certain diameters with corresponding number of threads only.

TABLE 1. INSPECTION LIMITS ON TAPS

Maximum Limit: Figures given in Table added to Standard Nominal Diameter. Minimum Limit: Standard Nominal Diameter

Number of Threads per Inch	Hand Taps		Tapper Taps	
	Outside Diameter	Pitch Diameter	Outside Diameter	Pitch Diameter
80	+ 0.0012	+ 0.0007	+ 0.0025	+ 0.0020
72	+ 0.0014	+ 0.0010	+ 0.0027	+ 0.0022
64	+ 0.0015	+ 0.0011	+ 0.0030	+ 0.0025
60	+ 0.0016	+ 0.0012	+ 0.0033	+ 0.0028
56	+ 0.0017	+ 0.0013	+ 0.0035	+ 0.0030
48	+ 0.0018	+ 0.0014	+ 0.0037	+ 0.0032
44	+ 0.0019	+ 0.0015	+ 0.0038	+ 0.0033
40	+ 0.0020	+ 0.0016	+ 0.0039	+ 0.0034
38	+ 0.0021	+ 0.0017	+ 0.0040	+ 0.0035
36	+ 0.0021	+ 0.0017	+ 0.0041	+ 0.0036
34	+ 0.0022	+ 0.0018	+ 0.0042	+ 0.0037
32	+ 0.0022	+ 0.0018	+ 0.0043	+ 0.0038
30	+ 0.0023	+ 0.0019	+ 0.0044	+ 0.0039
28	+ 0.0023	+ 0.0019	+ 0.0045	+ 0.0040
26	+ 0.0024	+ 0.0020	+ 0.0046	+ 0.0041
24	+ 0.0024	+ 0.0020	+ 0.0047	+ 0.0042
22	+ 0.0025	+ 0.0021	+ 0.0048	+ 0.0043
20	+ 0.0026	+ 0.0022	+ 0.0049	+ 0.0044
18	+ 0.0027	+ 0.0023	+ 0.0050	+ 0.0045
16	+ 0.0028	+ 0.0024	+ 0.0051	+ 0.0046
14	+ 0.0029	+ 0.0025	+ 0.0053	+ 0.0048
13	+ 0.0031	+ 0.0027	+ 0.0055	+ 0.0050
12	+ 0.0032	+ 0.0028	+ 0.0057	+ 0.0053
11	+ 0.0033	+ 0.0029	+ 0.0059	+ 0.0056
10	+ 0.0035	+ 0.0030	+ 0.0060	+ 0.0057
9	+ 0.0037	+ 0.0032	+ 0.0062	+ 0.0058
8	+ 0.0040	+ 0.0034	+ 0.0064	+ 0.0060
7	+ 0.0044	+ 0.0036	+ 0.0066	+ 0.0062
6	+ 0.0048	+ 0.0039	+ 0.0068	+ 0.0064
5	+ 0.0052	+ 0.0043	+ 0.0070	+ 0.0066
4	+ 0.0058	+ 0.0045	+ 0.0075	+ 0.0070

Machinery

With regard to limits for drills, the principle is reversed. Drills must never be permitted to have dimensions over the nominal standard diameter. If they were, they would not enter drill jig bushings of standard size, and, furthermore, a drill, no matter how carefully ground, generally will drill a hole that is slightly larger in diameter than the size of the drill. Hence all drills should be between a limit less than the standard nominal size and the nominal size. For example, a 1-inch drill should be between 0.999 inch and 1.000 inch. The limits for drills of all classes are given in Table 2.

* * *

Broaches are displacing reamers quite generally in manufacturing where it is necessary to finish many holes to the same diameter for a push, drive or running fit. The broaching process is much more rapid than reaming, and, moreover, the broach stands up for many times the number of holes that a reamer will finish before becoming very dull. The Robbins & Myers Co., Springfield, Ohio, uses a novel form of broach for sizing holes in a part that is a push fit in armature construction. The broaches are made of high-speed steel, and instead of having the teeth formed by parallel circumferential grooves, they are formed by cutting a helix or thread of buttress shape. The broach is sharpened by grinding the top of the teeth and tapering the broach so that the leading end is a few thousandths of an inch smaller than the rear end. Of course, the backs of the teeth drag in the hole, as there is no cutter clearance, but this defect seems to be of little practical importance, as the broaches do good work and size thousands of holes before they have to to be reground to a smaller size.

TABLE 2. INSPECTION LIMITS FOR TWIST DRILLS

Maximum Limit: Standard Nominal Diameter. Minimum Limit: Figures given below subtracted from Standard Nominal Diameter

Sizes of Drills, Inches	Value for Finding Minimum Limit, Inch	Sizes of Drills, Millimeters	Value for Finding Minimum Limit, Inch	Sizes of Drills, Number or Letter	Value for Finding Minimum Limit, Inch
1/32 to 1/16	— 0.00025	0.5 to 1.75	— 0.00025	No. 80 to No. 50	— 0.00025
5/64 to 1/4	— 0.0005	1.8 to 6.3	— 0.0005	No. 49 to No. 1	— 0.0005
17/64 to 1/2	— 0.00075	6.4 to 13	— 0.00075	A to D	— 0.0005
33/64 to 1 1/4	— 0.001	13.5 to 32	— 0.001	E to Z	— 0.00075
1 17/64 to 2	— 0.0015	32.5 to 50	— 0.0015	......	......
2 1/64 to 3	— 0.002	50.5 to 75	— 0.002	......	......

Machinery

FORMULAS FOR COMBINED BENDING AND TORSION

The subject of combined bending and torsion is one that has proved more confusing to machine designers than any other phase of the strength of materials that is ordinarily encountered by the mechanical engineer engaged in ordinary machine design. Several formulas have been proposed, but unless they are used with a thorough understanding of their limitations, mistakes are likely to be made. Prof. A. Lewis Jenkins of the University of Cincinnati, in a paper presented before the annual meeting of the American Society of Mechanical Engineers in December, 1917, thoroughly analyzes the subject and gives formulas which may be directly applied by machine designers when the bending moment, the twisting moment and the permissible working stress are known. Two formulas are given, one for the design of shafts of brittle materials and one for soft ductile materials.

The following formula, known as the Grashof formula, may be used for the design of shafts and similar machine parts constructed of brittle materials, such as cast iron, hardened or annealed tool steel, hard bronze, and other materials having a small contraction of area when tested in tension:

$$SZ = 3/8 M_b + 5/8 \sqrt{M_b^2 + M_t^2}$$

in which S = permissible or working stress in tension;
Z = rectangular (ordinary) section modulus;
M_b = bending moment to which member is subjected;
M_t = torsional moment to which member is subjected.

For the design of parts made of soft or ductile materials, such as mild (low-carbon or machine) steel, copper, soft brass and soft steel tubing, the following formula should be used:

$$S_s Z_p = 1.3 \sqrt{M_b^2 + M_t^2}$$

in which Z_p = polar section modulus;
S_s = permissible or working stress in shear,

the notation otherwise being the same as above.

The accompanying table gives values for the unit tensile and unit shearing stresses at the yield point, of a number of different materials. By using a suitable factor of safety, the permissible working stresses may be obtained from this table.

STRESSES AT YIELD POINT OF DIFFERENT MATERIALS

Material	Average Tensile Stress per Square Inch at Yield Point	Average Shearing Stress per Square Inch at Yield Point
Machine steel (mild carbon steel)..	47,000	30,000
Rivet steel	39,000	24,000
High-carbon steel	60,000	27,000
Nickel steel	70,000	37,000
Steel tubing	22,000	13,000

Machinery

If these two formulas are generally used when applicable, the Guest formula, the use of which has been often advocated during recent years, will be found unnecessary; it would perhaps be desirable if this formula were not so generally advocated, because it applies only to ductile materials, and if used for hard or brittle materials, would lead to the adoption of unsuitable dimensions.

• • •

The Davis Mfg. Co., Milwaukee, Wis., has developed a continuous rotary table milling machine with accelerated feed motion which automatically goes into action when the cutter has finished a piece. The lost time on the "wind cut" is thus reduced. A hob was required to hob the worm wheel, and Mr. Davis ordered an inserted tooth hob made, as he believed, so that it would serve the purpose as well as a solid hob and would be much cheaper in labor and material cost. The body was turned from carbon tool steel and holes were drilled in a helical path for 9/16 inch high-speed steel plugs. The plugs were shaped approximately to the required hob tooth shape and driven into place. The assembled hob was then chased and the teeth backed off in regular fashion and hardened. No trouble was experienced because of cutters loosening in the body, the shrinkage of the tool steel and high-speed steel being practically the same.

PERMANENT MOLDS FOR SHELL CASTING

In a paper presented before the American Foundrymen's Association, E. A. Custer, the inventor of the Custer process for casting in permanent molds, which was described in detail in MACHINERY, May, 1911, dealt with the possibilities of casting shells in permanent molds.[1] There is nothing new in the use of cast-iron projectiles, as before the present steel age they were the sole means of battering down defenses and of attack at long range. Some of the reasons why the use of cast-iron shells was abandoned are that the metal has never made a very good record for uniformity, freedom from sponginess and gas-holes; its tensile strength is low, and it lacks toughness. The defects commonly found in cast iron will seriously affect the trajectory and direction of a shell and render it comparatively useless. If one portion is spongy, and hence lighter than the remainder, it will wabble in its flight and its main purpose will be destroyed. The weakening effect of sponginess or blow-holes may cause the shell to break under the impulse of discharge, and destroy the gun. A forged steel projectile meets all these objections, and for that reason has been universally adopted.

As early as May, 1913, German and Italian munition makers were discussing the manufacture of cast-iron projectiles. In August, 1913, it was reported that shells had been made that were satisfactory, in that they had the proper degree of fragmentation and were strong enough to resist the effect of the propelling charge. These shells were made in iron molds with iron cores. Their peculiarly destructive effect was later observed in the field, not only in the open, but also against earthworks, and the then prevalent idea that the German forces were using cast-iron shells on account of the scarcity of steel was abandoned. Ordinary foundry iron, when properly cast in a permanent mold and when removed at the proper time, has in the resultant casting the same degree of hardness, irrespective of any variation in the chemical constituents, so long as the same size, weight and shape of casting is made. The time the casting remains in the mold is the determining factor. A casting weighing about 60 pounds remains in the mold 4 or 5 seconds, while a casting of the same general contour weighing 500 pounds will require 25 to 60 seconds.

The low cost and great output per day and effectiveness of cast-iron shells have been so completely recognized that two of the warring nations are using them to an enormous extent. France is casting them in sand, and Germany, from the best information available, is casting them in permanent molds. A steel forging for a 4.7-inch shell costs over $7 at the present writing, while a casting of the same shell can be made for a little over $2. Furthermore, a liberal saving in labor and machine-tool consumption can be effected.

• • •

REPEAL OF INCREASED SECOND-CLASS POSTAGE URGED

It is expected that Congress, during the present session, will repeal that part of the War Revenue Law passed last October which provides for an increase of from 50 to 900 per cent in the postage for periodicals, a matter that is of vital interest to all readers of mechanical and trade journals. Under the proposed zone system for second-class mail, it would cost 21 cents to send a copy of MACHINERY to Chicago, and proportionately more to send it to places farther away. It is quite evident that this is a prohibitive rate, when subscribers pay less than 20 cents a copy for their paper. Any readers of mechanical journals who are interested in maintaining the present usefulness of the engineering press could serve their trade or profession in no better way than by writing their congressman asking the repeal of the zone system for second-class mail. Particularly now, when the winning of the war depends to so great an extent upon the mechanical industries, it seems to be a very inopportune time to do anything that will throttle the spreading of useful information in these industries, and thereby hamper, to a considerable degree, the successful production of war materials.

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[1] See also MACHINERY'S ENCYCLOPEDIA, Volume II, page 20.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

IN THIS NUMBER

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HOLZ PERMEAMETER FOR MAGNETIC-MECHANICAL ANALYSIS OF IRON AND STEEL

Research work of scientists in this country and Europe has shown conclusively that there is only one set of mechanical characteristics corresponding to a given set of magnetic characteristics, and vice versa. Consequently, the magnetic properties of iron and steel give valuable information concerning structural conditions existing in the material. Until recently, this method has found little practical application in industrial plants owing to the difficulty of accurately determining the magnetic properties, but this difficulty has now been overcome through the development of the Holz "permeameter." This instrument may be used for testing milling cutters, reamers, twist drills, files, etc., and also for testing such products as wire, wire rope, drill rod, etc. An advantage of the method is that the entire piece is tested instead of a sample, and the test is made without in any way damaging the product, so that this method is equally applicable for use on raw materials and finished work.

RESEARCH work done abroad and at the U. S. Bureau of Standards has shown that the magnetic properties of iron and steel afford a most valuable index to the structural conditions existing in such materials, which is of special importance in those materials intended for use where strength or cutting properties are the essential factors. Not only do the initial processes of manufacture affect the magnetic characteristics, but subsequent heat-treatment also. Therefore, the magnetic test offers means of examining materials, tools, etc., during and after manufacture, without injuring or marring them, with a view to predetermining their mechanical performance. It also presents a method of investigating the "exceptional tool" or product, looking toward its routine duplication. In nearly every plant it happens that—by a combination of circumstances—a tool of remarkable quality, otherwise not distinguishable, is sometimes turned out which stands up far better than the average run of the product. It is, of course, important to obtain data to enable duplication of this high quality, and by the method of "magnetic-mechanical analysis" we are in a position to ascertain the characteristics of the remarkable product, so that a basis is created for its exact duplication. The method of "magnetic-mechanical analysis" is based upon the fundamental fact that "there is one, and only one, set of mechanical characteristics corresponding to a given set of magnetic characteristics, and conversely there is one, and only one, set of magnetic characteristics corresponding to a given set of mechanical characteristics."[1] The International Association for Testing Materials, the American Society for Testing Materials, the U. S. Bureau of Standards, and a number of private investigators are actively engaged on this important work, so that the science of properly correlating the underlying factors will surely make rapid progress in the near future, especially since accurate and convenient apparatus has now been developed to permit the practical application of this method of analysis in the industries. There are many advantages of "magnetic-mechanical analysis" which are of great importance. The material actually entering into the construction of the finished product and, in most cases, the final product itself can be subjected to the test without suffering the slightest injury. The various methods of testing now largely used (chemical, micro-

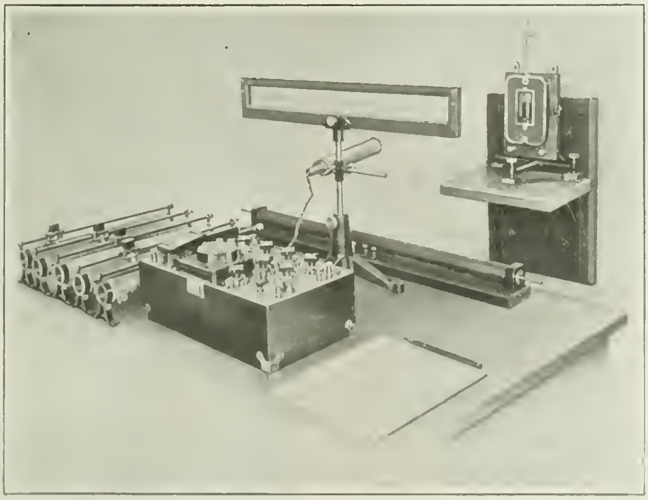

Fig. 1. Apparatus for Investigation of Mechanical Properties of Iron and Steel Wires, Ropes, Rods, etc., by Determination of their Correlated Magnetic Characteristics

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[1] From "Correlation of the Magnetic and Mechanical Properties of Steel," Scientific Paper No. 272, published by the U. S. Bureau of Standards, Washington, D. C.

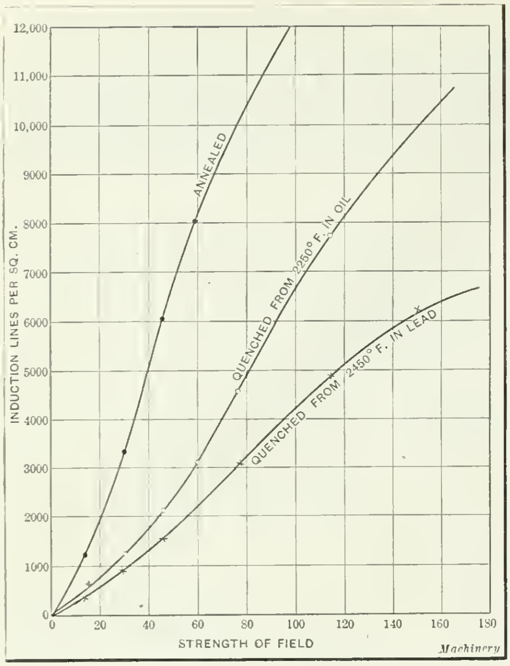


Fig. 2. Permeability Curves of Heat-treated High-speed Steel

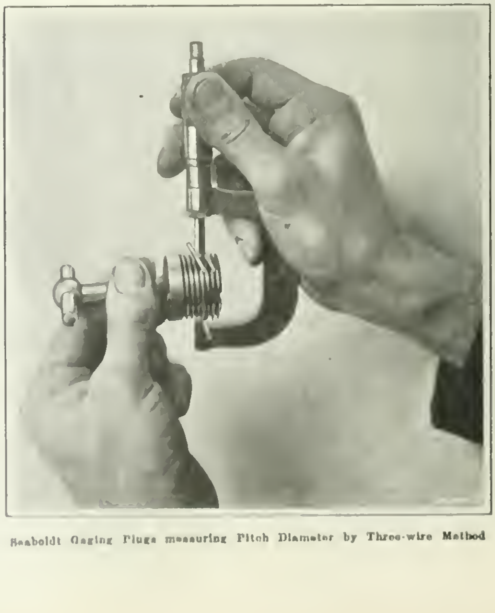
scopic, hardness, tensile, impact, etc.) are either destructive or local surface tests. As Dr. Henry M. Howe says:[1] "Our tests destroy the part tested. That is a crude state of the art of testing. A wholly different line of testing from that now employed is opened by these magnetic investigations; that is to say, the reaction of the material to forms of energy which have no permanent effect on the material itself. . . . I do believe that we need radically different methods of testing; that our present methods are those of a crude, ignorant age, and will give way in time to radically different methods of testing which determine the reaction of the substance to forms of energy which do not injure the substance." Besides the point of destruction emphasized by Dr. Howe, the important question of "sampling error" enters into all the old methods of chemical and physical tests. As the science of testing stands now, we are pulling to destruction a bar of steel or piece of wire and presume that the rest of the material under investigation is exactly the same quality as the small specimen tested. We cut off a piece of steel for observation under the microscope and relieve the internal stresses in the metal, which are an important factor in the investigation. We press a small steel ball into a spot of a forging, casting, etc., and assume that this gives us the hardness of the entire mass.

Another important feature of the magnetic-mechanical test is that it shows quite clearly differences in the mechanical properties of steel, where the other methods of test fail to indicate them, and where practice has shown that such differences do exist. Two pieces of steel may have the same "Brinell hardness," for instance, and still possess entirely different mechanical characteristics. This point was shown by R. P. Devries, who states:[2] "I wish to call attention to three specimens of steel, one annealed and two in the hardened condition. These pieces were tested by means of the Brinell hardness test, notch bar impact and the Martens scratch test. The tests easily differentiated between the annealed and the hardened specimens, but did not distinguish between the two hardened specimens. In Fig. 2 the "B H" (permeability) curves for these specimens are reproduced. They indicate that by differentiating between the annealed and the hardened state the magnetic test also discloses considerable differences between the two hardened specimens which the mechanical tests do not show." The magnetic-mechanical test is not restricted to work in the laboratory. Products like tools, saw blades, drills, ball bearing races, milling cutters, etc., can be subjected to routine tests in the plant, and in case some of these show distinct differences in magnetic properties against the average run, it is safe to assume that something is wrong with their mechanical properties, so that "seconds" can be easily separated and the quality of tools of established trademark can be at all times fully maintained. Among the many other steel products which readily lend themselves to this method of test are files, knives, drill rods, wires and wire ropes, springs, steel balls, plates, sheets, strips, etc. Fig. 1 shows a typical outfit for magnetic-mechanical analysis of wires, wire ropes and rods, and this apparatus is of considerable importance at this time for testing the wires used in airplane construction. Not a "specimen" of the material is subjected to the test, but the wires and cables actually entering into the construction of the planes. The slightest lack of homogeneity or otherwise invisible defects in the stranded wires are clearly shown up and danger is thus prevented. Similar tests can be applied to elevator and hoisting cables; in such cases the apparatus is mounted permanently and defects can be detected before accidents happen.

The main reason why this important method has not found considerably wider practical application heretofore was the difficulty in the operation of the instruments which had been available for conducting magnetic tests. Considerable progress was made by the development of the "Fahy" permeameter, fully described in Scientific Paper No. 306 of the U. S. Bureau of Standards, Washington, D. C., which has already found application in the industry for conducting magnetic-mechanical tests. Further progress has recently been made in the design of such apparatus by the development of a still simpler and just as accurate permeameter requiring no compensation, and of a new type of sensitive galvanometer—similar to the portable instruments used in pyrometry—so that any metallurgical and mechanical engineer or assistant will be able to make accurate determinations. This new line of magnetic testing instruments will also include a very accurate and convenient outfit for testing permanent magnets, such as are used in magnetos, etc. These instruments are being sold by Herman A. Holz, Metropolitan Bldg., New York City.

SEABOLDT LAPPED MEASURING WIRES

To provide for accurately testing the precision of thread gages and other threaded work by the familiar three-wire



Seaboldt Gaging Plugs measuring Pitch Diameter by Three-wire Method

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[1] Discussion on "Some Applications of Magnetic Analysis to the Study of Steel Products," Proceedings of American Society for Testing Materials, Vol. XVII, Part II, page 107

[2] Same proceedings, pages 110-111

method, the B. Seaboldt Corporation, 25 West Broadway, New York City, is now making sets of three steel wires which are hardened and lapped to size with a guarantee of absolute accuracy. In order to give satisfactory results, it is well known that the wires used for testing by the three-wire method must be of exactly the same size, and to meet the exceptional demand for means of checking the accuracy of thread gages which has been created through placing of large contracts for a variety of munitions of war, parts of which are required to be absolutely interchangeable, these sets of accurate measuring wires were placed upon the market. The accompanying illustration shows one simple way of using the wires, which consists of placing them on the thread gage or other part to be tested in the usual way, and using rubber bands at either end to hold the wires in place. The measuring is then done with a micrometer.

Another good way of using these wires is in connection with a Prestwich fluid gage of the type shown in Fig. 3, in the article describing thread comparators manufactured by the Coats Machine Tool Co., which appears elsewhere in the New Machinery and Tools Section of this number. The three-wire method of measurement has been adopted by the United States Government for all thread gage inspection at the Bureau of Standards and for use in all arsenals and for field inspection in various munition manufacturing plants. These sets of measuring wires, made by the B. Seaboldt Corporation, have been made for the government in sizes ranging from 0.011 to 0.144 inch in diameter, and sets have been made for the Bethlehem Steel Co. ranging in size from 0.010 to 0.150 inch in diameter. Each set consists of three wires which are guaranteed to be of the same size.

COATS THREAD COMPARATOR

In manufacturing airplane engines, motor trucks, ammunition, field guns, rifles, etc., one of the difficult problems with which manufacturers are confronted is the production of threaded parts which are interchangeable. Owing to the large scale on which the manufacture of various munitions of war is being carried on, it is necessary to produce different parts in widely separated plants, and under such conditions the only assurance which the manufacturer has that the parts he is turning out are interchangeable with other parts is that they measure up properly under the different gages provided for the purpose. It is usually the practice to have "master" gages which are simply used to check the accuracy of the "working" gages at specified intervals in order to see that these working gages fulfill all requirements. To provide for checking up thread gages, J. H. Wilhelm, superintendent of the gage division of the Ordnance Department of the Frankford Arsenal, designed a thread comparator to measure the pitch diameter of thread gages ranging from ¼ inch to 10 inches in diameter. It furnishes a convenient, accurate and rapid method of comparing working gages with master gages, giving the exact value of any error which may exist. This comparator may be used for establishing the size of a "master" gage through the use of Swedish gage-blocks or other standards, the accuracy of which has been properly verified by the Bureau of Standards.

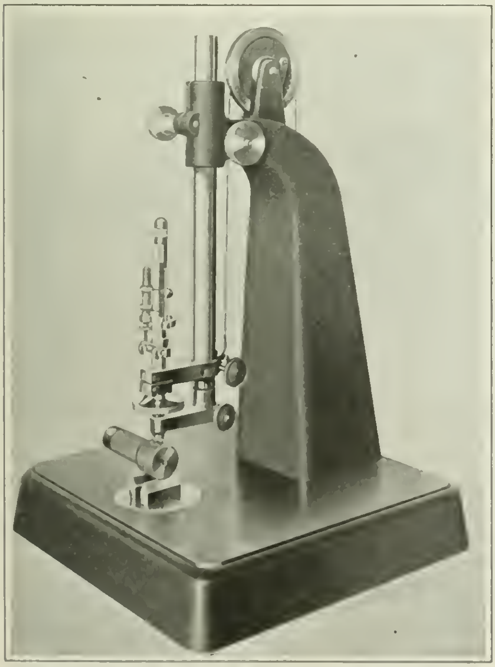


Fig. 1. Wilhelm-Prestwich Fluid Gage Pitch Diameter Comparator made by the Coats Machine Tool Co.

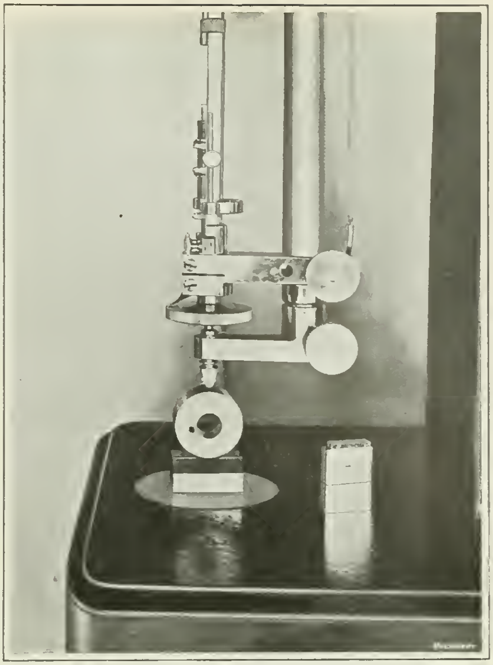


Fig. 2. Use of Swedish Gages on Pitch Diameter Comparator for establishing Size of Master Thread Gage

The elements of the thread comparator comprise a base and an upright overhanging standard. In the base there is carried an accurately lapped steel plate which is set square with the hole through the center of the standard; a bar slides through this hole and carries the upper measuring points, which are in the form of a double roller to rest on both walls of the upper part of the thread to be measured. Underneath the thread gage to be measured there are placed two five-sided parallel blocks that are made with the same accuracy observed in the production of standard gage-blocks, the upper surfaces coming together at an angle equal to the angle of the thread to be measured. These blocks are set on the lapped steel base-plate and the gage to be measured rests upon them, the walls of the thread being in contact with the angular upper sides. This method affords an accurate and convenient comparator for measuring the pitch diameter of threaded work.

Extreme accuracy of reading is obtained by the use of a Prestwich fluid gage on this apparatus. The upper thread measuring contact or roller is carried on the lower end of a vertically slidable spindle, while the upper end of this spindle rests against the bottom of the diaphragm of the Prestwich

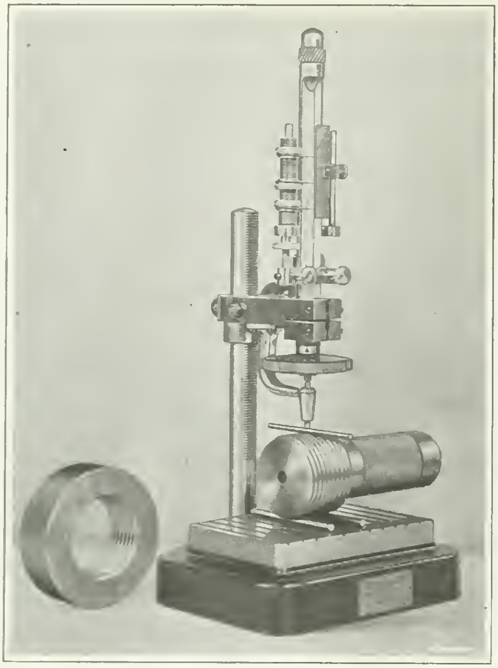


Fig. 3. Simple Type of Thread Comparator built by Coats Machine Tool Co.

gage. With this arrangement the slightest movement of the upper measuring contact gives a reading on the column of the Prestwich gage, while the thread gage being measured rests on the lower angular parallels and passes under the upper measuring contacts. When a second thread gage is passed through the machine, it will give the same reading on the Prestwich gage if it is of the same size, while if it is larger, it will cause the column to rise proportionately higher, and if it is smaller, the column will not rise as high as the position formerly reached while measuring the preceding thread gage. As a result, the difference of readings may be taken from the gage with great accuracy, as the scale on the gage is graduated to 0.0001 inch.

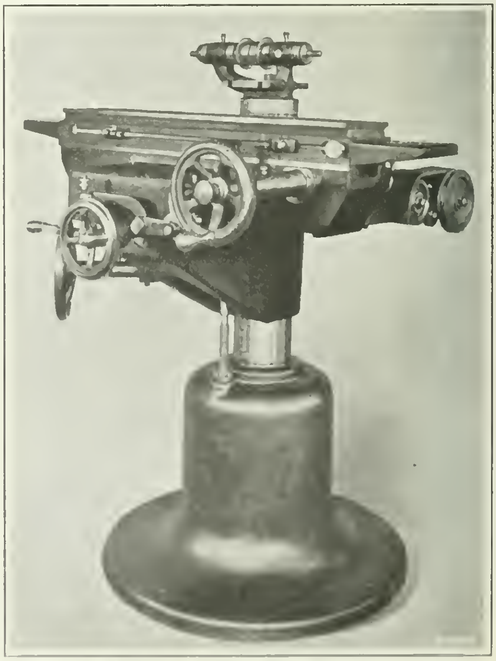
In order to establish the size of a thread gage with this comparator in conjunction with standard gage-blocks, the required size is first built up with the blocks and one of the angular five-sided blocks is then placed at the top of them. Then the arm carrying the upper thread measuring contact is vertically adjusted so that the contact fits over the angular sides of the block and the Prestwich gage column is at a "mean specific height." In this way the comparator may be set for any size absolutely without recourse to any other measuring machine. The master gage and the amount that a gage is above or below the required pitch diameter may be read direct from the scale on the instrument. The Prestwich fluid gage is manufactured under license for the United States and Canada by the Coats Machine Tool Co., Inc., 30 Church St., New York City. The results obtained with this thread comparator are, of course, dependent upon the use of the Prestwich gage, and the comparator has recently been added to the line of specialties made by this company

Figs. 1 and 2 show methods of setting up the thread comparator with Swedish gage-blocks, and how the comparator is used for measuring a master thread gage. It has already been explained that this apparatus was especially built to meet the requirements of the Ordnance Department of the Frankford Arsenal. It is provided with fourteen rollers of different pitches, and the equipment is of a character which makes the machine quite expensive. To meet the requirements of those shops that do not have enough gage testing to do to warrant investment in a machine of this type, the Coats Machine Tool Co. is building a simpler type of thread comparator, which is shown in Fig. 3. It will be seen that this operates on the familiar three-wire principle, and the possibility of using the Prestwich gage in connection with this method enables the accuracy of thread gages and other threaded work to be rapidly and accurately determined. Complete information concerning the application of the three-wire method of measuring threaded work is given on pages 1031 and 1032 of MACHINERY'S HANDBOOK.

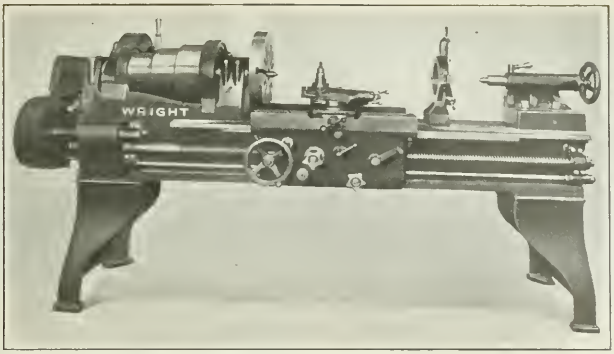
WOODS TOOL AND CUTTER GRINDER

In the accompanying illustration is shown a No. 2½ universal tool and cutter grinder which is a recent product of the Woods Engineering Co., Alliance, Ohio. This machine is designed to meet the requirements of tool-room grinding, and it will be seen that it is of the swivel head type with the work-table located directly under the countershaft at all times. All parts of the mechanism are readily accessible for cleaning, which is an important feature in the design of a grinding machine. As its name implies, the machine is strictly "universal" and will grind any cutter, reamer or other work which comes within its range, and do the work accurately and rapidly. Changes from one grinding operation to another are easily made, and provision for making all adjustments are worked out in such a way that the time involved in making changes is not excessive. An automatic longitudinal feed is a regular feature of this machine, but automatic cross-feed can also be furnished to special order. Twelve changes of table travel are obtained through change-gears and cover a range of from 24 to 143 inches per minute.

Provision is made for swiveling the head through 180 degrees and for setting it at any angle with the table by loosening a ⅝-inch clamping nut and then making the necessary setting through the use of a graduated dial at the top of the column. Dust guards are provided for the table slides and adjustable gibs provide means of compensating for any wear which may develop in these slides. The gibs extend the full length of the table and have a bearing for the full length of the saddle guide. The bearing surface of the sliding table has one vee and one flat way with ample bearing surface to maintain accurate alignment. The top table swivels on a central pivot with binding bolts at each end, so that the table may be



Woods No. 2½ Universal Tool and Cutter Grinder with Automatic Longitudinal and Cross Feed set for grinding tapered work held between centers, or work that is clamped to the table. Graduations at the ends of the table read to 1/16 inch taper per foot. Adjustable stops limit the table travel when grinding up to a shoulder, or for similar operations.



Heavy-duty Type H 18-inch Engine Lathe built by David A. Wright

For grinding operations that require the top table to be held at a greater angle than is possible with the screw adjustment, two dogs are provided for securely clamping the two tables. The knee is of the extended and box section type and slides on a V-key that is adjustable for wear. Both elevating and cross travel screws are provided with micrometer dials. The saddle slides on the knee on one vee and one flat way, and these bearing surfaces are never exposed for any position of the table. An internal attachment for this machine has two speeds and is so constructed that the spindle has a bearing next to the emery wheel, which eliminates vibration due to a long overhang. The universal vise has three swivels, which allow it to be set in any position. The countershaft is self-contained and provides three changes of speed for the work-spindle and two changes of speed for the grinding wheel.

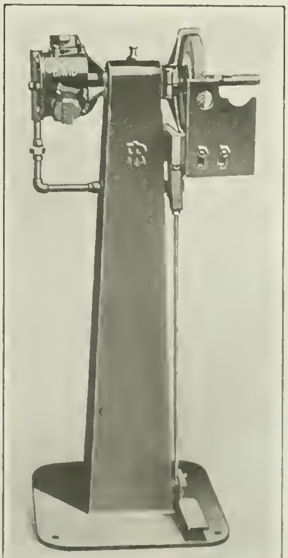
The principal dimensions of this machine are as follows: longitudinal travel, 22 inches; cross travel, 7½ inches; vertical travel, 10 inches; maximum distance between centers, 28 inches; swing, 9 inches; number of table speed changes, 12; dimensions of vise jaws, 1¼ inch high by 5¼ inches wide; opening of vise, 2¾ inches; and net weight of machine, approximately 1275 pounds.

WRIGHT ENGINE LATHE

David A. Wright, 568 W. Washington Blvd., Chicago, Ill., is now manufacturing an 18-inch heavy-duty engine lathe, adapted for use in the manufacture of shells, artillery hubs and other heavy-duty work of a similar nature. To stand up under this service, the machine is heavily constructed with bearings of liberal size, and with a lead-screw 2 inches in diameter. In general, the machines are capable of obtaining the maximum production from high-speed steel tools. This lathe is regularly equipped with a three-step cone pulley and double back-gears and an improved locking device, by means of which the cone pulley and spur gear can be instantly connected or disconnected, without requiring the use of a wrench. This permits the back-gears to be easily thrown in or out. Removable guards are furnished over all gears. The spindle is machined from a steel forging and is accurately ground with a hole through its entire length. The spindle bearings are lined with phosphor-bronze and equipped with oil pockets and chain oilers. Anti-friction thrust bearings are provided with a nut for adjusting the thrust washer, which is made of steel, hardened and ground.

In working out the design of the tailstock, provision has been made for setting the compound rest at right angles to the cross-slide; and the tailstock spindle is made of steel, accurately ground to size. An adjusting screw provides for setting over the tailstock for the performance of taper-turning operations. The carriage is securely gibbed at the front, center and back, and is scraped to a solid bearing on the bed throughout its entire length. Provision of a flat top for the carriage enables work to be clamped on the carriage. Power longitudinal and power cross-feeds are provided, and when the cross-feed is used the carriage can be clamped to the bed by means of a lever which is located conveniently for the operator. The compound rest is fitted with taper gibs which require only one screw for their adjustment; and the handle of the compound rest is removable, enabling it to be taken off when not in use, so that it does not interfere with manipulation of the cross-feed handle. Both the longitudinal and cross-feeds are reversible from the apron, and the longitudinal feed is so arranged that it is impossible for the lead-screw and feed-rod to be engaged at the same time. The feed reverse is controlled by a lever placed near the bottom of the apron, which is used for the turning feed only and not for screw cutting; reversal for screw cutting is obtained by shifting a lever located at the end of the headstock. A range of feeds and provision for cutting screw pitches are provided, which are sufficient to take care of all of those classes of work that are handled on a machine of this type.

The principal dimensions of this machine are as follows: swing over bed, 19½ inches; swing over carriage, 11 inches; capacity between centers, 4 feet; length of carriage bearing on ways, 30 inches; ratio of back-gears, 12 to 1; dimensions of front spindle bearing, 3½ by 6 inches; dimensions of rear spindle bearing, 2½ by 4⅛ inches; diameter of hole through spindle, 1⅝ inch; diameter of spindle nose, 3 inches; capacity for thread cutting, 2 to 32 threads per inch; width of driving belt, 5 inches; size of tools, ¾ by 1½ inch; capacity of steadyrest, up to 6 inches; and weight of machine with 8-foot bed, 3600 pounds. Regular equipment furnished with the machine includes a compound rest, double-friction countershaft, large faceplate, steadyrest, change-gears, and wrenches for making all adjustments that may be necessary.



"Little David" Air-driven Pedestal Grinder built by Ingersoll-Rand Co.

INGERSOLL-RAND AIR-DRIVEN PEDESTAL GRINDER

For general service where a stationary pneumatic grinder is preferred to a portable tool, the Ingersoll-Rand Co., 11 Broadway, New York City, has designed and is placing on the market the machine illustrated herewith, which is designated as No. 8 "Little David" grinder. The three-cylinder motor with its continuous power impulse, the rotary valve integral with the crankshaft, and the triple ball-bearing spindle are of similar design to the Ingersoll Rand No. 7 "Little David" grinder. The machine is rated to operate at 3400 revolutions per minute with compressed air at 80 pounds per square inch pressure. Control is effected by means of a convenient foot-lever. The grinding wheel usually employed is 8 inches in diameter and 1 inch face width.

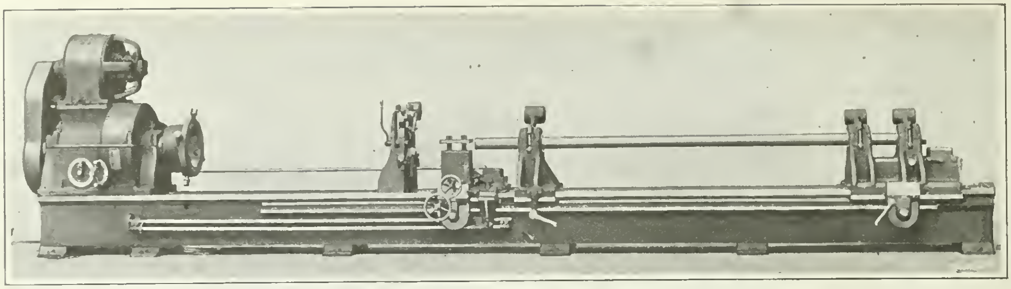


Fig. 1. Front View of R. K. LeBlond 38-inch Gun Boring Lathe with 32-foot Bed

LE BLOND GUN BORING LATHE

To meet the requirements of rough-boring tubes and jackets for guns up to 6 inches in diameter from solid forgings, and also to provide for finish-boring the rough-bored forgings, the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, has placed on the market a 38-inch gun boring lathe which is illustrated and described herewith. When provided with a 32-foot bed, this machine has a capacity for boring holes 8 feet in length, and an addition of two feet to the length of bed must be made for each additional foot of length of the work to be bored.

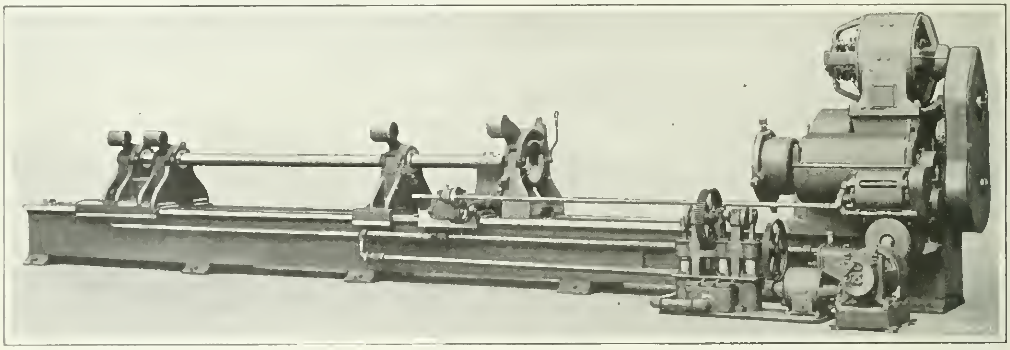


Fig. 2. Opposite Side of LeBlond Gun Boring Lathe, showing Pump and Power Traversing Mechanism

On this machine the bed is of box section with the center portion cast to form a reservoir for collecting the cutting lubricant. Flat shears are provided on the bed and the machine is equipped with a boring tailstock, a steadyrest and a support for the boring-bar, all of which are square-gibbed to the bed. Beds up to and including 32 feet in length are made in one piece, while beds above this length are made in sections and bolted together. Cross-ribs are provided in the bed, with an arched web cast in the top which forms a channel for carrying lubricant to the reservoir, no separate oil-pan being required.

This lathe is provided with a headstock of the all-geared type, with two mechanical changes of speed obtained through sliding gears operated by a lever at the front of the headstock. The main driving gear on the spindle is pressed on and keyed to the spindle, this gear being 34 inches in diameter by 7 1/2 inches face width, and 2 1/2 diametral pitch. Provision is made for bolting the headstock to the bed by means of six 1 1/4-inch bolts and a flange 12 inches in diameter by 1 3/4 inch thick at the front end of the spindle is provided with four 1-inch bolts to receive the driving chuck. Power for driving the lathe is furnished by a 25-horsepower, three-to-one, variable-speed motor, with a range of from 500 to 1500 R.P.M.; this motor is mounted at the end of the lathe and drives through spur gears and a pinion. Spindle speeds are available over a range from 5 to 60 revolutions per minute, and the motor controller is operated through a lever located on the carriage.

Mention has been made of the fact that the boring tailstock is gibbed to the bed. This tailstock is furnished with

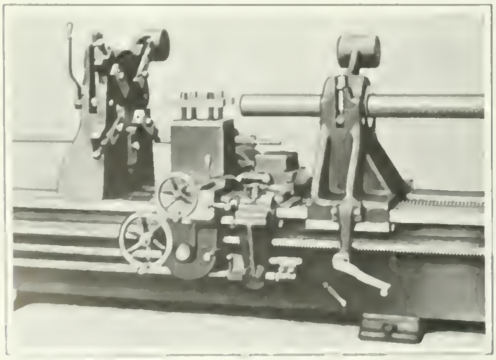


Fig. 3. Carriage, Boring Tailstock and Steadyrest in Position

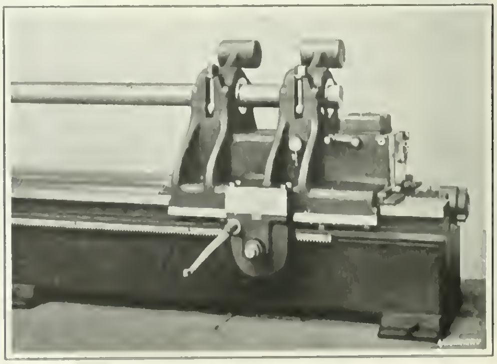


Fig. 4. Close View of Boring Tailstock of LeBlond Lathe

double bar supports which have counterbalanced hinged caps. These bar supports are bored 5 to 7 1/2 inches in diameter; and the tailstock is provided with rapid power traverse and a rack and pinion for hand adjustment. Feed to the boring tailstock is obtained through a screw 3 1/2 inches in diameter by 3/4 inch pitch, which is located and supported in bearings in the center of the lathe bed. The screw engages bronze half-nuts, made in separate pieces and easily renewable. The drive to the screw is through a worm and worm-wheel provided with ball thrust bearings. Feed changes are obtained by means of change-gears and cover a range from 0.004 to 0.064 inch per revolution of the spindle. The boring-bar support is square-gibbed and clamped to the shears, and provided with a counterbalanced hinged cap; it is bored 8 1/2 inches in diameter and bushed down to suit the boring-bar. This support has a bearing of 16 inches on the shears and the bearing for the boring-bar is 8¾ inches.

The carriage is furnished with automatic feed, quick-power traverse and a rack and pinion for hand adjustment, the same as the boring tailstock. It is provided with a plain tool-slide with cross adjustment by hand only. The length of the carriage on the shears is 24 inches and its width is 38 1/2 inches, provision being made for holding a tool 1 by 2 inches in size. Two steadyrests are furnished with the machine, which have a capacity from 1 to 18 inches and 1 to 24 inches in diameter, respectively; they are provided with five jaws and a removable cap, the jaws being faced with bronze. Both the boring tailstock and carriage have rapid traverse in either direction, which is obtained through a central screw in the bed and an independent motor mounted at the rear of the lathe. This motor develops 5 horsepower and runs at 1150 R.P.M.; it is controlled by a special E. C. & M. controller and solenoid brake operated by a lever on the carriage, which also starts and stops the feed.

A triplex single-acting pump of 4 by 4 inches capacity is direct-connected to a 3-horsepower motor for forcing lubricant onto the cutting tool, this pump having a capacity for delivering 32 gallons of lubricant at a pressure of from 40 to 50 pounds per square inch when running at 50 revolutions per minute. A boring-bar is not furnished with the machine, but the boring tailstock is arranged with piping from the pump to deliver lubricant to the boring-bar. The weight of this machine including the motors, pump, etc., is approximately 36,000 pounds, and the weight per extra foot of lathe bed is 450 pounds.

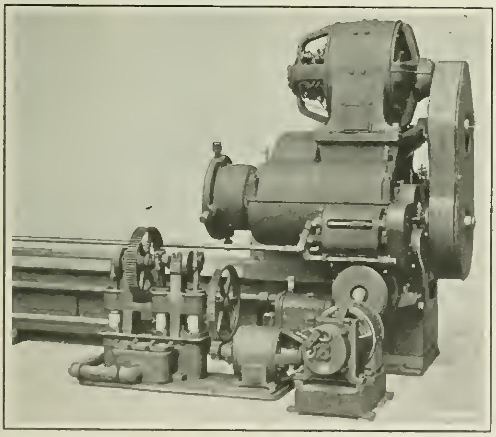
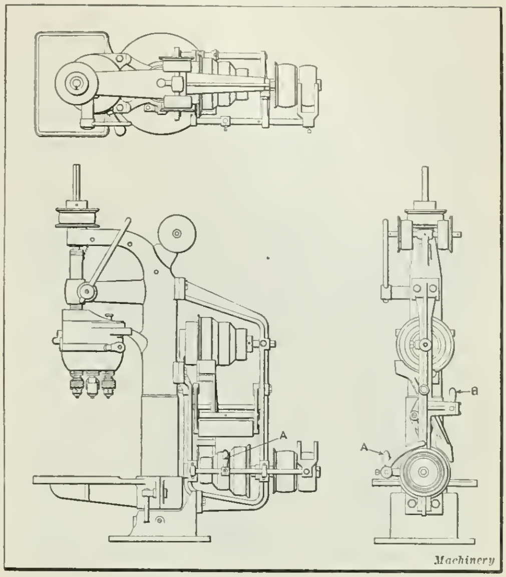


Fig. 5. Close Rear View of Head End of Lathe, showing Motor Mounting

LANDAU MULTIPLE DRILLING AND TAPPING MACHINE

In the July, 1916, number of MACHINERY there was published an illustrated description of a multiple-spindle drilling and tapping machine of the turret head type, which had just been developed and placed on the market at that time by J. N. Landau, of New York City. Recently, the Landau Machine & Drill Press Co. has been incorporated, and in its shop at 368-370 Broome St., the drilling and tapping machine shown in the accompanying illustration is being built. Comparing it with the machine previously described, it will be seen that the two designs are essentially the same, except that the present machine is furnished with means for quickly obtaining any of three speed changes, speeds of 650, 1150 and 1800 revolutions per minute being available. It will be seen that at the right-hand side of the machine there is a sliding bar, at the rear end of which is carried the belt shifter which moves the belt from the tight to the loose pulley and *vice versa*, this bar being manipulated by handle *A*.



Landau Multiple Drilling and Tapping Machine with Cone Pulley Drive

Similarly, at the left-hand side of the machine there is a belt shifter manipulated by handle *B*, which throws the belt to one of the three steps on the cone pulleys. A long idler pulley of the same width as the three steps on the cone pulleys, provides for maintaining a uniform belt tension. This machine has a capacity for drilling holes up to 1/4 inch in diameter; and for the performance of tapping operations in iron or steel the capacity is 3/16 inch, while 1/4-inch holes may be tapped in brass. The tapping attachment is driven from the main spindle when the latter is running at 1150 R.P.M., and gives a speed of 140 R.P.M. for the tapping spindle. Hand feed is employed on this machine.

LANGELIER TURNBUCKLE DRILLING MACHINE

The machine shown in Figs. 1 and 2 was designed by the Langelier Mfg. Co., Arlington, Cranston, R. I., especially for drilling the central tap hole in tobin bronze airplane turnbuckles, ranging in length from 2 to 4 inches. The drilling is done simultaneously from both ends, thereby reducing the drilling time to at least 50 per cent of that required by a single-spindle drilling machine. An ordinary, inexpert operator, will easily average sixty buckles drilled per hour on 4-inch turnbuckles, and for shorter lengths he can do considerably more. The two drilling spindles in this machine advance and withdraw in unison, when the operator moves a single pilot connected by gearing highly compounded for easy operation of both spindle sleeves. The construction of the machine consists of two heads fitted with these sleeves geared to a vertical pinion that meshes with interconnected racks inside of the bed. The feed is operated by a three-armed handwheel that is connected by gears to the feed sleeve; and the drilling spindles run on ball bearings that are mounted inside of the feed sleeves. They are driven by flanged pulleys mounted on their outer ends and are belted to wide drum pulleys on the overhead countershaft. An adjustable drilling stop is provided on the right-hand head.

To avoid the drills coming together at the center, the left-hand head is provided with a feed release mechanism that can be adjusted to operate just before the drill ends meet. The spindle is returned by the pull of a long spring, seen at the left-hand end of the machine. Both spindles have adjusting collets with sockets to take No. 2 Jacobs chucks with taper shanks. The size of drills used for the 4-inch turnbuckles was No. 12 drills, 6 inches long; they were made of high-speed steel and run at a speed of 3000 revolutions per minute. The expense and difficulty of getting special length drills, that would be required when drilling from one end are avoided, as the drills used in this machine are standard stock lengths. The turnbuckles are located and held in the drilling position by a specially designed vise, which is located midway between the drilling heads, and this vise is controlled by one-half turn of a handwheel. The turnbuckles are first centralized both axially and lengthwise, by two opposed 60-degree cupped bushings mounted in T-slides that are operated by a double path spiral cam. This cam is geared to the handwheel shaft. After the turnbuckle is centralized, a plier type of vise jaw that is operated by a circular double wedge cam, mounted on a handwheel shaft, grips the central portion of the turnbuckle and holds it without affecting its alignment while it is being drilled. The vise can be adjusted to take turnbuckles from 2 to 4 inches in length. This machine is provided with an automatic oil feed that delivers oil to the drills only when they are cutting. The oil is fed directly into the locating bushings by means of metallic flexible tubes; and the oil-pump is belted direct to the countershaft. The floor space occupied by this deep-hole drilling machine is 5 feet, 9 inches by 2 feet, 2½ inches and the machine stands 49 inches high.

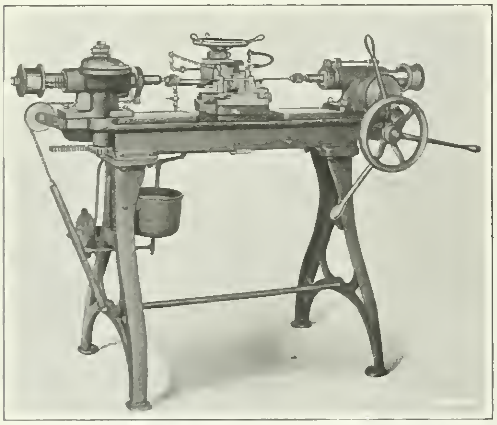


Fig. 1. Langelier Two-spindle Horizontal Turnbuckle Drilling Machine

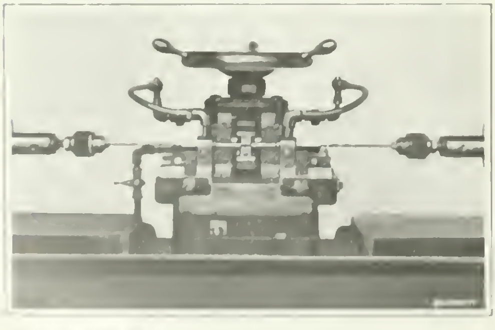


Fig. 2. Close View of Drills and Work on Machine shown in Fig. 1

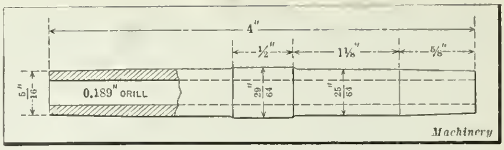
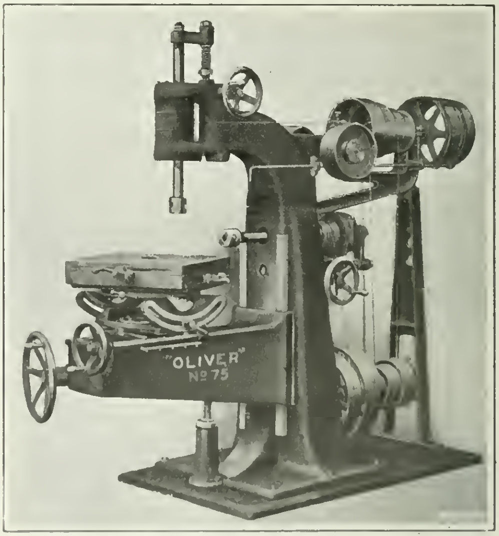


Fig. 3. Tobin Bronze Airplane Turnbuckle drilled in Machine shown in Figs. 1 and 2

OLIVER WOOD MILLING MACHINE

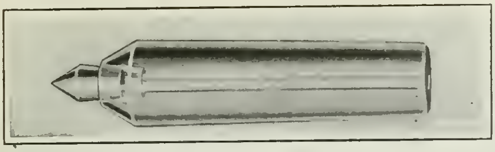
In the accompanying illustration there is shown a No. 75 wood milling machine, which is a recent product of the Oliver Machinery Co., 7 Coldbrook St., Grand Rapids, Mich. In general respects the design of this machine follows that of an Oliver wood milling machine which has been on the market for some time, but the design has been improved in certain important details. Among these changes the most important is the provision of a new form of table which, like the original table, may be tilted and rotated in a horizontal plane, in addition to which the improved table may be rotated in a plane at any angle to the horizontal, thus making the machine entirely universal. Compound cross-slides are located above the double swivel and tilting mechanism so that these slides will operate in any position. There was only one slide on the old table. In addition to the change in table design, the column of the machine has been broadened and made of heavier construction, while the size of the base has also been increased, the result of these changes being to render the machine practically free from vibration.



No. 75 Wood Milling Machine built by Oliver Machinery Co.

HOOVER INSERTED-POINT CENTERS

In the accompanying illustration there is shown what is known as an "inserted-point" lathe center, which is a recent product of the Hoover Mfg. Co., Anderson, Ind. It will be seen that this consists of a holder and center point,



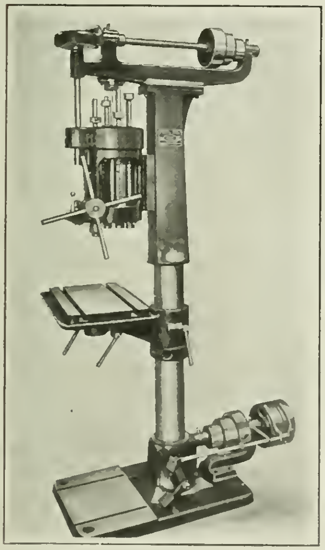
Hoover Inserted-point Lathe Centers

and the use of this form of lathe center enables new points to be inserted without the necessity of grinding centers back to the required form. In this way the production from each machine is increased and a saving of steel is also effected.

TURNER TURRET TYPE DRILLING MACHINE

In the accompanying illustration there is shown a Model B turret type drilling machine, which is a recent product of the Turner Machine Co., Danbury, Conn. It will be seen that this machine is built with a round column, and either a round or square table is provided. The table is swung on a universal knee which is attached to the column, so that the table may be tilted to any desired angle required for handling the work. Graduations on the universal joint enable the operator to set the table readily to any angle desired; the table can also be removed, giving the machine a very wide range. When a square table is furnished on the machine it is 16 1/2 by 24 inches in size and fitted with an oil-pan. The round table furnished on the machine is made in two sizes, 18 or 20 inches in diameter.

Mention has already been made of the fact that the table may be removed from the machine to enable work to be set up on the floor base, which is of exceptionally large size and planed true with the column to assure accuracy of work machined while held on the base. Four spindles are provided on this machine, only one of which is in operation at a time. After each operation of the sequence has been completed, the next spindle is indexed to the operating position and this spindle then becomes operative while the other three spindles are idle. An oil tank, pump and piping are furnished when required in connection with those drilling operations for which the use of coolant is necessary.

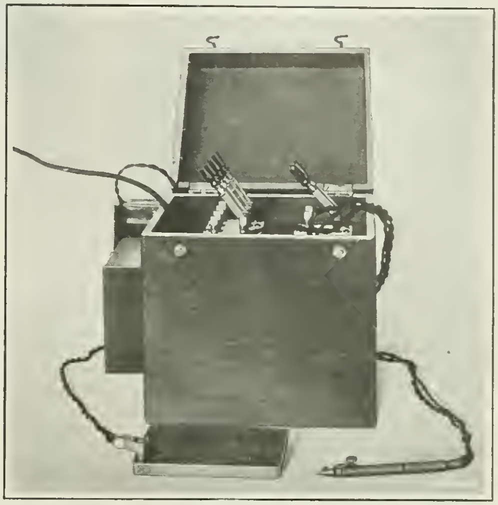


Turner Model B Turret Type Drilling Machine

ROBINSON ELECTRICAL ENGRAVING MACHINE

An improved machine for electrically engraving hardened steel tools, etc., with any kind of mark or name has just been placed on the market by the Production Equipment Co., 118 E. 28th St., New York City. The machine is made for this company exclusively by the R. I. Electrical Tool Co., Providence, R. I. As will be understood from its name, the Robinson electrical engraving machine does not require the use of acid, as in the ordinary etching process, thus eliminating the trouble caused by acid spots, to say nothing of the time taken in applying the wax and acid process. With this engraving machine, the tool or piece of work to be marked is simply placed on the plate shown in the forepart of the illustration, and the etching pencil is used in the same way as an ordinary pencil, for etching in the steel whatever mark or lettering is required. A special resistance block with adjusting switches is supplied for regulating the depth of the etching and to accommodate various thicknesses of steel, down to even ribbon steel.

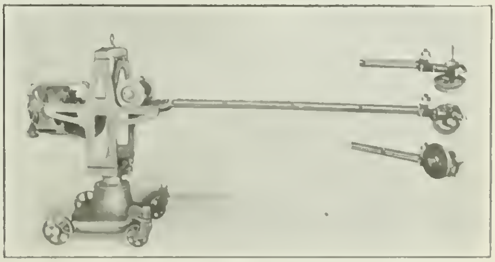
The Robinson electrical engraving machine is exceedingly simple to use. Lettering of any kind can be marked on metals with no more effort or time than is required to write with an ordinary pen or pencil. Electrical connection is made from an ordinary electric light socket, and there is nothing to get out of order. The cost of operation is negligible. The standard equipment is suitable for use on alternating-current circuits, but a special converter can be supplied for direct-current circuits. This machine has been brought out principally for use in marking tools, gages, etc., such as are used in every machine shop, not only in the case of new tools, but also those used in any tool-room, thereby reducing to a minimum the liability of their being stolen. The chief point of advantage of this method of marking is that a special patented feature prevents sparking each time the pencil is applied to or removed from the piece of work to be marked.



Robinson Electrical Engraving Machine sold by Production Equipment Co.

MUMMERT-DIXON RADIAL GRINDER

The 8-inch portable radial grinding machine which forms the subject of the following description is a recent product of the Mummert-Dixon Co., Hanover, Pa. It will be seen that this machine is motor-driven without the use of belts, and it is equipped with ball bearings, so that all movements are easily made. This is said to be an exceptionally convenient



Mummert-Dixon 8-inch Portable Radial Grinding Machine

machine for the performance of grinding operations in inaccessible positions, and it is well adapted for general classes of light grinding and buffing. The flexibility of the machine adapts it for handling a wide range of work.

To adapt the machine for portable service, it is made self-contained, with the grinding wheel driven by an electric motor mounted at the rear end of the tubular arm. This motor is coupled direct to a shaft which runs through the tubular arm to a set of hardened spiral gears in the head that drive the grinding-wheel arbor. The hardened steel spiral gears are enclosed in an oil-tight case and the gears are packed in transmission grease. The head, arm and motor are carried on a two-wheeled ball bearing trolley, which rolls back and forth on a steel track and is kept in alignment by a rack and gear on each side of the carrying frame. By attaching the arm to the trolley at the proper location, the motor is made to accurately balance the head so that the whole weight is in equilibrium when the workman releases his hold. The bolster of the trolley-carrying frame is mounted at the top end of a trunnion which turns in the base, so that the arm with the grinding head can be turned through the entire circumference around the base, making a full radial grinder.

It will be seen that the head can be twisted or turned completely around, making it possible to use this machine for grinding on the top, along either side, or on the under surface of a casting. The machine is portable, so that it may be carried by a crane or rolled over the floor on its own wheels. While the machine is being moved the trolley can be locked at the middle of the frame, and by dropping a lock-pin, the bolster can also be locked to the base to prevent radial movement. This is an advantage when moving the machine over the floor, as the arm can be used as a guide similar to the tongue on a wagon. All hand movements on this machine are easily made, and provision for the operator's safety is assured by means of guards covering all running mechanism except half of the grinding wheel. The electric switch is conveniently located within reach of the operator and the electric wires are protected by a steel conduit running along the top of the arm. The grinding wheel arbor is driven at a speed of 2800 R.P.M. and the electric motor develops one horsepower. A single-phase or other type of motor suitable for connection to electric lighting circuits is most convenient for use on this machine when it is to be moved about from one place to another. The length of the arm from the trolley to the head is 7 feet and the maximum travel of the trolley is 30 inches, while the vertical movement of the head is from the floor to as great a height as a man can reach. The over-all height of the machine is 4 feet, 6 inches; the maximum length, 9 feet; the base area, 30 by 30 inches; and the net shipping weight, 700 pounds.

The flexibility of this machine makes it well suited for handling a wide range of grinding operations, in addition to those classes of work for which a radial grinding machine is especially adapted.

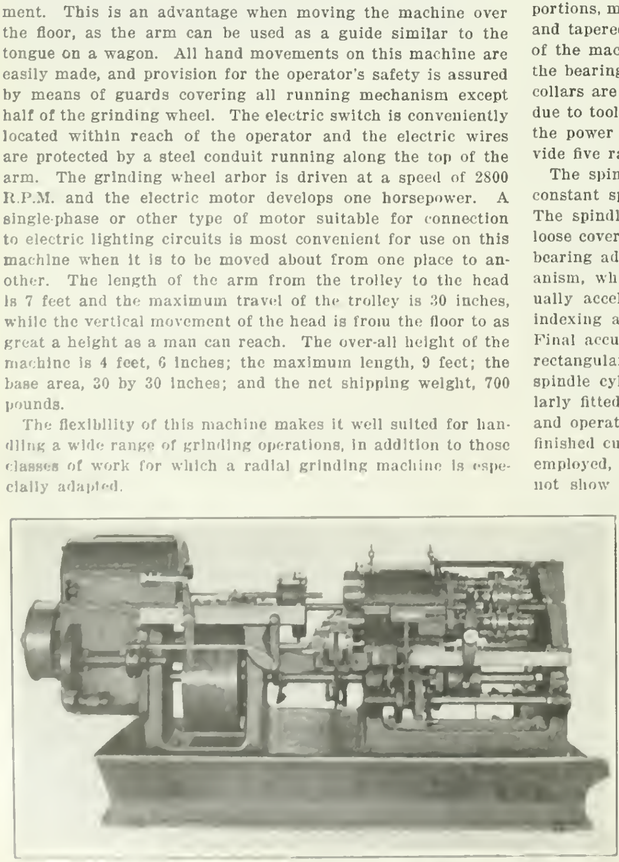


Fig. 2. Opposite Side of New Britain Automatic Chucking Machine shown in Fig. 1

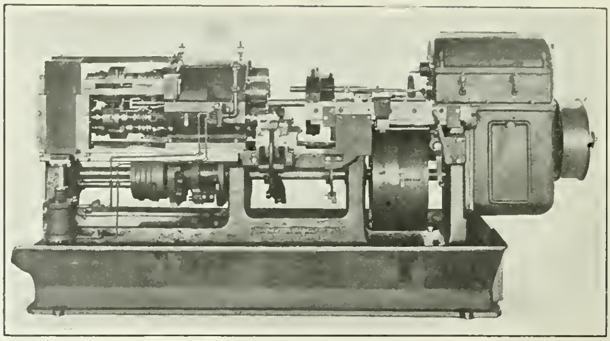


Fig. 1. Front View of New Britain Multiple-spindle Automatic Chucking Machine

NEW BRITAIN AUTOMATIC CHUCKING AND BAR MACHINES

The New Britain Machine Co., New Britain, Conn., is now building an automatic multiple-spindle chucking machine of the work-revolving type which is shown in Figs. 1 and 2. This machine, although designed to handle much the same variety of work as the regular single-head automatic chucking machine, exhibits two main points of difference, *i. e.*, the work is held and revolved by the spindles, the tools being fixed in the tool-slides; and the use of cross-slide tools is thus rendered possible. The six spindles are of liberal diameter, hammer-forged from chrome-nickel steel, heat-treated, hardened and ground. These spindles are carried in bearings of ample proportions, made of bronze bearing metal, ground straight inside and tapered outside. In order to retain the original accuracy of the machine, provision is made for taking up the wear in the bearings without disturbing their alignment. Ball thrust collars are provided on the spindles to receive the end thrust due to tool pressure. The result is a 30 per cent reduction in the power required to drive the spindles. Change-gears provide five rates of spindle speed and twelve variations of feed.

The spindle cylinder is heavy in design and is indexed at constant speed, irrespective of production and spindle speed. The spindle cylinder housing is split horizontally and has a loose cover, which permits of immediate access to the spindle-bearing adjusting nuts. On this machine the indexing mechanism, which is patterned after the "Geneva motion," gradually accelerates the heavy spindle cylinder at the time of indexing and as gradually checks its motion without shock. Final accuracy in indexing is controlled by means of a wide rectangular latch entering notches in the circumference of the spindle cylinder. A differential or hurry-up motion is regularly fitted to this machine and indexes the spindle cylinder and operates the tool-slide at high speed when the tools have finished cutting. Draw-in spring collets of special design are employed, which will operate satisfactorily where pieces do not show a variation exceeding 1/32 inch in diameter. If there is a greater variation than this, the parts should be sorted into lots and the spring chucks adjusted to each lot. The machine is regularly equipped with a handwheel for operating spring chucks for holding the work, and, if desired, an air-chucking attachment may be provided, with an air cylinder of large size to insure successful operation on low air pressure. This device makes chucking a simpler, easier and quicker operation, resulting in accelerating production where the operations are short.

To insure protection of the operator, the spindle is automatically disconnected from the drive while loading and unloading. A threading attachment may be installed in the fourth tool-slide position. For work which is to be handled from a chucking jig, and which requires no threading, the machine may be arranged to index in the opposite direction (clockwise), thus bring-

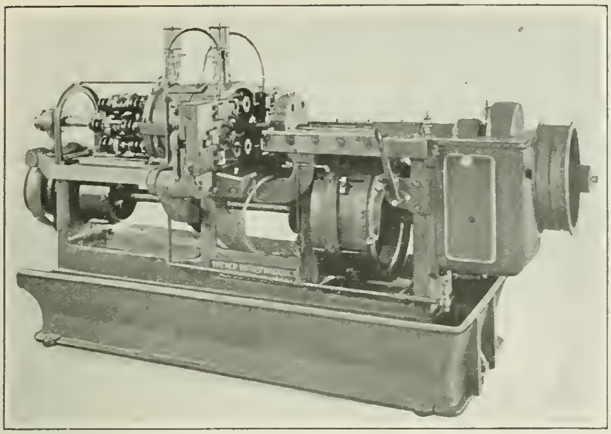


Fig. 3. Front View of New Britain Sextuple-spindle Automatic Bar Machine

ing the finished piece to its final position opposite a cross-slide, which may be fitted with a cutting-off blade. It is possible in this machine, with the work revolving, to handle second-operation work so that the first and second operations will be concentric. The tool-slide is of extremely rigid construction and so designed that the thrust of the work above and below the center line is evenly balanced, thus eliminating any tendency to bring a cramping strain upon the tools. The slide has five tool positions. The tool-slide cam is laminated similar to a leaf spring. This patented construction permits of adjustment of one cam to all lengths of work within the capacity of the machine. Drive to the camshaft is through a large internal gear on the inner circumference of the feed cam drum, and the thrust of the tool-slide against the feed cam is taken by a hardened steel roll fixed to the frame, which bears against the edge of the drum. Standard tools, drills, reamers, etc., are used, the direction of spindle rotation being right-hand.

All gearing is machine cut, largely by the generating process, which produces a quiet, smooth-running machine. Hand control levers on each side, within easy reach of the operator, enable the power feed to be instantly stopped or started. These, in connection with a hand feed crank for testing all feed movements and tool positions, are essential features of a machine of this type. In setting up, testing and adjusting tools they save breakage. The oil distributing system is designed to avoid as much exterior piping as possible. This is accomplished by conveying the oil through the under side of the tool-slide into a chamber at the center surrounding the driving shaft bushing, from which it is tapped off at the circumference through short tubes to the individual tools. The oil-pump is driven at constant speed. The base forming the chip-pan extends to the floor, thus dispensing with legs; and the broad foundation thus obtained, together with the stiff construction and ample weight of the machine, tends to prevent vibration and insure smooth, accurate work. That portion of the bed directly beneath the work has a 45-degree slant toward the back side of the machine, so that chips, as they are cut off, are carried to the side. The chip-pan is widest on this side and slopes toward the rear end, where there is an oil-well with a strainer, from which oil is distributed to the work. This construction permits the oil to drain off before the chips are removed and makes it possible to rake out the chip-pan endwise without stopping the machine or removing the splash apron. The New Britain automatic chucking machines may be equipped with either belt or motor drive.

New Britain Sextuple Automatic Bar Machine

The New Britain sextuple automatic bar machine, shown in Figs. 3 and 4, is similar in construction in many respects to the six-spindle automatic screw machine. In the present machine, however, the spindle cylinder does not index, the machine being designed to feed, drill, chamfer and cut off in each position. On simple work, such as rolls, sleeves, couplings, etc., this makes possible production rates six times those obtainable on single-spindle automatics. Change-gears provide six rates of spindle speed, and a separate system of change-gears is provided for effecting changes in feed by varying the speed of the camshaft. The spindle cylinder housing is split horizontally and has a loose cover, which permits of immediate access to the spindle-bearing adjusting nuts. By withdrawing the locking pin, the cylinder may readily be revolved into any desired position. A differential or hurry-up motion is regularly fitted to this machine and operates the tool-slide at high speed when the tools have finished cutting. Standard drills are used, the rotation being right hand. In other respects this machine is the same as the chucking machine.

VICTOR ENGINE LATHE

The Victor Lathe Co., 151 Lafayette St., New York City, is now manufacturing the 9-inch Victor engine lathe which is illustrated and described herewith. This machine is built in both the bench type shown in the illustration or with legs so that the lathe may be set up on the floor; and in addition to the power-driven machine, a lathe of this type is built to be operated by foot power. These Victor lathes have been designed to meet the requirements of tool-rooms, experimental departments and manufacturing shops handling small work. The design embodies the latest improvements in lathe construction, and the usual power-driven cross- and longitudinal-feed movements are available. A reverse lever on the headstock enables both right- and left-hand threads to be cut, and the same lever provides for operating the longitudinal- and cross-feeds in either direction. The gears are all covered to meet the requirements of the various state laws concerning provisions for safety of the operators.

On this lathe the headstock is ribbed to provide the necessary rigidity, and the hollow spindle is accurately ground to size with a 5/8-inch hole extending through its entire length. The three-step cone pulley carries a 1 1/4-inch belt and the spindle bearings are bushed with phosphor-bronze. The tailstock is of the offset type, and has a long bearing on the bed; this tailstock is furnished with side adjustment for the performance of taper turning operations. The carriage and apron are securely gibbed to the bed and provided with liberal sized bearings on the ways. The design has been so worked out that only one of the two power feeds can be used at any one time, thereby avoiding danger of breaking the gears. A

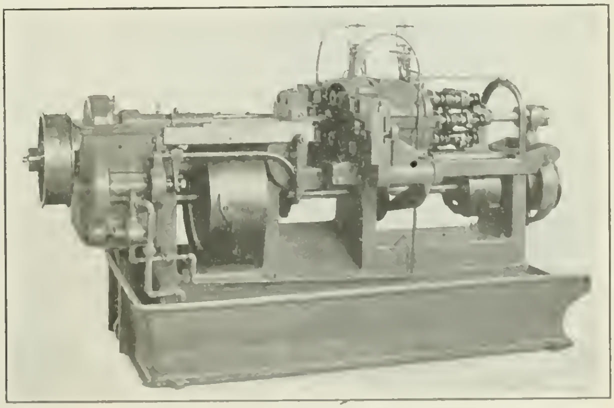
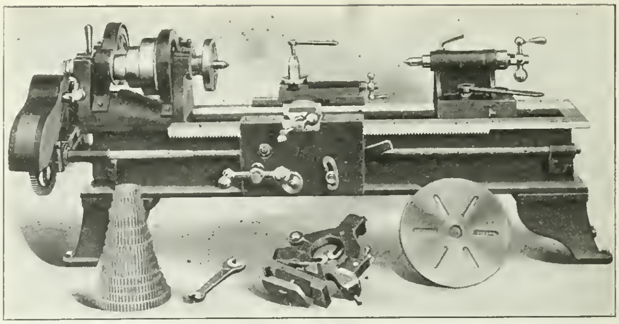


Fig. 4. Opposite Side of New Britain Automatic Bar Machine shown in Fig. 3

locking device is provided which secures the carriage in any given position when the cross-feed is being employed, and the cross-feed screw is furnished with a micrometer collar reading to 0.001 inch. The bed is reinforced at frequent intervals to provide the necessary rigidity, and the feed rack is cut from one solid piece of stock. The compound rest is securely gibbed and graduated in degrees. For thread cutting, the range is from 4 to 40 threads per inch, with the regular equipment on the machine, but metric threads and finer threads than indicated above may be cut through the use of special gears. The split nut is so constructed that it cannot be engaged when either feed is in use. The regular equipment furnished with the machine includes large and small faceplates, a steadyrest, a toolpost, a compound rest, a double friction countershaft or foot-treadle, a full set of screw cutting change-gears, and the necessary wrenches for making all adjustments.

The principal dimensions of this lathe are as follows: swing over ways, 10 inches; swing over carriage, 6 3/8 inches; diameter of hole through spindle, 5/8 inch; taper of center hole of spindle, No. 2 Morse; diameter of spindle nose, 1 3/8 inch; number of threads per inch on spindle nose, 8; size of front spindle bearing, 1 1/4 by 2 1/4 inches; size of rear spindle bearing, 1 1/16 by 2 inches; dimensions of three-step cone pulley, 2 1/4, 3 5/8 and 5 inches, by 1 1/4 inch face width; ratio of back-gears, 7 to 1; diameter of tailstock spindle, 1 inch; maximum distance between centers, 22 inches; range for thread cutting, 4 to 40 threads per inch; size of lathe tools used, 3/8 by 3/4 inch; size of pulleys on countershaft, 7 by 2 1/4 inches; speed of countershaft, 200 R.P.M.; and net weight of machine, 450 pounds.


Bench Type of Engine Lathe built by Victor Lathe Co.

MARTIN HYDRAULIC MARKING MACHINE

The Martin Machine Co., Greenfield, Mass., has recently placed on the market the marking machine shown in the accompanying illustrations. This is a hydraulically operated machine and is intended for the rapid marking of names, trademarks and nomenclature upon metal products, shells, etc. An important feature of the machine is that it will mark evenly, irrespective of the working surface of the article to be marked, that is, the marking pressure varies with the resistance of the die in impressing the lettering. Fig. 1 shows the front view of the Martin marking machine and Fig. 2 shows the rear view. By referring to these illustrations the operation of the machine may be clearly followed.

Referring to the rear view of the machine, power is received on the driving pulley as shown and this operates a rotary pump within the column of the machine, for the purpose of operating the hydraulic system which controls the movements of the marking slide and work-table. By means of this pump the oil pressure is maintained, and this pressure operates both the vertical table that raises the work to the marking dies and also the horizontal die-holding slide. In operation, pressure upon the foot-treadle, that may be seen in Fig. 1, causes the oil pressure to raise the work-holding table to the operating point, and when this point has been reached the oil pressure also commences to act upon the slide, and then traverses the die across the work to be marked. As soon as the die has completed its travel across the work an adjustable stop

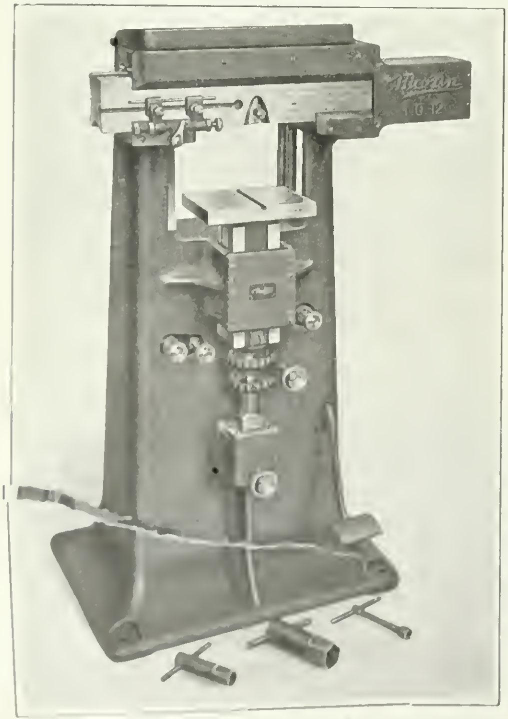


Fig. 1. Martin Hydraulic Machine for marking Shells and Other Metal Products by Impression Method

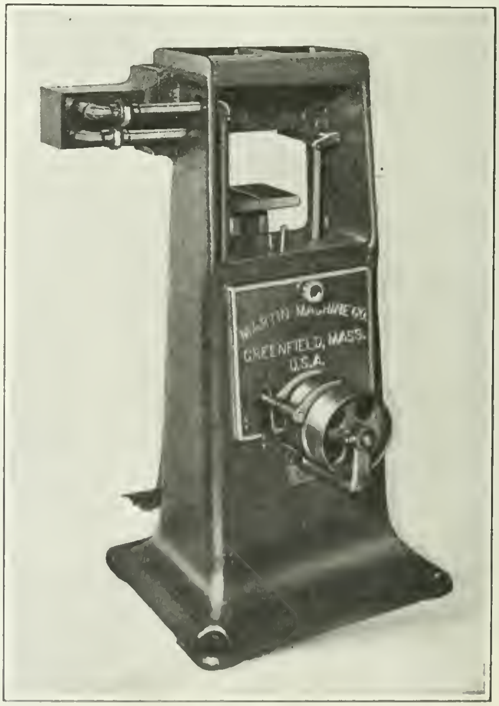


Fig. 2. Opposite Side of Martin Hydraulic Marking Machine shown in Fig. 1

on the slide trips the reverse lever, shown in Fig. 2, that operates the valve, releasing the pressure that has moved the slide forward and allowing the oil pressure to return the slide to the starting point. At the same time the oil pressure beneath the work-table is immediately released and the table drops back ready for the removal of the work.

Through the compounding system inside the column of the machine, pressure beneath the work-table is automatically increased when the action of the slide in forcing the die across the work becomes harder. Thus should the pressure required for marking suddenly change during the stroke, the result would be to automatically increase or decrease the hydraulic pressure under the work-table and supply an amount of pressure to give an even impression, irrespective of the amount of lettering on the die and the unevenness of the surface being marked. On the machine it is possible to mark either cylindrical or flat work, and by using special holding attachments irregular surfaces may be handled. In marking flat work, cylindrical or roll dies are used that turn as they are rolled across the article being marked. Conversely, in marking cylindrical work, a flat die is used in a die-holder which is inserted in the slide, and the work turns as the die is traversed across.

All adjustments provided are readily accessible for increasing or decreasing the pressure on the table, the speed of the slide, etc. The capacity of the machine is from one to ten lines of ⅛-inch letters, and the maximum length of lines is 11 inches. The length of stroke of the die-holding slide may be quickly and easily adjusted to any desired length by means of the adjustable stops shown in Fig. 1. The work-table is readily adjustable from 0 to 6 inches, according to the requirements of the work. A feature of the machine is its simplicity and practically automatic operation, requiring almost no adjustment on the part of the operator. The machine may just as effectively be operated by girls and unskilled labor. Provision is made for holding interchangeable die-holders so that the change from one class of articles to another is quickly made. For continuous marking, the foot-treadle may be depressed and caused to catch, allowing the operator to devote his entire time to inserting and removing the work. In this connection the machine may be set at any desired speed and run continuously just fast enough to allow the work to be removed and inserted between strokes. The machine requires a floor space of 24 by 30 inches and weighs 900 pounds.

RED-E BENCH LATHE TOOL-HOLDER

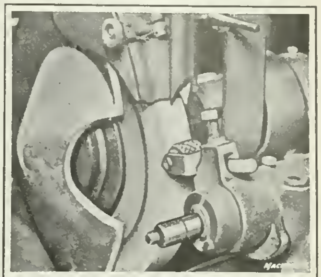
The Ready Tool Co., Bridgeport, Conn., has recently added to its line of Red-E tool-holders a Style 00 tool especially adapted for use on bench or watchmakers' lathes. This tool-holder is 5/16 by 1/2 inch in size, and it takes a 3/16-inch square high-speed steel cutter. Solid tools have generally been used on bench lathes and watchmakers' lathes, and it was to enable the users of such machines to economize in the use of tool steel through employing tool-holders, that this new Red-E tool was developed for use on machines of the types to which reference has been made.

Red-E Bench Lathe Tool-holder made by the Ready Tool Co.

ROSS GRINDING WHEEL TRUING TOOL

To meet the requirements of truing grinding wheels used for precision work, the Ross Mfg. Co., Cleveland, Ohio, is making a wheel truing tool which is shown in operation in the illustration. This tool consists of a hardened steel cylinder milled with a succession of slots which break up the surface of the grinding wheel into rows of diagonal squares. This cylinder is mounted on dustproof ball bearings which are furnished with means of adjustment to take up end play, and with provision for adequate lubrication. The hardened steel cylinder and its supporting bearings are carried in a fork made to fit the diamond tool holding fixture on grinding machines. When the truing tool is applied to the grinding wheel there is little grinding action on the tool because both contacting surfaces are running at the same speed; the effect of pressure, however, is to loosen the top layer of blunted crystals so that a fresh lot of sharp crystals are exposed ready to be applied to the work.

Advantages claimed for the Ross grinding wheel truing tool are as follows: The cost of upkeep is small, because there is very little grinding action to wear out the working face of the wheel dresser. Also, it is claimed that a saving is made in the cost of grinding wheels because less frequent dressing is required on wheels where the Ross tool is used, as compared with certain other methods of dressing. It is further claimed that the production of grinding wheels trued with this tool is greater than that of wheels trued in some other ways. For instance, it is said that a certain firm in Cleveland using these truing tools finds it necessary on a certain job to redress the grinding wheels every three hours where they were formerly redressed every hour. The time required for the dressing operation averages five minutes, and while the production of each grinding machine was formerly 1500 pieces a day, this production has been increased to 1800 pieces; *i. e.*, a gain of 20 per cent. It is also claimed that harder grades of abrasive can be used because the wheel structure is opened up and does not "load" so readily, and also because the cutting crystals have a keener edge. This truing tool is especially valuable for use on wide faced grinding wheels, due to the fact that it does not heat or chip when held in contact with the grinding wheel for the period of time required to dress a wide faced wheel. These Ross truing tools are made in several grades for roughing and finishing different types of grinding wheels.



Ross Grinding Wheel Truing Tool in Operation

DAVIE GAGING MACHINE

To meet all the requirements of the tool-room or inspection department for gaging tool work where the highest attainable accuracy is required, or for the inspection of commercial work where it is only required to maintain the dimensions of pieces within ordinary limits, the Davie Tool Co., 1666 E. 118th St., Cleveland, Ohio, has developed a gaging machine which is illustrated and described in the following article. This machine is so designed that it may be arranged to give readings to three different degrees of accuracy, namely, 0.001 inch, 0.0001 inch and 0.00001 inch, respectively, these different readings being obtained by means of compound levers which actuate the dial indicator. These multiplying levers are accurately balanced and provided with means of adjustment to compensate for any inaccuracy in the fulcrum. Three different mountings are provided on the machine for the dial indicator, which is set in one of these positions according to the degree of accuracy required in testing the work. It will be seen that the test indicator dial is arranged to read plus and minus, so that the amount which work is either over size or under size may be accurately determined. The machine is intended for use in place of snap gages or micrometers, and the makers claim that a gaging device on which the result is visually indicated gives uniform results when used by different operators, while the "feel" of a snap gage or micrometer involves the personal equation and may vary with different men.

A good idea of the way in which this gaging machine operates will be obtained by referring to Fig. 1 in connection with the following description. Here it will be seen that work *A* to be tested is supported on a gaging table *B*, this table being carried by a vertical column *C*. To provide for adjusting the position of the table for gaging different pieces of work, lever *D* is turned to secure an approximate setting; this lever turns a pinion that meshes with rack teeth cut in column *C*. When the gaging table has been set in the desired position, the table is clamped by means of binding lever *E*. Multiplying levers that actuate the dial test indicator are contained in case *F*, and the column on which this case is supported may be raised or lowered and clamped in any desired position by lever *G* that actuates an eccentric binding clamp. In Fig. 1 the gaging machine is shown set to read to 0.0001 inch, but by simply removing a screw and placing the dial indicator unit on base *H* in order to bring the indicator into contact with "lifter" *I*, provision is made for obtaining readings to 0.00001 inch. To provide for obtaining readings to 0.001 inch, it is merely necessary to loosen screw *J* and then disengage the indicator and mount it on a stud (not shown in the illustration) which is tapped to receive screw *J*. It will, of course, be apparent that the two chief uses of this gaging machine are for reading to 0.0001 inch and to 0.00001 inch, and, as shown in the illustration for reading to 0.0001 inch, the machine is most useful for the inspection of commercial work.

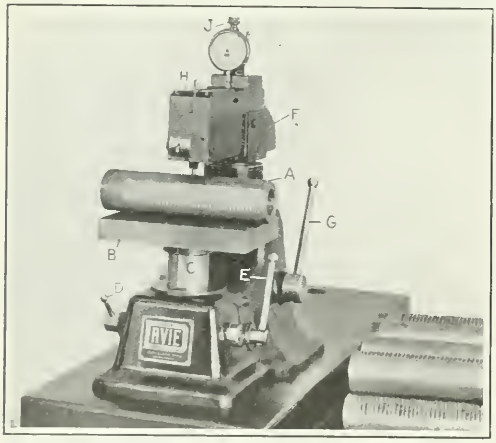


Fig. 1. Davie Gaging Machine with Dial Indicator reading to 0.00001, 0.0001 or 0.001 Inch

In Fig. 2 are shown attachments provided for use on this machine for testing the concentricity of milling cutters, gear cutters, etc., and centers for testing the concentricity of arbors, spindles, etc. It will be seen that these attachments are provided with tapered shanks so that they are interchangeable with the regular gaging table. This table is also shown in Fig. 2, and it will, of course, be apparent that the tapered shank of either the table or the other two attachments fits into a socket in vertical column *C* of Fig 1. The top of this column is threaded at the nose and provided with a backing-off nut which is used when a change must be made from the gaging table to one of the attachments, or *vice versa*. The gaging table is made of high-grade tool steel, hardened to a scleroscope hardness of 100, and then lapped to a perfectly flat surface. The balance bearings of the multiplying levers are made of the best tool steel, hardened, ground and lapped.

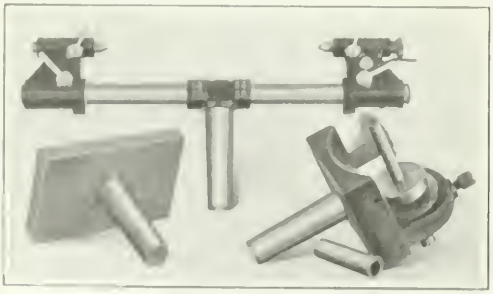


Fig 2 Attachments for testing Concentricity of Milling Cutters and of Cylindrical Work

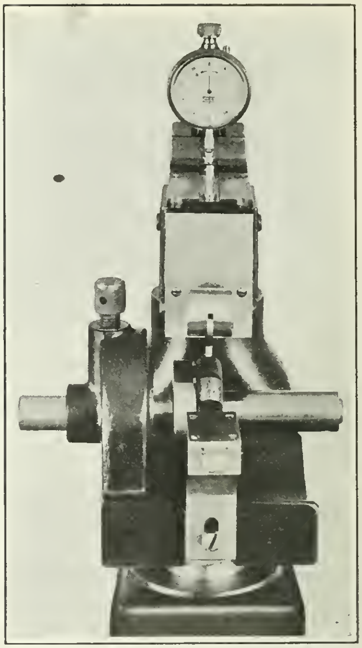


Fig. 3. Davie Gaging Machine with Attachment for testing Concentricity of Gear Cutters, etc., shown in Operation

The principal dimensions of this gaging machine are as follows: distance from center of gaging spindle to back of throat, $4\frac{1}{4}$ inches; maximum distance from top of table to end of gaging spindle, 4 inches; size of gaging table, 6 by 5 inches; range of adjustment provided for gaging table, 4 inches; vertical adjustment of gage bracket, ½ inch; maximum diameter of cutters or disks that may be gaged for concentricity, 4 inches; maximum distance between centers on attachment for testing cylindrical work, 13 inches; swing of attachment for cylindrical work, 4 inches; maximum height of gaging machine, 18 inches; area of base, 15 by 9 inches; and weight of gaging machine with attachments, 96 pounds.

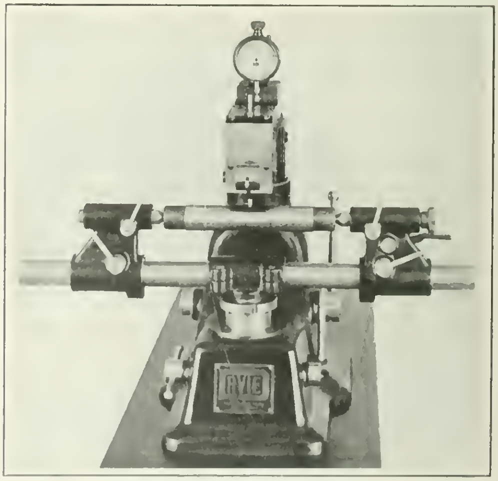


Fig. 4. Davie Gaging Machine with Attachment for testing Concentricity of Cylindrical Work, shown in Operation

NEW MACHINERY AND TOOLS NOTES

Quick-action Ball Crank: Cincinnati Ball Crank Co., Oakley, Cincinnati, Ohio. A line of quick-action ball cranks which have the spool or swivel type of handle to allow heavy work to be brought to the proper position with a minimum effort on the part of the operator. These cranks are built in various sizes, the largest having an over-all length of 13 inches.

Ball-bearing Centers: J. A. Moller, 57 Lawton St., New Rochelle, N. Y. These ball-bearing centers have been developed for use on lathes and other machine tools. The revolving center is of the familiar cone shape, and is held in the body by means of a bushing while support is furnished by a three-ball thrust bearing which tends to distribute the radial stresses on the stem.

Oven Furnaces: Tate-Jones & Co., Inc., Pittsburg, Pa. Two "recuperative" gas oven furnaces. One of these is known as a Series A furnace, while the other is designated a Series H furnace. The Series A furnaces are designed for a temperature range from 900 to 1600 degrees F, while furnaces of the Series H type are adapted for temperature ranges from 1600 to 2400 degrees F.

Cone-head Lathe: National Lathe Co., 15 W. Second St., Cincinnati, Ohio. A lever-controlled cone-head lathe built in 18- and 22-inch sizes. The drive is through a three-step cone pulley carrying a 3½-inch belt and double back-gears having a ratio of 3 to 1 and 9 to 1. The machine is also built with a four-step cone pulley and single back-gears having a ratio of 5½ to 1.

Milling Cutters: Bilton Machine Tool Co., Bridgeport, Conn. This firm is now making a line of milling cutters which are made in both plain and form types. This line of cutters includes regular spiral mills, bayonet grooving cutters, cutters for milling teeth in pliers, thread milling cutters for shells, concave cutters and a number of formed cutters for munition work.

Geared-head Lathe: National Lathe Co., 15 W. Second St., Cincinnati, Ohio. Geared-head lathes built in 18- and 22-inch sizes and adapted for either motor drive or belt drive from the line-shaft. These lathes are built with any length of bed from six feet, advancing by intervals of two feet, and they may be furnished with plain or cabinet legs. Either metric or standard lead-screws and gears may be furnished.

Bench Saw Table: S. A. Stewart & Co., 85 Hall St., Waltham, Mass. In the January, 1913, number of MACHINERY a description was published of a bench saw which had just been placed on the market by this firm. Recently a pedestal base and special countershaft drive has been developed for use in connection with this machine, which enables the bench saw to be set up as a floor machine in those shops where such an arrangement is desirable.

Dynamic Balancing Machine: Fitz-Empire Double Pivot Last Co., Rochester, N. Y. This machine is adapted for balancing parts weighing from 5 ounces up to 75 pounds, and machines of larger size could be built to special order. The standard machine weighs 650 pounds and a 1/2-horsepower motor is required to drive it. Equipment furnished with the machine includes a balancing arbor, two U-bearings, two floor stands, two marking rests and a driving belt.

Drop-light Extension Reel: Cincinnati Specialty Mfg. Co., Powers and Sylvan Sts., Cincinnati, Ohio. An automatic electric drop-light extension reel which is furnished with a swivel joint to enable one to walk in any direction with the lamp. The cord furnished with the outfit is 25 feet long and it is automatically wound over a spring pulley. The reel is stopped or started in a manner similar to that used in manipulating an ordinary window blind roller. Ordinarily, this reel is attached to the ceiling and connection is made with the electric circuit in the usual way.

Combination Center Drill and Countersink: Apex Drill Co., 2455 McMicken Ave., Cincinnati, Ohio. A combination center drill and countersink which is so designed that it cuts a clearance at the top of the countersunk surface in the work. As a result, a center entering the hole produced by this drill is not directly in contact with the work at the periphery of the hole, and so it is possible to face the end of the work right up to the center without employing half centers or adopting the somewhat difficult practice of partially withdrawing the tailstock center from the work.

Wheel-truing Device: Precision Truing Device Co., 519 Main St., Cincinnati, Ohio. A wheel-truing device which consists of a self-contained electrically driven grinding machine that may either be placed in a holder the same as an ordinary diamond tool, or clamped in any position on the machine that is convenient for the operator. The small grinding wheel used on this truing device is composed of a hard abradant and the wheel runs at a speed of approximately 8000 feet per minute in the opposite direction to that of the grinding wheel which is to be trued. The truing wheel is moved across the face of the grinding wheel to be trued in the same way that an ordinary diamond would be employed.

Tool-room Lathe: Rockford Tool Co., Rockford, Ill. A 16-inch tool-room lathe in which the number of controlling levers has been reduced as far as possible. This feature of simplicity combined with a heavy construction are the two outstanding points of the design of this machine. The lead-screw is not splined and a graduated chasing dial hung on a pivot is provided to facilitate the performance of thread cutting operations. An independent feed-rod is furnished and motion imparted by this rod can be reversed by a lever at the right-hand side of the apron. There are thirty-six available rates of feed, covering a range from 0.003 to 0.166 inch per revolution of the spindle. Any number of threads from 1½ to 80 per inch, including the 11½-inch standard pipe thread, can be cut on this machine.

Pneumatic Drill: Ingersoll-Rand Co., 11 Broadway, New York City. A light-weight, high-power, non-reversible drill which represents an addition to the line of "Little David" pneumatic tools of this company's manufacture. The new drill has a capacity for reaming work up to 5/16 inch and for drilling up to 9/16 inch. It is known as a "No. 5" drill, weighs fifteen pounds, and develops a free spindle speed of 1000 R.P.M. The motor is of the four-piston type, and by removing five cap-screws, the entire crankshaft assembly may be withdrawn as a self-contained unit. The valve is of the rotary type and is gear-driven. This machine may be furnished with either a breast-plate, spade handle or a telescoping feed-screw; and where power feed is provided, the maximum length of feed is 2½ inches at one setting.

Heavy-duty Drilling Machine: Defiance Machine Works, Defiance, Ohio. A No. 3 24-inch vertical drilling machine with capacity for driving 3-inch high-speed steel drills in solid steel to the limit of their cutting capacity. Among the distinctive features of this machine the following may be mentioned: Two cones of gears are employed, which are operated by a lever to provide the feed changes, while the spindle speeds are secured through two cones of gears and a roll-in gear. A gravity oiling system is employed with special provision to guard against unnecessary use of oil. The machine is equipped with a single driving pulley belted direct to the lineshaft and eight spindle speeds are available, ranging from 51 to 408 R.P.M. Four feed changes are provided, covering a range from 0.046 to 0.007 inch per spindle revolution, and the feed is transmitted to the spindle by a large worm-gear which runs in an oil bath. Power feed is available through a maximum spindle travel of 16 inches.

* * *

AMERICAN CORPORATIONS IN NEUTRAL COUNTRIES

The War Trade Board has authorized branches of American corporations and other American houses established and engaged in business in neutral countries and in countries associated with the United States in the war to accept and pay drafts, to deliver goods, warehoused or otherwise stored, and to perform other similar acts, notwithstanding that such acts may involve trading with "enemies" or "allies of enemies," when such acts are necessary to prevent a breach or violation of a law or commercial obligation enforcible in the courts of the country in which such branch is established; provided, however, that nothing herein contained shall be held or construed to authorize said corporations, houses or their branches to hereafter undertake or enter into contracts or business or commercial transactions which will involve trading with "enemies" or "enemy allies" in order to carry out or perform the same; and that every case involving transactions of trading with the "enemy" or "enemy allies" be reported to the War Trade Board within thirty days after the occurrence thereof, upon a form to be furnished by the War Trade Board.

* * *

OLD TRACINGS ASKED FOR BY RED CROSS

The American Red Cross requests manufacturers and others using tracing cloth to donate discarded tracings to the Red Cross. The tracings are washed and the material—linen or cotton—is employed for the making of surgical dressings to be used in the field hospitals. The Red Cross has made arrangements with large laundries in all cities to collect material of this kind, and any manufacturer who wishes to aid should call up the local Laundry Owners' Association or one of the large laundries in his city, who will send for such material as he will give them.

READJUSTMENT AND OPERATION OF INDUSTRY IN ENGLAND SINCE 1914

The Merchants Association of New York has published a report dealing with the statements made by the special commission from the British Ministry of Munitions which visited the United States in the latter part of the past year with a view to giving manufacturers in this country the benefit of the experience of England in munition industries since the outbreak of the war. Although the representatives of the commission did not offer advice, the information given should prove of great value to employers at this time, when so much depends upon the successful solution of our industrial problems.

Agreement between Government, Manufacturers and Labor Unions

All legislation in Great Britain relating to the regulation of manufacture and labor since the beginning of the war has been the result of agreement between the government, employers, and labor unions, and covers practically everything that is manufactured for war purposes. There is not a single clause in the legislative acts that has not been the result of discussion and agreement between the three interests mentioned. The principal features of the legislative acts that have been passed are given in the following paragraphs.

Power of Ministry of Munitions

The Minister of Munitions received power to control factories engaged principally on the manufacture of munitions. The control of these factories amounted to a right of the Minister of Munitions to take over the plant altogether from the owners. That right has been rarely exercised, and exercised only when the management failed to comply with the requirements of the government. Such cases have been exceptional, probably only two or three in number. As part of his powers in regard to these factories the Minister of Munitions has definite authority to limit the profits of such plants. The profits were limited to an increase of one-fifth over an average of the profits of the two years preceding the war.

The trade unions agreed that, in view of the fact that a definite limitation had been put on profits, the wages of the employes should be fixed at the rates which existed at that time. There was to be no fluctuation upward or downward in the wages except by consent of the Minister of Munitions. It was agreed that neither capital nor labor should make a profit out of the nation's needs. The government, having fixed wages, appreciated that it became its duty to see that the labor so dealt with should not suffer from the increased cost of living. It set up a Committee on Production. One of the duties of this committee consisted in hearing evidence as to the increased cost of living three times every year. Evidence is brought before it by trade unions' officials, or anyone concerned, and the committee has all the government statistics in regard to the increased cost of the necessities of life. Assuming that the living costs have gone up, the committee then makes (in the nature of a war bonus) a national award to all employes on war work payable by the employer, but to be recovered from the government.

Strikes and Lockouts

Strikes and lockouts became illegal and arbitration became compulsory. It was agreed that any trade disputes in war industries should, for the period of the war, be submitted compulsorily to arbitration, which the government should arrange. The government took the view that it could not tolerate interruption of supplies resulting from differences between employers and employes. It took the view that its duty was to interfere between the employers and employes to prevent interruption of supplies vital to the success of the armies. The government viewed this matter with such gravity that power was granted to imprison for life anyone who incited to strikes or interfered with the operation of the agreement. It has never become necessary to enforce this penalty. Public opinion has generally enforced the act very effectively.

Limitations of Rights of Labor Unions

The trade unions agreed to waive all their practices and customs which tended to restrict either employment or output, such as the employment of only union labor, and the use of only skilled persons on skilled jobs; and they promised to do their utmost to see that that agreement was carried through. They agreed also that any person, man or woman, would be allowed to do any kind of work. In return for these important concessions the government pledged itself to restore pre-war conditions in shops after the war. The trade unions, their leaders, and the rank and file, have abided loyally by that agreement and act.

Compulsory Arbitration

The first Munitions of War Act set up machinery for compulsory arbitration. Despite this system of compulsory arbitration, it would be misleading to say that there have not been labor troubles or strikes, but there have been only three strikes which have had to be regarded as serious, and of these none has lasted more than a week. Not a strike has arisen for higher wages since the war began. Moreover, there has not been a single strike in which the responsible trade union officials have not stood side by side with the government and done their utmost to bring every man back to work at the earliest possible moment. One of the lessons which has been learned in England is that the war is a war of the civil organizations—of mechanism and mechanics, of the machine shop and the factory—just as much as it is a war of the army. Organization of industry at home must be as complete and thorough as at the front. If one leaves organization at home to chance, he imperils the army. Industrial peace at home, continuity of supplies, and ever-increasing output—these things are vital if this war is to be won without useless waste of life and supplies.

Prevention of Shifting of Labor

The shifting of labor from establishment to establishment, from work of great importance to work of less importance, from war work to civil work, has been checked by a system of licenses. No non-essential industry which uses materials essential for war purposes or employs labor which could be used in the manufacture of munitions now exists in England. Therefore there is little risk of labor, which is engaged in the manufacture of munitions, leaving for civil work. It was soon found in England that some manufacturers had taken on orders that could not be filled without a large increase in their labor force. Accordingly, such manufacturers had set about getting the necessary workmen in the most uneconomic way possible; that is, they tried to get labor from other plants. A system of labor auctioneering and enticement was found to be going on all over the country. This situation was ended by two regulations under the Defense of the Realm Act, which stated in effect that no employer in the engineering industry (machine shops and other metal-working plants) should offer an enticement or endeavor to entice away an employe from any other employer in that industry. Should he do this, he was liable to a heavy penalty. Further, the Ministry of Munitions was empowered to regulate and restrict the employment of labor in any factory. If an employer offers an enticement to other labor, or if he is found using the labor he has in an uneconomic way (holding labor for future contracts or using a skilled man on a machine which a less skilled man could operate), an embargo is laid on that firm and it is not permitted to engage any labor of any sort except under license from the Ministry of Munitions. In this way a plant can be watched and the man-power in that plant can be economized as much as possible.

Hours of Labor

In England there are no regulations or laws as to hours of labor. This matter is always dealt with by means of agreement between the trade unions and the employers' federations. The only alteration that has been made during the war is that the hours which a woman might be worked were limited to sixty per week. There is no over-time limit for men. In general, the normal hours actually worked at the present time in England amount in the metal trades to about fifty-four to fifty-six per week for men and fifty-two to fifty-four hours for women, with perhaps four to six hours over-time for men and one to four hours over-time for women. In an explosive factory women usually work forty-eight hours.

There was a period when England worked her men and women perhaps one hundred hours a week. There was an initial output during the first four to six months which was larger than was expected; but after that it began to decrease to less than that of normal hours. As a result, an effort has recently been made to cut down the excessive hours and to get rid of over-time as much as possible. All Sunday labor, except on continuous processes, has now been done away with. Similarly an effort has been made to abolish over-time or to reduce it to a minimum. The obstacle in the way of any further reduction is not on the part of the government, nor employers, but because the workers desire to earn extra pay.

War Munitions Volunteers

The War Munitions Volunteers system has been of tremendous assistance to England in stabilizing the labor supply and in controlling priority of labor on war work. The War Munitions Volunteers are skilled workmen who have offered their services to the Ministry of Munitions for the duration of the war. They constitute a mobile force—now numbering about 200,000—which can be shifted into any form of munitions work that the Ministry considers especially vital at any given time. Workmen have become members of the War Munitions Volunteers because of the appeal of patriotism and because membership carries with it exemption from military service. Members receive the established rate of pay in the plant which they leave, or the plant to which they go, whichever may be the higher. The formation of the War Munitions Volunteers system has produced many of the beneficial results of industrial conscription without any of the dangers. The government can now select men scientifically whenever there is special need of additional skilled workmen in any factory or in any district, and these men can be taken from work on which their loss will be felt least.

* * *

TREATMENT OF WOUNDS DUE TO INDUSTRIAL ACCIDENTS

The so-called Dakin's solution, an antiseptic which has been developed in Paris in connection with the treatment of wounded soldiers, will find a valuable application in the treatment of injuries due to industrial accidents. The solution has been tried by the medical departments of a number of industrial plants in the United States, and the report of its successful application in the dispensary of the General Electric Co. at West Lynn, Mass., has brought out some interesting facts. The works' physician, Dr. Frank E. Schubmehl, makes the following statement relating to its use:

> All wounds occurring in this plant are considered infected wounds at the very beginning and are treated as such. A dressing is applied over the wounded area in such a way that the denuded or exposed tissue laceration is free from pressure. First, the wound is thoroughly, but carefully, cleansed with Dakin's solution, either by spray or swabbing off with cotton. Pressure is made around and about the outside edges of the wound, previously covering the uninjured parts to be included in the bandage with vaseline gauze. The bandage is then applied and the patient is instructed to pour through the depression in the bandage, where the opening of the original dressing appears, enough of the Dakin solution, every two hours, to thoroughly wash out the chamber within. The patient is supplied with a bottle of the Dakin solution sufficient to carry him over to the next dressing. When the injury is a small one, the dressing is applied as above, and the patient is supplied with a medicine dropper, in addition to the bottle of the solution, and is instructed about the use of the solution.

From an observation of 6000 injuries, large and small, at the General Electric Co.'s plant since the introduction of this treatment, it is believed that the method described is the most efficient that has been developed. Several cases of lacerated fingers and of compound fractures of the bone have been treated by Dakin's solution, and the partially severed members held only by a slight piece of integument have been saved.

JOBBING-SHOP PRODUCTION

BY CHARLES A. CARPENTER[1]

The jobbing machine shop offers problems in production that are, in general, much more difficult than those of manufacturing establishments. In the latter, machinery is installed to perform certain definite functions. Great ability is needed in designing and selecting this machinery, and a versatile repair gang is indispensable to maintain full output; the actual production work then becomes simple. In jobbing shops, the work taken must conform to the limitations of the equipment. It is impossible to secure work to keep all machines working equal hours; hence two problems confront the jobbing-shop manager. He must balance the work ahead of all machines by careful sales and strict attention to scheduling production, and he must increase the utility of machines by cheap alterations, fixtures or other accessories. The installation of new equipment requires shrewd judgment mixed with plenty of gambling faith, and the repair gang should be in charge of a mechanical genius who is an all-around machinist.

In order to get the best results and the largest profits from a shop taking special contract work, it is necessary to keep all equipment equally busy on operations suitable for the machinery involved. To secure these results it is necessary to keep a complete and detailed record of all machinery and small tool capacities. Thus a lathe record should accurately show the diametral and length limits, thread-cutting capacities, accuracies, etc. The importance of this information is easily shown. Suppose a long shaft is to be turned to close limits. While more than one machine may be satisfactory for swing and length, only one may be sufficiently accurate to turn to the size wanted. Some lathes turn out of round, some show chatter marks on the work, and some may not have thread-cutting capacities for the full working length. It may often be essential to have an extra length on long shafts for driving so that threading or other special work may be done at the headstock end. A little experience in jobbing work, carefully recorded, will quickly enable an alert superintendent to secure the necessary data on small machinery and small tools. In addition, a critical study must be made of all blueprints issued to the shop to determine the proper assignment of work to each machine. This problem requires intimate knowledge of the capacities of the machines and an understanding of the complete shop routing system. For example, some work is taken that must go on one particular machine; other work might be handled equally well on two or more machines.

The first step in the proper assignment of work is to list definitely all jobs that any one machine must handle. For instance, assume that a shop has several planers: one taking work 10 feet wide, another work 8 feet wide, and a third work 7 feet wide, etc. Any planer work over 8 feet wide should go on the 10-foot planer unless special rigs are available for one of the smaller machines. After he has scheduled for the 10-foot planer the work it should take, the superintendent may find that this machine has more work than it can complete in the time desired; or that it is just properly balanced with the other equipment; or that it has too little work ahead. Each condition must be considered in connection with the entire production system. If there is apparently too much work for the time available, one solution of the difficulty is to ignore promised deliveries and let each job take its turn; that is an admission of failure. Another plan is to make a close study of one of the smaller machines to see if a special set-up will take care of one or more of the jobs. A third plan is to run the 10-foot planer extra hours. Sub-letting part of the work might be desirable. If the work ahead is just right for the shipping schedule, no adjustment is necessary unless caused by overcrowding of other machines. Should there be too little work ahead, other tools might be relieved so as to balance working hours, or part time might be advisable. When considering work suitable for two or more machines, an effort should be made to assign work to secure the lowest costs and at the same time to balance the equipment in so far as is practicable.

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Advantages and Disadvantages of Routing Work

It is frequently necessary for the superintendent to decide when the routing of the work should be changed. Men who have never handled a jobbing shop may say that no interference of schedule should be permitted, while most jobbing-shop foremen will say no schedule is worth anything because it cannot be kept. While a shop taking special work cannot develop a routing system that will eliminate the disruption of schedule plans, tentative schedules of the work should always be made. Schedules must frequently be broken, because it is impossible always to estimate correctly the time that will be required to do a job never before attempted. Besides, the amount of finish and the character of metal may render ineffective estimates based on past performances; breakdowns of equipment cannot be entirely prevented; defective material is frequently manifest only after considerable machining; desirable contracts may be taken with the full knowledge that schedules will be broken; and cancellations, "hold-up" orders and requests for deferred shipments may justify a schedule change.

The reasons in favor of making tentative schedules are just as numerous. By carefully studying the work ahead of each machine, a larger output is obtainable because the tendency is to keep all machines equally busy, and by studying routing, new methods will come to mind. A much closer watch is kept on shipping dates, improving the reputation of the firm; oftentimes desirable contracts may be taken for quick delivery that otherwise would be lost through haphazard delivery promises. The importance of hurrying in materials purchased outside is clearly brought to mind. The most important reason for making a tentative schedule, however, is the better grasp it gives the superintendent of the problem of production. An executive properly in touch with his shop can head off undesirable contracts.

Obtaining Mechanism Output with Greatest Efficiency

For keeping the records of machine and tool capacities, a card file is preferable, the cards being grouped according to machines, such as lathes, planers, horizontal boring mills, taps, drills, boring heads, etc. A volume might be written about the information that should be kept on these cards, but any practical shop man can start such a record and every new job will afford information on the limitations of the equipment. Before a person will have kept his file many weeks, he will be surprised to find the number of jobs that have been done at low cost on tools that, before the file was kept, were considered unfit for that purpose. As a result, the shop will be running nearer to 100 per cent capacity than ever before. Few machinists realize how many things a good machine tool can do, so that it is only by a careful study that the full range of capacity can be determined. But such a study will show that many jobs formerly assigned to a very few machines may be done with commercial efficiency on many others by inexpensive special rigging. The accumulation of this rigging also helps the management to obtain 100 per cent output.

To avoid dependence upon memory, a route sheet should be kept of every machine or small tool that may at any time become overscheduled with work. Thus there should be a sheet for each lathe, planer, vertical mill, etc. Then an examination of a new drawing will suggest assigning one job to, say, an 8-foot planer, another to a 42-inch lathe, a third to a 9 foot vertical mill, and a fourth to a 6-foot radial drilling machine. The complete sheet for each machine will show several jobs ahead, giving the shop order numbers, bill of material, marks or pattern numbers, descriptions of the pieces, operations to be done, approximate number of hours required for each, and the tentative date of completion. From these routing charts, it is comparatively simple to select the jobs that should be taken up as each preceding job is completed. To decide the order of future assignments, an analysis must be made to determine if work should be shifted from one machine to another, if material will be received in time to keep schedules, and the importance of keeping previously promised delivery dates.

With adequate information available, it is best to note a tentative sequence for the jobs ahead of each tool. Frequent conferences of the shop executives will enable the management to change this arrangement readily to meet new conditions. Should it be impossible to take up any job in its turn, it is generally better to take the next one in order, leaving the delayed job for future consideration. Definite instructions should be issued whenever this procedure is desirable, and the foreman in charge should be advised, should it be decided to hold any machine waiting for its scheduled work.

Because of the many factors that enter into the work, the man in charge of production in a jobbing shop must always be "on the job." He must clearly understand the shop's limitations and possibilities. He must be conversant with the status of each contract and must be ready to have each day start his problems anew. He cannot feel any sense of permanency in the plans made and yet he must have faith in those plans when made. With these characteristics mixed with practical judgment and ingenuity, a production man can maintain a high state of efficiency in his plant and he will be rewarded by securing a greater output, lower costs, and better deliveries than he ever thought possible.

* * *

CONVENTION ON FOREIGN TRADE

The Fifth National Foreign Trade Convention will meet at the Gibson Hotel, Cincinnati, Ohio, Thursday, Friday and Saturday, April 18-20, inclusive. The theme of the convention will be "The Part of Foreign Trade in Winning the War." In the formal call to the convention, James A. Farrell, chairman of the National Foreign Trade Council, calls attention to the fact that American participation in the war against Germany has laid a new obligation upon the foreign trade enterprises of the United States and at the same time presented a new opportunity. The object of the convention is to consider that obligation and that opportunity; to discuss the different elements of foreign trade; and to give serious thought to the demands and the problems of the future

All Americans engaged in, or desirous of entering overseas commerce, and especially all chambers of commerce, boards of trade and other commercial and industrial organizations, as well as firms and individuals, are invited to take part in the convention, individually or by appointment of delegates. The discussion will be led by men who are foremost in the foreign trade experience of the United States. Approximately one-half of the time of the convention will be given to the presentation of papers and reports dealing with one or another of the numerous phases of the convention theme. The remainder will be devoted to group sessions for the discussion of single problems under the leadership of specially qualified experts.

* * *

NEW CLUB HOUSE OF DAYTON ENGINEERS' CLUB

The Engineers' Club of Dayton, which was organized in February, 1914, for the purpose of advancing the engineering knowledge and practice and the professional standing of its members by means of meetings for the reading and discussion of appropriate papers, as well as by the opportunity of social and professional intercourse, has recently erected a large club house in Dayton, which will be dedicated on Saturday afternoon and evening, February 2. The membership of the society is about three hundred, Colonel A. E. Deeds, chief of the Aircraft Production Board, being president. The new building is located at the southeast corner of Monument Ave. and Jefferson St., facing 150 feet on the avenue and 125 feet on Jefferson St. It is three stories high and contains, in addition to the regular club house accommodations, an auditorium with a seating capacity for 450 people. The building and grounds are the gift of Colonel E. A. Deeds and Charles F. Kettering, members of the club.

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CORRECTION

The formula on page 455 in the January number of MACHINERY, left-hand column, should read:

$$K = D\left(1 + \cos\frac{A}{2}\right) - \left(\frac{P}{2}\cos\frac{A}{2}\right)$$

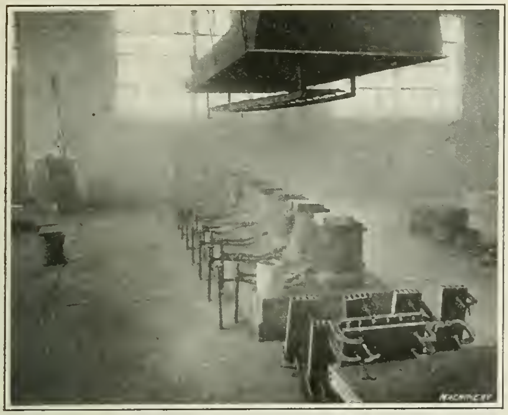

Fig. 1. Gas Furnaces for melting Stellite in Crucibles

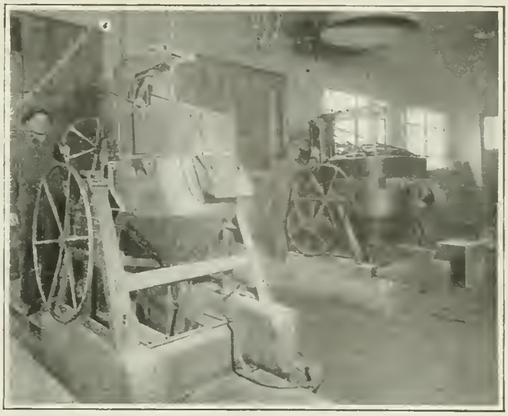

Fig. 2. Snyder Single Electrode Furnace in Position for melting Charge

NOTES ON THE MANUFACTURE AND FABRICATION OF STELLITE

Some years ago Elwood Haynes, of Kokomo, Ind., the metallurgist and engineer, discovered that an alloy of cobalt, chromium and certain other metals resisted oxidation indefinitely at all ordinary temperatures. In these experiments Mr. Haynes was intent on finding an alloy that could be used as a substitute for tableware silver. He was successful in producing an alloy that resisted the acids of apples, lemons, grapefruit and other common fruits and foods. In the course of his investigations he discovered another alloy of much greater interest and value to the engineering world, which also is a compound of cobalt and chromium with certain other metals, such as tungsten and molybdenum. This alloy, called "stellite" because of its starry and untarnishable luster, was found to be the most efficient metal for cutting tools, especially lathe tools. In fact, stellite is in a sense a revolutionary discovery, as it makes possible the machining of metals at speeds impossible of attainment with any known high-speed steel. The scarcity of tungsten, and the resulting scarcity of high-speed steels containing tungsten, has given a great impetus to the manufacture of stellite. The object of the present article is to give an idea of the general processes of producing it and fabricating it into cutting tools.

The cobalt, chromium and tungsten are reduced from their native ores in the Kokomo plant and are mixed in the various proportions required for the different grades required. Stellite has a high melting point, requiring a temperature of about 1930 degrees C. (3506 degrees F.) to render it sufficiently fluid to flow; but even when raised to this high temperature it does not flow the same as molten cast iron, but rather like a thick syrup. Because of this peculiarity, some difficulty is experienced in casting stellite in any but the simplest forms.

Two types of melting furnaces are used, electric and oil gas. The Snyder electric furnaces, which are of the single electrode type, require about 25 minutes to melt a charge, while the gas furnaces shown in Fig. 1 require about 1¾ hour. The gas furnaces are also at a disadvantage because they require the use of crucibles, which have been nearly unobtainable, and of poor quality and high price since the outbreak of the war. The electric furnace hearth is lined with magnesite and the cost of lining is less than that of crucibles required for an equivalent output.

The Synder electric furnace has a vertical carbon electrode mounted in the center above the hearth. The arc extends from the electrode, and the heating takes place by means of radial conduction and resistance. When the stellite is melted, the furnace is tipped forward on its trunnions and the charge poured into a large crucible. The pouring crucibles are filled from the large crucible, great care being taken to skim off all oxidized and foreign matter. Stellite is molded for cutting tools into bars of varying cross-section, according to the size and weight of the tool-bit required. The molds are made of graphite slabs held together by C-clamps, as shown in the foreground of Fig. 1. These molds are planed on a shaper, the grooves being cut to form the cross-section required when the two halves of the mold are matched together. When pouring the metal, the utmost care must be taken to skim off all dross and slag, but notwithstanding the care taken, a considerable percentage of the bars cast are found defective on test and must be rejected. These are broken up and remelted with

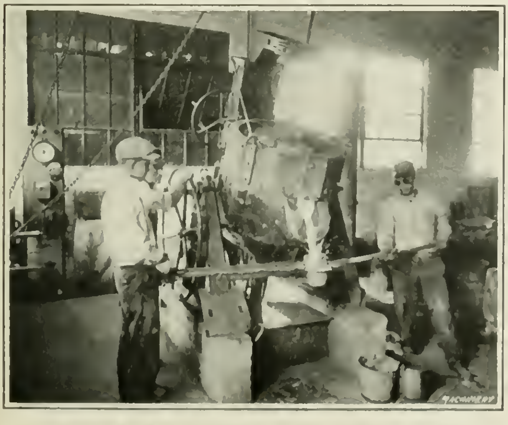

Fig. 3. Snyder Furnace pouring off Melted Stellite Charge

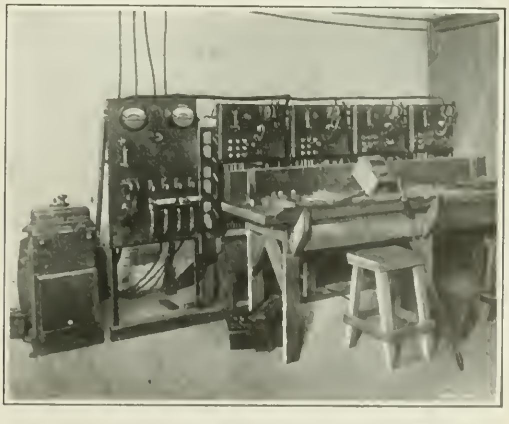

Fig. 4. Electrical Equipment for welding Stellite Bits to Steel Holders

additional cobalt, chromium or tungsten required to produce the grade of stellite desired. The stellite bars are fabricated into tool-bits for lathes and planer tool-holders, and are electrically welded to machine steel shanks, thus making the cutting point integral with the shank. All forming is done by grinding, as it is impracticable, if not impossible, to machine it. No method is known by which it can be annealed.

The electric butt-welding process is used successfully for welding stellite to the end of machine steel shanks when the cross-section of the bit and the shank are the same. The electric arc process is preferred for welding points to holders when the bit is of a smaller cross-section than the holder. The shank is notched to receive the bit, and the "saddle" is beveled at each side. The stellite bit is also beveled on the lower sides, as indicated at *A* in Fig. 5. The beveling is done in order to secure a more satisfactory weld. The bit is first "tipped" in place with the electric arc and then the V-grooves are filled in flush with stellite, thus forming a solid union with the shank. The object of sloping the sides of the saddle is to insure a solid, dependable stellite cutting material clear down to the machine steel beneath. It was found that if the saddle was not sloped, the steel and stellite alloyed during the melting process and produced an inferior cutting tool when nearly ground away. This trouble is entirely eliminated by the present practice, which insures to the customer the full value of his investment. F. E. R.

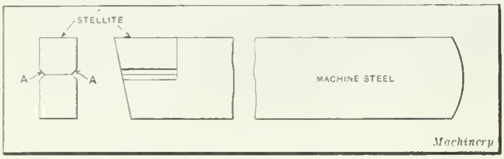

Fig. 5. Stellite Bit and Machine Steel Tool Shank Ready for Welding

* * *

THE LIBERTY MOTOR

At the annual convention of the Society of Automotive Engineers, held in New York City January 9 and 10, one session was given over to the discussion of the Liberty motor, at which time some interesting facts not previously published were brought out. The Liberty motor embodies the best principles of foreign aeronautical motor design, combined with the experience of American builders of automobile and airplane engines. It is intended for fighting planes, and can develop 400 horsepower on the ground. It has twelve cylinders, and its weight is 800 pounds, or approximately two pounds per horsepower. The main considerations in its design were to produce an engine that was compact, had a small number of parts and was reliable. In fact, reliability was made the prime consideration, and hence no experimental features have been included, but only such points are embodied in the design as have been thoroughly tried out in the past. The engine which, during the past year, has been most commonly used in airplane service in Europe develops from 200 to 220 horsepower on the ground and weighs 520 pounds. Hence the Liberty motor is a distinct advance for high power and proportionately reduced weight. The Army machines are not provided with self-starters, as the engine cannot be stopped after it has left the ground, unless, of course, subjected to such an accident that even the self starter would be without avail. The motors for the Navy airplanes, however, are provided with self-starters. The ignition is by means of dry batteries, the ignition equipment, complete, weighing only 29 pounds. This method of ignition was selected because of being the lightest equipment obtainable in combination with reliability. The cylinders are set at an angle of 45 degrees with each other. The piston clearance is 0.020 inch at the lower end of the piston. Pressure fuel feed is used, and the carburetor is manually controlled. Mineral oil is used for the lubrication, but castor oil is preferred.

During the discussion, an interesting fact relating to the life of airplanes was brought out. It was stated that fighting machines have a life of about 100 flying hours, equivalent to about two months of service. An observation plane has a life of about three months. Bomb-dropping planes used for flying only at night, and hence being more immune from attack, are likely to have a longer life. In speaking of the life of an airplane, it is not intended to convey the idea that any of its working parts are worn out, but simply that, on an average, the plane meets with an accident or is brought down by the enemy after the period mentioned.

* * *

GROUP INSURANCE AT THE CINCINNATI PLANER CO.'S PLANT

BY A. J. SCHNEIDER[1]

As many employers are now studying methods tending toward decreasing the labor turnover and increasing production, the following description of the group insurance method used by the Cincinnati Planer Co., Cincinnati, Ohio, may prove of interest. The object in adopting this method of insurance was to make this plant a desirable place to work in, so that the labor turnover would in that way be decreased. The insurance having been in effect only since October, 1917, it is too early to state positively whether the expected results will be forthcoming or not. The average cost is about $4 per year per employe, or about 1 1/3 cent per working day, the actual cost in each case depending upon the age and length of service of the six hundred employes covered by the insurance.

In starting the system, a letter was typewritten on the company's regular stationary addressed to the employes of the Cincinnati Planer Co. and stating in plain terms the object and conditions of the insurance. The letter was mailed on a Friday, so that it would be received on Saturday, which would give the men an opportunity to talk the matter over with their families during Saturday afternoon and Sunday. In the employment department an immediate increase in the number of applications was noticeable.

The insurance includes the following details: Those who have been in the company's employ for three months are insured for $500; those who have been in constant employ for six months, for $600; those who have been continuously employed for one year, for $700; and for every additional year of continuous employment another $100 is added to the insurance, until a maximum amount of $1500 is reached. The company pays all premiums, no deductions from wages or contributions of any kind from the employes being required. In addition to offering a life insurance protection, the insurance also provides an income in case of permanent disability, whether resulting from disease or accident.

One part of this proposition which received considerable study was the question as to whether the amount of the insurance should be based on wages or on length of service. It was decided that the latter plan was simpler and more efficient, for several reasons. In the first place, there is a specific advantage in remaining with the company, as the insurance increases with length of service. Hence there is an incentive for remaining with the organization even if some other concern should also adopt an insurance plan, because the new employe with another concern would be likely to be insured for a smaller sum than the insurance carried if he stays with the old concern. Another advantage of basing insurance on length of service is that it is very simple and leaves no room for doubt. Insurance based on wages requires considerable computation in order to be equitable under the present premium, piece-work and bonus systems. It might also create dissatisfaction among the employes, as the size of the insurance policy would be a measure of the wages received.

The work required in connection with the insurance plan is simple and requires very little time, probably not more than two hours a week for a force of six hundred men. Of course, at the inauguration of the system a record card giving complete information about each employe must be filled out, stating in full the name of the company and employe, date of birth, address, beneficiary, etc.; afterward, however, no further work is required unless the employe leaves the company or dies, except for the checking of invoices and reports, which can be handled by a very simple system.

[1] Employment Manager, Cincinnati Planer Co., Oakley, Cincinnati, Ohio

OBSERVATIONS AROUND THE SHOPS

BY DONALD A. HAMPSON[1]

We were passing in the rear of one of the buildings of an up-state specialty foundry while several men were cleaning out the cupola. "See that slag pile?" said the proprietor. "Well, we used to dump all of that stuff over there in the swamp, but we don't do it any more. I attended a foundryman's convention in Boston four or five years ago and saw a process for working over cupola cleanings—wouldn't have believed it possible unless I had seen it—so I put in an order for a machine on the spot and learned just how to do everything before I left. Now, we wash the slag and run it through the machine and we have been reclaiming five tons of good iron a week. That's a pretty good saving for a foundry of this size and with the pig where it is today, you can imagine what a nice percentage that Boston trip is paying."

Maintaining the Proper Speed for Grinding

The grinding room of the same foundry had a good scheme for keeping the emery wheels always running at a nearly correct surface speed. The machines were equipped with the best of hoods and exhausters and the work was wide or long enough so that, if held straight, it would not pass between the sides of the hoods. New emery wheels were twenty inches in diameter and the hood on the first machine was cut so that by the time the wheels were worn down to seventeen inches the work struck the hood. The wheels were then changed to the next machine and worn to fourteen inches, and so on. Each machine was belted to give a fair average speed for its wheels.

Reversing a Steam Engine

It was at a rather unfortunate time that the writer visited the paper mill down on the river road. The boss was storming, and didn't want to see anyone, naturally enough, for the help were all standing around idle and not a wheel was turning. Dry weather was the indirect cause, though the machinist who had just been fired was at the bottom of the trouble.

The mill was run by waterpower but it had a steam engine to hook up in case of emergencies, which had been so rare that the engine had not run for ten years. During that time, the machinery had been changed so that the drive from the engine would have to be in the opposite direction. Foreseeing this while the drought was still young, the boss had taken up the matter with the machinist, who was also the engineer to be, and learned, almost against his will, that reversing the engine was a matter of a few minutes and could be put off until steam was up. Well, steam had been gotten up that day and on starting up the engine it had run in the same old direction. Easiest thing in the world to fix! Two men had been put at the flywheel and a man on each of the big pulleys upstairs with instructions to "swing her over good and lively when I shout—and when you get her started backward I'll give her steam and we'll be all right." Repeated attempts had failed to turn the trick and the machinist had been asked to leave for other fields, carrying a blessing with him.

A Newspaper Job

There was as great rivalry between the *Times* and the *Argus* as between any of the papers on Park Row, and every second counted in getting the paper on the street after the last dispatches were in. In the final work of putting the forms on the press, four tap bolts had to be inserted and tightened. To make this a quicker job, the heads were rounded and a strap wound on them; then when the bolts were inserted, the pressman gave the strap a pull, as a boy does a top, and a second was saved that would otherwise have been spent in screwing the bolt in its inch of threaded hole.

It Can't be Done

The hardest thing to combat in bettering a manufacturing process is the spirit that opposes any movement because it was never done before or because the individual never knew it to be done. Such was the situation at the Ultra Tool Works. The trouble was in the grinding department: the men wouldn't stay or they were always behind and the other departments had to wait. The men sat in rows on boards over the tops of the grindstones and ground as best they could in that awkward position. They were covered with mud from head to foot and wore leather breeches to keep from getting soaked; the windows were also covered with mud. If they hadn't done it that way in England, perhaps they would have started it differently in this country, but once started with some is to go on to the bitter end. No one could blame the workmen for disliking their working conditions, and it had been determined experimentally that the grinding could be done on emery wheels with men working in a natural position and under healthful conditions. This experimenting, of course, had to be done outside, but the management took the stand that such methods would not stand the test of time, as had the old way with Ohio sandstones, and moreover the emery wheels were too expensive. And yet every time they put on another grindstone, the total handling from car to scrap pile cost from $10 to $14. Yes, the Ultra failed several years ago.

Building Their Own

"Come in here and I will show you the design of a machine we're going to have built to stamp our parts," said Mr. Hessler. The shop made hardware specialties and had heretofore stamped the name on by hand. "We had thought of buying a Bliss press but they cost $600 so Harry laid out this machine and it isn't going to cost us more than half of that." Harry was an electrician who had bluffed his way into a created position of mechanical engineer. The design was good, but by the time the patterns had been made, the machine work done and Harry's time added in, $500 would hardly pay the bill; yet any number of second-hand No. 18 Bliss presses, which would have been heavy enough, could have been purchased for $150 each.

Machinery in Duplicate

Montrose is not a manufacturing center so when Mr. Aaron Bloomstein appeared before its Board of Trade with a proposition to establish a plant for making his patent lock washer and nut combined, he was gladly received and a committee lost no time in soliciting the funds required to buy the patent (first) and to equip a plant. Montrose is a residential village. Its business and professional men and the farmers close by are well to do and they all welcomed the chance to get an industry, such as this promised to be. Come to think it over, they could remember instance after instance where a nut had come loose and caused disaster, so why shouldn't a factory to make "safe" nuts pay?

Mr. Bloomstein had been a tailor in his early days but had given that up when he invented this nut and made a study of manufacturing processes; this proved him to be the logical man to buy the machinery and start the plant going. Many novel ideas of Mr. Bloomstein's were to be seen when the appraisal was being made after the failure of the Safe Nut Co. which followed Mr. B's unexpected departure with his family, mostly salaried officers of the concern. But most novel of all was the double row of machines down every aisle—machines in duplicate, Mr. B had called it and no one had ever questioned his statement that all progressive plants are run that way. "It's the surest kind of a guarantee against manufacturing losses, for whenever a man breaks a drill or his spring coiling machine clogs, all he has to do is to swing around in his seat and there is a duplicate machine ready and waiting to be started on the very same job. That's what we call 'guaranteed production'," said the inventor. Just who were included in the "we" was not explained.

The lock washer and nut itself was also a novelty. It was guaranteed to stay on, yes, even to tighten up a bit at times. It was well that the company failed before the customers had fully acquainted themselves with all the good qualities of the nut, for while the nuts could be turned either way on bolts held in the hand, it was an utter impossibility to unscrew them when set up against a surface, for the only release was from the inner face of the nut.

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[1] Address: Box 157, Middletown, N. Y.

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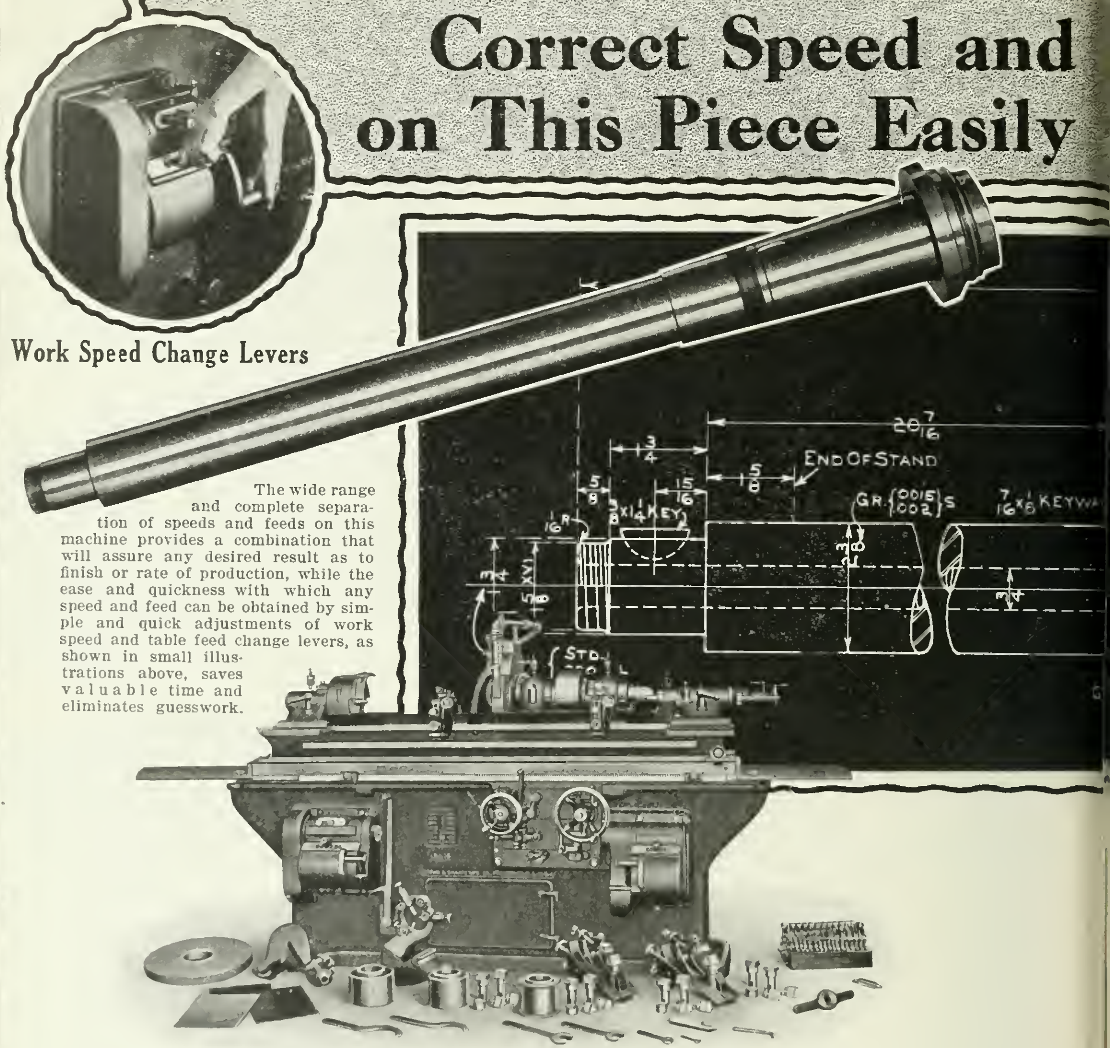

Work Speed Change Levers

The wide range and complete separation of speeds and feeds on this machine provides a combination that will assure any desired result as to finish or rate of production, while the ease and quickness with which any speed and feed can be obtained by simple and quick adjustments of work speed and table feed change levers, as shown in small illustrations above, saves valuable time and eliminates guesswork.

Brown & Sharpe Plain Grinding Machines

fulfill the various conditions to be met with in handling a wide variety of cylindrical grinding in a way that instantly appeals to both the operator and the production man. Work of large or small diameter, work which includes both large and small diameters, such as the piece shown above, or long slender pieces are all the same to the operator of one of these machines as far as accuracy and fast production are concerned. The wide range, complete separation and ease and quickness of obtaining work speeds and table feeds, while especially important, are but a few of the many features of these accurate and rapid machines.

May we tell you about them in detail? Send for literature and Catalog 136.

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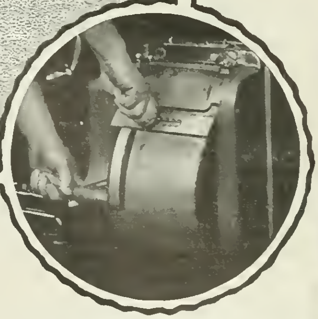
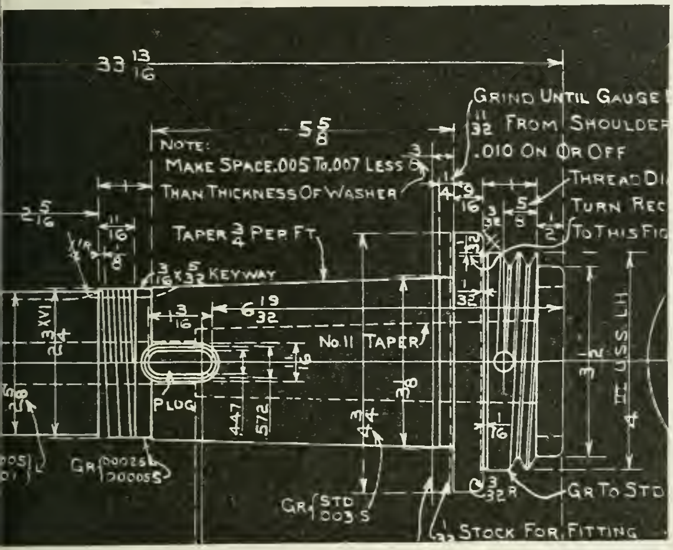
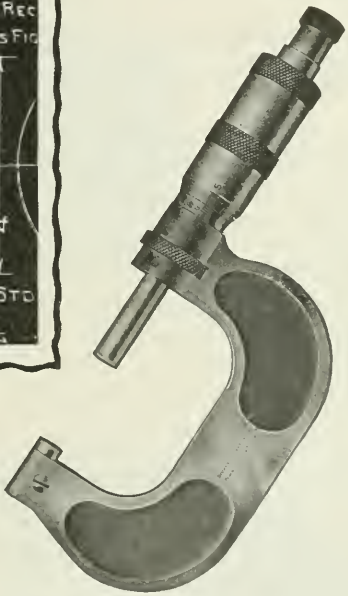


Table Feed Change Levers





The close limits allowed in the work shown above demand the accuracy that Brown & Sharpe Equipment provides. A small but highly important part of this equipment is a careful selection from among the many varieties of

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MANUFACTURING AUTOMOBILE STEERING POSTS

BY P. J. VISCO[1]

A large number of automobile steering posts, as shown at *A*, Fig. 1, were made from seamless steel tubing, and at one end it was necessary to turn down the tubing from 2 1/16 inches to 1 1/8 inch in diameter. It was not feasible to rotate the tube on the tailstock center on account of the small amount of surface at the end of the post which made it impossible to get truly cylindrical work. So a special center *B* was made. This center was hardened and ground all over, and was composed of three parts: the body, the ball-thrust bearing, and the 60-degree, conical-shaped part that revolved on the body. The conical-shaped part was corrugated, thus making certain that it turned on the body and not that the tube turned on it. The first center made did not have any thrust bearing and it became red-hot from the friction, due to the expansion of the tube.

The length of these tubes was approximately four feet and they were turned on a "Lo-Swing" lathe with one traverse of the carriage, as three tools were used—two for roughing and one for finishing. A roller follow rest was also used. Although a coolant was copiously supplied, the tube got hot, expanded and crushed the balls in the bearing so that it was necessary to find some way to hold the post. A wooden washer *C* was made to replace the ball bearing; after these washers became glazed they gave no trouble.

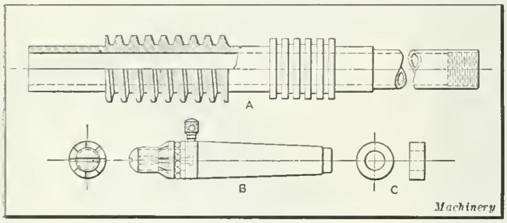

Fig. 1. Steering Post and Special Center for holding on Lathe

The triple thread on the posts and the series of grooves to the right of these threads were cut on thread milling machines. These grooves are used to take the end thrust of the post and therefore had to be cut within close limits. After trying several methods with various results, a set of cutters, as shown in Fig. 2, was made, consisting of seven high-speed cutters and five machine-steel washers, carefully surface-ground and lapped so that when assembled the entire cutter measured within 0.0005 inch, this being the allowed limit. This cutter was placed on the spindle of the thread-milling machine and after making sure that the cutters ran true, the carriage of the machine was disengaged so that the work would revolve without traveling forward or backward. The cutters were sunk into the posts to the required depth, and the work was given a complete revolution, the result being a satisfactory job. Lard oil was found suitable for this operation.

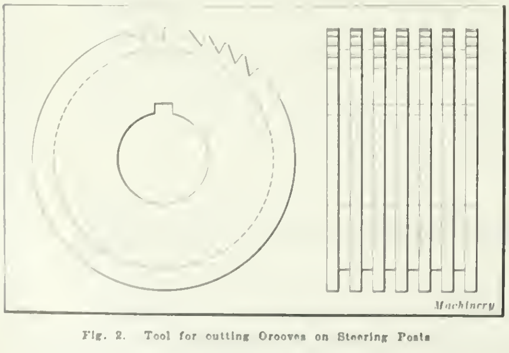

Fig. 2. Tool for cutting Grooves on Steering Posts

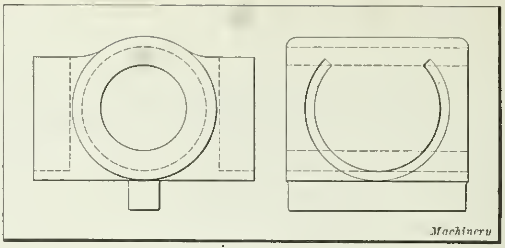

Fig. 3. Steering-post Nut

One end of the posts is threaded internally to a depth of about ⅞ inch. These threads were chased in a lathe and a 1-inch, 14-pitch tap (United States form) was used to size them, until a description was read in MACHINERY of the Gun tap made by the Greenfield Tap & Die Corporation. Then the tap used was ground as nearly as possible to the shape of the tap described, which saved the time necessary for chasing. This tap performed satisfactory work, whereas the ordinary tap sometimes seized the work and spoiled the threads.

The chasing of the triple thread in the steering-post nut, Fig. 3, was quite a problem, as the material was very tough and it was necessary for the thread to fit well on the post. After experimenting with taps it was concluded that the thread should be chased on a lathe, but indexing for each thread was too expensive, so the triple chasing tool, shown in Fig. 4, was made. The chasing tool *A* was made of a piece of carbon steel that fitted well into a bar *B* and was held securely by two taper pins. The tool was then turned to a diameter of 1 11/16 inch, after which the three teeth were generated on a thread miller in the same manner as when cutting any other thread. The tool was then taken out of the bar and some material shaped off the top so as to bring the cutting edge as near the center of the holder as possible, and the cutting edge at *C* filed back by hand. The tops of the teeth were shaped at right angles to the sides. The pitch diameter of the steering post was different from that of the chasing tool, so when the teeth were generated the head angle of the machine had to be set differently than for the thread on the steering post. The assembly of the toolpost is shown at *D*, the center piece being made so as to fit in the T-slot of the compound rest and bored ⅛ inch larger than the bar, the two side pieces on which the bar rests being bored the size of the bar and the required height so as to align the bar with the center of the lathe. These nuts were chased on an ordinary engine lathe that did not permit the disengagement of the carriage from the lead-screw and the return preparatory to taking another chip. So a lead-screw and a split nut having the same lead as the thread to be cut, but of suitable dimensions, were made. The lead-screw of the lathe was then replaced by this special lead-screw. This made certain the correct engaging of the threads and of course dispensed with the belt shifter. After chasing these nuts, a tap was run through them for sizing.

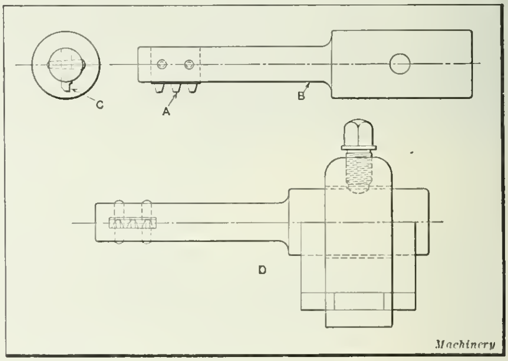

Fig. 4. Tool for cutting Thread in Steering-post Nut

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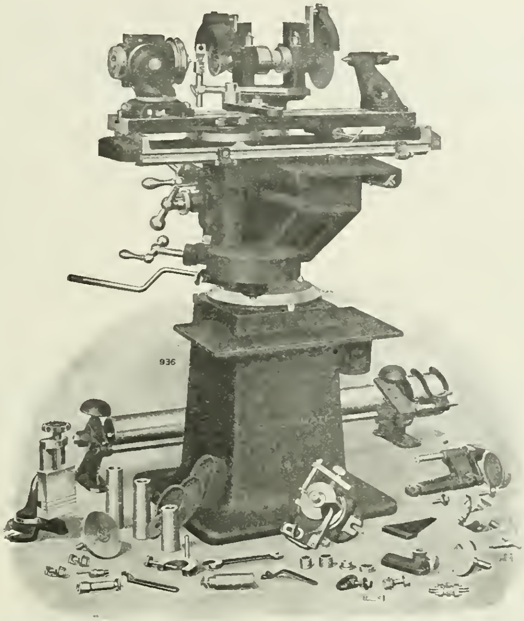
[1] Address: 570 N. Main St., Springfield, Mass.

CLEARANCE



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Incorrect cutter clearance will reduce the output of your milling machines as much as twenty per cent.

Clearance depends upon certain mathematical relations between the cutter and the grinding wheel.

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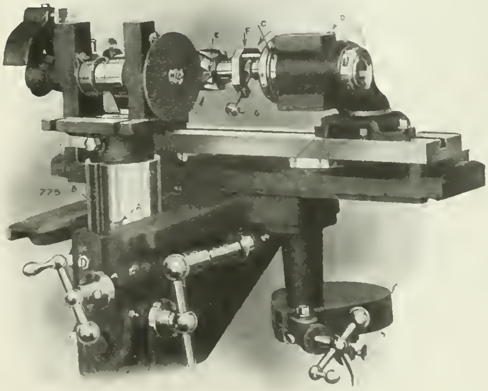
Compare the Cincinnati method. After a simple preliminary setting the swivel head is revolved the desired amount, the clearance angle being read direct from the dial—the cutters are ground with the correct clearance— and your milling department profits.

This is only one of our *exclusive features.*



Method of setting for clearance.

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Cincinnati Milling Machine Company

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JANUARY MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

In a paper on "The Relation of Manufacturing to Banking and Research" read by Walter Rautenstrauch, professor of mechanical engineering at Columbia University, before the January meeting of the New York Section of the American Society of Mechanical Engineers, special emphasis was placed upon the necessity for a closer cooperation between the banking, manufacturing and engineering interests. Continued development in the manufacturing and engineering field will require increased banking facilities, and this, in turn, necessitates that bankers either directly or indirectly acquire a more thorough understanding of the principles of manufacturing and engineering, so that they may thoroughly appreciate the problems laid before them by manufacturers. The latter, in turn, must be made to appreciate more thoroughly the value of engineering and research in promoting their business. In the discussion, an example was cited of the experience of one well-established concern whose production had been increased nearly 70 per cent by the use of experts to do research work, while the overhead cost and the number of men employed had been decreased. Emphasis was also placed upon the necessity of broadening the scope of engineering education so that the young man passing into industrial life from college will be able to comprehend more fully the commercial requirements and limitations that must be considered in connection with engineering problems.

* * *

A TRADE JOURNAL EXHIBITION

An exhibition of about one thousand trade journals is being held in the Library Art Gallery, Newark, N. J., under the direction of the Newark Free Public Library and the Newark Museum Association. The exhibition opened January 13 and will continue until February 12. The journals are arranged on sloping screens, presenting an attractive appearance and making it possible to see the papers clearly and handle them easily. Exhibitions of this kind are, no doubt, of great value in industrial centers, as they make it possible for men engaged in business and the trades to compare the various journals in their field and make a survey of the many trade and technical journals published.

PERSONALS

R. J. Morgan, formerly supervisor of sales for the American Steel Export Co., Woolworth Bldg., New York City, has been appointed assistant general manager of sales.

Henry M. Shaw, for several years connected with the sales department of Sherritt & Stoer Co., Inc., is now associated with the Monarch Machinery Co., Philadelphia, Pa.

D. H. Macdonald, of the sales department of Young, Corley & Dolan, Inc., 115 Broadway, New York City, has been made general sales manager of the machine tool department.

C. P. Coleman was elected president of the Worthington Pump & Machinery Corporation, 115 Broadway, New York City, at a meeting of the board of directors held December 31.

C. Harper Halfmann, formerly sales manager of Slocum, Avram & Slocum Laboratories, Inc., New York City, is now in charge of sales in the small tools department of Young, Corley & Dolan, Inc., 115 Broadway, New York City.

Robert L. Arms, for several years connected with the sales departments of Manning, Maxwell & Moore and Sherritt & Stoer Co., Inc., is now sales manager of the Monarch Machinery Co., Philadelphia, Pa.

Charles A. Swan, formerly superintendent of the Becker Steel Co. of America, has joined the sales organization of the Hess Steel Corporation, Baltimore, Md., and will represent the company in the Cleveland and Detroit territory.

Fred J. Miller, recently assistant to the president of the Union Typewriter Co., New York City, and formerly editor of the *American Machinist*, has been given a commission as major in the Ordnance Reserve Corps, and has been assigned for duty at the Rock Island Arsenal.

Charles Spalding, who had charge of the sales for the Gisholt Machine Co. in the Detroit and Michigan districts, resigned to become general manager of the Amalgamated Machinery Corporation, Chicago, Ill. Mr. Spalding had been connected with the Gisholt Machine Co. for twelve years.

Nelson P. Hall has been made district sales manager for the Chicago territory of the Van Dorn & Dutton Co., Cleveland, Ohio, and will devote especial attention to the gear and pinion requirements of electric railways and mines in the Chicago field. Mr. Hall will occupy offices at 14 E. Jackson Blvd., Chicago, Ill.

P. C. Gunion has been made advertising manager of the industrial bearings division of the Hyatt Roller Bearing Co., Newark, N. J. Mr. Gunion has been in the sales department of the Hyatt Roller Bearing Co. for two years. Just previous to his appointment as advertising manager, he was manager of the Pittsburg office.

D. Gleisen, formerly assistant manager in charge of bushings sales with the Hyatt Roller Bearing Co., Newark, N. J., has been made manager of the industrial bearings division of the company. Mr. Gleisen is a graduate of Stevens Institute of Technology and has been connected with the Hyatt Roller Bearing Co. for the past six years.

George A. Lautz will discontinue his active and financial connection with the Niagara Machine & Tool Works, Buffalo, N. Y., about the end of February. Mr. Lautz has been general manager of the firm for twenty-seven years and president for about ten years. He expects to take a much-needed rest, and has not yet formulated his plans for the future.

George S. Thompson, Paris representative of the Vulcan Steel Products Co., Inc., was recently appointed to the purchasing board of the American Expeditionary Forces in France. He has been assigned particularly to the handling of steel matters. This board is composed of American civilians living in France, and their duties consist of passing upon all purchases made in Europe by the American Army.

Franklin T. Chapman has become assistant general sales manager of E. F. Houghton & Co., Philadelphia, Pa. Mr. Chapman was formerly assistant to the manager of the Olympian Motors Co., Pontiac, Mich., and has had a wide experience in the manufacturing field, particularly in the automobile industry. He succeeds W. Burton Piersol, who has become assistant general manager of the Bethlehem Shipbuilding Corporation.

Milton Rupert has been elected vice-president and assistant treasurer of the R. D. Nuttall Co., Pittsburg, Pa., manufacturer of gears, pinions and trolleys. Mr. Rupert has been with the R. D. Nuttall Co. since 1893. In 1903 he was appointed head of the general offices, being directly in touch with all office matters and manufacturing operations. He was later made assistant to the president and general manager. In his new position, Mr. Rupert will have charge of sales and manufacturing activities.

Arthur N. Talbot, professor of municipal and sanitary engineering at the University of Illinois, has been elected president of the American Society of Civil Engineers for the coming year. Prof. Talbot also has charge of the departments of theoretical and applied mechanics at the university, and under his direction laboratories for testing the strength of materials and for hydraulic tests have been developed. In 1913-1914 he was president of the American Society for Testing Materials.

Guy E. Tripp, previously chairman of the Westinghouse Electric & Mfg. Co., has been appointed by the War Department as chief of the production division of the Ordnance Department, intrusted with the task of supervising and stimulating the production of all ordnance supplies, and has been given a commission as colonel. Mr. Tripp was selected because of his experience in the manufacture of munitions of all kinds.

OBITUARIES

F. A. Driver, for many years a director of the Driver-Harris Co., Harrison, N. J., died January 21, aged eighty-two years. Mr. Driver was identified with the Driver-Harris Co. ever since it was formed.

JOHN RIDDELL

John Riddell, mechanical superintendent of the Schenectady Works of the General Electric Co., died in Schenectady, December 31, 1917, aged sixty-five years. Mr. Riddell was born in Ireland, and at the age of twelve was apprenticed in a jobbing machine shop in Jersey City owned by Nicholas B. Cushing, who made elevators and repaired machinery, especially marine engines. Even as an apprentice, his employers selected him to handle some special marine engines that they were repairing, because of his remarkable aptitude for the work. The work brought him in contact with seafaring men, and he spent two years as second engineer on trading steamers plying between the West Indies and Central America and New York.

His first association with the electrical business was with the Daft Electrical Co., where he was rated as a machinist, but was really doing experimental mechanical work, especially

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in the railway field. In 1887 he entered the employ of the Thomson-Houston Electric Co., at Lynn, Mass. In 1888 he became foreman of the railway motor shop and was recognized as one of the leading mechanical experts at the time the General Electric Co. was formed in 1892. He moved to Schenectady in 1895, and shortly after his arrival was appointed mechanical superintendent. In this important position he designed special machine tools for increasing the production of the machine shops and also for carrying on the many special processes involved in the manufacture of electrical machines. Many of these machine tools were built by the General Electric Co. under his direction; and for such tools as were purchased outside, Mr. Riddell not only prepared the specifications, but actually purchased them himself as the company's representative. He was consulted in regard to all automatic machinery and was called upon when a solution was sought for different mechanical problems that baffled the average expert.

The records of the United States Patent Office show that thirty-seven patents were taken out in the name of John Riddell. There are hundreds of improvements on machine tools which he either invented or regarding which his opinion was sought by manufacturers in various lines. Frequently designing engineers of machine tools have taken journeys to Schenectady to show Mr. Riddell a suggested machine tool improvement and ask his opinion, criticisms and suggestions. Among the notable achievements of Mr. Riddell in the various works of the General Electric Co. is a boring mill—the largest in the world at the time—which was built from his design and which has a sixty-foot swing. This was so successful for machining the large wheels for the rotors and stators of water-wheel-driven generators that he designed a forty-foot boring mill embodying the same principles as the large one and used for turbine work. Another one of his machines was the bucket-cutting machine for large steam turbines which he developed in 1902. It was at this time that the General Electric Co. was building the first 5000-kilowatt steam turbine ever constructed, and this labor- and time-saving device became an important factor in the development of the steam turbine industry at the time when the steam engine was pre-eminent in the largest power plants in the world. Almost automatic was the field-coil winding machine which he built and which was adopted both in Lynn and Schenectady. In the opinion of many, there was no single achievement of Mr. Riddell's which advanced the electrical industry more than this winding machine.

John Riddell

Mr. Riddell was a member of the American Society of Mechanical Engineers, the Engineers' Club of New York, the Society of Engineers of Eastern New York, the General Electric Quarter Century Club, and of several other clubs and societies. He delivered several papers on engineering subjects before various associations. He was awarded a gold medal at the Panama-Pacific Exposition in San Francisco in 1915 as collaborator in the exhibit of the General Electric Co. He leaves a widow and a daughter, Mrs. William Newcomb.

COMING EVENTS

February 28—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 828 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

April 18-20—National Foreign Trade Council conference in Cincinnati, Ohio; Gibson Hotel, headquarters. Secretary, O. K. Davis, 1 Hanover Square, New York City.

April 24-25—Annual convention of the National Metal Trades Association at the Hotel Astor, New York City. Homer D. Sayre, secretary, 1021 Peoples Gas Bldg., Chicago, Ill.

May 15-17—Joint convention of the National Supply and Machinery Dealers' Association, Southern Supply and Machinery Dealers' Association and the American Supply and Machinery Manufacturers' Association in Cleveland, Ohio. Secretary of the American Supply and Machinery Manufacturers Association, F. D. Mitchell, Woolworth Bldg., New York City.

June 20-22—Fifth annual convention of the American Drop Forge Association held at the Iroquois Hotel, Buffalo, N. Y. E. B. Horne, "The American Drop Forger," 108 Smithfield St., Pittsburg, Pa., secretary.

SOCIETIES, SCHOOLS AND COLLEGES

Lowell Textile School, Lowell, Mass. Quarterly bulletin 1917-1918 giving a list of the names and addresses of the graduates and undergraduates of the school who are in military service and the branch of service which they have entered.

University of Illinois, Urbana, Ill., announces that the university maintains fourteen engineering experiment station research fellowships and that one other such fellowship has been established under the patronage of the Illinois Gas Association. These fellowships, for each of which there is an annual stipend of $500, are open to graduates of approved American and foreign universities and technical schools. They are for two consecutive college years, at the expiration of which period, if all requirements have been met, a degree of master of science is conferred. Additional information may be obtained by addressing The Director, Engineering Experiment Station, University of Illinois, Urbana, Ill.

NEW BOOKS AND PAMPHLETS

Electric Pumping. By H. W Wagner. 80 pages, 6 by 9 inches 17 illustrations. Published by the Engineering Experiment Station, Iowa State College of Agriculture and Mechanical Arts, Ames, Iowa, as Bulletin No. 46.

Determination of Absolute Viscosity by Short-tube Viscosimeters. By Winslow H Herschel. 55 pages, 7 by 10 inches Published by the Government Printing Office, Washington, D. C., as Technologic Paper of the Bureau of Standards No. 100. Price, 10 cents.

The Modern Gasoline Automobile. By Victor W. Page 1032 pages, 5½ by 8½ inches, 725 illustrations. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $3.

The seventh edition of this treatise on the construction, operation, and maintenance of gasoline automobiles has been revised and enlarged. It contains additional material relating to ignition, the action of generators and the basic principles on which they operate, different types of tractors, cycle cars, the combination gasoline-electric drive, a discussion of ball and roller bearings, the latest types of gasoline and kerosene carburetors, and other important developments.

Motion Picture Education. By Ernest A. Dench. 353 pages, 5 by 7½ inches. Published by the Standard Publishing Co., Cincinnati, Ohio. Price, $2.

This book relates to the value of moving pictures in education, and deals with many of the important services that may be rendered by the educational film. While not intended specifically to convey any information relating to the use of moving pictures in the study of mechanics and engineering, except for a brief section relating to the industrial uses of the motion picture, the book, nevertheless, suggests how moving pictures might be well employed to an increasing extent both for engineering and industrial education. In addition, it gives some interesting information relating to the methods by means of which motion pictures are made.

Precision Grinding Machines. By Thomas R. Shaw. 214 pages, 5½ by 8½ inches; 164 illustrations. Published by D. Van Nostrand Co., 25 Park Place, New York City.

This book deals with grinding machines used for manufacturing purposes, omitting tool and cutter grinders, which belong to another class. The various types of machines and their uses are first described, after which grinding wheels and methods of grinding are taken up. The book is divided into twelve chapters dealing with Importance and Advantages of Grinding; Cylindrical Grinding Machines; Plane Surface Grinding Machines; Bed and Table Construction; Driving Arrangements; Reversing Mechanism and Automatic Feed; Wheel-head; Work-heads and Tailstocks; Work-holding Devices; Profile and Form Grinding; Grinding Wheels; and Care and Operation of Grinding Machines. In order to make the reader more familiar with grinding machines, photographs of representative machines are shown and a number of line illustrations of various grinders are included, showing the construction of the principal mechanisms. The theory of grinding, on which there is much difference of opinion, has been purposely omitted. The book should be of interest both to designers and users of grinding machines.

Steam Power Plant Engineering. By George F. Gebhardt. 1057 pages, 6 by 9 inches; 640 illustrations. Published by John Wiley & Sons, Inc., 432 Fourth Ave., New York City. Price, $4.

This is the fifth edition of Gebhardt's well-known work on steam engineering The same treatment of the subject has been followed in this edition as in those previously published, but the book is practically a new one and has been greatly increased in volume. Particular emphasis has been placed upon the subject of fuels and combustion, and supplementary chapters on elementary thermodynamics, properties of steam, and properties of dry and saturated air have been added. The scope of the work having been greatly enlarged, the entire text has been rewritten and reset with the exception of a few minor sections The work is divided into twenty-five chapters headed as follows Elementary steam power plants; fuels and combustion; boilers; smoke prevention; superheaters; coal and ash handling; chimneys; mechanical draft; reciprocating steam engines; steam turbines; condensers; feed water purifiers and heaters; pumps; separators, traps, drains; pipe fittings; lubricants and lubrication; testing and measuring apparatus; cost of power; specifications; typical central stations; typical modern isolated stations; properties of steam; elementary thermodynamics; properties of air.

Eye Hazards in Industrial Occupations. By Gordon L. Berry, field secretary, National Committee for the Prevention of Blindness, with the cooperation of Lieutenant T. P. Bradshaw, formerly technical assistant to the director of the American Museum of Safety. 150 pages, 6 by 9 inches; 49 illustrations. Published by the National Committee for the Prevention of Blindness, 130 E. 22nd St., New York City. Price, 50 cents.

In this volume the author reviews the chief industrial hazards to eyesight in the industries of the United States. Case reports illustrate each section; the special dangers are described and recommendations made for such changes of working conditions or installations of protective devices as have been found effective for protecting workers. The following section headings indicate the scope of the book: Statistics of Eye Accidents; Chipping Operations; Machine Operations; Abrasive Wheels; Sand-blasting; "Mushroomed" Tools; Riveting; Radiations from Intense Light and Heat Sources; Ultra-violet Rays in Illuminants; Radiant Energy in Arc-welding and in Molten Metal; Metallurgic Operations; Glassblowers' Cataract; Infections; Gage Glasses; Acids and Chemicals; Treatment of Acid Burns; Industrial Poisons; Removal of Dangerous Fumes, Vapors and Gases; Spray Process Hazards; Methyl Alcohol; Bottling Accidents; Mining and Quarrying; Agricultural Hazards; Goggles; Garment Trade Hazards; Industrial Lighting; and the Safety Movement.

NEW CATALOGUES AND CIRCULARS

Link-Belt Co., Chicago, Ill. Catalogue 200, treating of the application of Link-Belt silent chain in rubber mill machinery.

Aluminum Castings Co., Cleveland, Ohio. Circular of Lynux bronzes. Also reprint of an advertisement of Lynux bronze gears that appeared in MACHINERY for January.

Gisholt Machine Co., 1201 E. Washington Ave., Madison, Wis. Circular of Gisholt universal tool grinder, containing illustrations showing step by step the operations in grinding tools.

Fafnir Bearing Co., New Britain, Conn. Catalogue treating of the application of Fafnir ball bearings in pleasure cars and pointing out the advantages of this type of bearing for this particular line of service.

Sherman Service, 10 State St., Boston, Mass. Booklet entitled "Industry, Society, and the Human Element," describing the various activities of the Sherman Service in cases of industrial disputes and strikes.

Fitchburg Grinding Machine Co., 76 Winter St., Fitchburg, Mass. Circular of Fitchburg 6- by 20-inch hand-operated plain grinding machine with a capacity for work up to three inches in diameter and twenty inches in length.

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L. S. Starrett Co., Athol, Mass. Catalogue entitled "The Tools Mechanics Buy," treating of methods of selling Starrett micrometers, verniers, caliper squares, height gages, dividers, surface gages, rules, tapes, screw-pitch gages, drill gages, wire gages, hacksaws etc.

Titanium Bronze Co., Inc., Niagara Falls, N. Y. Circular descriptive of T B C phosphor-bronze castings, pointing out the essentials of a high-grade phosphor-bronze. Specifications are given for a phosphor-bronze for gears and one for bearings that are used by this company.

Martin Machine Co., Greenfield, Mass. Circular of the Martin No. 12 marking machine designed for marking trade name, size or patent marks on all round or flat surfaces of tools or similar work. The machine is operated hydraulically, giving a smooth and even movement.

Lincoln Twist Drill Co., Taunton, Mass. Booklet describing the group insurance plan that the company put into effect beginning January 1. Copies of the booklet were distributed to the employes at Christmas to announce the insurance plan that will be put into effect without cost to them.

National Scale Co., 2 Mechanic St., Chicopee Falls, Mass. Catalogue of National counting and weighing machines, National-Chapman elevating trucks, National calling system and "multi-unit" sectional steel shelving. The catalogue is printed in two colors and illustrated with excellent halftone and line engravings.

Reynolds Machine Co., Massillon, Ohio. Catalogue E, illustrating Reynolds screw-driving machines for driving wood or machine screws by power. It is claimed that one of these machines replaces from three to six hand operators, driving from 8000 to 16,000 screws per day, according to the class of work and the dexterity of the operator.

L. S. Starrett Co., Athol, Mass., is distributing two pamphlets entitled "Building a Business" and "Essentials to Success." The former contains the autobiography of L. S. Starrett and a brief account of the invention and development of some of the Starrett tools. The other pamphlet also contains a collection of incidents from the life of L. S. Starrett.

L. F. Grammes & Sons, Allentown, Pa. Circular of safety devices including circular saw guards, hand jointer guards, shaper guards, grinding wheel hoods, eye protectors, press guards, gage glass protectors, safety oil-cans, protective gloves, shoes, etc., safety flanges for emery wheels, safety respirators, first-aid outfits and many other safety devices.

Oliver Machinery Co., 7 Coldbrook St., Grand Rapids, Mich. Circular illustrating Oliver universal saw bench, single-cylinder surfacer, universal vertical and horizontal boring machine, hand planer and jointer, disk sander, heavy-duty engine lathe, tool-room engine lathe, motor-head speed lathe, universal and wood milling machine and other woodworking and metal-working machines.

Precision Truing Device Co., 519 Main St., Cincinnati, Ohio. Booklet illustrating and describing a grinding wheel for truing grinding wheels. The device is a self-contained electrically driven machine that drives a small wheel of hard abrasive at a peripheral speed of about 8000 feet per minute. This high-speed wheel is moved back and forth across the face of the wheel to be trued the same as a diamond.

Bacharach Industrial Instrument Co., 422 First Ave., Pittsburg, Pa. Catalogue E, describing "Hydro" gas meters. A review is given of the various methods employed for measuring gases, such as impact and pitot tubes, orifices, nozzles, venturi tubes, etc. A detailed description of the "Hydro" instrument, which measures and records the differential pressure, is included. This instrument is made portable for the use of the testing engineer and the efficiency expert.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Catalogue 8-E, treating of Westinghouse industrial electric heating apparatus, including steel-clad heaters, immersion type water heaters, stoves of various forms, electric oven heaters for use in enameling, etc. Several pages are devoted to the subject of electrically heated ovens covering design and construction, a discussion of the various types and their uses, and the efficiency that can be secured in operation. Westinghouse electrical heaters of the ribbon type are described, as well as the Westinghouse system of thermostatic control.

Fafnir Bearing Co., New Britain, Conn. Catalogue 17, containing a discussion of the principles relating to the application of ball bearings to machinery. The book is divided into two sections, the first containing an analysis of the loads carried by ball bearings and dealing specifically with the design of the Fafnir radial type of ball bearing. This section is illustrated with blueprints and detailed line drawings. The second section illustrates machines equipped with Fafnir ball bearings, among which are drilling machines, chucking machines, screw machines, automatic lathes, turret lathes and grinding machines.

Carnegie Steel Co., Carnegie Bldg., Pittsburg, Pa., each year prints and distributes about twenty-three different publications. Most of these publications are written for technical readers and discuss in an educational way the products of the company that are adapted to the particular field in which the reader is most interested. None of these publications deals with all the products of the company, and to supply the need in non-technical language of a general description of the chief products, a pamphlet entitled "My Dear Jim" has been printed. This is in the form of a letter from a retired steel man to a friend, and it gives a comprehensive statement of the products of the company.

TRADE NOTES

Vixen Tool Co. has moved from Philadelphia, Pa., to 865 Mt. Prospect Ave., Newark, N. J.

W. B. Knight Machinery Co., St. Louis, Mo., has moved from 2019 Lucas Ave., to its new factory at 3920 W. Pine Blvd.

Ott Grinder Co., Indianapolis, Ind., had its plant destroyed by the fire which, on January 13, burned down the Industrial Building in Indianapolis.

Walworth Mfg. Co., Boston, Mass., has opened a branch office at Seattle, Wash., which will be in charge of Thomas Nickerson.

Wagner Electric Mfg. Co., St. Louis, Mo., has removed its Seattle office to 535 First Ave., S., where a service station will also be maintained. C. Kirk Hillman will continue in charge.

W. K. Millholland Machine Co., Indianapolis, Ind., had its plant destroyed by fire January 13, together with thirty other industries which suffered a total loss by the burning of the well-known Industrial Building.

Bowen Products Corporation is the successor of the Wickley Co., manufacturer of grease- and oil-cups. The company will be located in the same quarters at 866 W. Warren Ave., Detroit, Mich.

Pangborn Corporation, Hagerstown, Md., is making plans for the erection of a foundry 150 by 100 feet, an extension to its machine shop of 100 by 60 feet, and a wood shop 60 by 40 feet. The construction will be of steel and brick with metal sash.

Boston Scale & Machine Co., Boston, Mass., whose factory was destroyed by fire on December 23, asks the indulgence of its customers, as some delay must necessarily ensue in filling orders. All orders will be filled, however, with as little loss of time as possible.

Pangborn Corporation, Hagerstown, Md., manufacturer of sand-blast equipment, presented its employes last Christmas with life insurance policies ranging from $500 to $1000, according to length of service. The Pangborn Corporation bears all expense of maintaining the insurance.

Amalgamated Machinery Corporation, 72 W. Adams St., Chicago, Ill., at its annual meeting of the board of directors, elected the following officers for the ensuing year: President, T. K. Webster; vice-president, L. I. Yeomans; secretary, Walter A. Strong; treasurer, C. M. Moderwell.

New Standard Hardware Works, Mount Joy, Pa., manufacturers of hardware specialties, have made an addition to their plant and organization for the hot-tinning of gray iron, malleable iron, steel and brass stampings, and are now in a position to take care of increased quantities of hot-tinning work.

Driver-Harris Co., Harrison, N. J., announces that it is now prepared to supply 99 per cent cold-rolled pure nickel sheets to manufacturers who are interested in the use of this metal. Many former uses for this metal have been abandoned, due to the inability of manufacturers to secure the necessary raw material.

W. J. Baird Machinery Co., Detroit, Mich., dealer in new and second-hand machine tools and also supplies, has outgrown its old quarters at 54-56 E. Jefferson St. and removed to 265-209 E. Jefferson St. The company will occupy the entire building, which will provide excellent facilities for displaying its large line of tools.

Queen City Machine Tool Co., Cincinnati, Ohio, manufacturer of plain cylindrical grinding machines and back-geared crank shapers, has inaugurated a system of rewarding regular attendance in the shop by presenting thrift saving stamps to the men who meet certain requirements for a given period.

Gisholt Machine Co., 1201 E. Washington Ave., Madison, Wis., has made agency sales arrangements with the Charles A. Strelinger Co., 43 E. Larned St., Detroit, Mich., to look after the sale of Gisholt machines in the Detroit and Michigan districts. Charles Spalding who heretofore had charge of the sales in these districts has resigned.

Simonds Mfg. Co., Fitchburg, Mass., has appointed the T. P. Walls Tool & Supply Co., 75-77 Walker St., New York City, its sales agent for the territory of Connecticut, New York and New Jersey. A complete stock of Simonds hacksaw blades, hand-saws and cold-saws will be maintained in the T. P. Walls Tool & Supply Co.'s warehouse.

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio, is now occupying its new buildings and the plant is again in operation to its full capacity. New equipment especially adapted for the building of hydraulic presses, pumps and valves has been installed. The new buildings and equipment will double the capacity of the plant.

Vulcan Steel Products Co., 120 Broadway, New York City, dealer in steel, iron and machinery products, by its association with the Othophon Steamship Corporation is assured direct service to Brazil and the Argentine. Favorable connections with other railroad and shipping interests secure the most prompt deliveries to all other countries.

Amalgamated Machinery Corporation, 72 W. Adams St., Chicago, Ill., has secured a $750,000 order for gun boring machines and lathes, and a $500,000 order for shell boring machinery. With its present capacity of turning out ten machines a day, the plant is in a position to handle these large orders as well as additional ones and still assure a thirty-day delivery.

Victor R. Browning & Co., Mansfield, Ohio, have recently been awarded a contract for 200 five-inch gun mounts by the Navy Department, and are in the market for a large supply of small and large size machine tools, including lathes, vertical and horizontal milling machines, radial drilling machines, grinding machines and shapers. The company would also like to hear from manufacturers who are making parts, both raw and finished products, for gun mount construction.

American Pneumatic Chuck Co., 9 S. Clinton St., Chicago, Ill., has been incorporated in Illinois for the manufacture of air chucks and air-operated devices for mechanical purposes. John Olson, formerly with the Detroit Pneumatic Chuck Co., will be in charge of design and manufacture. The company will specialize for the present in standard and special air-operated equipment for the rapid production of shells and other munition parts. Later it is the intention to place on the market a complete line of air chucks. Neidow & Payson Co. of Chicago has been appointed selling agent.

Deane Machine Co., Fitchburg, Mass., maker of machine tools, jigs, fixtures, tools, etc., has recently been incorporated. The officers are John H. Graves, president and general manager; A. P. Cate, treasurer; and William P. Coyle, secretary. Mr. Graves and Mr. Coyle were formerly connected with the Putnam Machine Co., and have had wide experience in the machine tool trade. The company is at present engaged on two contracts for the government and is seeking a site for a larger plant, and is prepared to do general repair and contract work.

Driver-Harris Co., Harrison, N. J., announces that on January 1 a life insurance policy for $500 was distributed to all employes having been with the company at least six months. The extra wage distribution for this year was also increased by one per cent over what has heretofore been paid. This distribution is based on salaries earned and terms of service, and is made twice yearly. The percentage is graduated, beginning at 6 per cent to employes who have been with the company six months, and increasing by one-half per cent for each succeeding year of continuous service.

Louisville Industrial Foundation, 909 Columbia Bldg., Louisville, Ky., has made an announcement of interest to manufacturers of war materials, to the effect that the Louisville central station has at this time more than 10,000 kilowatts surplus electric power for industrial service, and is one of the few cities in the United States having electric power in excess of the present demand.

Little Giant Truck Co. is a new organization which has been formed to take over the motor truck interests of the Chicago Pneumatic Tool Co. From a small beginning the motor truck department of the Chicago Pneumatic Tool Co. had grown to such proportions that a separate ogranization to handle its many interests became absolutely necessary. The Little Giant Truck Co. is owned and controlled by the Chicago Pneumatic Tool Co., and the officers are the same, viz., W. O. Duntley, president; W. B. Seelig, secretary; L. Beardsley, treasurer; and T. J. Hudson, sales manager. The headquarters will remain in the Little Giant Bldg., 1615 Michigan Ave., Chicago, Ill.

Root & Van Dervoort Engineering Co., E. Moline, Ill., is a consolidation of the Moline Automobile Co., maker of Moline-Knight motor cars, and the Root & Van Dervoort Engineering Co., maker of R. & V. gasoline and kerosene engines. The officers and management remain the same, the only change being in the name of the company. In the past these two companies have been practically identical, being under the control of the same general officers, but were operated under the two firm names. The Root & Van Dervoort Engineering Co. was established in 1898 to manufacture gasoline and kerosene engines. In 1910 the company branched out into the manufacture of special munition lathes, and also filled a large contract on 8-inch high-explosive shells for the British government.

Oesterlein Machine Co., Cincinnati, Ohio, manufacturer of milling machines and cutter and tool grinders, has purchased the buildings of the Samuel C. Tatem Co. on Colerain Ave., Cincinnati, Ohio, consisting of a four-story and basement concrete building 60 by 260 feet, a one-story building 103 by 800 feet, and also a separate power house. The ground acquired covers 270 by 480 feet and has a spur from the main track of the Baltimore & Ohio Railroad. The building, which is only a few years old, is patterned after the Dayton Cash Register Co.'s buildings at Dayton, Ohio, and is light, airy, and sanitary; it is considered one of the most up-to-date manufacturing plants in Cincinnati. The floor space of the Oesterlein Machine Co. will be considerably greater in the new buildings than in the old location, providing an opportunity for expansion and increase in capacity.

U. S. Ball Bearing Mfg. Co., Palmer St. and Kolmar Ave., Chicago, Ill., manufacturer of ball bearings, at the last meeting of the board of directors elected the following officers: W. H. Strom, president and treasurer; E. N. Strom, vice-president; and O. A. Strom, secretary. The change in officers was brought about by the recent death of A. A. Strom, father of the three members of the present board, who, during his life, was president of the company, but who was associated with it in an advisory capacity only. No actual change in management has taken place, as the present president retains his position as general manager, which he has occupied for the past five years. Previous to Mr. Strom's death, it had been decided by the active members of the company that, in recognition of Mr. Strom's successful activities, the name of the product of the company should be changed from "U. S. ball bearings" to "Strom bearings," and one of the last official acts performed by the late Mr. Strom in his advisory capacity with the company was to sanction the change of name as planned. At the annual meeting, appropriations for a considerable increase in the capacity of the present plant were made.

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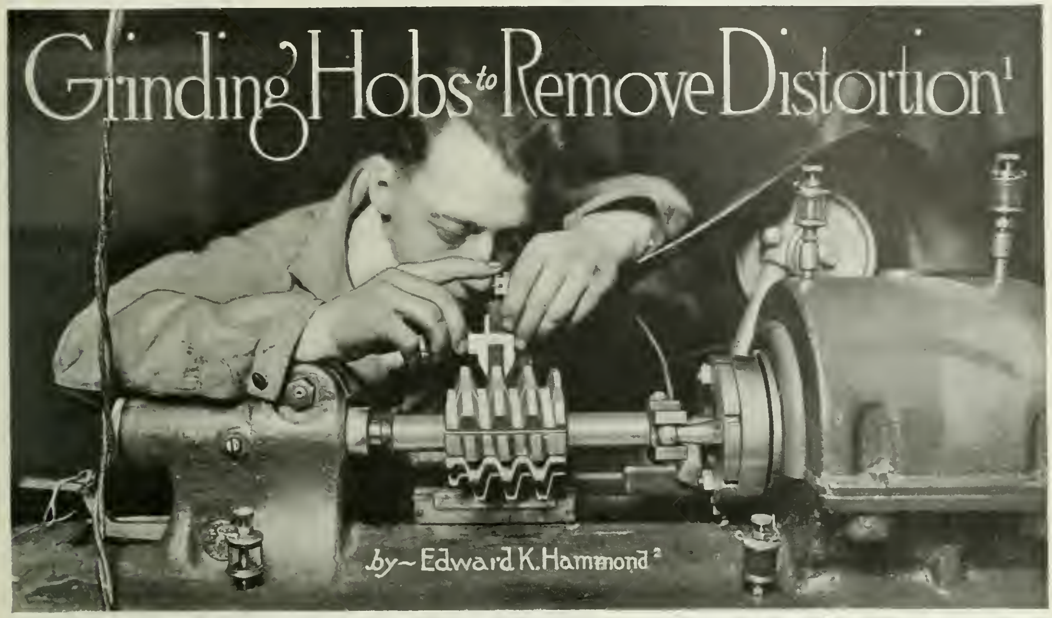

Grinding Hobs to Remove Distortion[1]

by—Edward K. Hammond[2]

In order to produce hobbed gears that will transmit power with a minimum amount of noise and that will not wear rapidly, the hobs with which the gear teeth are generated must be perfectly accurate. Regardless of the care taken in making hobs and the degree of accuracy attained before heat-treatment, a certain amount of distortion is sure to take place during the hardening process. This distortion of the hob introduces slight inaccuracies in the generated gear teeth, and trouble from this cause can only be overcome by grinding the hob after it has been heat-treated. This article describes the methods used by the Illinois Tool Works, Chicago, Ill., in grinding hobs.

WHEN gear-hobbing machines first began to be extensively used for cutting the teeth of spur, spiral, and worm-gears, there was a great deal of discussion among mechanical men as to the relative merits of this method of gear-cutting as compared with other methods which were known to give satisfactory results. That higher rates of production could be obtained by hobbing than by using certain other methods was generally conceded by all manufacturers who had had experience with the operation of gear-hobbing machines; but among builders of automobiles and other products in which gearing of an exceptionally high degree of accuracy was required in order to give noiseless transmission of power, the hobbing method was criticized on the ground that the quality of gears produced was not up to the required standard. Some manufacturers became so convinced of the seriousness of this lack of accuracy in hobbed gears that they changed over to other methods of gear-cutting, regardless of the fact that such methods gave lower rates of production and, hence, made the cost of gears considerably higher.

In the process of cutting gear teeth by the application of the molding-generating principle which is employed on gear-hobbing machines, it is a well-known fact that the hob teeth are of the same shape as rack teeth and that generation of the gear teeth is secured through rotating the gear blank and hob in contact with each other to produce a result that is the equivalent of rolling a gear in mesh with an ordinary straight rack. The basic principles of gear-hobbing have been fully discussed in previous numbers of MACHINERY, so that at this time it is sufficient to call the reader's attention to the fact that unless the hob used for generating gear teeth is accurate, it is impossible for such a tool to produce accurate work. It is absolutely necessary for all dimensions of the hob teeth to be held within close limits of tolerance, and, in addition, the lead of the spiral thread of the hob must be uniformly accurate, because any deviation of the thread from a true helix of the desired lead would result in introducing inaccuracies in the gear teeth. That this is the case will at once become apparent when consideration is given to the action of a hob and gear blank during the process of cutting teeth by the molding-generating process. Evidently, any lack of uniformity in the lead of the hob thread would result in causing successive teeth that are being cut in the gear blank to engage the hob at slightly different points, with the inevitable result that inaccuracies would be produced in the gear teeth.

Where experienced toolmakers exercise the necessary care in making hobs according to methods used by up-to-date toolmaking shops, the accuracy of the finished hobs will be all that is required to produce the necessary degree of accuracy in gearing for average classes of service, without spending additional time in grinding to remove distortion produced in hardening. But extremely slight errors in the form of the hob teeth and in the lead of the thread result in producing errors of corresponding size in the gear teeth; these may seem almost too small to be worthy of serious consideration, but for the gears of automobile transmissions, for the timing gears of automobile and airplane engines, and for certain other exacting classes of service, such errors are sufficient to produce gearing which will prove to be noisy and not durable. However, particular emphasis is laid upon the fact that this article in no way condemns the usefulness of unground hobs. Such hobs have their place and are capable of producing perfectly satisfactory gears for a great many classes of service. It is only in those exceptional cases where a very slight inaccuracy in hobbed gears would prove serious that the need arises for using a hob which has been ground to make it as nearly perfect as possible.

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[1] For additional information on hob grinding, see also "Results Obtained with Ground Hobs," published in MACHINERY for May, 1915

[2] Associate Editor of MACHINERY

Effect of Distortion Produced in Hardening

When these criticisms concerning the accuracy of hobbed gears came to the attention of the builders of gear-hobbing machines and manufacturers of hobs, these men immediately started to investigate the justice of the criticism, and when this had been done, the next move was to develop means of removing the cause of the trouble. In this article we are concerned with the steps taken to correct inaccuracy in the hobs, the article being based upon the practice of the Illinois Tool Works, 154 E. Erie St., Chicago, Ill., in grinding hobs to correct the inaccuracy due to distortion produced during the process of hardening. Investigations made by this firm's engineers showed that while the errors in unground hobs were very slight, they were of sufficient magnitude to give trouble in cases where production of gears of the greatest accuracy and quiet-running properties was required. Hobs made in this firm's shops were produced on the best types of machine tools, operated by specialists of experience and judgment, so that, as far as manufacturing methods were concerned, all requirements were being fulfilled. The most rigid inspection of the hobs after the machining operations had been completed showed them to be perfectly accurate, but after the hobs had been hardened, the same claim could not be made.

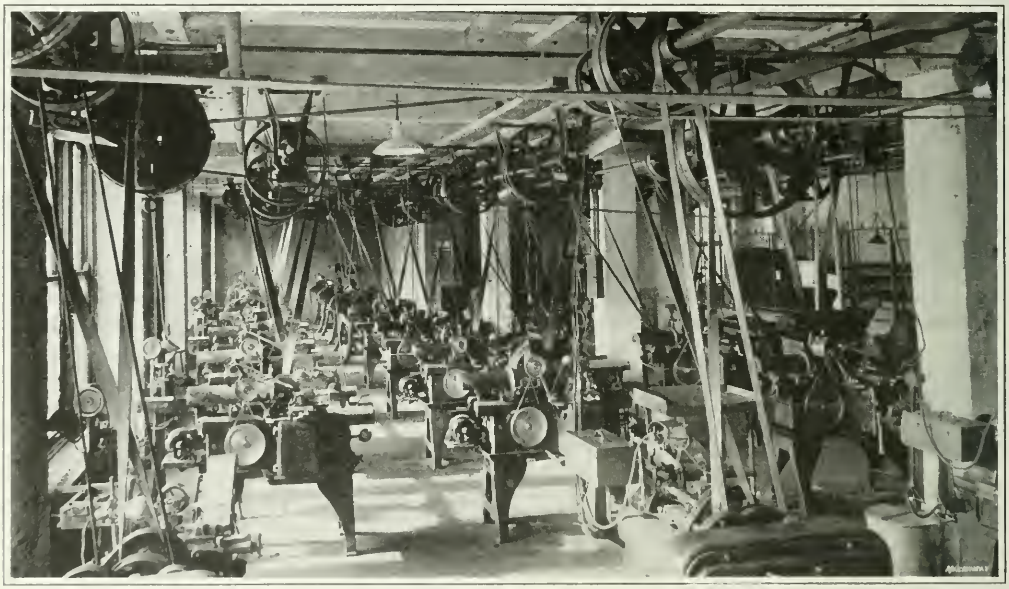

Fig. 1. View of Part of Hob-grinding Department of Illinois Tool Works

It is a well-known fact that there is a tendency for steel to become distorted during the process of heat-treatment, and regardless of the care which is taken, it is very difficult to overcome this trouble entirely. Where the proper precautions are taken in heat treating, however, there will be only a very slight distortion, so that the error produced in a hob will not be of importance in the hobbed gears except where gearing of an exceptionally high degree of accuracy is required. In the case of hobs, the trouble caused by this slight amount of distortion in hardening was found to manifest itself particularly in lack of accuracy of the lead of the hob thread, and with hobs distorted in this way, there was almost sure to be lack of accuracy in the gears, due to the reasons which have already been explained. As the greatest care was already being taken in each step of the process of manufacturing hobs in the shops of the Illinois Tool Works, and as the most rigid inspection showed the hobs to be up to every reasonable requirement before heat-treatment, it at once became obvious that the only way to overcome the difficulty was to devise some method of grinding the hobs after they had been hardened in order to remove the distortion produced while heat-treating. For over five years, engineers employed by the Illinois Tool Works have been working upon the development of this grinding process, and for the last four years hobs have been ground on a commercial basis. Patents have been granted on machines developed for grinding hobs and for performing certain other operations connected with the hob-grinding industry. The hob-grinding department of the factory, a partial view of which is shown in Fig. 1, has now been fully organized. It is the purpose of this article to illustrate and describe the hob-grinding machines and explain the method of doing this work.

Methods and Machines Used for Hob-grinding

Briefly stated, the method of grinding hobs used in this company's shops consists of grinding the space between the hob threads with a "grinding point," the shape of which conforms to the space between adjacent threads. A little thought will make it evident that this is about the only way in which grinding of the hob could be accomplished, but in order to work satisfactorily, there are many interesting details of the process which have been cleverly thought out and applied; obviously, it is necessary for the spindle which drives the grinding point to be carried on a reciprocating slide, similar to the relieving attachment of a lathe, so that the grinding point will be enabled to follow the thread of the hob continuously.

Design of Hob-grinding Machine

The machine on which the hobs are ground is a special form of lathe furnished with a main carriage running on ways which extend the whole length of the lathe bed, although the carriage actually extends over each end of the lathe bed. The hob to be ground is carried by a mandrel supported on centers and driven by a dog making connection with the live center. As the hob rotates, it is also traversed past the grinding point through the action of a lead-screw which imparts the necessary feed movement to the main carriage. The grinding point is driven by a head supported on a slide which has a reciprocating movement at right angles to the line of travel of the main carriage, in order that the grinding point may follow the relief provided on the hob teeth.

Having briefly explained the features of this machine, we are ready to take up a discussion of the way in which the machine is constructed to secure these results, and there is probably no better way than to start at the driving pulley and explain the method by which motion is transmitted to the different machine members. In Figs. 2 and 3, are shewn two views of a hob-grinding machine in operation, and Fig. 4 shows plan, front, and end views of the machine. It will be seen that the main driving pulley *A* is carried on a shaft *B* journaled in the frame of the machine. This shaft carries a worm which transmits power to worm-wheel *C*; the hub of worm-wheel *C* extends out at each side for a sufficient distance so that it may be carried by bearings in brackets on the machine frame.

In this way, provision is made for rotating worm-wheel *C*, although it is maintained in a fixed position as regards longitudinal movement. Shaft *D*, that is driven by this worm-wheel, is connected to the wheel by a spline, so that it may be traversed longitudinally in addition to being rotated. At the left-hand end, shaft *D* is carried by bearings *E* in a bracket projecting down from the under side of main carriage *F*, so that the longitudinal movement of shaft *D* must correspond with any longitudinal traverse movement of carriage *F*. Through pinion *G*, power is transmitted to gear *H*, secured to the head spindle *I* that rotates the work; and secured to the rear end of spindle *I* there is a lead-screw *J* that runs in a nut *K* carried in a bracket on the main frame of the machine. As a result, rotation of spindle *I* causes lead-screw *J* to rotate in nut *K* and the main carriage *F* to be traversed along the bed of the machine.

It now remains to describe how the reciprocating transverse motion is imparted to the cross-slide which carries the grinding point. At the end of main driving shaft *B*, there is a pinion *L* from which power is transmitted through spur gears *M*, *N*, and *O* and bevel gears *P* and *Q* to an eccentric *R*; the latter fits into a slot in the under side of cross-slide *S* which supports the grinding point *T*, with the result that rotation of eccentric *R* results in imparting a reciprocating transverse motion to slide *S*. By providing the proper arrangement of gearing, rotation of the hob, traversing of the hob past the grinding point, and transverse reciprocation of the grinding point are so timed in relation to each other that the grinding point follows the hob thread and provides for grinding it to remove distortion.

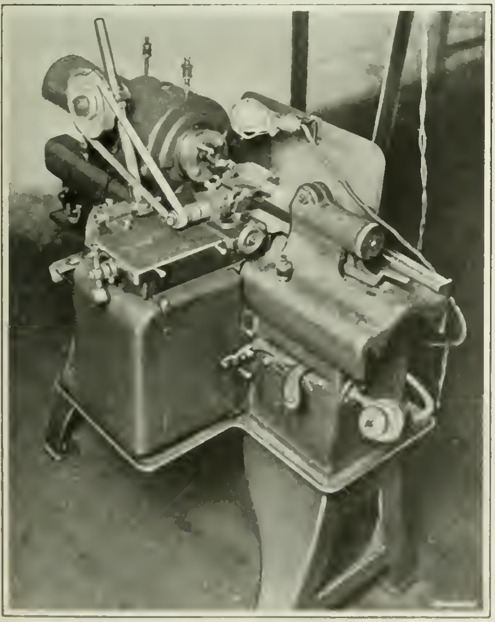

Fig. 2. Special Grinding Machine designed and built by the Illinois Tool Works for grinding Hobs to remove Distortion produced in hardening

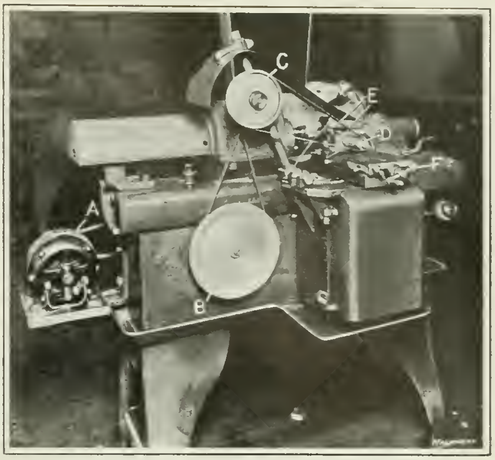

Fig. 3. View of Hob-grinding Machine showing Method of driving Grinding Spindle and setting "Grinding Point" for Different Sized Hobs

It will be seen in the view of the machine shown in operation in Fig. 3 that there is an additional electric motor *A* bolted to a bracket at the end of the machine. The motor is belted to a pulley carried at the rear side of the machine on a transverse shaft which extends through the bed and carries pulley *B* at the front of the machine. From this pulley a belt transmits power to a shaft that carries pulley *C* from which a flat woven fabric belt drives the pulley at the rear end of spindle *D*, the grinding point being carried at the front end of this spindle. Reference to the illustration will make it apparent that the speed ratio from *B* to *C* and from *C* to *D* is increased in both cases, in order to give the required cutting speed of approximately 5000 feet per minute for the grinding point, which is of small diameter. It is necessary to true up the grinding points used on these hob-grinding machines at frequent intervals; this work can sometimes be done with the point in place on the hob-grinding machine, while, at other times, it is necessary to remove the grinding point for truing. A detailed description of this work and an explanation of the reasons for removing the work in some cases and truing it while in position in other cases, will be presented in subsequent sections of this article.

To facilitate the work of removing the grinding point for truing, a special spindle was designed which is shown in detail in Fig. 5. Here it will be seen that the spindle *A* is furnished with a draw-rod operated by thumb-nut *B* to provide for pulling arbor *C*, which carries the grinding point, back into the tapered socket of the spindle. It will also be apparent that thumb-nut *B* secures driving pulley *D* onto the tapered rear end of the spindle. Spindle *A* runs in bronze bushings *E* which are furnished with means of compensation for wear; and these bushings are secured in each end of a main sleeve *F* by a pair of lock-nuts *G*. In this way, bronze bearings *E*, sleeve *F*, and lock-nuts *G* constitute the equivalent of a single bushing in which spindle *A* is free to rotate, making it possible for the spindle and its bearing to be removed from the machine as a unit.

Referring to Fig. 3, it will be seen that on the cross-slide that carries the grinding spindle, there are two wing-nuts *E* that provide for tightening a cap over the bracket in which the grinding spindle is mounted. In setting up the grinding point in the carriage, sleeve *F*, Fig. 5, is placed in the socket in this bracket, and the cap is placed on top of sleeve *F* and then tightened by means of wing-nuts to secure the spindle firmly in place in the carriage. After this has been done, ball-crank *F*, Fig. 3, provides means of adjusting the position of the grinding point relative to the hob which is to be ground. When it is necessary to true the grinding point, the spindle is removed by loosening wing-nuts *E*, and then the entire spindle unit can be taken out and set up in the grinding point truing machine.

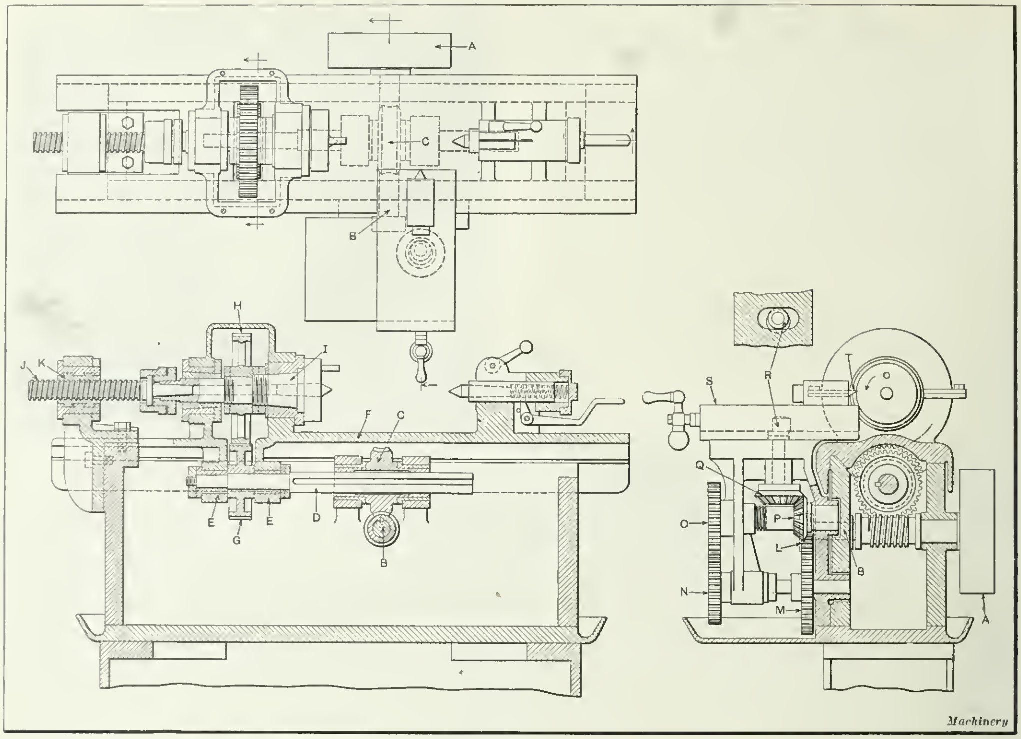

Fig. 4. Plan, Front, and End Views of Hob-grinding Machine, showing Arrangement of Driving and Feed Mechanism

Truing Grinding Points

In grinding hobs, two types of grinding points are used, one of these being shaped like the frustum of a cone, while the other is of similar shape, except that it is formed on the side instead of being straight. Devising methods for truing up the grinding points to bring them accurately to these forms was one of the most difficult problems that had to be solved. Finally two systems were devised, both of which give satisfactory results for truing the two types of grinding points. For points the shape of which is the frustum of a cone, the truing device is mounted directly on the hob-grinding machine, so that the grinding point may be trued up without removing it from the machine; but in the case of grinding points, the sides of which are formed, it is necessary to remove the point to a special truing machine.

Figs. 6 and 7 show a machine using a grinding point formed to the true frustum of a cone, and the means provided for truing the grinding point. Referring to the first of these illustrations, it will be seen that attached to the hob-grinding machine, there is a plate *A*, the top surface of which is accurately finished and inclined to the horizontal at an angle corresponding to the angle that the sides of grinding point *B* make with the horizontal axis. Sliding over the top of plate *A*, there is a plate *C* on which is carried a rod *D* at the lower end of which there is a diamond for truing up the grinding point. An adjusting screw *E* furnished with two lock nuts provides for regulating the vertical position of rod *D* and locking this rod in the desired position, so that the diamond is located properly for truing up the grinding point. In this connection, attention is called to the fact that there is a groove extending into plate *A* from the front edge (this groove is covered by plate *C*) to provide clearance for rod *D*, so that, when plate *C* is slid back and forth over plate *A*, rod *D* can have the necessary movement to enable the diamond to true up the grinding point. The advantage of this method is that when the grinding point requires truing, the operator can do the work very quickly without the necessity of either stopping the machine or removing the grinding point. The method of truing will be best understood by referring to Fig. 7 after reading the preceding description.

In Fig. 8 is shown the type of machine used for truing up grinding points for hobs where the teeth are of such form that it is necessary to true the grinding point to some shape other than the true frustum of a cone; and Fig. 12 shows part of the mechanism of this machine. In connection with the description of the hob-grinding machine, an explanation was presented of the way in which the spindle for carrying the grinding point is constructed. This spindle design was worked out with the view of facilitating truing of the grinding point. These grinding machine spindles are constructed with a bushing, shown at *A* in Fig. 12, which enables the spindle to be set up interchangeably in either the hob-grinding machine or the grinding point truing machine, by simply tightening hand-screw *B* that secures a bearing cap down onto this bushing which supports the grinding spindle. It will be apparent from the illustrations that this machine is designed on the pantograph principle, a master form or templet *C* being made of the shape required for the grinding point and a reduction made from this form to

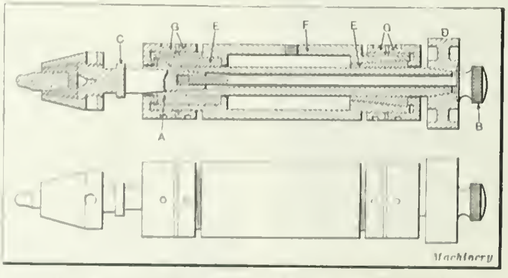

Fig. 5. Design of Grinding Spindle which is Interchangeable between Grinding Machine and Truing Machine

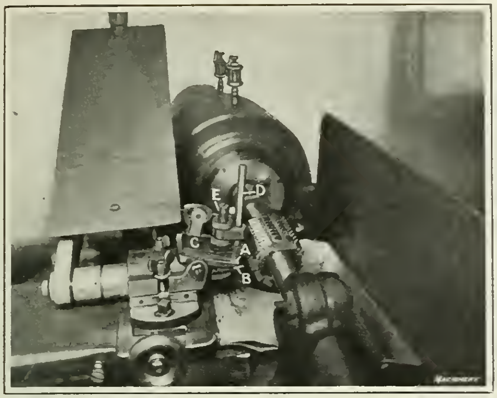

Fig. 6. Provision made for truing Grinding Point without removing it from Hob-grinding Machine

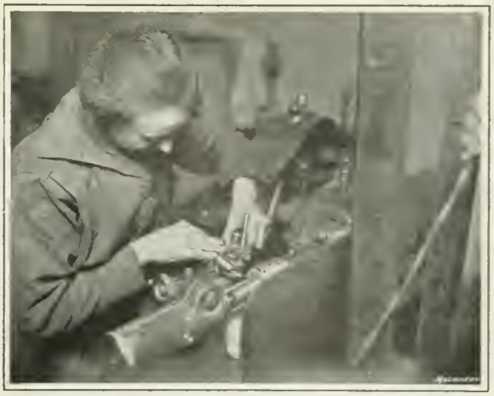

Fig. 7. Grinding Point Truing Device of Type shown in Fig. 6, in Operation

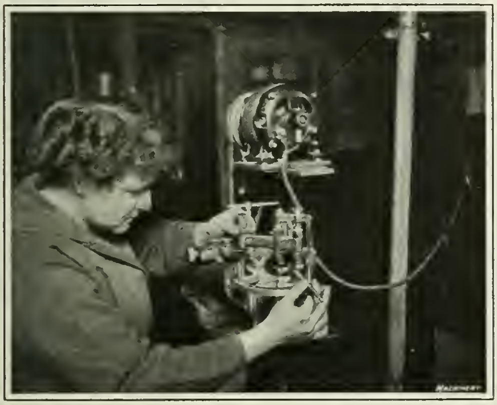

Fig. 8. Special Truing Machine for Grinding Points formed to Some Other Shape than Frustum of Cone

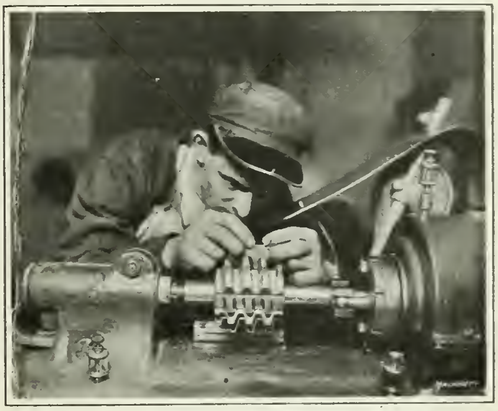

Fig. 9. Method of gaging Hob during Grinding Operation to test Accuracy of Angle of Side of Thread

the grinding point *D* by means of a 3 to 1 pantograph link mechanism. It will, of course, be evident that at one extremity of the pantograph there is a guide pin that runs in contact with master form *C*, while at the other end there is a diamond which trues grinding point *D* up to a shape exactly the same as form *C*, but of one-third the size. Through the use of a 3 to 1 pantograph link mechanism, it is possible to make the master form *C* to a larger scale, which facilitates the work of toolmaking.

As the guide pin runs over form *C* there is, of course, a definite relation between the angle of the pantograph bar carrying the diamond point and the outline to which it is required to true up the grinding point. It is particularly important to maintain the angle between the diamond bar and the grinding point constant during the entire truing operation, because, if the manner in which the diamond is presented to the grinding point varies, a difference in the shape of the diamond, which is always irregular, is almost certain to result in inaccuracy of the form of the grinding point. Provision for maintaining the required relation is furnished by means of the guide-bar *E* which is attached to the yoke that carries the diamond. While truing the side of the grinding point, bar *E*

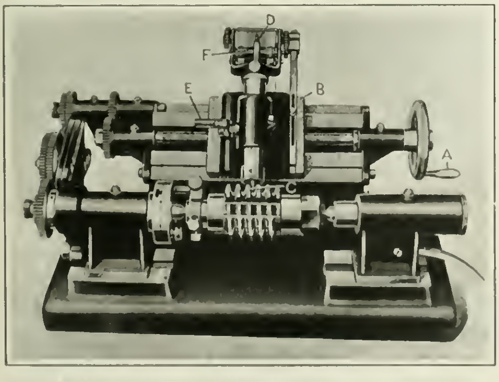

Fig. 10. Front View of Gaging Machine for measuring and recording Magnitude of Error in Lead of Hob Thread after grinding

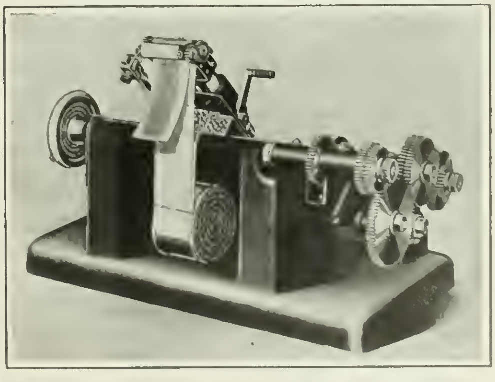

Fig. 11. Opposite Side of Gaging Machine shown in Fig. 10, illustrating Arrangement of Reel for feeding Record Paper past Pen

is made to slide in contact with pin *F* as the pantograph links go through their movement in reciprocating the diamond and guide pin back and forth over the diamond point and master form, respectively. Then, when the side of the point has been trued up and it is desired to true the end, which is accomplished by moving the guide pin over the square end of form *C*, rod *E* is brought down so that it slides in contact with pin *G*, thus maintaining a uniform relation between the diamond and grinding point while the end of the point is being trued up. After this operation has been completed, hand-screw *B* is loosened so that the entire grinding spindle may be taken out of the truing machine and transferred to the hob-grinding machine where the spindle is secured in place in a similar bearing holder.

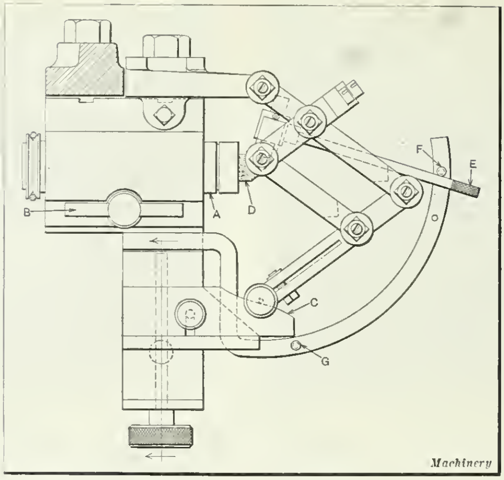

Fig. 12. Arrangement of Master Form, Pantograph, and Diamond on Grinding Point Truing Machine of Type shown in Fig. 8

Determining when Grinding Operation is Completed

In grinding a hob, the machine is so designed that the grinding point is traversed around the hob until it has traveled from one end to the other, after which it is backed away and the carriage traversed back to the starting point, where the grinding point is once more brought into contact with the hob ready for the next traverse. This operation is analogous to the familiar operation of thread chasing, but in grinding a hob to eliminate distortion produced in hardening, the depth of the cut is extremely light and the greatest care must be taken not to grind away a sufficient amount of metal to make the thickness of the hob thread less than the required dimension. During the early stage of the grinding operation, the machine operator is guided by the removal of the steel surface which was discolored while hardening, but when this means of guidance is gone, he must depend upon the use of gages to determine what results are being produced.

In the first place, it is necessary to watch the angle of the side of the thread carefully to see that this is maintained standard, because wearing of the grinding point may easily result in producing an inaccurate thread angle, which would make the hob worthless. For this purpose, the operators of the hob-grinding machines make use of gages of the form shown in Fig. 9. These are simply flat steel gages very accurately formed, which are used by placing a piece of plate glass in successive hob gashes, so that the glass rests against the cutting edges of the teeth, and then bringing the gage up against this glass in the manner shown in the illustration. If there is any inaccuracy in the thread angle, this will be made apparent by the appearance of light between the gage and the side of the thread. Repeated use is made of this gage during the process of grinding, and when any discrepancy is discovered in the thread angle, it must be removed by truing up the grinding point according to the methods which have already been described.

The two ultimate tests to show when the grinding operation has been completed are measurement of the tooth thickness at the pitch line with a gear tooth caliper, as shown in the title illustration of this article, and proof that the hob has been ground, so that the lead of the thread is both accurate and perfectly uniform. Uniformity of the lead is determined by carefully listening to the "hum" of the grinding point as this point is traversed from one end of the hob to the other. Experienced operators of hob-grinding machines become proficient in judging the uniformity of lead by this method, and if, in their judgment, the sound made by the grinding point in traversing over the full length of the hob is quite uniform, it will generally be found that the desired degree of uniformity has been obtained when the hob is sent to the inspection department and subjected to a rigid test under a precision gaging machine.

Gaging Machine with Recording Attachment for Testing and Tabulating Magnitude of Error in Lead of Hob Thread

In Figs. 10 and 11, are shown front and rear views of a special machine built for use in testing and automatically recording the magnitude of errors in the lead of the hob threads for each successive tooth of the hob. It will be seen that this machine is provided with centers supporting an arbor that carries the hob to be tested, and that a dog connects the arbor to the live center. By turning handwheel *A*, the lead-screw traverses carriage *B* along the ways of the machine so that gaging point *C* and the recording mechanism *D* are traversed from one end of the hob to the other. At the left-hand end of the lead-screw which traverses carriage *B*, it will be seen that connection is made through gearing with the live center, which provides for rotating the hob as gaging point *C* is traversed along the hob. In operating this machine, handwheel *A* is turned until gaging point *C* comes opposite the space between two adjacent teeth on the hob, the gaging point being normally located at a point above the tops of the hob teeth.

Rotation of handwheel *A* is then stopped and lever *E* is pulled forward, which results in forcing the gaging point *C* down into the space between the hob teeth. The gaging point is pivoted in such a way that it actuates a set of multiplying levers which manipulate arm *D* that carries the recording pen. The arrangement of this recording mechanism will perhaps be better understood after referring to the rear view of the machine, where it will be seen that a reel is provided that feeds a strip of paper through rollers which move the paper through the machine continuously as the gaging operation progresses from tooth to tooth of the hob. An interesting feature of this machine is that a grooved roller *F*, which is kept continuously inked, provides for ruling the graduation lines on the paper as it is fed through the machine. It will be seen that there are fifteen lines which are so spaced that the record paper is divided into seven spaces on each side of the center line, indicating errors in the hob thread from 0 to 0.007 inch, respectively. Fig. 13 shows one of the records made on the machine, and indicates clearly how close the ground hobs come to being perfectly accurate. While the record paper is ruled to provide for an error of 0.007 inch, such

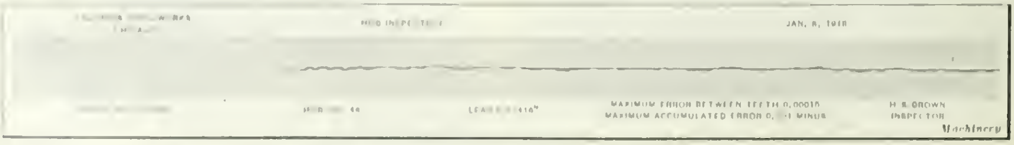

Fig. 13. Record of Magnitude of Error in Lead of Hob Thread tested on Gaging Machine shown in Figs. 10 and 11

an error is never found in the ground hob. An important feature of this machine is that by having the gaging point *C*, Fig. 10, enter the space between two adjacent teeth, that is to say, come in contact with opposite sides of the thread, which are separated from each other by one revolution of the thread around the body of the hob, the machine provides for gaging both sides of the thread simultaneously to make sure that the lead of both sides is uniform within the required limits.

* * *

SNAGGING MALLEABLE IRON CASTINGS[1]

Malleable iron castings are important factors in the production of agricultural implements, automobile and railway equipment, and various other classes of work subjected to corrosion and shock. The grinding of these castings has become a subject of much importance to the foundry superintendent and the grinding wheel manufacturer. In selecting the grinding wheel best adapted for any particular class of work, the physical properties, size, and shape of castings must be taken into consideration.

A malleable casting is made of a special grade of cast iron, chilled in a sand mold and then annealed. Before annealing, the castings are very hard and brittle, showing a white fracture when broken, the carbon contained then being in the combined form. The castings are annealed by being packed with rusted rolling mill scale in cast-iron annealing pots and heated to a redness for a period of about sixty hours. The oxide of iron yields a portion of its oxygen to the metal which is decarbonized, giving off carbonic oxide. In this process most of the combined carbon is removed, leaving the remainder in the form of graphitic carbon surrounding the molecules of iron. This carbon gives the fracture a black appearance, termed "black-heart," which is the appearance of 95 per cent of our American product. The European methods produce a white-heart casting, due to a longer heat-treatment in which nearly all of the carbon is removed by oxidation.

Physical Characteristics

The American malleable iron castings have an elongation of approximately 11 per cent in two inches, and a tensile strength of from 40,000 to 50,000 pounds per square inch. As a result of extensive tests carried out in 1914, 72 per cent of the malleable iron castings tested showed a tensile strength of over 44,000 pounds per square inch; in 1915, 86 per cent; and in 1916, nearly 90 per cent of the castings tested showed a tensile strength of over 44,000 pounds per square inch. From these tests it will be seen that the physical properties of malleable iron castings are changing and that they vary at different foundries. The surface, at least, of malleable cast iron is essentially a low-carbon steel and possesses similar physical properties.

Wheels and Abrasives for Grinding

Alundum or some aluminous abrasive should be used on annealed malleable iron castings. Small castings are often ground on bench stands mounting 10- or 12-inch diameter wheels, 1 to 2 inches thick, with 1¼-inch holes. For grinding heavy castings, 18- or 24-inch wheels are sometimes mounted on swing-frame grinding machines, but the following sizes, mounted on floor stands, are most commonly used:

Diameter, Inches	Thickness, Inches	Diameter of Arbor Hole, Inches
14	1½–2	1½
16	1½–2–2½	1½
18	2 2½–3	1¾
20	2 2½–3	2
24	2 2½–3	2

Assuming the physical properties to be uniform, the size of grain to be used would depend chiefly on the size of the fins and gates, the rate of cutting, and the finish desired. While the grade depends on the area of contact between the wheel and the work, the surface speed of the wheel depends on the size of the castings and the method of applying the work to the wheel. The following three types of wheels are most generally used on annealed castings:

24-Q alundum vitrified, for castings up to five pounds.

20-R alundum vitrified, for miscellaneous castings from five pounds to twenty-five pounds.

20-S alundum vitrified, for large castings and castings having sharp fins and narrow edges.

For grinding unannealed castings, a carbide of silicon abrasive is best adapted, such as crystolon. The grains employed range from 16 to 24 and the grades from R to U crystolon vitrified. For the majority of work, 20-S crystolon vitrified will be found efficient. The surface speed of wheels should range from 5000 to 6000 feet per minute. Any speed below 5000 feet per minute results in a rapid wear on the wheel and a lower rate of production.

In order to know exactly what each grinding wheel is doing, the following records should be kept: the length of time that the wheel is in continuous service and the tonnage of castings ground, and the abrasive consumed or lost by the wheel. From these records, and knowing the cost of abrasive per cubic inch, monthly reports should be made showing: (1) pounds ground per hour, indicating rate of cutting; (2) abrasive cost per ton of castings ground; (3) abrasive cost per cubic inch for ton of castings ground. The use of wheels showing the lowest abrasive costs may not show a low labor cost or maximum daily production. With these records at hand, it should be an easy matter to bring the rate of production and abrasive costs to values showing the highest efficiency consistent with the labor costs.

Testing a New Wheel

When a new wheel is to be tested, the following method will be found simple and easily carried out. Mount a regular stock wheel on one end of the spindle of a double floor stand, and on the other end mount the new wheel to be tested. Have the two grinders take their castings from the same pile, and have them change daily from one wheel to the other. By keeping accurate records of the wheel life and production, the comparative efficiency of the new wheel is found as accurately as can be determined.

List of Wheels Adapted for Grinding Annealed Castings

1. Use alundum wheels.
2. Most commonly used wheels: 24-Q; 20-R; 20-S. Railroad journal boxes, 10-W. Automobile castings, 20-S. Miscellaneous barn hardware, 16-Q. Heavy railroad castings, 16-S. Journal boxes, 80 to 140 pounds, 10-T. Miscellaneous castings large and small, 16-R.

List of Wheels Adapted for Grinding White Iron (Unannealed) Castings

1. Use crystolon wheels.
2. Most commonly used wheels: 16-R; 20-S; 16-S. Agricultural links, 16-S and T. Pipe fittings, 20-S. Automobile parts, 20-S. Parts of metal beds, 24-V. General smoothing, 16-R. Small automobile castings, 16-R.

* * *

Some of the experiences of manufacturers of machinery with users of their product are almost incredible. They indicate in many cases profound ignorance of mechanical principles and tool action. A maker of drilling machines received a complaint that a machine purchased several months before was not giving satisfaction. The superintendent took the train and went to the plant. On presenting his card and explaining his mission he was taken into the shop to the job. The foreman explained that the feed gears broke repeatedly and that the production of drilled holes was very slow. The superintendent started the machine and began to drill a hole. He quickly discovered that the drill entered the piece very slowly, and disengaged the feed. The center of the hole was brightly burnished. Removing the drill, he saw that it had been ground with no clearance, and the bearing was some distance back of the cutting edges. The situation was critical; he courteously asked permission to touch up the drill on a nearby emery wheel, and in a few moments had the drill cutting metal at a lively rate. Neither the foreman nor the superintendent of the plant seemed to realize the importance of correct drill grinding, although the concern was a large manufacturer.

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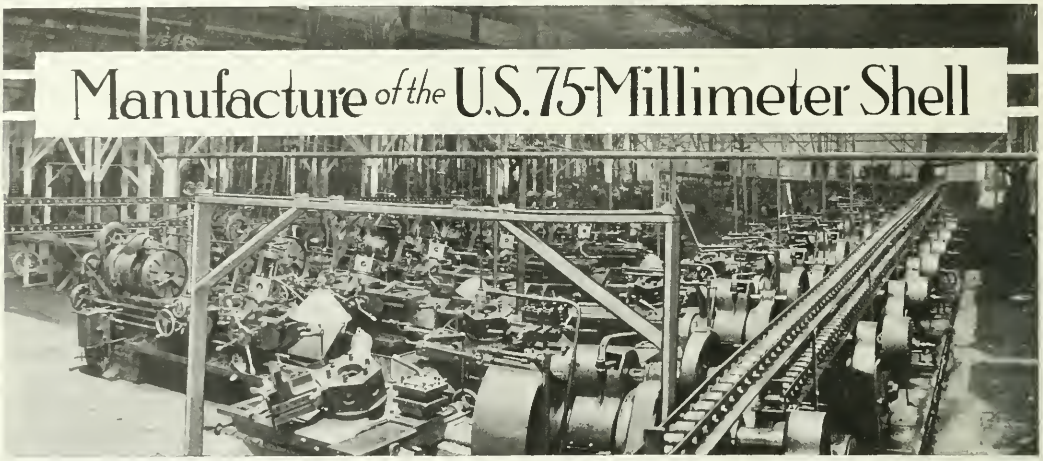
[1] Abstract of an article by W. T. Montague in "Grits and Grinds"

Manufacture of the U.S. 75-Millimeter Shell



First of a Series of Articles Describing Approved Methods Employed by the American Shell Co. in the Making of U. S. Ammunition — By Erik Oberg[1]

WHILE millions of shells have been made in the United States during the past three years, and a great many articles have appeared relating to the methods used by various manufacturers, nothing has been published since the entrance of the United States into the war on the making of the shell that will probably be most generally used by the United States Army. One of the most highly standardized plants for the manufacture of these shells is that of the American Shell Co., Paterson, N. J., which, under the managership of Carl G. de Laval and under the direct supervision of A. H. Williams, general superintendent of the company, who is responsible for the mechanical developments, has been completely equipped for the making of the United States 75-millimeter high-explosive shells. The reason why the United States is using the 75-millimeter shell is because the guns used for this shell are an adaptation of the French 75-millimeter type. This plant will be likely to be used as a model for some fifty other plants which are preparing to make the same shell, and, hence, a description of this plant, its methods, and the problems that have been solved in its equipment, will prove of great value in the manufacture of these shells all over the United States. While in the past this factory has been making Russian 3-inch shells, it has been entirely rearranged for making the United States ammunition; different methods have been adopted for many operations and improved facilities have been installed for handling and routing work.

The plant of the American Shell Co. has been laid out with a view to finishing 10,000 shells per day. It has been termed an "automatic" plant on account of one of the prominent features involved in its lay-out—that of having all the machines for the different operations so arranged that the shells pass continuously through the shop, an efficient conveyor system having been developed for this purpose, so that there is no trucking of material of any kind throughout the whole plant. The rough forgings, which are supplied by an outside concern, enter on a conveyor at one end of the shop, and the finished shells, properly inspected, varnished, and ready for loading, pass out of the shop on another conveyor at the other end, to be packed and shipped. The conveyor system is developed to such an extent that the shells are fed and timed automatically through the heat-treating furnaces, and pass on conveyors through the quenching oil tanks. The shells also pass by the same conveying system to and from every inspection and testing table. A general view of one department in the plant, typical of the appearance throughout the shop, is shown in Fig. 1.

General Lay-out of Plant

Fig. 2 shows the general lay-out of the plant. As the forgings are not of exactly the right length when received from the forge plant, they are cut to size in a shop provided with hacksaw machines, which is located outside of the plant proper. From the saw shop, the shells enter the main plant on an elevating conveyor at *A* and are discharged onto a gravity conveyor, arriving at three centering machines located at *B*. From the centering machines, they pass to a battery of rough-turning machines at *C*, ten of which are located on each side of the conveyor. From the rough-turning machines, the shells pass to the

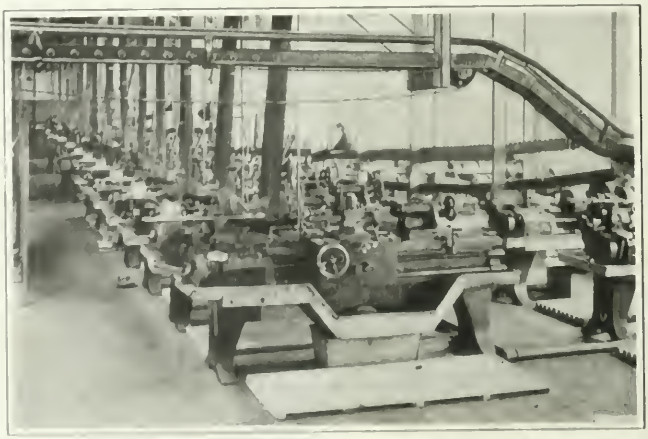


Fig. 1. General View of a Department in the American Shell Co.'s Plant

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[1] Editor of Machinery

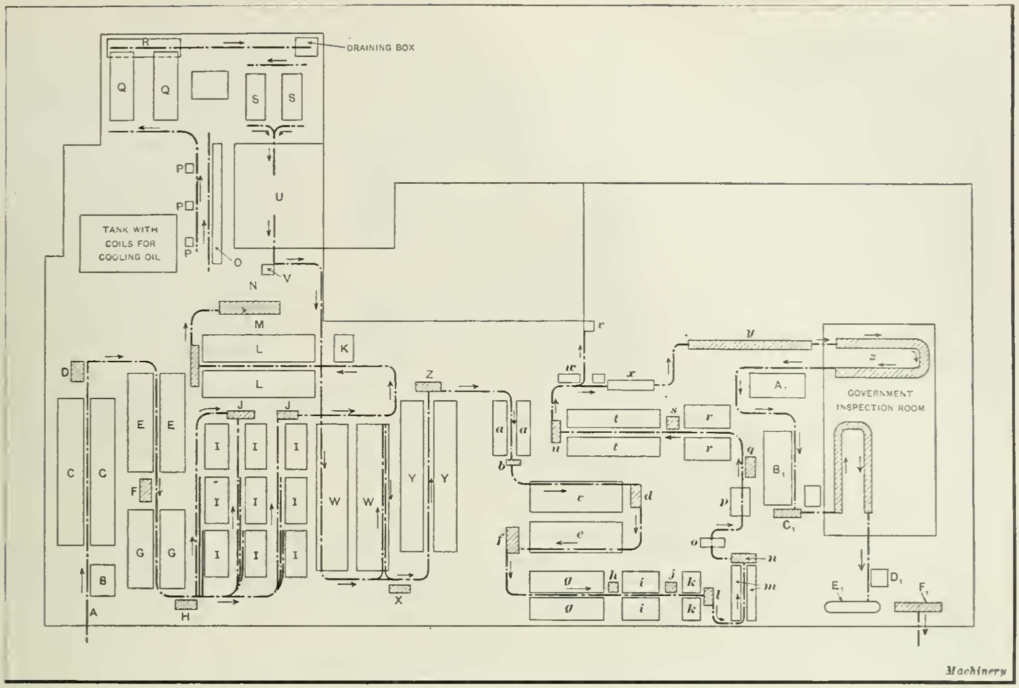

Fig. 2. Plan of Plant showing how Shells pass continuously through Works

inspection table at *D*, and from here to two batteries of eight machines on each side of the conveyor at *E*, for rough-facing the base. They are again inspected at *F*, and then pass to two batteries of six machines each at *G*, for rough-facing the open end. After again having been inspected at *H*, they pass onto three sets of conveyors to the machines at *I*, where the inside is reamed and the inside of the bottom finished. For these operations, sets of three machines are provided, one for rough-reaming, one for finish-reaming, and one for finishing the bottom, there being nine sets of these machines in all—three sets along each conveyor.

After having passed the inspection tables at *J*, the work passes to the two centering machines at *K* for a second centering, and to the two batteries of eight machines each at *L* for the second rough-turning. Another inspection table is located at the end of this battery of machines, from which the shells pass to the first government inspection at *M*. In the space at *N*, the shells are then stored in piles, according to the heat number of the forgings which is stamped on them; these heat numbers remain on the shells during the entire passage through the shop. It is necessary to keep the shells in separate piles, according to the lot in which they belong at the time of forging, in order that they may be given the proper heat-treatment in the shop. From the storage place, they are put onto a conveyor passing in front of five heat furnaces at *O*, from which they are transferred across the passageway to the three nosing presses *P*, a conveyor in front of which carries them to the furnaces *Q* in which they are heated for hardening. The shells are carried on automatic timing conveyors through the hardening furnaces and are discharged on an automatic conveyor in the oil tank at *R*, by which they are moved up an incline for draining and deposited in a draining box; from here they are carried by a conveyor in front of the tempering furnaces, through which they pass automatically, and are discharged onto automatic conveyors at the back of the furnaces at *S*. These conveyors carry them into the cooling shed *U*, where they are stored until cold. They then pass by a conveyor back into the shop proper to a Brinell testing

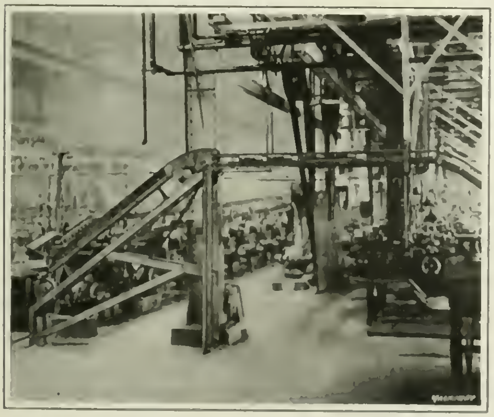

Fig. 3. Elevating Power Conveyor carrying Shells over Passageways

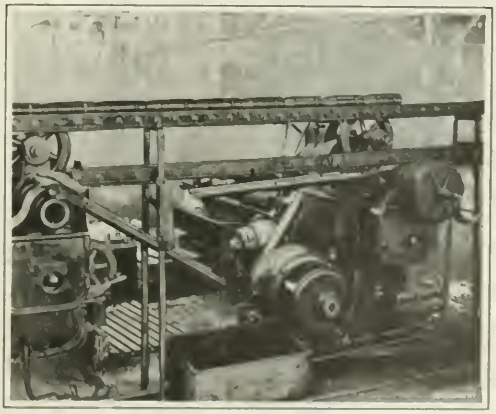

Fig. 4. Gravity Conveyors which carry Shells to and from Machines

press *V*, where 10 per cent are tested to determine if the heat-treatment has given them the proper hardness. A conveyor then carries them to the base-finishing machines *W*, which are grouped into two batteries of four machines each. After an inspection at *X*, the shells pass to the boring, recessing and open-end facing machines *Y*, ten of which are located on each side of the conveyor. After having been again inspected at *Z*, they pass to the grooving and knurling machines at *a;* there are ten grooving and two special automatic knurling machines.

After inspection at *b*, the shells pass to the four rough-nosing machines *c*, the inspection table *d*, the eight finish-nosing machines *e*, the inspection table *f*, the finish-turning machines *g*, of which there are seven on each side of the conveyor, and the inspection table *h*. At *i*, there are four finish-base-turning machines on each side of the conveyor. Another inspection takes place at *j*, and the shells then pass to the four beveling machines *k*. An inspector's table is located at *l*, from which the shells are conveyed to the twelve grinding machines at *m* for grinding the bourrelet. After an inspection at *n*, two presses *o* are passed, where the boss for the center is removed. The journey is continued past the six base-finishing machines *p*, the inspection table *q*, the eight machines for cutting and under-cutting the base cover groove *r*, inspection table *s*, and the twelve thread milling machines *t*, six on each side of the conveyor. After inspection at *u*, 10 per cent of the shells are tested in the hydraulic press *v* and then returned to the finish-tapping machines *w*, after which all the shells are notched for the detonator and passed through the washing machine *x*. The final shop inspection then takes place at *y* and the government inspection at *z;* then the shells return to the shop to have the copper bands pressed in place and turned; five band presses are located at A_1 and five band-turning machines at B_1. An inspection table is located at C_1. The base cover is now put in place, after which a second government inspection is made. The shells now pass from the government inspection room to the numbering machine D_1, and lacquering machine E_1, after which they are put in cartons at F_1 and are conveyed directly into the railway car by a conveyor.

The machine equipment enumerated is intended, as mentioned, to take care of a production of 10,000 shells per day, the shop running three shifts of eight hours each. The average production per machine per hour may be roughly calculated in each case from these data. In most instances, each machine requires one operator, as the operations are very brief. There are some exceptions to this rule, however. The ten hacksaws for cutting the rough forgings to length are operated by one man; two of the machines for both the first and second rough-turning operations are run by one man; and two machines are also operated by one man for rough-facing the base, rough-facing the open end, boring the hole for the fuse, and milling the thread.

On all the machining operations, except where otherwise noted, high-speed steel is used for the cutting tools; stellite is used in one instance—for the first rough-turning.

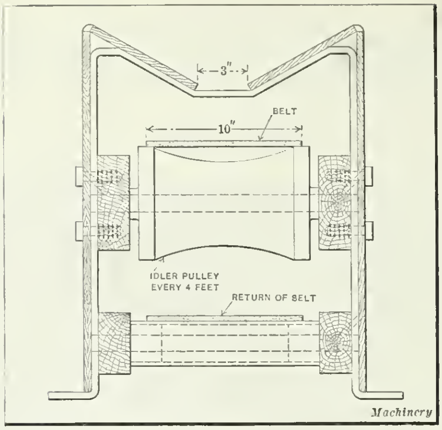

Fig. 5. Arrangement of Belt Conveyor carrying Chips from Machines

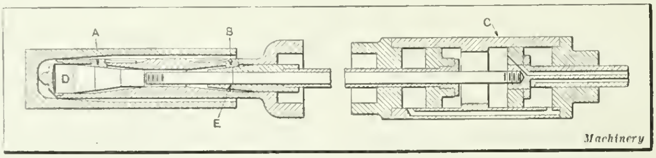

Fig. 6. Diagrammatic View of Pneumatic Centering Arbor used in Centering Machines

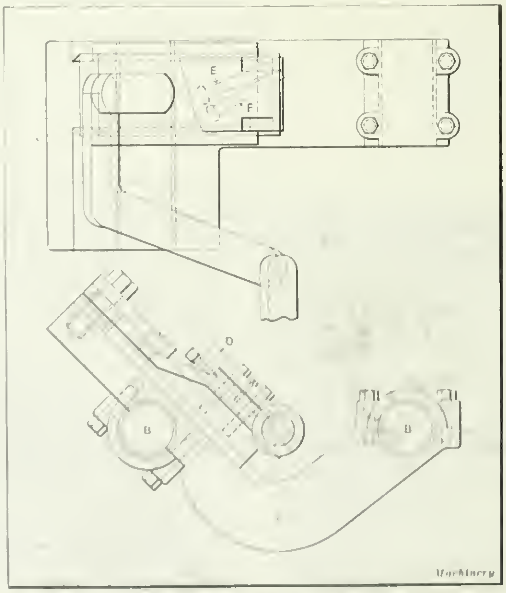

Fig. 7. Diagrammatic View of Facing Tool used in Hydraulically Operated Machines for facing Base of Shells

Conveying System

Different types of conveyors are used for carrying the shells through the plant while in process of manufacture, some being power-driven elevating conveyors, some belt conveyors, and others gravity conveyors. Fig. 3 illustrates a power-driven elevating conveyor to the left, and a belt conveyor in the center. The shells are generally carried up from the inspection tables to a suitable height by an elevating conveyor and are then passed over passageways by belt conveyors, after which they pass by gravity on roller conveyors to the various machines. By this arrangement, the shells are carried clear of passageways and at the same time to a height which makes it possible to give the gravity conveyors the required inclination, so that the shells will roll along on the rollers to the machines. A view illustrating the gravity conveyors is shown in Fig. 4. Two conveyors are generally arranged one above the other, the shells to be operated upon passing along upon the lower conveyor and, after the operation is completed, being placed by the operator upon the upper conveyor, on which they pass to the next inspection table. The belts for the belt conveyors used for carrying the shells over passageways are provided with small metal guides or strips upon which the shells rest. Suitable guides are also provided on the sides to prevent the shells from falling from the conveyor.

Belt conveyors are used for carrying the chips from the machines. The belt has a frame around it, as indicated in Fig. 5, the upper part of which is formed into a trough into which the chips are shoveled; the trough has a 3-inch opening in the center,

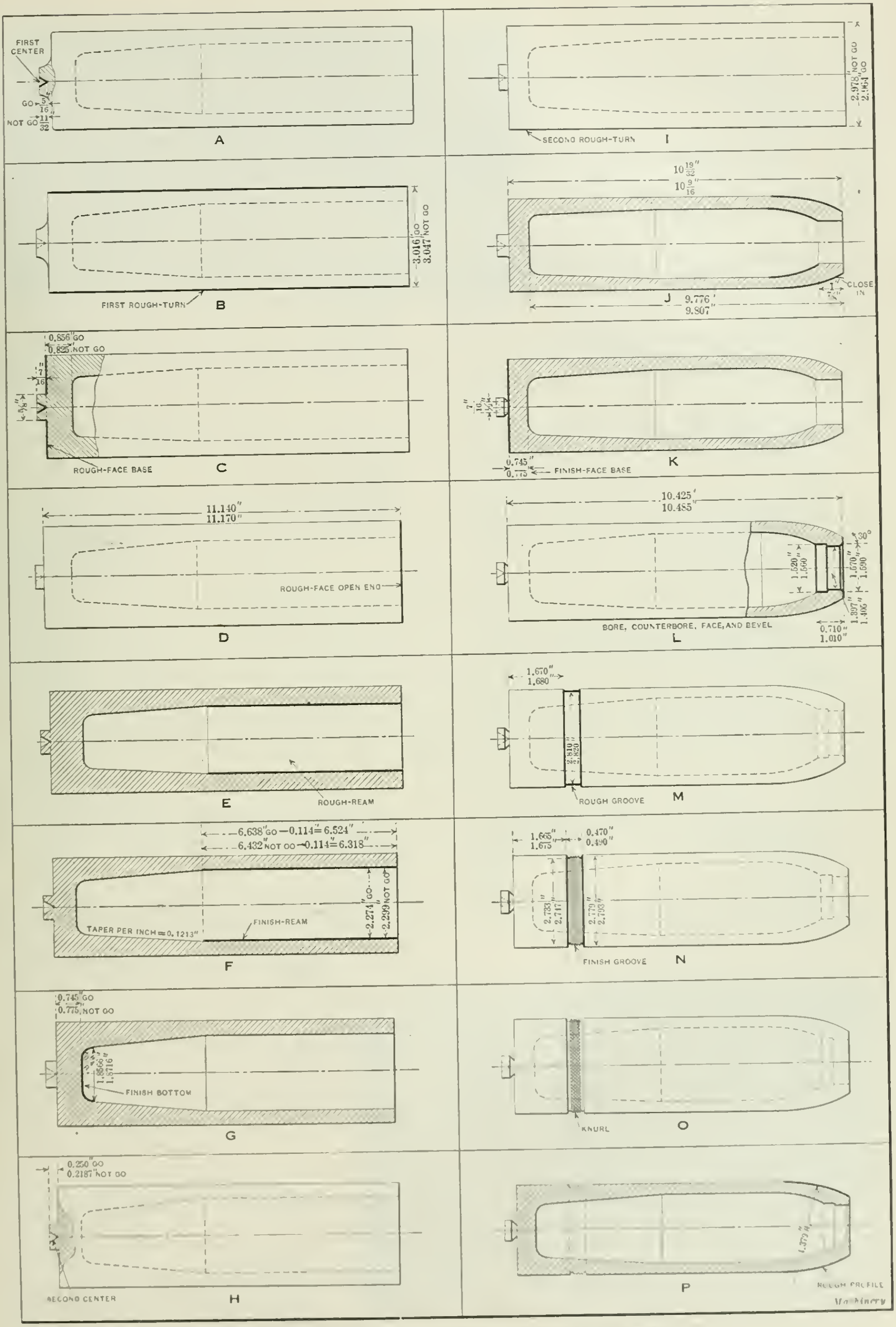

Fig. 6. Sequence of Machining Operations on United States 75-millimeter Shell

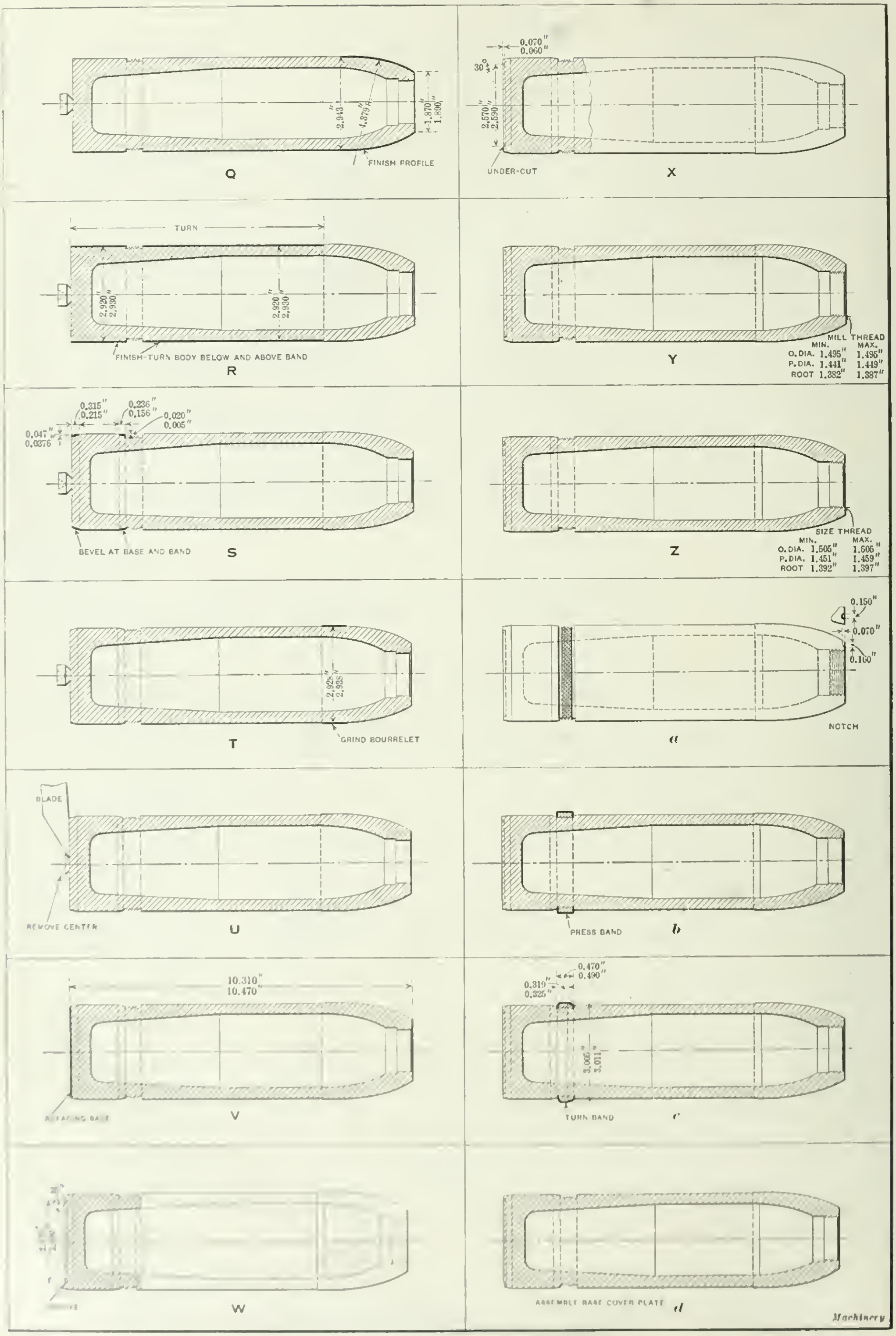

Fig. 9. Sequence of Machining Operations on United States 75-millimeter Shell—Continued

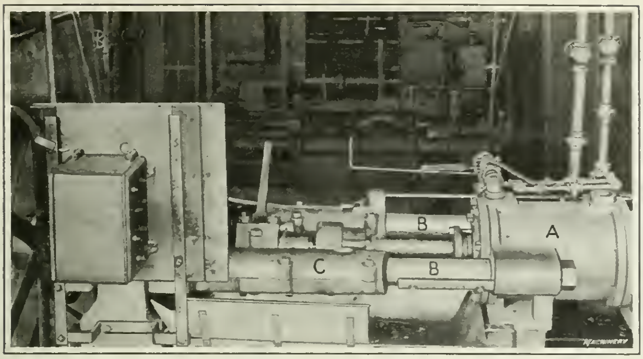

Fig. 10. Type of Hydraulic Machines used for rough-turning and facing Ends of Shells

from which the chips fall onto the conveyor belt below, which, in turn, is supported by concave idler pulleys as indicated. The return of the belt, of course, is supported by straight rollers.

Material Used for Shells

The shells are made from a low-carbon, open-hearth steel with a carbon content of from 0.40 to 0.50 per cent, and a manganese content of from 0.60 to 0.70 per cent. The specifications call for the following physical requirements: elastic limit, 45,000 pounds per square inch; ultimate tensile strength, 90,000 pounds per square inch; and elongation, 15 per cent in two inches. The reduction in area is not specified, but usually is from about 40 to 60 per cent. The shells must be machine-finished all over, and free from scale on the inside. The shell wall must be concentric within 0.030 inch, the bourrelet must be ground, and the base must be concentric with the band to within 0.005 inch, with the base cover securely fastened in place.

ORDER OF OPERATIONS ON U. S. 75-MILLIMETER SHELL

1. Cut off on power hacksaw.
2. Inspect for length.
3. Center. (*A*)
4. First rough-turning of entire outside. (*B*)
5. Inspect turning.
6. Rough-face base. (*C*)
7. Inspection of base-facing for thickness.
8. Rough-face open end. (*D*)
9. Inspect open-end facing.
10. Rough-ream inside. (*E*)
11. Finish-ream inside. (*F*)
12. Finish inside bottom. (*G*)
13. Inspect entire inside.
14. Recenter to make following operations concentric with inside. (*H*)
15. Second rough-turning of entire outside. (*I*)
16. Inspect turning.
17. First government inspection of inside.
18. Heat nose for closing-in operation.
19. Close in nose, or "bottle." (*J*)
20. Heat for hardening.
21. Quench in oil.
22. Drain previous to tempering.
23. Temper.
24. Cool.
25. Subject 10 per cent of shells to Brinell test.
26. Finish base and under-cut boss for center. (*K*)
27. Inspect base and undercut.
28. Bore, recess, face, and bevel hole for fuse. (*L*)
29. Inspect previous operations.
30. Rough and finish groove for copper band. (*M* and *N*)
31. Inspect groove.
32. Knurl in groove. (*O*)
33. Inspect knurling.
34. Rough-turn nose. (*P*)
35. Inspect rough-turning of nose.
36. Finish-turn nose. (*Q*)
37. Inspect finish-turning of nose.
38. Finish-turn body above groove for copper band. (*R*)
39. Inspect previous finish-turning.
40. Finish-turn body below groove for copper band. (*R*)
41. Inspect previous turning.
42. Bevel body for cartridge case. (*S*)
43. Inspect beveling operations.
44. Grind bourrelet. (*T*)
45. Inspect grinding operation.
46. Remove boss for center by shearing. (*U*)
47. Reface base surface. (*V*)
48. Inspect refaced surface.
49. Cut groove in base for cover. (*W*)
50. Under-cut for base cover. (*X*)
51. Inspect groove for base cover.
52. Mill thread. (*Y*)
53. Inspect milled thread.
54. Subject 10 per cent to hydraulic test.
55. Size thread by tapping. (*Z*)
56. Notch for detonator. (*a*)
57. Wash shells in oakite solution.
58. Final shop inspection of whole shell.
59. Second government inspection of whole shell.
60. Press copper band in place. (*b*)
61. Turn copper band. (*c*)
62. Inspect copper band.
63. Assemble base cover. (*d*)
64. Press base cover in place.
65. Final government inspection.
66. Stamp number on shell.
67. Lacquer and dry.
68. Pack in cartons.

Order of Operations

The work is inspected after almost every machining operation, and the order of procedure in completing a shell, from beginning to end, including the inspection to which it is subjected, is given in the table. The appearance of the shell after the most important operations, and the dimensions, together with the required limits, are shown in Figs. 8 and 9. The letters in parentheses refer to the reference letters in these two illustrations.

Machining Operations

In the following paragraphs a brief review of the machines and tools used for the machining operations that precede the heat-treatment will be given. The machining operations after heat-treatment, the gages used for inspection, and the inspection methods and tests to which the shell is subjected will be dealt with in subsequent articles.

The first centering, Operation 3, is performed in a lathe provided with a special pneumatically operated arbor for holding the shell while centering, as shown in Fig. 6. There are three points at each end of the arbor at *A* and *B*, which are pushed outward and hold the shells central. Part *C* of the arbor is held in the bearings of the lathe. Two pistons are provided, so that when the air is admitted between them the tapered sections *D* and *E*, which operate the binding points, are moved outward. To release, air is admitted at the outer ends of the pistons.

Operation 4, the first rough-turning, is performed on a special hydraulically operated machine developed by the American Shell Co. This machine is shown in Fig. 10. It is provided with a hydraulic cylinder *A* of the duplex type, by means of which the center is hydraulically moved in and out of position and the tool carriage *C* is fed along by hydraulic power. The carriage is not mounted on a bed as in an ordinary lathe, but on two heavy rods *B* which connect the front and rear of the machine. The base is rough-faced in a machine designed

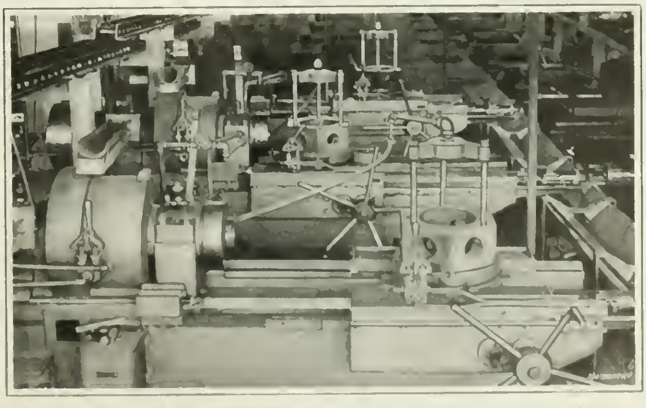

Fig. 11. Set of Three Machines for rough-reaming, finish-reaming, and finishing Inside Bottoms of Shells

very much along the same lines as that shown in Fig. 10. In this case, however, the carriage is provided with a lever-operated cross-slide, the lever being operated from the hydraulic piston-rod; this construction is diagrammatically illustrated in Fig. 7. The cross-slide *C*, carried on the connecting-rods *B* of the machine, is equipped with a special tool-block *D*, which holds two tools *E* and *F*, one of which faces the surface on the end and forms the boss for the center while the other faces the boss. The rough-facing of the open end is done on the same type of machine as is used for facing the closed end, except that a regular parting tool is used.

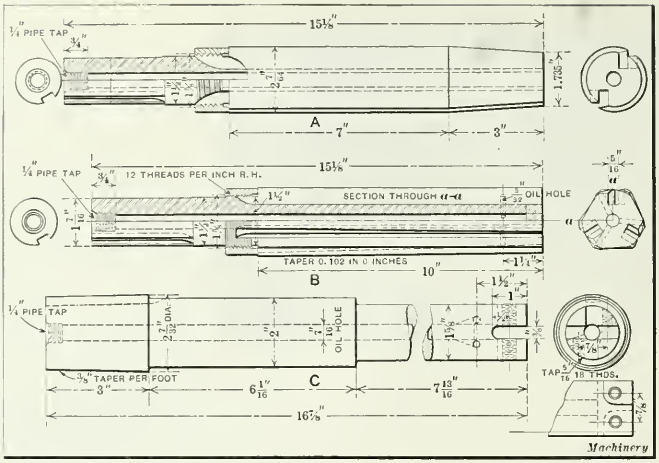

Fig. 12. Roughing Reamer, Finishing Reamer, and Inside Finishing Bar

Finishing Inside of Shell

The rough-reaming, finish-reaming, and finishing of the inside of the bottom are performed in sets of three machines, each placed side by side as shown in Fig. 11. These machines are specially designed by the American Shell Co., having pneumatically operated carriages. Referring to Fig. 11, the first machine rough-reams the shell; it is then passed to the second machine, which finish-reams it, and from there to the third machine, which finishes the inside bottom. For the rough-reaming operation a two-bladed reamer, as shown at *A* in Fig. 12, is used, and for the finish-reaming, a three-bladed reamer, as shown at *B*, is employed. The inside bottom of the shell is machined by means of a special tool-bar, as shown at *C*.

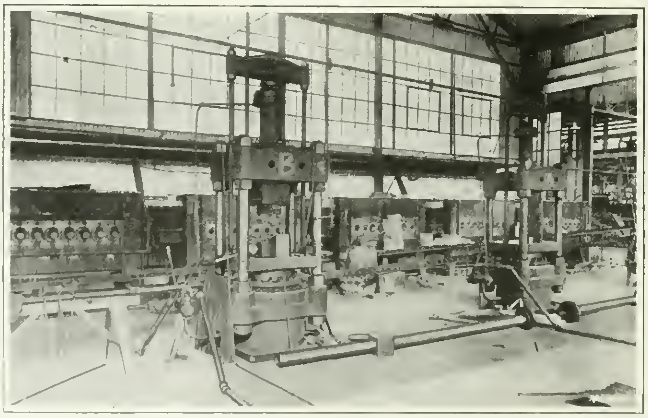

Fig. 13. Heating Furnaces and Presses for nosing Shells

Fig. 11 shows in the upper left-hand corner a section of the gravity conveyors by means of which the shells pass to these machines. The operators put the shells in the holders shown while passing them from machine to machine in the same battery. On the right-hand side is a view of the chip conveyor, showing the trough into which the chips are shoveled and the belt that carries the chips away, which passes immediately beneath the trough.

Recentering and Second Rough-turning

After the inside has been finished, the shell is recentered in order that all subsequent operations may be performed on a center which is absolutely concentric with the finished inside of the shell. This recentering is performed on a machine of the same type as that used for the first centering operation. After this centering, the shell is subjected to a second rough-turning, a 16-inch engine lathe being used for this purpose, provided with a special crank on the tailstock for rapid operation, the entire tailstock being moved quickly along the bed in this way. An expanding mandrel is used for the open end of the shell, the design of which is shown in Fig. 14. Three jaws *A*, moved outward by the tapered expander *B*, center and hold the open end of the shell, the other end being supported by the regular lathe center.

Nosing or "Bottling"

After the second rough-turning operation, the shells are nosed or "bottled"; that is, the open end of the shell is closed in to the pointed form required. Five heating furnaces, Fig. 13, are used for this work, each of which has provisions for eight shells. The openings through which the shells pass into the furnace are water-jacketed, a casting, as shown at *A* in Fig. 15, having been inserted in the regular furnace opening. The shells project from this casting 2 1/4 inches into the furnace. As soon as the shell has become sufficiently heated, it is removed and placed in the nosing or "bottling" press. There are three of these presses, two of which are shown in Fig. 13, each one being able to close in three shells a minute. A nosing die *B*, in Fig. 15, is used for this work.

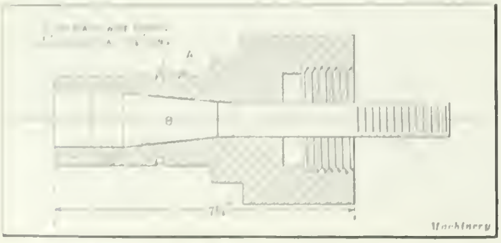

Fig. 14. Expanding Mandrel used in Second Rough-turning Operation

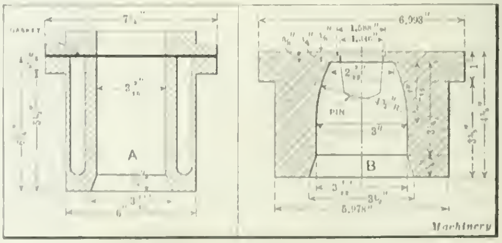

Fig. 15. Water Jacket for Nosing Furnaces and Die for Nosing Presses

WOMEN WORKERS IN MACHINE SHOPS IN GREAT BRITAIN

In a booklet published by the Merchants' Association of New York, relating to the readjustment and operation of industry in England since 1914, a report is given of labor conditions in Great Britain, the information having been obtained directly from a special commission from the British Ministry of Munitions which visited the United States in the latter part of the past year. As the United States can doubtless profit by the experience of Great Britain in regard to many, if not all, of the various problems connected with the war, some of the more interesting points brought out in the report referred to will prove of value in American industries. One of the most peculiar conditions in the British industries probably is that relating to the employment of women in machine shops, railroad shops, and other industries, where, in the past, men only were generally employed.

Sources from which Women Workers are Drawn

Women workers in industries have not been extensively recruited from the non-working class, as has often been believed in the United States. The patriotism of the British women has not, to any large extent, induced those not generally employed in gainful occupations to enter such employment. Instead, the supply of women workers has come from the non-essential industries, from small stores, from millinery and dressmaking establishments, from homes in which the bread-winner has been called into the army, and from the servant class. The best age for women who work on munitions has been found to be between twenty and thirty, and especially between twenty and twenty-five years of age. Their output generally compares favorably with that of men, and on shell work, except on the heavier types, the output from the women workers has been better than that of men.

Conditions of Work Due to Employment of Women

Practically no change in the machines on which the women work has been made, except that lifting appliances have been provided to an increased degree. Apart from the facilities for lifting heavy weights, little change in processes has been made necessary in the machine shops by the employment of women. The women work day and night shifts, the same as men. Generally, the women have not been segregated, except in a comparatively few cases. It has been found that in machine shops where men and women have been employed in separate departments, there is a slight increase in production, but not great enough to warrant separate departments, if the work does not readily admit of such an arrangement.

Frequency of Accidents

In many cases there has been a substantial decrease in the number of accidents resulting from the employment of women. Reports from many employers indicate that, since the introduction of women workers, accidents have been fewer and there has generally been less trouble from injuries. For instance, the operation of practically all cranes at the present time is done by women, who are more careful and cause fewer accidents. On the whole, it has been found that when working on dangerous work, women are more careful than men.

It was with extreme reluctance that women were employed on munition work in England. It was feared that the women's nerves would not stand the occasional explosions that are practically certain to happen in the manufacture of munitions. They appear, however, to stand these strains as well as the men. In one factory engaged in the manufacture of picric acid, a fire occurred in a department where both men and women were working. The men disappeared, and the firemen put out the fire with the help of the women. The women generally wear some kind of a working uniform. For any work where required, they wear trousers, and in machine shops they always wear caps over their hair to avoid accidents.

Labor Unions of Women Workers

Women had before the war two general unions of their own, which are now largely unions of munition workers. These unions have gained greatly since the beginning of the war, and have been a source of assistance to the government. Since the war, women have also been admitted to the railway unions.

Women's Wages

It was agreed from the beginning that women undertaking skilled work should receive the same day rate as skilled men and the same piece rate. A woman's wage could differ from that of a man only when employed on unskilled or semi-skilled work; and then she came under an order which fixed the minimum wage at a rate which, in general, came to about two-thirds of the man's wages, varying with the district involved. The lower rate on unskilled work was due to the fact that women were found to be less effective on these general tasks, because on heavy lifting and such work it was found necessary to replace two men with three women. About from 30 to 40 per cent of the women employed work at the rate of two-thirds of men's wages.

The conditions of pay for women have not been particularly advantageous to employers directly, but indirectly they have been of great value. As a result of the good wages that women have been able to earn on munitions work, employers have never lacked applicants for almost every kind of work. At the present time the employment of women in England is limited only by the facilities for training them. As a further result of equal wages, the class of women taken into the munitions plants has been much above the class of the factory girl and the woman employed by textile works before the war. Women of good position and with fair education have been found, and this has undoubtedly had a great influence on the success of the employment of women in shops.

Work on which Women are Employed

Shell, fuse, grenade and similar repetition work of an easy type, calling for no particular accuracy, is obviously women's work as far as the operating is concerned; but there are now shops that employ women on nearly all the skilled work in shell factories. One factory, on light shells, employs about 94 per cent women. Taking shell, fuse and grenade work as a whole, the average number of women employed is about 80 per cent. On the skilled operations, such as howitzer work, the averages are not so high, but there are individual cases which show just as high a percentage of women employes. In the largest English explosive factory there are 15,000 employes, and of these, 11,000 are women. On trinitrotoluol manufacture the average is about 80 per cent women, and on picric acid the average is about 40 per cent. On filling fuses and similar classes of work, the average is generally well over 90 per cent. There are now in England over a million women working on munitions. They have undertaken work in every industry which has any bearing on munitions. Outside the machine shops, their work is largely laboring work, and they have undertaken laboring in every industry and under the worst possible conditions, even under such conditions as exist in blast furnaces, acid works, iron and steel plants, etc.

Training Required

For all simple repetition work, it has been found that women need no training at all, but for the more highly skilled work on howitzers, airplanes, engines, etc., the Ministry of Munitions has assisted the employers by equipping training schools. By far the greater part of the women on that work, however, have been trained in the factories themselves, but the smaller factories have found considerable difficulty in doing their own training, and in many factories there is too little work of this nature on which women can gradually acquire skill. The ministry has, therefore, organized two classes of training establishments—training schools attached to various technical colleges that exist in most industrial centers, and factories taken over by the ministry equipped as instructional plants. They do actual munition work in these training establishments. They do not attempt to give general training, but they give specialized training on a specific type of machine, and in that way the women acquire a considerable degree of skill in a period of from six to eight weeks. On the whole, this has proved very satisfactory.

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

Fred E. Rogers, for nineteen years editorially connected with MACHINERY, and for eleven years its editor, has retired from that position to again take up mechanical constructive work. His first undertaking will be the development of a line of special machinery. In retiring, Mr. Rogers takes with him the good wishes of everyone connected with MACHINERY in all its departments.

Erik Oberg, who has been an associate editor of MACHINERY since 1906, becomes the editor with the current number. Mr. Oberg was born and educated in Sweden, and is a graduate of Boras Technical College. After some practical shop experience in that country he came to the United States in 1901 and entered the employ of the Pratt & Whitney Co. at Hartford, where he remained for five years, except for a short period spent with the Cincinnati Milling Machine Co. Mr. Oberg's widely varied practical experience has formed the basis of many articles on mechanical subjects published in MACHINERY since 1906, and for a "Handbook of Small Tools" published in 1908. For several years Mr. Oberg has had editorial charge of MACHINERY'S book publications, and is well known as the editor of MACHINERY'S HANDBOOK and MACHINERY'S ENCYCLOPEDIA.

* * *

PREVENTABLE WASTE OF COAL

Two hundred and fifty million dollars a year is going to waste through improper operating methods in boiler plants. By the introduction of proper methods, ten per cent of all the coal now burned for steam-raising purposes might be saved. Such a saving would release for other service freight car space equal to the total coal-carrying capacity of the Pennsylvania Railroad east of Pittsburg. The above statements were made by David Moffat Myers in a paper read at the annual meeting of the American Society of Mechanical Engineers. Investigations made in one steel mill, he also declared, showed that it was possible to save in the boiler furnaces of that mill alone, 40,000 tons of coal yearly. Yet the plant in question was comparatively modern in its methods. There are many more extreme cases.

In one hand-fired plant the steam evaporation was raised from six to nine pounds per pound of coal by simply giving a few days' instructions to the employes. The saving or wasting of one-quarter of the coal consumption at an industrial plant depends entirely on the efficiency of its operating management. Yet, under present conditions, a plant operated carelessly at an efficiency of from 40 to 50 per cent receives the same consideration in the delivery of coal as a plant having an efficiency of from 70 to 75 per cent. This is unfair. If food products were thrown away as fuel is at hundreds of plants, public condemnation would smite the delinquents without delay. Yet waste of coal is, perhaps, more dangerous than waste of food.

Waste of fuel in power plants may be prevented in two ways: by enforcing upon coal consumers measures of economy, or by inculcating patriotism as a motive and emphasizing the advantages to be derived from coal saving. Coal users will probably make many objections to the first plan; yet, were it once put into effect, most of them would doubtless realize its pecuniary value to themselves. Were the second method to be adopted, the necessary educational work might be undertaken by the American Society of Mechanical Engineers, and by the United States Bureau of Mines and other government agencies.

* * *

FACILITATING WAR WORK BY PUBLICITY

Cooperation in every branch of war activity is essential to success in modern warfare; cooperation between the various establishments in the United States making similar munitions of war is the keystone of victory. To secure such cooperation there is no better way than to give widespread publicity to the processes used in munition manufacture, so that the best of them may be widely adopted and those found unsatisfactory discarded. Great Britain points the way for us in this phase of cooperation. The headquarters of the British Ministry of Munitions of War in the United States has issued a booklet of instructions for the gaging and inspection of screw threads. It describes the apparatus that has been found most accurate and useful. It gives the information and formulas required by inspectors of thread gages and screw threads in general. It is a booklet that should be imitated by the War and Navy Departments of the United States in order to facilitate the manufacture of all kinds of war materials.

Why should not the United States Government have competent engineers, with experience in recording technical data for publication, study the methods of manufacture and inspection used in making the different classes of arms and munitions required for the American Army? Having obtained and classified the data, the Government could then place in the hands of every manufacturer with whom it closes a contract a set of instructions for the particular work to be done, based on the reports received from its engineers. In this way the methods employed in some plant already manufacturing the kind of munitions desired, which, from the reports of the engineers, had been adjudged the best methods for that kind of work, could be brought to the attention of other manufacturers about to engage in munition making, and the result would be that the materials needed by the Government could be manufactured much more rapidly than if each concern should be compelled to work out its own methods without such valuable guidance.

The Government, of course, is too busy just now to publish a great many booklets of this kind. It should do the next best thing, which is to cooperate with the engineering journals of the United States, allowing them to study methods of manufacturing war material in shops designated by the Government as embodying a high standard of accuracy and efficiency. With these facilities at their disposal, the engineering journals could record, for the benefit of all manufacturers working on a certain class of war material, information that would tend to improve the quality and increase the quantity of their output. In a crisis like the present there is nothing to be gained by secrecy regarding manufacturing processes. Publicity of methods used in the manufacture of war materials will help win the war, and that, after all, is the main thing. MACHINERY places its editorial staff at the disposal of the Government, if aid of the kind outlined above should be required.

VALUE OF TRADE JOURNAL ADVERTISING TO ENGINEERS AND DRAFTSMEN

BY C. C. MARSH[1]

The advertising section of the engineering trade journals constitutes a valuable source of information for engineers and draftsmen; but the value of this material depends entirely upon the manner in which it is collected and classified. In plants that must improve their products from year to year, in order to be able to compete with their rivals, many changes in design call for improved and even entirely new methods of machining, requiring new types of machine equipment from the machine tool manufacturer. The new ideas thus created, taking the form of new machines, are recorded in the advertising pages of the trade journals, and a complete file of these, classified so that any one of them may be easily found, will be of great value to both the engineer and the draftsman. These men, therefore, should observe, read, and take note of really good and valuable data written in the form of advertisements. There are many clear illustrations and much useful information to be obtained. Trade journal advertising always precedes the manufacturers' catalogues; in fact, it is first-hand information.

The machine shop foreman is the one who generally calls the engineer's or draftsman's attention to some new idea in machine tool equipment. Being more directly concerned with production, he is the one who is looking for such information, and who reads these advertisements most carefully. He is also the one whom the purchasing agent asks for specifications before buying. The machine shop foreman often remarks, "I could turn out these parts in larger quantities and with greater accuracy if I had up-to-date tools like these," pointing to an advertisement. He keeps in touch with the progress in the development of machine tools and he watches closely the advertisements of manufacturers.

That filed and indexed information and records of machine tool advertisements is labor well spent is easily proved. After a plant in the Middle West obtained a contract for war munitions, in which time was one of the essential factors, it found that it did not have the proper machine shop equipment to make the parts accurately enough to pass the government inspection; it also found that to meet some of the requirements the new equipment must be of the most improved design. Machining operations were called for in which the plant had had no experience. During a meeting of the executives a draftsman, who had on several occasions furnished the purchasing agent with machine tool specifications, was called in. Someone soon noticed that he constantly referred to a notebook and asked what the book contained. The draftsman thereupon placed the book on the table saying that it was an indexed list of modern machine tools and their manufacturers that he had made up during his spare moments; in addition, he had tried to make note of some special improvement. He then showed them a page, which read as follows:

Tapping Attachment for Drill Press
John Smith & Co.,
Smithstown, N. Y.
Features: Fits drill presses from small sensitive type up to largest radial. See cuts and advertisements in *Manufacturer's Review*, issue July 14, '17.

By means of this index he said that he could immediately find the advertisement of any particular kind of machine tool or attachment therefor, as he kept all copies of the different trade journals for which he subscribed that contained any advertisements of new tools or improvements on old ones. Recognizing at once the value of this index, the chief engineer asked him to make a list of machine tools as the various operations to be performed on the different parts were mentioned, which the draftsman did, and the next morning he gave it to the chief engineer with the advertisements attached. As a result, by noon letters had been mailed to the various manufacturers for catalogues, specifications and quotations, together with delivery dates. Thus much time was saved and one requirement of the contract was complied with at once.

Another firm in the same locality was working on a government contract, when the government engineers found it necessary to change the design of one of the parts, and, as often happens, this caused changes in several of the other parts. Work had proceeded to the point of starting the tool-room on the making of the fixtures, although some of the latter had not been drawn when the firm received a message that some changes were necessary. It immediately stopped work in the tool-drafting department on the designing of the jigs and fixtures, hoping to receive the changed instructions within a few hours. The chief tool designer, not wishing to see his men idle, handed each one a machinery trade journal with instructions for its use. Shortly afterward the superintendent and the chief engineer entered the room. When the former noticed that the tool draftsmen were diligently reading the magazines, he said to the chief tool designer: "Nice way to spend time, especially government time. What's the idea; do you think this is a good place to start a class in reading, or perhaps you think this is a public library? Why are those fellows spending their time like that?"

"While we are waiting for information concerning these changes, I thought that I could keep the men busy obtaining some useful data on tool design," answered the chief tool designer. "You see, each of these men is working on the design of a different fixture for the same part. So when we received orders to stop work temporarily, I gave each one a trade journal with instructions to find the advertisement of a machine similar to the one on which the jigs they were drawing would be used, and pick out some idea that they could incorporate into the drawing they were making, and to see if other ideas would not be suggested by the cuts and pictures. I think that this is a better idea than to send them home for the rest of the day. Besides, looking over the various advertisements whets their interest, while idleness doesn't."

There are many other little incidents that could be related, but these show that the valuable data printed in the form of advertisements, together with many clear illustrations, a great number of which are made from actual photographs, can be used often and well if properly classified. It is interesting to note that all classes of mechanical men realize more and more the value of trade journal advertising and that it is no longer only those who are directly interested in the buying that read these pages.

* * *

CARE OF SCREW THREADS WHEN ERECTING MACHINERY

The erector of machinery can make repairs difficult or comparatively easy, according to the care taken, when inserting studs and screwing on nuts, to lubricate the threads with an oil or compound that prevents rust. The careless erector gives little or no thought to the problems of the men following him, who at some future time will be called upon to take the machine down and repair broken or worn parts. If studs, bolts, screws and nuts are set up dry, or lubricated with a thin oil that soon evaporates and leaves the threads unprotected, the inevitable result is rusting and seizure of the threads. When the repair men undertake to dismantle the machine, the "seized" nuts have to be split and rusted bolts have to be drilled out, thus delaying progress and increasing the cost of the repairs.

When erecting machinery, especially steam, oil, and gas engines, it is good practice to use machine oil mixed with graphite on all screws, especially those securing the cylinder heads, valve chambers, and covers. Graphite affords a peculiarly efficient protection for metal surfaces. Studs whose threads are covered with graphite may be in use for years on steam engines, and the nuts will loosen readily when repairs are needed. The importance of erecting machinery so that repairs can be made quickly in time of need is emphasized in war times. The designer may carefully lay out and plan a machine to secure long life and high efficiency, but the best machinery must occasionally be overhauled, and it is then that the work of the erector assumes the greatest importance, especially if an emergency arises. If the threaded parts can be easily removed, the probability is that the machine can be repaired and re-assembled with a minimum of expense and trouble.

---

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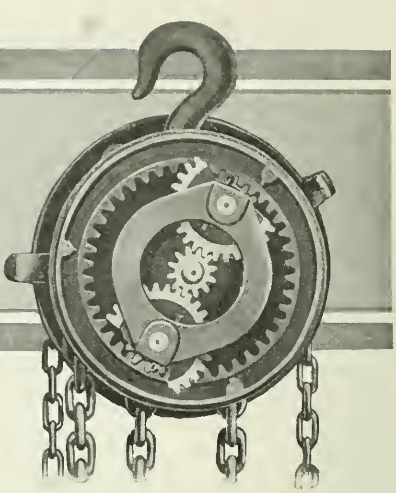
Differential Motions and Planetary Gear Combinations

By Franklin D. Jones[1]



First Installment of a Treatise on Mechanisms that Require Differential Motion and Methods of Determining Relative Velocities of Planetary or Differential Gears[2]

A DIFFERENTIAL motion may serve to greatly reduce the movement of a driven member in a train of mechanism, either for the sole purpose of securing a relatively small motion or adjustment, as in the case of the differential screw, or as a means of increasing the power or lifting capacity by sacrificing speed, as, for example, when utilized in connection with the differential hoist to be described. A mechanism capable of differential action may also be used to transmit motion between two driven parts, in order that they may operate either in unison and at the same speed or independently and with the speed of either part ranging from zero up to the maximum, as may be required by variable operating conditions. The application of the differential principle has often made it possible for machine designers to accomplish by mechanical means what would otherwise have been impracticable or entirely impossible. Some of the more important forms of mechanisms which have a differential action will be described to illustrate the practical application of this principle in machine construction.

Differential Screw and Hoist

The differential screw, which is a simple example of a differential motion, is a compound screw from which a movement is derived that is equal to the difference between the movements obtained from each screw. The diagram *A*, Fig. 1, illustrates the principle. A shaft has two screw threads on it at *e* and *f*, respectively, which wind in the same direction but differ in pitch. Screw *f* passes through a fixed nut, and screw *e* through a nut that is free to move. The motion of the movable nut for each revolution of the screw equals the difference between the pitches of the threads at *e* and *f*. This combination of screws of different pitch makes it possible to obtain a very slight motion without using a screw having an exceptionally fine pitch and a weak thread. Another form of differential screw is shown at *B*, which illustrates a stop that enables fine adjustments to be obtained readily. The screw bushing *g* is threaded externally through some stationary part and is also threaded internally to receive screw *h*, which is free to move axially but cannot turn. Both screws in this case are right-hand, but they vary as to pitch. If bushing *g* has a pitch of 1/32 or 0.03125 inch and screw *h* a pitch of 1/36 or 0.02777 inch, one complete turn of *g* will advance screw *h* only 0.00348 inch (0.03125 — 0.02777 = 0.00348), because, as bushing *g* advances 1/32 inch, it moves screw *h* back a distance equal to the difference between the pitches of the two threads. By turning the bushing only a fractional part of a turn, very small adjustments may be obtained.

The Chinese windlass shown by the diagram *C*, Fig. 1, is another simple example of a differential motion. The hoisting rope is arranged to unwind from one part of a drum or pulley onto another part differing somewhat in diameter. The distance that the load or hook moves for one revolution of the compound hoisting drum is equal to half the difference between the circumferences of the two drum sections. The well-known differential chain hoist illustrated at *D* operates on the same general principle as the Chinese windlass. The double sheave *a* has two chain grooves differing slightly in diameter, and an endless chain passes over these grooves and around a single pulley *b*. Pulley *b* and the hook attached to it is raised or lowered, because for a given movement, a greater length of chain passes over the larger part of sheave *a* than over the smaller part. If the upper sheave is revolved by pulling down on the side *d* of the chain that leads to the groove of smaller diameter, the loop of chain passing around pulley *b* will be lengthened, thus lowering the pulley; the opposite result will be obtained by pulling down on the side *c* of the chain, which leads up to the larger diameter of the sheave.

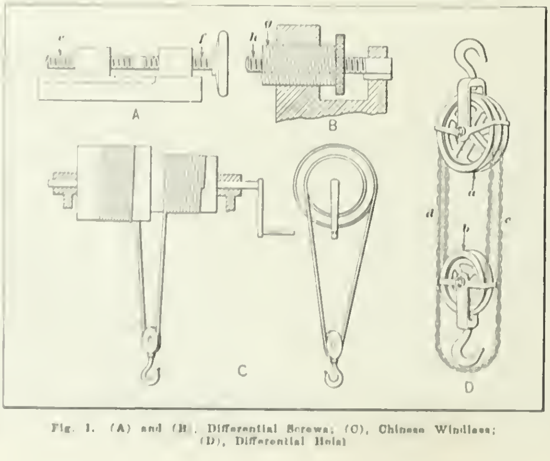


Fig. 1. (A) and (B), Differential Screws; (C), Chinese Windlass; (D), Differential Hoist

Differential Motion between Screw and Nut

Variations of movement are sometimes obtained by the differential motion between a revolving screw and a nut which is rotating about the screw at a different speed. One application of this principle is illustrated by the variable-speed mechanism of a milling machine shown in Fig. 2. This mechanism is designed to increase the efficiency of a machine by accelerating the speed of the table when the cutters are not at work. The machine table moves rapidly up to the cutting point, then the speed is reduced while milling, and, after the operation is completed, the table is quickly returned to the loading position.

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[2] A chapter that will be included in the author's book "Mechanisms and Mechanical Movements" to be published in the near future

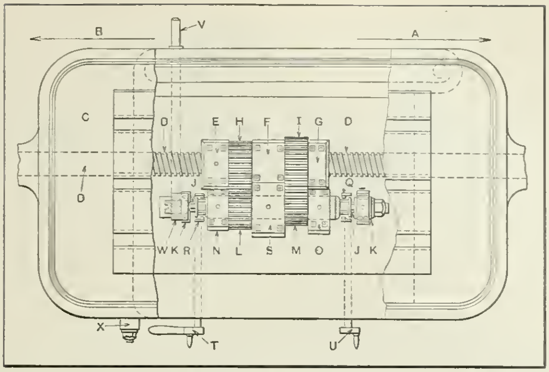

Fig. 2. Variable Feeding Mechanism partly controlled by Differential Movement between Revolving Screw and Nut

This mechanism is located beneath the machine table *C*, which is traversed by a screw *D* that passes through the plain bearings *E*, *F* and *G*, mounted upon the base of the machine. The pinion *H* is confined longitudinally between bearings *E* and *F*, and it is splined to screw *D*, so that the latter must turn with the pinion but is free to slide in a lengthwise direction. The hole through gear *I* is threaded to fit screw *D*, so that it is practically a nut and gear combined. The auxiliary shaft *J*, supported in bearings *K*, carries two pinions *L* and *M*, which are loosely mounted upon the shaft. This shaft *J* is rotated continuously in one direction through spiral gears *W* from the driving shaft *V*. Within the housings *N* and *O* are clutch sleeves which encircle the shaft *J*. The sleeves are splined to the shaft, but are free to slide upon it, and they may be locked with teeth formed on pinions *L* and *M*. These clutches are controlled by levers *T* and *U* at the front of the machine, which are connected by the shafts shown, with the clutch shifting devices at *R* and *Q*. The action of the clutches is controlled automatically by adjustable stops located on the front of the machine table.

The clutch connecting with gear *L* is first engaged by hand-lever *T*. The table then moves forward rapidly (in the direction indicated by arrow *A*) as gear *H* revolves screw *D* and causes it to turn through the gear nut *I*, which is held stationary at this time. Just before the milling cutter begins to act upon the work, lever *U* strikes a stop, thus engaging the clutch with gear *M*. The gear nut *I* is then revolved in the same direction as gear *H* but at a slower speed, so that the forward movement of screw *D* is reduced, because of the differential action between the screw and nut. Both sets of gears continue to operate while the cut is being taken; when the milling operation is completed, another stop engages lever *T*, thus stopping the rotation of gears *L* and *H*. As the gear nut *I* continues to revolve about the screw, the movement of the machine table is reversed, since screw *D* is not rotating. The motion continues in the direction indicated by arrow *B* until a third stop to the right of lever *U* trips the latter, thereby stopping gear *I* and the table movement. The table is now in position for removing the finished parts and replacing them with others that require milling.

Differential Motions from Planetary Gearing

Most differential motions are derived from combinations of either bevel or spur gearing. In some applications, all the gears of the train revolve as a unit and without any differential action, except when such action is essential to the operation of whatever machine or mechanism the gearing forms a part. Combinations of gears arranged to give a differential motion are known either as planetary gearing, epicyclic gearing, or as differential gearing. The term "planetary gearing" is, of course, based on the similarity between the motion of a gear or pinion revolving about another fixed gear (which is common with gearing of this general type), and the movement of a planet about its own axis and around the sun. The name "epicyclic" is applied to these gear trains because, when a spur gear or pinion revolves around the outside of another fixed gear, any point on the revolving gear describes epicycloidal curves. This is not the case, however, when bevel gearing is used, so that the name "epicyclic" is not altogether appropriate and is less expressive or explanatory than "planetary." The term "differential" indicates the differential action and is almost invariably applied to some planetary gear combinations, as, for example, those applied to automobiles and to certain classes of textile machinery.

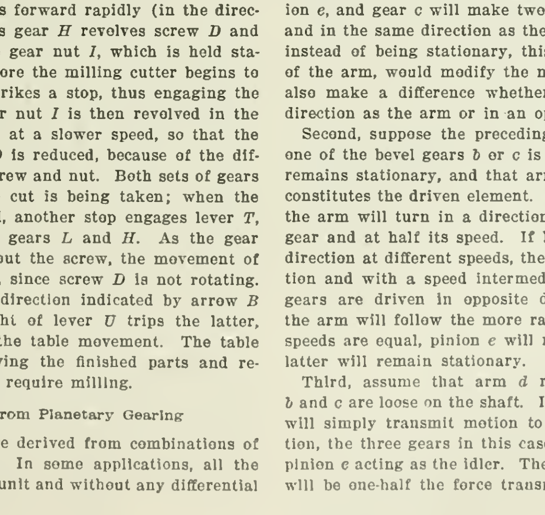

Fig. 3. Planetary Trains of Bevel and Spur Gearing

The planetary bevel gear train illustrated by diagram *A*, Fig. 3, is applied to many mechanisms of the differential type, and its action under different conditions should be thoroughly understood. The shaft *a* has mounted on it two bevel gears *b* and *c* and an arm *d*. The arm is attached to the shaft and carries a pinion *e* which meshes with each gear and is free to revolve upon the arm. There are several conditions that can exist with a gear train of this kind.

First, assume that gear *b* is stationary and *c* loose on the shaft. If the shaft and arm *d* are revolved, motion will be transmitted from the stationary gear *b* to gear *c*, through pinion *e*, and gear *c* will make two turns for every one of arm *d* and in the same direction as the arm. If gear *b* should rotate instead of being stationary, this motion, combined with that of the arm, would modify the motion of gear *c*, and it would also make a difference whether gear *b* turned in the same direction as the arm or in an opposite direction.

Second, suppose the preceding conditions are reversed and one of the bevel gears *b* or *c* is revolved while the other gear remains stationary, and that arm *d* carrying the bevel pinion constitutes the driven element. With only one gear revolving, the arm will turn in a direction corresponding to that of the gear and at half its speed. If both gears rotate in the same direction at different speeds, the arm will follow in that direction and with a speed intermediate between the two. If the gears are driven in opposite directions at different speeds, the arm will follow the more rapidly moving gear, and if the speeds are equal, pinion *e* will revolve upon the arm, but the latter will remain stationary.

Third, assume that arm *d* remains stationary and gears *b* and *c* are loose on the shaft. If gear *b* is the driver, pinion *e* will simply transmit motion to gear *c* in the opposite direction, the three gears in this case forming a simple train with pinion *e* acting as the idler. The force tending to rotate arm *d* will be one-half the force transmitted from gear *b* to gear *c*.

A practical application of this last principle is found in the Webber differential dynamometer. The arm of this dynamometer which supports the scale pan and weights corresponds to arm *d* and is pivoted on a shaft carrying two bevel gears. On the arm and meshing with these two bevel gears are bevel pinions, and the amount of power transmitted through this train of gearing is measured by the weights in the scale pan. The combination of gear-

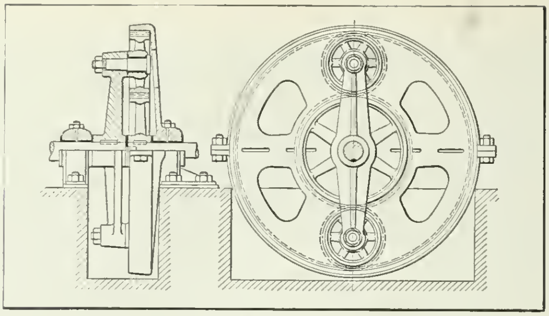

Fig. 4. Planetary Gearing for obtaining Speed Reduction

ing illustrated by diagram *A* usually has two or more pinions meshing with the bevel gears. In many cases, there are two pinions located diametrically opposite, as indicated by the full and dotted lines. The addition of other pinions, however, does not affect the action of the gearing.

The diagram *B*, Fig. 3, shows an arrangement of planetary spur gearing. This combination consists of an ordinary spur gear *g*, an internal gear *h*, and a pinion *k*. This pinion is free to turn on a stud that is attached to arm *l*. In the application of this gearing, there are three possible conditions. In the first place, the internal gear *h* may be stationary, and the gears *g* and *k* may revolve. Second, the arm *l* may be stationary, in which case either the internal gear *h* or gear *g* may be the driver. Third, gear *g* may be stationary and the motion transmitted in either direction between gear *h* and arm *l*. Fig. 4 shows a practical application of this gear combination. In this design, there are two intermediate pinions (corresponding to *k* in diagram *B*, Fig. 3), which are mounted on an arm and located diametrically opposite each other. This arm is keyed to the end of a shaft. The large internal gear is stationary and forms part of a casing enclosing the gears. The central gear is keyed to another shaft which is in line with the shaft carrying the pinion arm. This arrangement is simply used to obtain a reduction of speed. The design is compact, although differential or planetary gearing, in general, is inefficient as a transmitter of power. Such gear combinations, however, have certain mechanical advantages, and they are often utilized by designers for a variety of purposes, as indicated by the different mechanisms to be described.

Differential Governors for Water Turbines

Many of the automatic governing devices used for controlling the speed of water turbines have a differential action. A simple form of governor is illustrated in principle by the diagram *A*, Fig. 5. An auxiliary water motor drives the bevel gear *a* by belt *d*, and bevel gear *c* is driven by belt *e* from a shaft operated by the turbine to be governed. Both gears *a* and *c* are loose on their shaft, but the arm *n* which carries the bevel pinions *b* is fast to the shaft. On one end of the shaft there is a pinion *f* which meshes with a rack *g* that operates the turbine gate, and thus controls the flow of water to the turbine. The auxiliary motor has no work to do except to drive part of the governing mechanism, and it runs at practically a constant speed. The variations due to the rise or fall of the water level are so small a percentage of the total head of water that the speed of this motor is little affected. It will be assumed, then, that the speed of gear *a* is practically uniform. The speed of gear *c*, however, changes with an increase or decrease of the load upon the turbine, and, as gear *c* runs faster or slower than gear *a*, the arm *n* follows it around one way or the other, and in this way opens or closes the turbine gate.

The governor shown at *B* also has a differential action, but it is controlled by centrifugal force acting on a fly ball governing device. The governor is operated by a belt *a* connected with the turbine. This belt passes around idler pulleys and over the wide-faced pulleys *b* and *c*. These pulleys, through bevel gearing, drive the differential gearing composed of gears *d*, *e* and *f*. Gears *d* and *e* are loose on their shafts and pinion *f* is pivoted on an arm that is keyed to the shaft. Gear *e* is connected by the gearing shown with a centrifugal governing device at *g*. The belt pulley *b* is conical and the diameter at the center is the same as that at pulley *c*. When the turbine is operating at normal speed, the belt is at the center of the conical pulley *b* and, consequently, gears *d* and *e* revolve at the same rate of speed in opposite directions. The result is that the arm carrying pinion *f* remains stationary. If the turbine begins to run too fast, the balls at *g* move outward under the action of centrifugal force, and belt *a* is shifted by a mechanism (not shown) to a smaller part of the conical pulley *b*. The resulting increase in the speed of gear *d* causes the arm carrying pinion *f* and the shaft *h* to which it is attached to revolve in the same direction as gear *d*. As a result of this movement, the turbine gate is lowered by means of gearing (not shown), and the speed of the turbine wheel is reduced. If the turbine should begin to run more slowly than the normal speed, the shifting of belt *a* by governor *g* would cause gear *d* also to revolve slower, thus turning shaft *h* in the opposite direction and raising the gate.

Another modification of the differential governor is shown by the diagram Fig. 6. This particular type of governor was installed in one of the large power plants at Niagara Falls. It is equipped with two sets of epicyclic gearing. The gears *A* and *B* are free to turn on the shaft, but may be retarded by brake bands at *E* and *F*. The inner gears *C* and *D* are driven by belts connected in some way with the turbine. One of these belts is open and the other crossed, so that the gears revolve in opposite directions. The brake bands are so arranged that, when one tightens, the other loosens its grip on the brake drum. Both of these bands are operated by a shaft *G*, and the tightening of the bands is effected by a double ratchet mechanism (not shown) having two pawls. One pawl rotates shaft *G* in one direction and the other in the opposite direction. When the speed increases or decreases, one pawl or the other is operated by a fly-ball governor driven from the turbine. As the result of this motion of the pawl, one band is tightened and the other released, so that one of the gears *A* or *B* is held with a greater or less degree of friction or is prevented from turning altogether, while the other one runs free. If gear *A* is held by the brake, the arm carrying pinion *H* will begin to turn in the same direction in which gear *C* turns, whereas, if gear *B* remains stationary, the arm carrying pinion *J* will follow gear *D*; consequently, the pinion *K* on the end of the shaft will, by means of a rack, raise or lower the turbine gate. This governor depends for its sensitiveness upon the fly-ball governing device, and for its power upon the open and crossed belts, which may be proportioned to transmit any required amount of power.

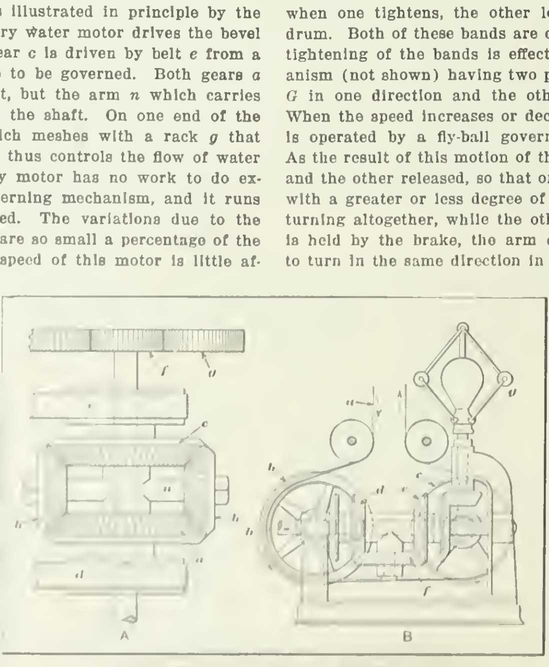

Fig. 5. Differential Governing Devices for Water Turbines

Compound Planetary Gears for Varying Speeds

The planetary speed changing mechanism shown in Fig. 7 has spur gears

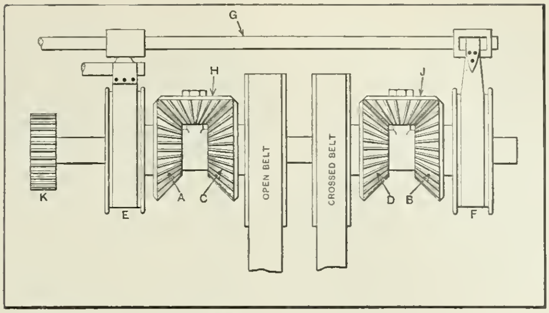

Fig. 6. Differential Governing Mechanism controlled by Ratchet-operated Brakes

and pinions but no internal gear. This is a compound or reverted train and is intended for an automatic screw machine of the heavier class (the Cleveland), in order to provide a slow and powerful movement to the spindle for heavy thread-cutting operations, or for any other heavy work that requires a powerful drive. The gearing is contained within the spindle-driving pulleys on the back-shaft of the spindle head. There are three pulleys, and the slow speed is obtained by shifting the belt to the center pulley *A*, and engaging the sliding clutch *B* with gear *C*; as this clutch slides upon a square shaft and cannot revolve, the gear *C* is held stationary. There are two sets of planetary pinions *D* and *E* located diametrically opposite each other. The pinions on each stud are locked together but are free to revolve about the stud. Pinions *D* rotate around the fixed gear *C*, while pinions *E* revolve the driven gear *F* at a slow speed, but with considerable power. Gear *F* is keyed to the extension of pinion *G*, which meshes directly with the front spindle gear of the machine. When this slow speed is not required, clutch *B* is disengaged, so that the entire train of planetary gears is free upon the loose center pulley *A*. Two spring plungers (not shown) attached to pulley *A* engage the rim of pulley *L* and cause both pulleys to revolve together when the slow-speed attachment is not engaged, so that the planetary pinions will not revolve upon their studs at this time. Clutch *B* is shifted by a cam-operated rod *H* acting in conjunction with a spring *J*.

With this arrangement of gearing, the differential action and reduction of speed is the result of the difference in the diameters of pinions *D* and *E* and their mating gears. When the slow-speed attachment is operating, the larger pinions *D* roll around the stationary gear *C* and force gear *F* to follow slowly in the same direction. This action will be more apparent if that part of the larger pinion *D* which is in engagement with stationary gear *C*, at any time, is considered as a lever pivoted at the point where the teeth mesh with the stationary gear. As the pinion *D* revolves and the imaginary lever swings around its fulcrum, the teeth of the smaller pinion *E* in contact with gear *F* force the latter to move in the same direction in which the rolling pinions *D* and *E* and pulley *A* are moving.

Planetary Gearing Combined with Cone Pulleys

The use of a cone pulley and planetary gearing is shown at *A*, Fig. 8. The cone pulley has a pinion *a*, which meshes with pinion *b*, mounted on a stud carried by plate c. Pinion *b* also meshes with an internal gear forming part of casting *e*. This casting and the cone pulley are both loose upon the shaft, but plate c is keyed to it. When lock-pin *d* engages a notch in plate c, the gears are locked together and the shaft is driven directly by the cone, the entire mechanism revolving as a unit. When lock-pin *d* is engaged with a stationary arm *g*, the internal gear is prevented from rotating and motion is transmitted to the spindle of the machine from the cone pulley, as pinion *a* causes pinion *b* to revolve about the stationary internal gear and carry with it plate c, which transmits a slower speed to the spindle than is obtained with the direct drive. This design, which has been applied to some upright drilling machines, is sometimes known as a "differential back-gear."

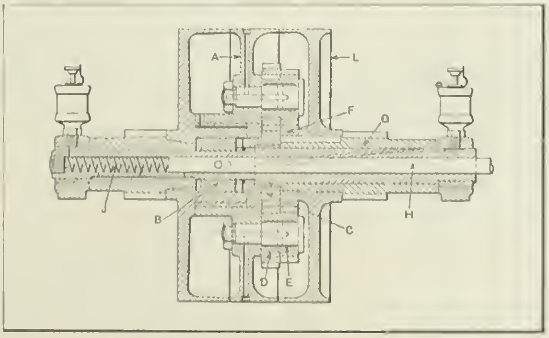

Fig. 7. Compound or Reverted Train of Planetary Gearing for reducing Speed

Another cone pulley containing planetary gearing is shown by the diagram *B*, Fig. 8. Bevel gears are employed in this case, instead of spur gears, and the combination is known as "Humpage's gear." This gearing was designed originally to replace the back-gearing of a lathe, but it has been applied to various classes of machinery. When used in conjunction with a cone pulley, the arrangement is as follows: The cone pulley is loosely mounted on its shaft and carries a pinion *a* which meshes with gear *b*. This gear is locked to pinion c, thus forming a double gear that is free to turn about arm *d*, the hub of which is also loosely mounted on the spindle or shaft. Gear *b* meshes with gear *f*, whereas pinion c meshes with gear *e*. Diametrically opposite arm *d*, there is another arm which carries gears corresponding to *b* and c. This additional gearing is included because of its balancing effect and need not be considered in studying the action of the gearing. Gear *e* is keyed to the spindle, and, except when a direct drive is employed, gear *f* is stationary. With fulcrum gear *f* stationary and gear *a* revolving, gear *e* and the spindle are rotated at a much slower speed, as arm *d* and the intermediate connecting gears roll around gear *f*. The direction in which gear *e* rotates for a given movement of gear *a* depends upon the ratio of the gearing, and the direction may be reversed by changing the relative sizes of the gears. When the ratio $\frac{f \times c}{b \times e}$ is less than 1, gears *a* and *e* will revolve in the same direction, whereas, if this ratio is greater than 1, they will revolve in opposite directions. This is a very compact form of gearing and the velocity ratio may be varied considerably by a slight change in the relative sizes of the gears.

The velocity ratio when $\frac{f \times c}{b \times e}$ is less than 1 may be determined by the following formula, in which the letters represent the numbers of teeth in the gears marked with corresponding reference letters in the illustration:

$$\text{Ratio} = \frac{\frac{f}{a} + 1}{1 - \frac{f \times c}{b \times e}}$$

If gear *a* has 12 teeth, *b*, 40 teeth, c, 16 teeth, *e*, 34 teeth, and *f*, 46 teeth, then:

$$\text{Ratio} = \frac{46/12 + 1}{1 - \frac{46 \times 16}{40 \times 34}}$$

$$= \frac{4\ 5/6}{39/85} = 10.53 +$$

Therefore, gear *a* will revolve 10.53 times while gear c is making one revolution. If the expression $\frac{f \times c}{b \times e}$ is greater than 1, the formula may be changed as follows:

$$\text{Ratio} = \frac{\dfrac{f}{a}+1}{\dfrac{f\times c}{b\times e}-1}$$

Differential Gearing of Automobiles

One of the important applications of planetary or differential gearing, at the present time, is found in automobiles. The object of transmitting motion from the engine to the rear axle through differential gearing is to give an equal tractive force to each of the two wheels and, at the same time, permit either of them to run ahead or lag behind the other, as may be required in rounding curves or riding over obstructions. The axle is not formed of one solid piece, but motion is transmitted to the right- and left-hand wheels by means of separate sections, the inner ends of which are attached to different members of the differential mechanism. The type shown in Fig. 9, which is equipped with bevel gearing throughout, is very generally used, although some "differentials" have spur gears instead of the bevel form. The propeller shaft extends from the transmission case where speed changes are obtained, and revolves the bevel pinion *N* which drives the large bevel gear *M*. This gear *M* and the casing *O* to which it is bolted revolve freely on the hub of gears *F* and *E*. Attached to the casing *O* are radial pivots on which bevel pinions *D* revolve loosely. These pinions engage bevel gears *E* and *F* which are connected with the right- and left-hand axles or shafts *T*. Under ordinary conditions, the rotation of gear *M* causes gears *F* and *E* both to revolve at the same rate of speed, since the connecting pinions *D* are moved around with the casing *O*, but do not revolve. To illustrate the action, assume that the wheels are jacked up and are simply revolving in one position; then, if one wheel is held from turning so that, say, gear *E* is stationary, the rotation of bevel gear *M* will roll pinions *D* around on gear *E*, with the result that gear *F* will revolve twice as fast as when gear *E* is revolving with it and at the same speed. On the other hand, if the opposite wheel and gear *F* were held stationary, the gear *E* would run at twice its normal speed; moreover, if the speed of either of the gears is reduced, the other side is speeded up a corresponding amount

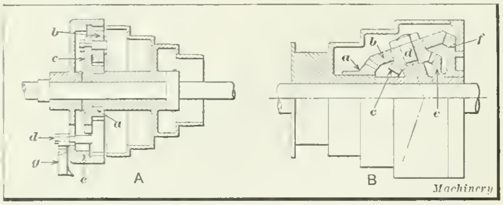

Fig. 8. Planetary Gear and Cone Pulley Combinations for varying Speed

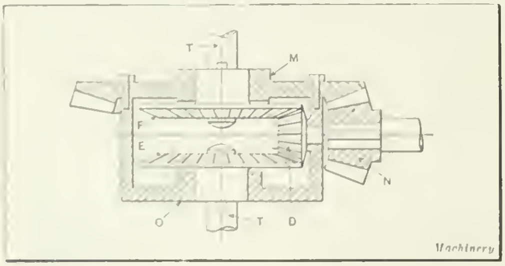

Fig. 9. Common Type of Automobile Differential Gearing

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Where the western division of the East-West Transcontinental Railway of Australia crosses the Nullabor Plain there is a section of 330 miles of absolute straight line, which is the longest length of straight line on any railway in the world.

ROLLER CHAIN STANDARDIZATION

A joint meeting of the roller chain committee of the American Society of Mechanical Engineers and the roller chain division of the Society of Automotive Engineers' standards committee was held in connection with the annual convention of the American Society of Mechanical Engineers in New York last December. It was recommended that roller chain be standardized as follows:

The pitches are to be the existing series of roller chain pitches—½, ⅝, ¾, 1, 1¼, 1½, 1¾, and 2 inches, with the addition of a 2½-inch pitch.

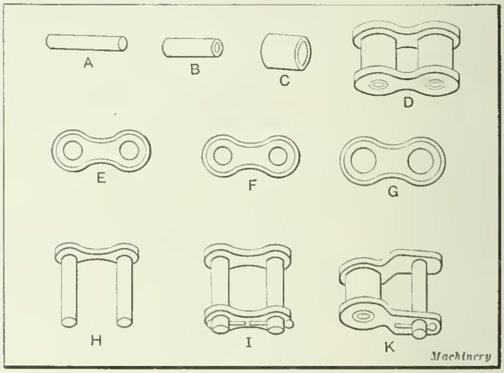
A series of roller diameters was recommended as follows:

Pitch	½	⅝	¾	1	1¼	1½	1¾	2	2½
Roller diameter..	0.306	0.400	15/32	⅝	¾	⅞	1	1⅛	1 9/16

The width of chains, defined as the distance between the inside links, was recommended as follows:

Pitch	½	⅝	¾	1	1¼	1½	1¾	2	2½
Width	¼	⅜	½	⅝	¾	1	1	1¼	1½

The serious results from the use of sprockets with over-size "bottom diameters," and chains with under-size "lengths" were emphasized. It was also recommended that the trade numbers of roller chains giving the recommended pitches be prefixed by the word "Universal." The number of the chain is equal to the number of quarter-inches in the pitch; thus, for example, a chain of ½-inch pitch will be known as "Universal No. 2 roller chain."



Nomenclature of Roller Chain Parts

The nomenclature indicated by the accompanying illustration was recommended for the component parts of a roller chain: *A*, pin; *B*, bushing; *C*, roller; *D*, roller link; *E*, pin link plate; *F*, connecting link plate; *G*, inside plate; *H*, pin link; *I*, connecting link; *K*, offset link.

* * *

ECONOMY IN USE OF LUBRICATING OILS

Notices are displayed in German machine shops giving hints on economy in lubricants which should be valuable in any country. These are:

Use only closed oil-cans with spouts that will deliver drops or at most only a thin stream.

Use all lubricating apparatus strictly according to the instructions and put the oil only where it will actually lubricate. If a machine has automatic droppers, shut off the supply while the machine is standing.

Do not use cylinder oil on shafting or elsewhere when cheaper oil will answer.

Keep all rubbing surfaces in good condition; rough surfaces and too tight boxes consume more oil; worn and leaky bearings waste oil.

Always use drip pans and arrange to filter and cleanse the oil so caught; it is as good as new.

Collect all greasy waste and wiping cloths, so that the oil may be recovered; never burn them.

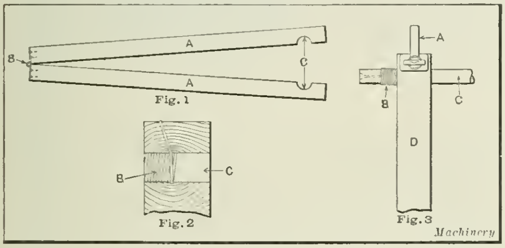
Be careful about using lubricating oil for cooling a bearing; water will often do as well.

Be careful about using oil for cleaning and polishing. Never clean the hands with oil; a greasy cloth will do as well.—*Commerce Reports*

DEVICE FOR WINDING SPRINGS

BY GUSTAVE J. HORAK[1]

No doubt everyone, at one time or another, has experienced trouble in making helical expansion and compression springs. While most springs may be made by clamping the wire between two pieces of brass and the tool-holder and setting the lathe so as to feed a certain number of revolutions per inch, phosphor-bronze or brass wire often gives trouble because the tension is not strong enough or is irregular. It is well known that, although phosphor-bronze wire is not as hard as piano wire, it does not hold its shape after being bent as well as the latter. Springs made of fine wire but of large diameter generally give trouble. When they are taken off the mandrel, light can be seen between the coils, and the springs are very weak, because the larger the diameter of the spring the smaller is the angle at which the wire bends, and consequently, as there is no tension, there is no contracting energy in the spring. It is necessary, in such a case, to find some means of pressing the coils against one another as the spring is forming, in order that there may be no air space between the coils when the spring is finished.



Figs. 1 to 3. Method of winding Brass or Phosphor-bronze Springs

To accomplish this result, the writer uses two pieces of hard wood, which are hinged and grooved as shown in Fig. 1. Hard wood is absolutely necessary, as the harder the wood is the longer it will hold the thread that is cut into it. The strips *A* of wood should be about eight or nine inches long, an inch wide, and a half inch thick; the length depends on the diameter of the spring. The strips are fastened together at one end by a hinge *B*, and a groove *C* is cut near the other end. This groove must fit the mandrel on which the spring is to be wound, but it must not be so deep that it will entirely enclose the mandrel; the ends of the sticks should be separated about three-sixteenths inch when the strips of wood are clamped over the mandrel.

Drill rod should be used for the mandrel because its surface is hard and smooth and it is not readily cut by the pressure on the spring; but if only a small number of springs are to be made, Bessemer rod will do. The objection to using a soft rod is that after a number of springs are wound, the surface of the mandrel becomes cut and grooved so that the spring becomes uneven. One end of the mandrel should run on a center while the other end is held in a chuck so that the rod will run true. A small hole should be drilled through the rod near the chuck end so that the wire can be passed through it and fastened by being bent over on the other side.

Now as the wire is held tightly with one hand the machine should be turned over with the other and six or seven coils formed on the mandrel; then form two coils on top of the coils already formed, winding the wire back at such an angle that about one-half revolution will bring it on top of and between the second and third coils of the spring. Great care must be taken to hold the wire very tightly, so that when it is wound on top of the other coils, it will not slip down between the coils. When the wire is wound on top properly, it should appear as is shown in Fig. 2, where *B* represents the coils of the spring, and *C* the groove in the block.

The blocks should then be placed over the mandrel so that the grooves will fit over the spring snugly and a hand vise or clamp fastened over them just tight enough to hold the wire in place. As the machine is again turned by hand, the wire should cut into the wood, reproducing the shape and coils of the spring. The section of wire that is laid back must rest on top of the wire and not down between the coils. This is easily done by holding the wire very tightly until the clamp is in place. When the spring has once cut a thread in the wood, this part of the wire should cut a deep groove in the wood running diagonally back across the rest. The impression in the wood should be as shown in Fig. 2.

The point where the wire begins to turn back must always be embedded in the wood; it must never come in the space between the strips of wood. When the impression is once made in the wood, the same grooves can be used many times by taking care to see that the wire is always in the same grooves at the beginning as in the case of the last spring cut. When a few turns have been made, after clamping the strips together and making sure that no space can be seen between the coils, the clamp should be tightened still more. If a space appears between the last two turns and the rest of the spring, the overlapped wire has sunk down, showing that the wire was held too loose at the beginning. The remedy is to take off the clamp and start over again, taking care to hold the wire very tightly.

It is better to tighten the clamp a little at a time, making a few turns between each tightening, because then a thread is cut in the wood gradually and the overlaid wire is not forced down, as it will be if the clamp is tightened too much at once. This precaution is necessary only when a new groove is being started; after a groove is once formed, the clamp may be tightened sufficiently at once. If no space can be seen between the coils when the clamp is tightened the second time, the blocks should be held in one hand and the power started. As the spring forms, it will force the blocks toward the end of the rod, and all that is then necessary is to feed the wire fast enough. It does not have to be held tight, as there will be sufficient tension between the blocks.

This method eliminates all the trouble of setting up a lathe to a certain feed per inch to correspond with the number of turns in the spring, which was always necessary by the old method; and it sometimes happened that the right feed could not be obtained. As high a spindle speed can be used as can be obtained without overheating the wire. The spring will become heated considerably, but this does no harm unless the wire begins to color; in this case a little lard oil should be applied to the mandrel; never on the spring. However, oil should be used only when absolutely necessary, as the slight heating increases the strength of the spring. This is especially true of phosphor-bronze and spring brass wire, which will stand considerable heat without annealing.

Sometimes the temper of wire varies; some wire will be found harder and more brittle than another section off the same spool. In such cases it will be necessary to vary the tension on the wire. The harder the wire, the less it will have to be laid back, and *vice versa*. Different tensions are easily obtained by laying the wire back more or less. Experimenting with different kinds of wire will soon show the exact tension required. If after the spring is taken off the mandrel it forms a series of loops when expanded, the wire was laid back too far. If the spring has no strength, the tension was not sufficient. For average wire, two turns back will be found about right. The method of clamping blocks over the wire is shown in Fig. 3, where *A* is the clamp, *B* the wire, *C* the mandrel, and *D* the wooden blocks. The wire should run up through the blocks from the back of the lathe. Wire up to one-eighth inch in diameter can readily be wound by using longer clamps and blocks.

Helical compression springs can also be made by this method. In this case a hook should be made out of a piece of wire, the exact diameter of the space between the coils of the spring that is to be made, and passed over the rod between two coils of the wire. The wooden strips should be clamped over the mandrel as before and the threads cut. When this is done the wire hook can be removed.

It will be found that with this device one man can make three or four times as many springs as was possible before, and they will be more uniform. Although used in many cases, this method has never failed to produce good results.

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[1] Address: 286 E. 70th St., New York City

GRAPHIC METHOD OF GENERATING AN INVOLUTE GEAR TOOTH

EASY METHOD OF LAYING OUT GEAR TEETH ABOVE AND BELOW BASE CIRCLE

BY DOUGLAS T. HAMILTON[1]

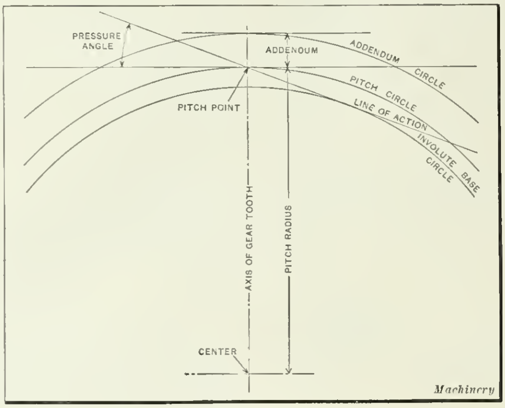

Fig. 1. Laying out Tooth Elements on Tooth Axis

An involute curve is one that may be described by the end of a cord as it is unwound from a circle. In practical gear-tooth design, however, the string is replaced by more exact methods of generation, which, however, are just as simple in principle and are easily mastered by any draftsman or mechanic. The method described here is a practical and correct way of generating an involute gear tooth like that produced by the gear shaper.

The first thing necessary is to decide on the scale to which the drawing is to be made. If an analysis of the tooth action merely is desired, an enlargement of 4 to 1 is satisfactory. If, on the other hand, it is desired to find the strength of a gear tooth, a 10 to 1 scale is preferable. The next step is to draw a vertical line representing the axis of the gear tooth, as shown in Fig. 1, then lay off on this line the various elements of the tooth, such as the addendum and the pitch radius. Now, placing the needle point of a pair of compasses (or trammels) on the center of the gear, describe the pitch and addendum circles, and the base circle, from which the involute curve of the tooth is generated. The position of the base circle can be determined by means of a protractor, or it can be calculated. To find the base circle diameter by calculation, multiply the cosine of the pressure angle by the pitch diameter. If a drafting machine is available, set it at 14½ degrees or 20 degrees, depending on the pressure angle of the gear to be investigated; then move it until the horizontal scale is on the point where the pitch circle cuts the vertical center line (this is known as the pitch point), and draw the angular line that represents the pressure angle or line of action. Then describe a circle that is tangent to and cuts this line, as illustrated in Fig. 1. With a pair of dividers, lay off the distance indicating the thickness of the tooth on the pitch line.

Generating the Involute Curve

The involute curve for a gear tooth can be very accurately laid out on the drafting board if proper care is taken. After the base circle diameter is laid out, with a pair of dividers, space off on it an equal number of divisions. The number of divisions is unimportant, but the smaller the divisions the more accurate will be the curve that is constructed. As a general rule, the divisions should be such that the arc between the axis of the tooth and the point of tangency of the line of action with the base circle diameter should be divided into five equal parts.

After dividing the base circle, as shown in Fig. 2, draw lines tangent to the base circle, starting from the various points of division on the circle. If a drafting machine is not available, this can be accomplished by drawing lines from the division points on the base circle to the center of the gear and then using a regular triangle for laying off the tangent lines. If a drafting machine is available and has a scale long enough to reach from the base circle radius to the center, these radial lines are not necessary. If, on the other hand, the scale on the drafting instrument is not long enough, the radial lines should be drawn and one scale of the drafting instrument should be set parallel with these radial lines and the drafting instrument moved up, as shown in Fig. 3; lines tangent to the base circle may then be drawn from the points of tangency. This procedure is continued until enough divisions have been made for the involute curve of the tooth to be laid off accurately.

When the tangents, as indicated in Figs. 2 and 3, are drawn, the involute curve of the tooth above the base circle may be laid off. Set the needle point of a pair of compasses on the division point *A* of the base circle, Fig. 4; this is the starting point on the tangent line nearest to the point on the pitch

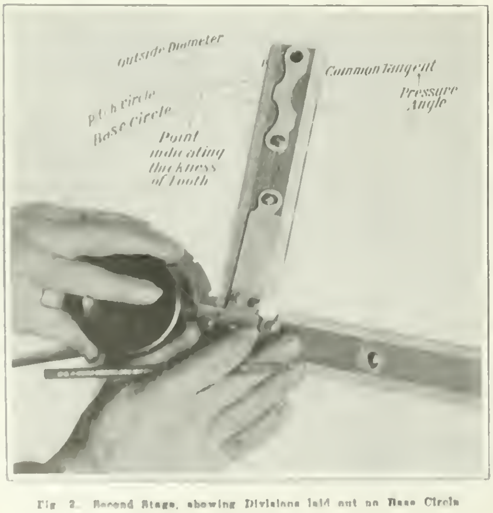

Fig. 2. Second Stage, showing Divisions laid out on Base Circle

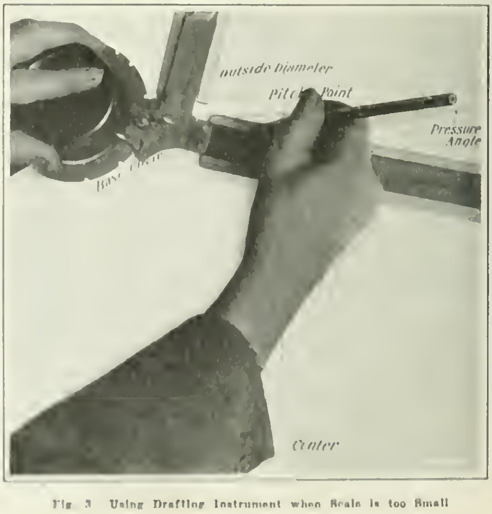

Fig. 3. Using Drafting Instrument when Scale is too Small

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[1] Address: 45 Woolson Ave., Springfield, Vt.

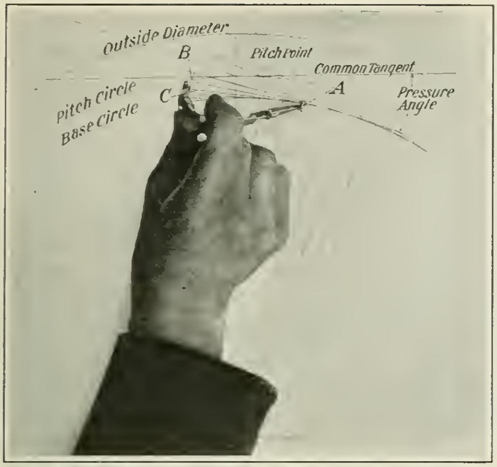

Fig. 4. Laying off Curve above Base Circle

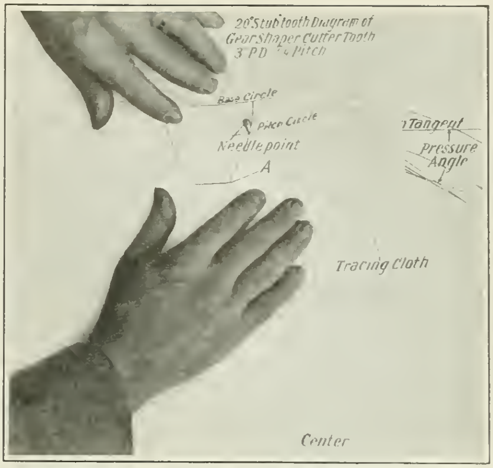

Fig. 5. Diagram of Gear Shaper Cutter Tooth

circle and indicates the thickness of the tooth. Then describe an arc cutting the point on the pitch circle representing the thickness of the tooth and covering the distance included between the two tangent lines *B* and *C*. This process is repeated with the other points of division on the base circle as center points and describing arcs cutting the tangent lines, until the involute curve is complete. Care must be taken in all cases to see that the arcs accurately join each other; otherwise the involute curve will not be accurate. When the curve above the pitch line is complete, the flank and fillet, or that part of the tooth below the base circle, may be generated.

Constructing Diagram for Gear Shaper Cutter Tooth

Before the fillet can be laid out, it is necessary to make a diagram of the gear shaper cutter tooth on tracing cloth. This is constructed in exactly the same way as the gear tooth just described, with the exception that the addendum is made 25 per cent greater than that of the gear tooth. Also, the pitch diameter of the cutter should be made 3 inches for gears of 7 pitch and finer, and 4 inches for gears of 6 pitch and coarser. The scale to which this diagram is drawn should be the same as that used for the gear tooth. The form of the diagram for the gear shaper cutter tooth is shown in Fig. 5.

Generating the Flank and Fillet

The flank and fillet of the gear tooth are generated in a different manner from that used in constructing the involute curve above the base circle. The procedure, however, is simple if the proper precautions are taken. It consists simply in rolling the cutter tooth diagram on the diagram of the gear tooth, care being taken to keep the pitch circles of the two diagrams tangent to each other. Place the diagram, as indicated in Fig. 5, with the two pitch circles and the two involute curves tangent to each other; then, by means of a needle point, prick through the tracing cloth into the drawing, holding the cutter diagram in the position indicated. The cutter tooth diagram is now located on the starting point from which the flank and fillet are generated. To proceed, hold the cutter diagram in place so that it does not slip, and move the needle point from the point of tangency of the involute curve to the place where the two pitch circles start to separate, moving it slightly to the left of the position shown in Fig. 5. With the needle point in this position, swing the tooth diagram toward the gear tooth, and with another needle point prick through the extreme inward point *A* of the cutter tooth. Continue this process until the tooth diagram is rolled around sufficiently on the pitch circle of the gear for the point of the tooth to pass the involute base circle diameter, thus completing the flank and fillet of the gear tooth. If the gear has a small number of teeth and the pressure angle is 14½ degrees, the point of the tooth will not come exactly in line with the involute curve at the base circle, but will fall inside the curve, indicating that there is a certain amount of under-cutting of the tooth.

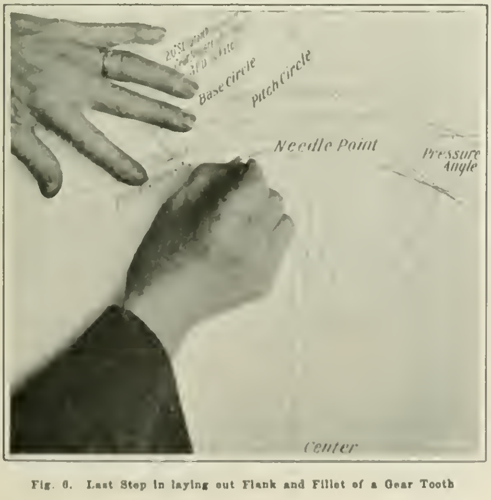

Fig. 6. Last Step in laying out Flank and Fillet of a Gear Tooth

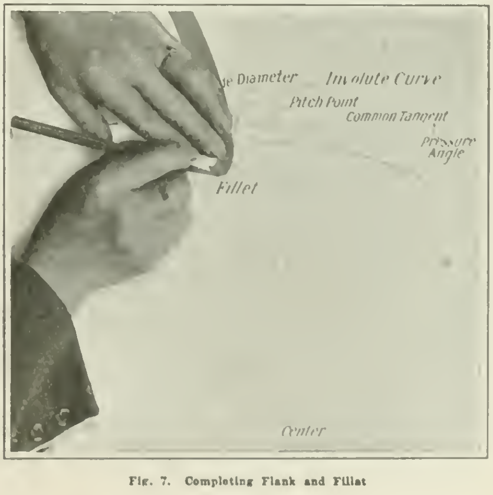

Fig. 7. Completing Flank and Fillet

The only precaution that need be taken in generating an accurate flank and fillet is to draw the tooth diagram accurately, having fine inked lines for the pitch circles and involute tooth curves and using a very fine needle point so that the various points indicating the sweep of the cutter tooth will be accurately located. It is also necessary to keep the cutter tooth diagram from slipping on the drawing and to keep the two pitch circles tangent to each other, or the curve generated will not be accurate. If proper care is taken, however, a very accurate flank and fillet can be generated.

Fig. 6 shows the gear shaper cutter tooth diagram swung around to the point where the point of the cutter tooth has practically reached the base circle diameter. A comparison of this illustration with Fig. 5 will give a clear idea as to how the generation of the flank and fillet is accomplished. After the cutter tooth diagram is swung around to the point indicated in Fig. 6, the construction of the flank and fillet is completed. The only step remaining to complete one side of the gear tooth is to connect the various needle points on the drawing by means of an irregular curve, as indicated in Fig. 7. The other side is generated in a similar manner.

Generating the flank and fillet of a gear tooth produced by a hob is accomplished by using a diagram that, instead of having the outline of the gear shaper cutter tooth drawn on it, has the outline of a rack tooth. The method of generating the lower part of the tooth is the same as that just described, with the one exception that for small numbers of teeth the hob tooth should be corrected for interference, this being automatically taken care of in the gear shaper cutter.

* * *

PROPOSED NEW BRITISH PATENT LAW

The president of the Board of Trade of Great Britain has introduced into the House of Commons a bill to amend the Patents and Designs Act of 1907. The main purposes of the amended bill are stated to be the prevention of abuses of the monopoly rights under patents, and the securing of new inventions that shall, if possible, be worked on a commercial scale in the United Kingdom without undue delay.

The section in the 1907 act which dealt with compulsory working has been cancelled and in its place there is a new section, according to which any person may, at any time, present a petition to the comptroller alleging that there has been abuse of the monopoly rights under the patent, and asking for relief. Monopoly rights under a patent are deemed to be abused if, after the expiration of four years from the date of the patent, a patented invention (being one capable of being worked in the United Kingdom) is not being worked within the United Kingdom on a commercial scale, and no satisfactory reason is given for such non-working. It will also be an abuse of the monopoly rights of a patent if the working of the invention on a commercial scale is prevented or hindered by the importation from abroad of the patented article, either by the patentee or by infringers against whom the patentee has not brought action. It will also be regarded as an abuse of the monopoly rights of a patent if the demand for the patented article is not met to an adequate extent and on reasonable terms; or if the patentee refuses to grant licenses upon reasonable terms; or if any trade or industry is unfairly prejudiced by the conditions attached by the patentee, to the purchase, hire, or use of the patented article, or to the using or working of the patented process. The petition is heard by the comptroller, and if he is satisfied that the allegations are true, he has several alternative modes of dealing with the matter. For instance, the comptroller may grant the petitioner an exclusive or a non-exclusive license, or he may order the patent to be revoked. If the comptroller grants an exclusive license to a petitioner, the patentee is to be precluded from himself working or using the invention, but is to be protected in that he is to secure the maximum royalty compatible with the licensee working the invention on a commercial scale and at a reasonable profit, and he is also to be guaranteed a minimum yearly royalty, the license to be revocable if the licensee fails to carry out the terms of the license. The new proposal appears to be much better and fairer both to the patentee and to the public than are the terms of the present law.

The term of a British patent is fourteen years. There have been constant demands that the term should be lengthened, and it is now proposed that British patents shall be granted for a term of fifteen years, thus bringing British practice into line with that of many foreign countries.

The proposed patent law also provides that if one or more claims in a patent specification are valid, the court, in an action for infringement, may grant relief in respect to the infringed claims without affecting the validity of any other claims in the specification. Hence a patent will not be invalid, as is now the case, if one single claim happens to be invalid, but as much of the patent as is found valid will be upheld and remain in force.

Patents of addition are also covered by the proposed law. At the present time a patent of addition expires with the main patent. This sometimes appears unjust, as the patent of addition may protect valuable new inventions. The amended law provides that if the main patent expires, the patent of addition shall, if a court or the comptroller so orders, become an independent patent, subject to renewal fees and with a life equal to the unexpired portion of the patent.

A bill has also been introduced to amend the Trademark's Act of 1905. This bill, if passed, will effect material changes in the uses of American trademarks in Great Britain, and in some instances will involve the practical confiscation of trademarks and the good will obtained through them. This bill provides that if the proprietor of a word-trademark registered after the passing of the bill, by advertisement or otherwise, causes the general public to make use of the word so registered as the name or general description of an article or type of article, and not as denoting an article or type of article specifically made by the manufacturer himself, the trademark shall be removed by the court from the register of trademarks.

It further provides that at any time after the expiration of four years from the passing of the bill, any word-trademark registered before the passing of the bill which is generally used by the public as the name or general description of any article, may upon the application of any person aggrieved be removed by the court from the register. It is apparent that there are a number of trademarks that have gradually come to refer to articles of a general class, irrespective of who is the manufacturer, and such trademarks would be invalid under this act.

* * *

STANDARD SYMBOLS

The Committee on Technical Nomenclature of the Society for the Promotion of Engineering Education, consisting of John T. Faig, S. C. Earle, W. D. Ennis, F. N. Raymond and Charles Warren Hunt, has prepared the accompanying tentative list of symbols to be used in works on mechanics. This list was prepared through consultation, by means of correspondence, with a large number of professors, editors and engineers in the mechanical field.

A = area;
a = linear acceleration;
b = breadth;
C = constant;
c = distance of extreme fiber from neutral axis;
D = diameter;
d = depth;
E = Young's modulus of elasticity;
e = eccentricity of application of load;
e_h = hydraulic efficiency;
e_m = mechanical efficiency;
e_v = volumetric efficiency;
F = force;
f = coefficient of friction;
g = acceleration due to gravity;
H = head;
H_p = horsepower;
h = height;
I = rectangular moment of inertia;
K = coefficient; constant;
k = radius of gyration;
L = length;
M = moment of force or sum of moments of forces;
m = mass;
N = revolutions per unit of time;
O = center of rotation;
P = concentrated load;
Q = quantity of liquid flowing, in pounds;
R = reaction;
R_h = hydraulic radius;
r = radius;
S_t = unit stress in tension;
S_c = unit stress in compression;
S_s = unit stress in shear;
s = distance passed over;
T = torque;
t = time;
V = volume;
v = linear velocity;
W = weight of a body, or total weight;
w = angular velocity;
y = deflection of beam;
Z = modulus of section.

COMPARISON OF COMPENSATION ACTS

PRINCIPLES ON WHICH COMPENSATION ACTS ARE BASED AND COMPENSATION ALLOWED IN EACH STATE

BY CHESLA C. SHERLOCK[1]

ONE does not get a comprehensive view of the workmen's compensation acts unless a thorough study is made of the compensation laws enacted by each state of the union. An individual statute may be taken as a model and held up for purposes of illustration, but to really know the law of any one state, that law must be compared with the laws of other states. The compensation acts of the different states are modeled quite generally after the English act of 1906. The later American laws had the benefit of the experience of sister states, with the result that some of these laws are, in the words of the Iowa industrial commissioner, "the product of the shears rather than of the pen." Because of this use of the shears, many flaws have crept in which have quite seriously discriminated against the rights of workmen and have unconsciously operated to the gain of the employers.

Compensation is based upon the principle that it is fundamental justice that if a man is injured while engaged in the production of wealth for society, society should share the loss. This principle is so well grounded in common sense and fair play that it became strong enough to overturn the ancient common-law rules for the treatment of injuries and the adjustment of the rights of master and servant. No more revolutionary or drastic legislation was ever enacted, and at the same time was so universally upheld by the courts. Such legislation, from a legal standpoint, would have been impossible a half century ago. It was modern industrialism that paved the way, and it was the increasing interest of the world in this game of industrial achievement that eased the minds of the masses and created the popular demand so necessary to a reform movement.

While there is some difference in the industrial situation of the different states, there seems to be no valid reason for so great a difference in the actual working out of the respective statutes. The principle underlying the compensation laws is the same everywhere. Because of constitutional objections, the acts are largely optional; that is, an employer may come under the provisions of the law at his pleasure or he may reject the terms of the law and run the risk of common-law action for damages. The acts have, however, attempted to save the employer from common-law liability where he has elected to accept the law, and have taken from the workman the right to bring suit at all. In cases where the employer elects to reject the law, the acts have taken from him his old common-law defenses of contributory negligence, assumption of risk, and the so-called fellow-servant doctrine. The effect of this action is that the employer's hands are virtually tied so that he has no means of defending himself in a common-law suit for damages. The tendency has been to make the way of the employe easy and that of the employer hard.

TABLE 1. SCHEDULE OF RATES PROVIDED BY WORKMEN'S COMPENSATION ACTS

State	Per Cent of Weekly Wage	State	Per Cent of Weekly Wage
Massachusetts	66⅔	Minnesota	50
New York	66⅔	Montana	50
Ohio	66⅔	Nebraska	50
California	65	Nevada	50
Wisconsin	65	New Hampshire	50
Kentucky	65	New Jersey	50
Texas	60	Oklahoma	50
Indiana	55	Pennsylvania	50
Ontario	55	Rhode Island	50
Arizona	50	Vermont	50
Colorado	50	West Virginia	50
Connecticut	50	Oregon, $30 to $50 per month maximum	60
Illinois	50	Washington, $15 to $35 per month maximum	60
Iowa	50	Wyoming, $15 to $35 per month	
Louisiana	50	Kansas	25 to 50
Maine	50		
Maryland	50		
Michigan	50		

Machinery

TABLE 2. LENGTH OF PERIOD BEFORE COMPENSATION BEGINS

	Weeks		Weeks
Arizona	2	Nevada	2
California	2	New Hampshire	2
Colorado	3	New Jersey	2
Connecticut	10 days	New York	2
Illinois	1	Ohio	1
Indiana	2	Oklahoma	2
Iowa[1]	2	Ontario	1
Kansas	2	Oregon	None
Louisiana	1	Pennsylvania	2
Maine	2	Rhode Island	2
Maryland	2	Texas	1
Massachusetts	10 days	Vermont	2
Michigan	2	Washington	None
Minnesota	1	West Virginia	1
Montana	2	Wisconsin	1
Nebraska	2	Wyoming	10 days

Machinery

[1] Absorbed in fifth, sixth and seventh weeks of incapacity

There can be no doubt of the wisdom of the attempt to take disputes between employers and employes out of the courts. Litigation under the old order was not very fruitful of results for the injured workman, and in the few cases where recovery was had they were generally grossly unjust to the employer. One man might win $30,000 for the loss of a leg, while dozens of others became public charges and died in almshouses. The common-law theory of damages was based upon the theory of fault. Locate the fault for the injury and the law would then assess damages against the offending party. But our complex industrial system was fast making a farce of this old and tried legal principle. Justice Brandeis, in his dissenting opinion in the case of the New York Central Railroad Co. *versus* Winfield, very ably states the matter in the following words:

> In the effort to remove abuses, a study had been made of facts, and of the world's experience in dealing with industrial accidents. That study uncovered as fiction many an assumption upon which American judges and lawyers had rested comfortably. The conviction became widespread that our individualistic conception of rights and liability no longer furnished an adequate basis for dealing with accidents in industry. It was seen that no system of indemnity dependent upon fault on the employer's part could meet the situation, even if the law were perfected and its administration made exemplary. For, in probably a majority of cases of injury, there was no assignable fault; and in many more it must be impossible of proof. It was urged: Attention should be directed, not to the employer's fault, but to the employe's misfortune. Compensation should be general, not sporadic; certain, not conjectural; speedy, not delayed; definite as to amount and as to time of payment; and so distributed over long periods as to insure actual protection against lost or lessened earning capacity.

While these statements are equally applicable to all the states, a vast difference in their statutes exists. It is worth 16 2/3 per cent more per week of his average wage for a workman to be injured in Massachusetts than in Iowa. A workman in Indiana receives 55 per cent of his average weekly wages, while across the Ohio River in Kentucky he would receive 10 per cent more. A workman injured in Michigan would receive 50 per cent of his average weekly wage, while if he were hurt in Wisconsin, he would receive 15 per cent more, or 65 per cent. Table 1 shows the percentage of his weekly wage recovered by a workman for all injuries suffered by accident arising out of and in the course of the employment. For instance, if a workman earns twelve dollars a week, his weekly payment in Illinois will be six dollars, while in New York it will be eight dollars.

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[1] Address: Box 258, Des Moines, Iowa

Length of Period before Compensation Begins

Compensation does not, however, start as soon as a workman is injured, or even from the date of incapacity. The acts have quite generally provided a "waiting period" for the employer's protection against workmen who would rather feign than work. As a result, compensation does not commence to run until a certain date after the date of incapacity. The waiting period does not date from the time of injury unless the incapacity started at the same time. This distinction between the date of injury and the date of incapacity should be kept in mind, for a man may be injured long before he is incapacitated so that he cannot do his usual work. Take, for instance, a man who receives a scratch on his hand. He may be apparently well for two or three weeks, when blood poisoning will set in and incapacity result.

TABLE 3. MEDICAL AID PROVIDED BY WORKMEN'S COMPENSATION ACTS

State	Length of Period	State	Length of Period
Arizona	None	Nevada	4 months
California	90 days	New Hampshire...	None
Colorado ($100)...	30 days	New Jersey ($50).	2 weeks
Connecticut	30 days	New York.........	60 days
Illinois ($200).....	8 weeks	Ohio ($200).......	
Indiana	30 days	Oklahoma	15 days
Iowa ($100).......	4 weeks	Ontario	None
Kansas	None	Oregon ($250).....	
Louisiana ($150)..	2 weeks	Pennsylvania ($75)	
Maine ($30).......	2 weeks	Rhode Island......	2 weeks
Maryland ($150)..		Texas	2 weeks
Massachusetts — no limit		Vermont ($75)....	1 week
		Washington	2 weeks
Michigan	3 weeks	W. Virginia ($150)	None
Minnesota ($200)..	90 days	Wisconsin	90 days
Montana ($50)....	2 weeks	Wyoming	None
Nebraska ($200)...	21 days		

Machinery

It is a rule that not more than one waiting period can be deducted from the amount of time lost by a workman. In many instances, workmen will be incapacitated one week after the waiting period, will return to work for a day or two, suffer a relapse for a week or so, and return to work again. Oftentimes a workman will make several attempts to return to work when he is not in physical condition to do so.

Table 2 shows the waiting periods in the various jurisdictions in America. The Iowa statute is unique in respect to this provision. While it follows the beaten path and provides for a waiting period of two weeks during incapacity from earning full wages, it reimburses the workman in case his incapacity extends to the fifth, sixth and seventh weeks by providing that one-third of two weeks' compensation be paid him during those weeks in addition to the regular compensation. In this way all the advantages of a waiting period are secured, and, in aggravated cases, the workman is not deprived of two weeks' compensation.

Workmen are often inclined to feel that the compensation acts were designed to favor the employer and to discriminate against them. Perhaps this feeling is never so noticeable as when they realize that there is a waiting period during which they cannot receive any compensation at all. Workmen who find themselves incapacitated and destitute are well-nigh desperate when they must face a waiting period ranging from ten days to three weeks in length. Those who feel this way, however, have lost sight of the underlying principle of compensation, namely, that the acts do not seek to provide damages or indemnity, but to share the loss of wages through the lessened or lost earning power of the injured man. Perhaps the most fruitful source of disagreement in compensation practice is due to a misunderstanding of the purpose of the acts. The old common-law theories of damage are almost as firmly implanted in the minds of the workmen as they are in the mind of the old-fashioned lawyer. It is hard to persuade these people that the "old order changeth" and to make them see the light. But, under the old system, the workman was in a sorry plight. When he became incapacitated, his income stopped and he had slight hope of reimbursement, even through the aid of the courts. The average waiting period under the acts is two weeks. This means that in the great majority of jurisdictions the compensation will start to run on the fifteenth day of incapacity and that the workman will receive his first compensation at the end of the third week.

Medical Aid Provided by Employer

In addition to the compensation provided for, the acts also provide that the employer shall furnish reasonable medical, surgical and hospital aid to the workman within certain limits. The extent of time during which this aid is to run varies greatly in the different states. Limitation is usually placed upon the amount to be expended, as shown by Table 3. It will be noted, however, that the aid provided runs, in the majority of cases, through the entire waiting period at least, so that the workman need not be troubled with medical bills or the dread of them during the time that he is not receiving compensation.

The provision for the payment of medical aid is of great advantage to the average workman. It insures competent medical attention at a time when it is greatly in demand. Further than that, it secures this attention at a time when, under ordinary circumstances, no attention would be given at all if the workman were paying the bills himself. The result is that the workman is back at work as soon as the medical profession can remedy his injuries. It means a conservation of our industrial forces and a preservation of life and limb, which was not possible under the old common-law or employer's liability systems of treating these cases.

Then there is another feature which cannot be emphasized too strongly. The acts generally provide that the employer shall have the right to designate what physician the injured workman shall consult during the time that the employer is required to pay the bill. Workmen often make strenuous objection to this provision of law, but if they really understood it they would see that it was to their own advantage. Inexperienced workmen often do not exercise good judgment in selecting their own physicians. Oftentimes they consult quacks, fakirs and other unscrupulous shysters. They are quick to adopt doubtful remedies and are easily imposed upon by the shyster fraternity. In the end they find themselves stripped of the amount of money set aside for medical aid and they do not have competent care. On the other hand, the employer is anxious to provide competent medical attention because he wants the injured man cured and back at work. As long as a workman is incapacitated, he is a burden upon industry; as soon as he returns to work, he will earn more money and will not be a burden to industry.

Amount of Compensation Allowed

The amount of compensation allowed in the various states is limited by the express wording of the statutes. A certain minimum and maximum is set and all compensation payments must range between these limits. Speaking broadly, the purpose of the acts is to make a payment to the workman graduated according to his earning power, within certain limitations. In New Jersey, for instance, a workman will receive

TABLE 4. MINIMUM AND MAXIMUM WEEKLY PAYMENTS ALLOWED BY WORKMEN'S COMPENSATION ACTS

State	Amount of Payment		State	Amount of Payment	
	Min.	Max.		Min.	Max.
Arizona	.....	......	New Hampshire	.....	......
California	$4.16	$20.83	New Jersey....	$5.00	$15.00
Colorado	5.00	8.00	New York......	5.00	15.00
Connecticut ...	5.00	10.00	Ohio	5.00	12.00
Illinois	6.00	12.00	Oklahoma	6.00	10.00
Indiana	5.50	13.20	Ontario	....	21.15
Iowa	6.00	15.00	Oregon[1]	....	50.00
Kansas	6.00	15.00	Pennsylvania ..	5.00	10.00
Louisiana	3.00	10.00	Rhode Island...	4.00	10.00
Maine	4.00	10.00	Texas	5.00	15.00
Maryland	5.00	12.00	Vermont	3.00	12.00
Massachusetts ..	4.00	10.00	Washington[1] ...	....	35.00
Michigan	4.00	10.00	West Virginia..	5.00	10.00
Minnesota	6.50	11.00	Wisconsin	4.69	9.37
Montana	6.00	10.00		6.25[2]	15.63[2]
Nebraska	5.00	10.00	Wyoming	....	.....
Nevada[1]	20.00	60.00			

Machinery

[1] Per month [2] For railway men

50 per cent of his wages, but the compensation must not exceed fifteen dollars a week nor be less than five dollars. In Arizona, New Hampshire and Wyoming there are no minimum or maximum amounts. Some of the states, such as Nevada and Washington, base the limitation upon the amount to be paid per month, while the remainder of the states express the minimum and maximum payments in terms of weekly payments. Table 4 shows the limitation of payments fixed by law.

Future of Compensation Acts

Compensation, while comparatively new in this country, has withstood the most severe shocks of changing industrial conditions. It is about to be put to a new test, namely, the war test—the fiercest and most unrelenting test that can come to any legislation. If it withstands the shock of war, the compensation system will be assured to future generations. While this is of untold importance, it is not nearly so essential as to preserve the system for the benefit of the working classes during the trials that are bound to come in the next three to five years. A tremendous strain is put upon the industries of this country by the war. Every effort is being made to increase production, to speed up every department of human activity, and to make prompt deliveries. All this means that an unusual number of accidents are bound to occur at a time when they will be doubly costly. Increased accidents will mean an increased loss in life and limb and an increased insurance rate to provide compensation for these unfortunates. All of which means that industry will be taxed with a heavier burden in respect to compensation than is usually the case.

Employers and workmen are beginning to study the compensation laws as they never did before. Workmen are looking to them as a possible haven in case misfortune should overtake them, while employers are making closer calculations as to the burdens that they will likely be called upon to bear. In this study of the acts, no better thought could be kept in mind than that expressed by Justice Pitney in the case of White *versus* New York Central Railroad Co.:

> Compensation under the act is not regulated by the measure of damages applied in negligence suits, but, in addition to providing medical, surgical, or like treatment, it is based solely on loss of earning power, being graduated according to the average weekly wages of the injured employe and the character and duration of the disability, whether partial or total, temporary or permanent.

* * *

PROGRAM OF WAR LABOR ADMINISTRATION

Secretary of Labor Wilson denies that there is any real labor shortage in this country, and says that the scarcity of workers in some places is due entirely to the improper distribution of the men and women available. As a means of remedying this condition, the plan suggested by the Council of National Defense has been adopted. This provides for the establishment of the following six agencies:

1. A means of furnishing an adequate and stable supply of labor to war industries. This will include a satisfactory system of labor exchanges; a satisfactory method and administration of training of workers; an agency for determining priorities of labor demand; agencies for dilution of skilled labor as and when needed.
2. Machinery for the immediate and equitable adjustment of disputes in accordance with principles to be agreed upon between labor and capital and without stoppage of work.
3. Machinery for safeguarding conditions of labor in the production of war essentials; this will include industrial hygiene, safety, woman and child labor, etc.
4. Machinery for safeguarding conditions of living, including housing, transportation, etc.
5. Fact-gathering body to assemble and present data, collected through various existing governmental agencies or by independent research, to furnish the information necessary for effective executive action.
6. Information and education division, which has the functions of developing sound public sentiment, securing an exchange of information between departments of labor administration, and promotion in industrial plants of local machinery helpful in carrying out the national labor program.

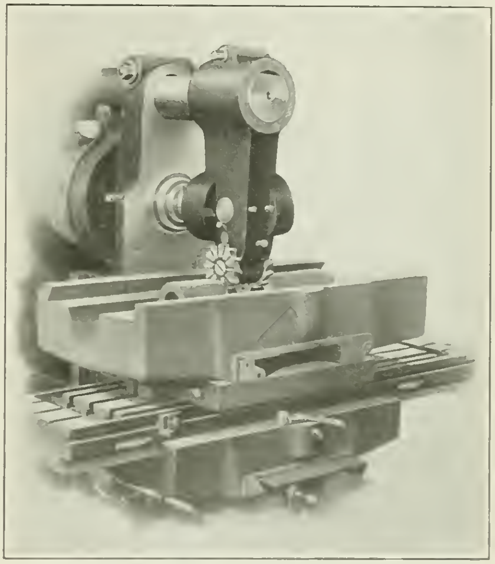
Some of these agencies are already in existence and for several months the Labor Department has been quietly preparing for its employment work. It is now covering the entire continent with a network of labor exchanges and is utilizing the facilities of state and municipal employment offices and the facilities of the various state councils of defense. Already more than two hundred exchanges are in operation and fifty more are to be opened immediately. The department estimates that it must furnish, within the next six months, 1,000,000 workers for agriculture, 400,000 for shipbuilding, 1,000,000 to man the ships, 250,000 for transportation, and 250,000 for munition manufacture. Other war industries will demand a similar number of workers.

John Lind, former governor of Minnesota, has been made chairman of the Advisory Council that will assist in the carrying out of this program. The other members are: Waddill Catching, president of the Sloss-Sheffield Steel & Iron Co., Birmingham, Ala., and A. A. Landon, general manager of the American Radiator Co., to represent the employers; John B. Lennon, of Illinois, and John J. Casey, of Pennsylvania, to represent the employes; Dr. L. C. Marshall, of the University of Chicago; and Agnes Nestor, of Chicago.

* * *

MILLING MACHINE ATTACHMENT FOR FACING FEED NUT ABUTMENTS

In the manufacture of milling machines of the knee type it is necessary to provide some means for facing off the abutments that hold the table feed nut in position in the saddle. These abutments are cast integral with the saddle, and the problem is to machine them square with the axis of the screw and to a specified width. A common method of machining them is to employ a boring-bar with a facing attachment. The boring-bar is used to bore the hole and face the ends at the same setting. However, this is a slow and rather unsatisfactory device for the purpose, being unsuited to straight manufacturing. Moreover, it makes necessary the use of a lathe or similar machine tool that requires considerable floor space



Kempsmith Special Milling Attachment for facing off Feed Nut Abutments

The illustration shows a milling machine fixture used by the Kempsmith Mfg. Co., of Milwaukee, Wis., for facing the abutments on the saddle of the Kempsmith machine. The attachment consists of a bracket mounted on the over-arm that carries at the lower end a short spindle, on which are mounted two milling cutters, one at each end. This spindle is driven by a train of gears from the main spindle. The cutters are set with their faces the distance apart required for the length of the nut that fits between the abutments, and the saddle is fed upward until the cutters are sunk to the required depth. The attachment is also used for facing the outer ends of the abutments.

MANUFACTURING TIME FUSE RINGS[1]

CHARACTERISTICS OF SOME MACHINES FOR ROUTING POWDER GROOVE

BY DONALD A. BAKER[2]

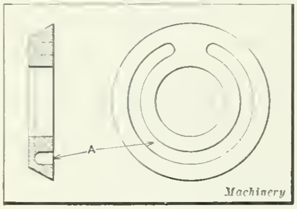


Fig. 1. Type 80 Time Fuse Ring

Of the many parts that make up a time fuse, the brass timing ring, a typical example of which is shown in Fig. 1, proved one of the most difficult to manufacture on account of the accuracy required in the machining of the powder train groove *A*. When the first contracts for time fuses were given out in this country at the beginning of the war, there were no machines on the market that were especially designed for this class of work, so it was necessary for each manufacturer to adopt such machines as came nearest to the requirements and could be purchased in the open market or design and build his own, and in either case it was a matter of experiment. To some it looked like a simple proposition, and machinery in quantity was purchased that was thought suitable but had not been first tried out. Results were anything but satisfactory from a productive point of view, and in the majority of cases the manufacturers, instead of looking around for better means of producing the parts and discarding what was obviously inefficient machinery, struggled along, spending a great deal of money in making changes in the various parts, which in some instances amounted to practically as much as the original cost of the machine, and more than would have been required to design and build entirely new and efficient machines.

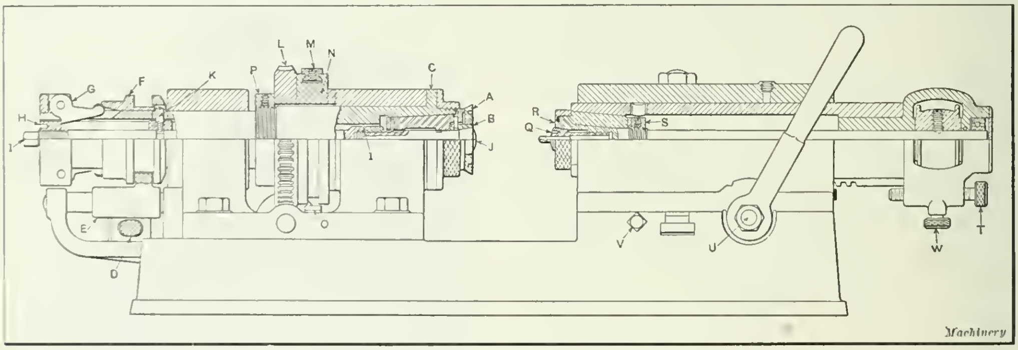


Fig. 2. Machine for routing Powder Groove

One of the manufacturers on the early contracts adopted high-speed drilling machines to which had been fitted suitable rotating and chucking equipment. These machines were used for taking a light finish cut, the groove having been previously roughed out on a special machine, using a circular cutter instead of an end mill. When the machines were put into use, trouble developed in the ball bearings that carried the lower or cutter end of the spindles, due to the unusual side thrust to which these machines were subjected. The ball bearings were replaced by solid bronze bearings, and hardened and ground spindles were used. After the spindle trouble had been reduced to a minimum, it was found that the machines lacked rigidity, the great amount of overhang in all the parts, the large number of gibs, slides, etc., all contributing to this condition. While this was of little account in a drilling machine in which the thrust is all in a vertical or end direction, it became a serious matter when side thrust was applied. It was also found that every change of temperature, such as would occur from the high spindle speeds and the heat of the cut, transmitted to the surrounding metal was sufficient to affect the setting of the machine and produce spoiled work.

There was a special machine on the market having a ball bearing spindle very little different and no stronger than the average drill spindle. The stops which controlled the length of the groove were inconveniently placed and entailed considerable trouble in setting. The work-table had bearings that were hard to adjust and constantly out of adjustment. Altogether the drilling machines before described were more satisfactory than this machine, which was soon abandoned by the manufacturer and the user as far as possible.

Next came a horizontal type of machine, also having a ball bearing spindle. With the work and cutters running dry and with a low production of thirty or forty rings per hour, these machines gave fair satisfaction, but as soon as it was attempted to speed them up and oil or compound was used to keep the cutter cool, the fine brass chips would work back into the spindle ball bearings, in spite of felt washers or other means provided to keep them out, and in a short time the ball bearings were ruined. Replacing the ball bearings in the front end of the spindle housing with solid cast-iron or bronze bearings, and substituting a hardened and ground spindle with double taper bearing surfaces such as are used in high-grade bench lathe spindles solved the spindle trouble. But the machine was still handicapped by inconvenient stops and chucking arrangements, and also by an elaborate overhanging spindle or chuck-driving mechanism. As an illustration of their inconvenience, it may be mentioned that the operators usually kept a piece of wood handy to use as a mallet or pinch-bar for operating the chuck and stops. Fifty to sixty rings per hour was the production of these machines, as attempts to produce more usually led to considerable trouble and loss of time from adjustments and repairs. Another machine that was put on the market might have been a success but for its work and cutter chucking arrangements. The cutter-spindle

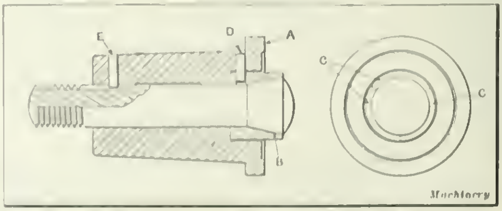


Fig. 3. Expansion Chuck for holding Time Fuse Ring

was of good design, except possibly a little heavier than necessary. The chuck which held the cutter, however, could not be depended upon to hold the cutter true, while the chuck for holding the work was not satisfactory. Nevertheless the machine was of rigid construction, and when the cutter ran true, produced good work. As a matter of fact, one Canadian concern, after remaking the machine as regards the chucking arrangements, obtained very good results.

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[1] For other articles on fuse manufacture and allied subjects published in MACHINERY, see "Tiling Turning, Facing and Serrating Machine," October, 1917; "Gages for Time Fuse Parts," August, 1917; "Fast Indexing Drill Jig for Time Fuse Cap," July, 1917; "Manufacturing Parts of Type 80 Time Fuses," December, 1916, and other articles there referred to.

[2] Address: Care of Anderson Forge Machine Co., Detroit, Mich.

In view of the foregoing, and with full knowledge and experience with the various methods, the machine shown in Fig. 2 was designed. It is essentially a single-purpose machine, built with rigidity, accuracy and durability as a basis of a continuous and uniform product, and for speed and convenience of operation and adjustment, so that the maximum production would be obtained. The problems presented were simply these: the rapid, accurate, and secure chucking of the time fuse ring; the accurate and positive chucking of a suitable cutter; a spindle for carrying the cutter and its chuck which would be so stiff that it would not spring out of line due to the side thrust of the work, and having suitable bearings so that it could be run continuously at a speed of from 6000 to 7000 revolutions per minute; a spindle for carrying the work and its chuck, and having means of rotating it slowly at given speeds as determined by the ability of the cutter to remove metal; a suitable starting and stopping device to control the lengths of the cuts; and means of advancing the cutter to the work, stops for depth of cut and adjustments for position or diameter of cut.

The illustration shows the principal details of construction in section. A finished time fuse ring *A* is shown mounted on the expansion chuck *B*. The construction of this chuck is better shown in Fig. 3. It consists of a body *A* of tool steel, hardened and ground, an expanding mandrel *B* and the three expanding jaws *C*, hardened and ground. Mandrel *B* is lapped to a good sliding fit in *A*. The jaws are held in the body of the chuck by three pins *D* that are driven into the chuck body but are a free fit in the jaws. The expanding mandrel passes through the jaws, has a bearing at both ends of the chuck body and is kept from turning by the key *E*, which is driven through the chuck body and engages with a keyway cut at the end of mandrel *B*. The assembled chuck is fitted into a taper in the front end of the work-spindle *C*, Fig. 2. The chuck is opened and closed by means of the hand-lever *D*, which operates the slide *E* and the spool *F*, which, in turn, acting through the fingers *G* and the nut *H*, draw back the rod *I* and also the expanding mandrel *J*, to which rod *I* is attached. To make sure that the chuck releases properly when the hand-lever *D* is pulled in the opposite direction, carrying the spool *F* with it, the spool strikes the pins *K*, which project through slots in the work-spindle. These pins engage with a groove turned in the draw-rod, so that the spool, striking against them, is sure to push rod *I* forward, which, in turn, will force the expanding mandrel out a slight distance so that the chuck jaws will close and release the work.

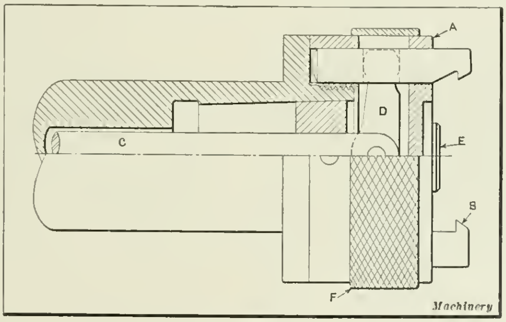

Fig. 6. Chuck for holding Type 85 Time Fuse Ring

The work-spindle is rotated by means of a worm and worm-gear *L*, the worm being driven by means of a round rawhide or leather belt passing over a grooved pulley. Two stops *M*, one for starting and the other for stopping the rotation of the spindle and controlling the length of the powder groove, are carried on the drum *N*, a groove being turned completely around it and cut away at one place to allow the inserting of the stops. These stops are held in place by headless set-screws, which force them out against the angle of the groove, giving them a wedging action and holding them securely. As the spindle revolves the stops strike against the sliding pin *O*, which is held up by a coil spring but is operated and thrown out of engagement, allowing the spindle to continue its travel, by means of a foot-treadle placed conveniently to the operator's left foot. Adjustment for end play of the spindle is made by means of the nut *P*. Adjustment for wear of the work-spindle hardly had to be taken into consideration on account of the slow speed and ample bearing surface, but, as a precaution, one side of the bearings was split along the center line with a one-eighth-inch milling saw, and a metal shim inserted; then holes were drilled and tapped through it and cap-screws inserted before the bearings were bored, so that, if necessary, a slight amount of adjustment may be had by removing the shims and thinning them down a little and replacing.

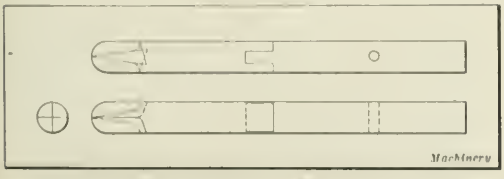

Fig. 4. Cutter and Pin affording a Stop and Positive Drive

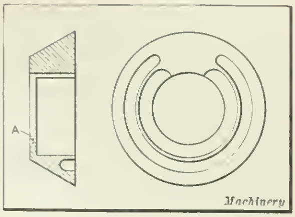

Fig. 5. Type 85 Time Fuse Ring

The cutter-spindle has a spring collet *Q* of somewhat similar construction to a bench lathe collet, which was decided upon as the best way to hold the cutter. The type of chuck used made it impossible to make the front end of the spindle so small as to be springy. To avoid making a hollow spindle, which would have been necessary if the usual draw-rod had been used for tightening the chuck, three holes were drilled in the face of the chuck, and a spanner wrench, having pins driven into it to fit the holes in the chuck and a hole through it to pass over the cutter, is used to tighten the chuck. This method also eliminates any danger of buckling the spindle from tightening a draw-rod through the center of it. As a stop for the back end of the cutter, and also to provide a positive drive without having to screw the chuck into the spindle with unusual force, the cutter is made as shown in Fig. 4, having a slot at the back end, while a hardened steel pin is driven into the back end of the collet, as shown, and pinned securely in place.

The spindle *R*, Fig. 2, has a double taper and is made of high-carbon machine steel, pack-hardened and ground all over. It is carried at the front end by a bronze bushing, ground to fit the double tapers on the spindle, the spindle being carefully lapped to a perfect fit in it. Small felt pads, inserted into holes drilled through the bottom of this bushing and connected by oil-grooves from the spindle housing, insure a continuous and plentiful supply of oil for the spindle. The end play of the spindle is taken up by means of the nut *S*, which is placed just back of the front bearing, while a hardened washer is keyed to the spindle between the nut and the bearing, taking the wear, and in connection with a locking screw through the nut, preventing changes of adjustment. As the end play is taken up so near the front end of the spindle, the spindle can run so hot that it cannot be touched by the hand without affecting the adjustment a noticeable amount, and as the ball bearing at the other end of the spindle has plenty of end play, the spindle always runs free, yet without any looseness. The bushing, or front bearing, is made removable.

so that in case of damage or wear it can easily be replaced. The back end of the spindle also has a bearing in the pulley housing that carries the stop-screw *T*; this screw is used to control the depth of the cut of the groove in the time fuse ring. On the outside right-hand end of the spindle housing on the under side a groove was milled, into which was fitted a rack. This rack meshes with a pinion connected through the shaft *U*, and the hand-lever is the means of advancing the cutter to the work. On the back side of this hand-lever is a simple locking device that engages with the V-groove shown, when the cutter is advanced into the work and serves to hold it there until the end of the cut.

Operation of Machine

The setting up the machine is usually accomplished by the aid of a master ring that is placed on the chuck; then the cutter is set as near to it as possible and the stops are adjusted. A blank ring is next placed on the chuck and a trial cut made and gaged. When the stops which control the length of the cut, and the cutter-head, which controls the diameter, have once been set, they need no further attention, as they will retain their setting indefinitely. The cutter-head is set by opposing screws *V* and clamped by two bolts which pass through the cutter-head casting and enter T-slots in the base. The setting for depth of cut is obtained by means of a block of proper thickness, which is held against the face of the chuck, the cutter being brought up against it and the adjustments being made by means of the knurled head screw *T* and locked by screw *W*. This adjustment needs attention only when changing cutters, as the cutters vary somewhat in length.

After the machine is properly set up, the operation is as follows: A ring is placed on the chuck by the right hand, and locked in place by operating the hand-lever *D* with the left hand. The right hand is then free to bring the lever on the cutter-head forward, and as the cutter enters the work it is automatically locked by means of the lock on the back of the hand-lever which engages with the V-groove. As soon as the lever is locked in the forward position, the foot-treadle underneath the machine is depressed, disengaging the pin *O* from the stop *M*, and the work-spindle commences to revolve and continues until the leading stop again strikes against pin *O* when the cut is completed. The lever on the cutter-head is then pushed back to the right, removing the cutter from the work, after which the foot-treadle is again depressed, allowing the work-spindle to move forward until the starting stop strikes against the locking pin *O*. During this period there is time to release the work by pulling the lever *D* forward, remove the work from the chuck, and replace it with a new piece. By this arrangement the motion of the work-spindle is almost continuous, each motion being so arranged and timed that the hands and feet follow them naturally and smoothly, hardly any exertion at all being required on the part of the operator.

To those who are familiar with the various types of machines that have heretofore been used for this class of work, particular attention is called to the simple means of obtaining all adjustments and movements, the rigidity of the construction throughout, the accessibility of the various parts, the compact construction and the almost entire lack of overhang of working parts, especially the chucks and spindles. There is also entire freedom from the use of gibs of any kind. As previously stated, the work-spindle is driven by a worm and worm-gear, which, in turn, receive their power from a round belt passing over a grooved pulley. As it is necessary that this motion be intermittent, as when the spindle revolves against the stops, some means had to be provided to take care of this. However, as the power required to drive the worm is very small, the belt is made of round leather or rawhide of just sufficient strength to furnish ample drive for the spindle, and yet to slip over the pulleys when the spindle is held from turning by the stops. The production of the machine described is about 120 brass rings per hour, such as are used on the Types 80 and 85 time fuses. The grooves are finished smooth and accurate in one cut.

The machine as illustrated is arranged to handle the Type 80 fuse shown in Fig. 1, while a different type of chuck is used for the Type 85 time fuse ring shown in Fig. 5, this being made necessary on account of the small bearing surface on the inside of the ring *A*, which prevents the use of an expansion chuck. The chuck for the Type 85 time fuse is shown in Fig. 6; the body *A* is made of machine steel, and is bored and threaded to fit the nose of the machine spindle. The chuck jaws *B* are of hardened tool steel, are fitted into reamed holes in the chuck body, and are operated by means of the draw-rod *C* in the same manner as the expansion chuck *B*, Fig. 2, the draw-rod in this case being connected to the jaws of the chuck through an equalizing bar *D*, Fig. 6, while *E* is a hardened and ground nose piece over which the work is accurately located. The knurled sleeve *F* is used to cover over the holes made in the chuck body through which the equalizing bar *D* was inserted. The action of the chuck is as quick and positive as the expansion type, but the overhang is slightly more. This is taken care of by moving the work-head of the machine back to the left the required distance, space having been provided for it on the base as shown in Fig. 2, and suitable holes tapped in the base accordingly.

The spindle speeds recommended for brass work run between 6000 and 6500 revolutions per minute for the cutter-spindle, and one revolution per twenty-five seconds for the work-spindle. An ideal way of setting up these machines is to place six of them on a bench, back to back, three on a side. Then, with a motor-driven lineshaft running along the center underneath the bench connected to the machines, a self-contained unit is formed which may readily be moved without the necessity of having to shift overhead shafting.

* * *

CONTACT-COUPLE METHOD OF TEMPERATURE CONTROL[1]

The most important step in the heat-treatment of a piece of steel is the proper control of temperature. When the kind of steel being used and the method of treatment are known, the next step is to know that it is given the treatment laid down. This is the most difficult operation in the entire process. In the first place, there is no metallic substance that will stand up under continual application of heat. Any piece of material heated from time to time, day after day, will gradually break down; therefore, it is difficult to make a pyrometer that will maintain its accuracy after it has been properly standardized for any length of time.

The contact-couple method eliminates the necessity of close standardization in the instrument for measuring heats, and can entirely eliminate the chemical checks, as far as treating the steel wrongly goes. In other words, the steel tells when it ought to be treated, and, as far as accuracy of the instrument goes, it can vary several hundred degrees and give a better result than was obtained without it. This method, when fully developed and placed on the market, will be the greatest step forward, from the standpoint of the manufacturer, that has been accomplished in the last twenty years. In this method, a standard base-metal thermo-couple is placed in contact with or in close proximity to the steel that is to be treated. In order to obtain a result, every unit of time required to heat the furnace must show an equal rise of temperature. When the decalescent point is reached, the heat that has been used in raising the temperature of the steel is consumed in the work of transforming the interior of the steel, and the temperature does not increase at the same rate as the furnace. As a result, the couple is influenced and shows a lag in temperature on the chart by a sharp deviation in the heating line.

* * *

By a more efficient use of their equipment, last May the railroads of the country carried 29,522,870,109 tons one mile, an increase of 16.1 per cent over May, 1916. This year, the average daily run of the locomotives was 71.3 miles, against 65.5 miles last year, and the average daily mileage of freight cars was raised from 28.3 to 29.6 miles.

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[1] Extract from an address delivered before the Steel Treating Research Society of Detroit, by F. F. Beall, vice-president of manufacturing, Packard Motor Car Co., Detroit, Mich.

ALIGNMENT CHARTS

EXPLANATION OF PRINCIPLES GOVERNING CONSTRUCTION AND ILLUSTRATIONS OF USE

BY GEORGE L. HEDGES[1]

An alignment chart, often called a "straight-line diagram," is a form of calculation diagram that is often much simpler to make and to use than is the ordinary curve plot on rectangular axes. In its usual form, such a chart consists of three or more parallel axes, usually vertical, the number depending on the number of variables in the formula to be plotted. To use such a chart, known values on two axes are joined by a straight line, the intersection of which with the third axis gives the desired value. With a chart of more than three axes, this intersection is joined to a known value on a fourth axis by a straight line, and its intersection with a fifth axis gives the desired value. If there are more than five variables, the straight-line operation is again repeated.

Alignment charts are additive charts; therefore, a formula to be plotted with this type of chart must be expressed as the algebraic sum of functions of the variables, that is, in the form:

$$F(Y) = F(X) + F(Z) + \dots$$

The functions of the variables may be the variable itself, its products, logarithmic functions, trigonometric functions, etc. The axes are named for the variables and are graduated to the functions of the variables. The usual engineering formulas consist of the product of functions of the variables, as:

$$F(Y) = F(X) \times F(Z) \times \dots$$

These may always be expressed as the sum of functions of the variables, as:

$$\text{Log } F(Y) = \log F(X) + \log F(Z) + \dots$$

in which form they are adapted for an alignment chart. The axes are named for the variables and graduated to the logarithmic functions of the variables, the scales used depending on the formula being plotted and on the chart size desired.

To graduate the axes, decimal-divided scales with a table of logarithms are generally used. However, if many charts are to be made, a set of special logarithmic scales on different bases, say from 2 to 10 inches, will be found convenient. Decimal scales are divided into parts of an inch and numbered continuously every ten divisions; that is, one unit on the scale equals ten divisions.

Let S = scale number and

l = length of unit on scale, in inches.

Then the relation between the length of unit and the scale number of a decimal-divided scale is:

$$S = \frac{10}{l}, \text{ or } l = \frac{10}{S} \qquad (1)$$

That is, on the 50 scale of an engineer's scale the length of one unit is $l = 10/50 = 1/5$ inch. There are, of course, any number of possible scales, each with its corresponding value of l; but generally the 10, 20, 30, 40, 50 and 60 scales, and the 10 or 0.1 multiples thereof, are used, as these may be plotted with the ordinary triangular engineer's scale. The values of the scale number and the scale corresponding to different values of l are given in Table 1.

TABLE 1. VALUES OF SCALE NUMBER AND SCALE ON ENGINEERS' SCALE CORRESPONDING TO DIFFERENT VALUES OF l

l	S	l	S	l	S	Scale to Use
100	0.1	10	1	1	10	10
50	0.2	5	2	1/2	20	20
33 1/3	0.3	3 1/3	3	1/3	30	30
25	0.4	2 1/2	4	1/4	40	40
20	0.5	2	5	1/5	50	50
16 2/3	0.6	1 2/3	6	1/6	60	60

Machinery

The principal labor in the making of an alignment chart is in arranging the lengths of the axes, or the distance along the axis between extreme graduations, so that available decimal scales may be used.

Let G = length of axis, in inches;

d = function difference, or numerical difference between extreme values of function plotted on axis.

Then:

$$G = ld \qquad (2)$$

The value of G for the longest axis determines the height of the chart. A graduated axis is used for each variable; with formulas of more than three variables, "dummy" axes, which usually are not graduated, are required. These dummy axes represent the partial additions in the formula, and are three less in number than the number of variables.

TABLE 2. TABULATED VALUES FOR EXAMPLE 1

Name of Axis	Symbol	Number Limits	Logarithmic Limits	Logarithmic Difference	l	Actual Length, Inches	Scale Number	Equivalent Scale	Scale to Use
Breadth	b	1 to 10	0 to 1	1	10	10	1	1	10
Depth	d^3	1^3 to 10^3	0 to 3	3	$3\frac{1}{3}$	10	3	1	10
Moment of Inertia	I	0.083 to 833	$\bar{2}.921$ to 2.921	4	$2\frac{1}{2}$	10	4	4	40

Machinery

Tabulating Data for Constructing Chart

The procedure in the making of an alignment chart can best be shown by examples. The example given in Fig. 1, the chart for a simple formula of three variables, shows the general scheme of procedure; the charts given in Figs. 2 and 3, for more complicated formulas, illustrate special features of the work. It is desirable to make use of a tabular form as shown in the examples. With a formula of three variables, the first two lines of the tabular form are used for the known variables and the third line for the unknown variable. With a formula of more than three variables, the first two lines of the form are used for two known variables and the third for a dummy axis, which represents the sum of the functions of these two known variables. The fourth line is used for a third known variable, and the fifth line for the resultant of it and the first dummy axis; and so on for additional variables. The tabular columns of the form should be filled in in the following order:

1. Name of axis.
2. Symbol. That is, the symbol of the quantity whose function is plotted. This quantity must be some function of the variable represented by the name of the axis. Constants in the formula are neglected in the tabular form; the constant serves merely to locate the position of the graduations on the intermediate axis, and this position will be determined in a more direct manner, which is explained later.
3. Number limits. Assume maximum and minimum values of the known variables and find the corresponding values of the unknown variable.
4. Function limits. The values of the functions of the variables given by their number limits.
5. Function difference. The arithmetical difference, for each variable, between its function limits.
6. Length of unit l on a decimal-divided scale, or the factor by which to multiply the function difference to get the actual length G between extreme graduations on the axis.
7. Actual length G, in inches, between extreme graduations on an axis.
8. Scale number. The scale number for an unknown variable axis is the sum of the scale numbers of the axes of which it is a resultant.
9. Equivalent scale. This is the scale which, used with the symbol with exponent omitted, will give the identical graduation as by the given scale and given symbol. The equivalent scale number is obtained by dividing the given scale number by the exponent of the symbol.

Let x = exponent of symbol;

E = equivalent scale number.

Then:

$$E = \frac{S}{x} \qquad (3)$$

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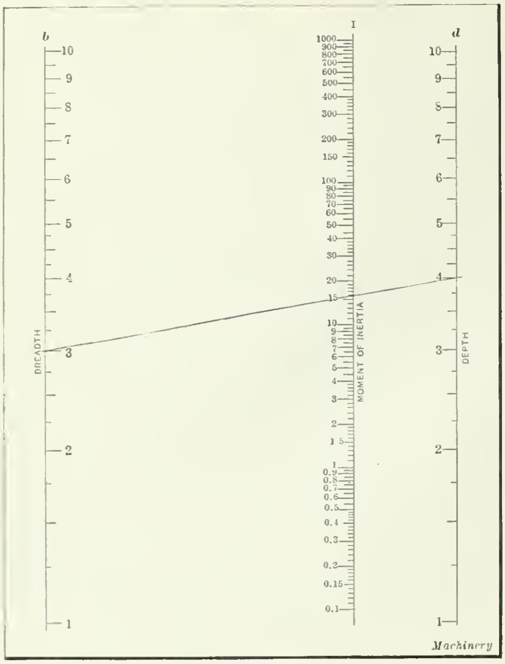

Fig. 1. Chart for determining Moment of Inertia of a Rectangle

In the chart in Fig. 3, for the axis "Gallons per Minute," the symbol is $Q^{2/5}$ and the scale number is 2; hence the equivalent scale number is 2 divided by 2/5 = 5. This means that Q plotted with the 5 scale (the 50 scale should be used) gives the same graduation as $Q^{2/5}$ plotted with the 2 scale (using the 20 scale), and is much easier to plot.

10. Scale to use, shown by Table 1.

Plotting the Chart

A sketch should now be made showing the positions of the axes and the directions of graduations thereon, and the values of maximum and minimum numbers whose functions are plotted. The width of the chart is determined by the fact that for accurate reading the intersecting line used in reading the chart should never make an angle much greater than 45 degrees with the axes. Where it may be necessary to draw a line from the upper end of one axis to the lower end of the other, the chart should be approximately square; where the line will usually be drawn nearly horizontal, the width may be considerably less than the height. In constructing the chart, the axes should be drawn first and the limit values marked thereon.

For a formula of three variables, the axis of the unknown variable is the intermediate axis. Its distances from the outer axes are inversely proportional to the scale numbers of those axes; for example, if S_1 and S_2 are the scale numbers of the outer axes, $S_3 = S_1 + S_2$ is the scale number of the intermediate axis. Then, if D is the distance, in inches, between the outer axes, the position of the intermediate axis is:

$$\frac{S_1}{S_3} \times D \text{ inches from the } S_2 \text{ axis} \qquad (4)$$

and

$$\frac{S_2}{S_3} \times D \text{ inches from the } S_1 \text{ axis} \qquad (5)$$

For a formula of more than three variables, it is necessary first to consider two known variables and find the position of the first dummy axis. Then this dummy axis is considered with another of the known variables, and the position of the second dummy axis is determined in the same manner as the first. Finally, from the last dummy axis and the last known variable, the position of the axis of the unknown variable is found.

To find the directions and positions of graduations on the axes, consider the axes in successive sets of three. The outer axes of a set will have known values, and the intermediate axis will have the unknown values. The corresponding unknown and known limit values should be at the same end of the chart. The graduation for the maximum unknown value at one end of the intermediate axis should be at the intersection of this axis with a line joining the corresponding known limit values on the two outer axes; similarly, the graduation for the minimum unknown value at the other end of the intermediate axis should be at the intersection of this axis with a line joining the other two limit values on the outer axes.

In graduating an axis, it is well first to check the chart layout by seeing if the distance between the extreme graduations on the axis, measured with the scale from Table 1 corresponding to the scale number for the axis, equals a 10 multiple of the function difference for the axis; then lay off the graduations for 0.1, 1, 10, etc., and, lastly, fill in the intermediate graduations desired.

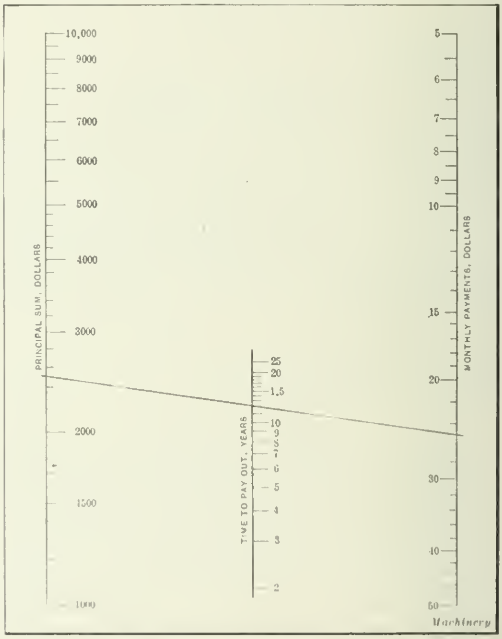

Fig. 2. Chart for determining Time required to pay, by Monthly Payments, a Given Sum with Interest

Example 1—Construct a chart for the formula $I = \dfrac{bd^3}{12}$, which is the formula for the moment of inertia of a rectangle of breadth b and depth d. In logarithmic form, it becomes $\log I = \log b + \log d^3 - \log 12$. The functions of the variables are logarithmic functions. As there are three variables, the chart has three axes; the known variables b and d are plotted as the outer axes, and the unknown variable I as the intermediate axis.

TABLE 3. TABULATED VALUES FOR EXAMPLE 2

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Principal sum	P	$1000 to $10,000	3 to 4	1	10	10	1	1	10
Monthly payment	p	$10 to $50	1 to 1.699	0.699	10	6.99	1	1	10
Time to pay out	[illegible]	([illegible]) 23.25 to 142.6	1.366 to 2.154	0.788	5	3.94	2	2	20

Machinery

TABLE 4. TABULATED VALUES FOR EXAMPLE 3

Name of Axis	Symbol	Number Limits	Logarithmic Limits	Logarithmic Difference	l	Actual Length	Scale Number	Equivalent Scale	Scale to Use
Gallons per minute	$Q^{2/5}$	$1^{2/5}$ to $10{,}000^{2/5}$	0 to 1.6	1.6	5	8	2	5	50
Friction	$F^{1/5}$	$0.1^{1/5}$ to $100^{1/5}$	— 1/5 to 2/5	0.6	16 2/3	10	0.6	3	30
Dummy	Not Graduated						2.6		
Length of Pipe	$L^{1/5}$	$1^{1/5}$ to $100^{1/5}$	0 to 2/5	0.4	25	10	0.4	2	20
Diameter of Pipe	d	0.0786 to 31.3	$\bar{2}.8954$ to 1.4954	2.6	3 1/3	8 2/3	3	3	30

Machinery

The first step is arranging the matter in tabular form, as shown in Table 2. The names of the axes are Breadth, Depth, and Moment of Inertia, and the symbols are b, d^3, and I. Maximum values of 10 inches and minimum values of 1 inch are assumed for both breadth and depth; hence the number limits will be 1 to 10 for breadth and 1^3 to 10^3 for depth, the corresponding logarithmic limits will be 0 to 1 and 0 to 3, and the logarithmic differences will be 1 and 3. An inspection of the formula for the example shows that the minimum limit value of I, the unknown variable, will be obtained from $b = 1$ and $d = 1$, for which values $I = 0.083$; similarly, the maximum limit value of I is found to be 833. The logarithmic limits are, then, log 0.083 = $\bar{2}.921$ and log 833 = 2.921; hence the logarithmic difference, which is the numerical difference between these quantities, equals 4.

For the axis Breadth, the logarithmic difference of which is 1, according to Formula (2) and Table 1, when l is 5, 10, or 16 2/3, the length G of the axis is 5, 10, or 16 2/3, respectively. Adopting the value $l = 10$, giving a length of axis of 10 inches, the chart may be plotted on paper 8 1/2 by 11 inches. For this value of l, Table 1 gives scale number = 1 and Formula (3) gives the equivalent scale number = 1, for which Table 1 gives 10 as the scale to use. Similarly, for the axis Depth, the logarithmic difference of which is 3, a value of $l = 3\,1/3$ will be used to give a length of axis of 10 inches; Table 1 gives the scale number 3 and Formula (3) gives the equivalent scale number 1, for which Table 1 gives 10 as the scale to use. The scale number for the unknown variable I is then the sum of these scale numbers, or 1 + 3 = 4. Formula (3) gives the equivalent scale number 4, for which Table 1 gives as the scale to use 40.

The distance between the outer axes of the chart is made 7.2 inches, which is about as great as can be used on a letter-size sheet; hence the position of the intermediate axis is, from Formulas (4) and (5):

$1/4 \times 7.2 = 1.8$ inch from depth axis, and
$3/4 \times 7.2 = 5.4$ inches from the breadth axis

The minimum limit value of I is 0.083, and the values of b and d corresponding thereto are $b = 1$ and $d = 1$. These values of b, d and I must be, therefore, at the same end of the chart, say the lower end, and a line joining the value of $b = 1$ on one outer axis to $d = 1$ on the other outer axis will intersect the intermediate axis at $I = 0.083$. Laying off on the outer axes their length of 10 inches, determines the points $b = 10$ and $d = 10$, and a line joining these points intersects the intermediate axis at the maximum value of $I = 833$. If the chart is correct so far, the distance between these points for I on the intermediate axis, measured with the 40 scale, should equal a 10 multiple of 4, the logarithmic difference for the axis. These points determine the position of the graduations on the axis. The logarithm of 0.083 is $\bar{2}.921$, and of 833 is 2.921. Place the 40 scale so that 9.21 on the scale coincides with 0.083 on the axis and 49.21 on the scale coincides with 833 on the axis, and mark off the points 10, 20, 30 and 40 on the scale corresponding to values of I of 1, 10, 100 and 1000, respectively, on the axis. Intermediate graduations may now be marked off as desired. The alignment chart for Example 1 is shown in Fig. 1.

Example 2—Construct a chart for the formula:

$$n = \frac{\log\left[\dfrac{1}{\dfrac{P}{p} - \left(\dfrac{P}{p} - 1\right)k}\right]}{\log k}$$

in which P = given sum, in dollars;
p = amount of each monthly payment, in dollars;
n = time to pay out, in months;
r = yearly rate of interest;

$$k = 1 + \frac{r}{12}, \text{ constant for a given rate of interest.}$$

The interest rate will be taken as 7 per cent, for which the value of k is 1.005833.

This is the formula for the time, in months, required to pay a given sum, with interest compounded monthly, by monthly partial payments made at the beginning of each month and at the end of the last month. This formula is often used in selling real estate on the pay-like-rent installment plan. This formula is not in the proper form for an alignment chart, but solving for P/p gives:

$$\frac{P}{p} = \frac{k^{(n+1)} - 1}{k^n(k - 1)}$$

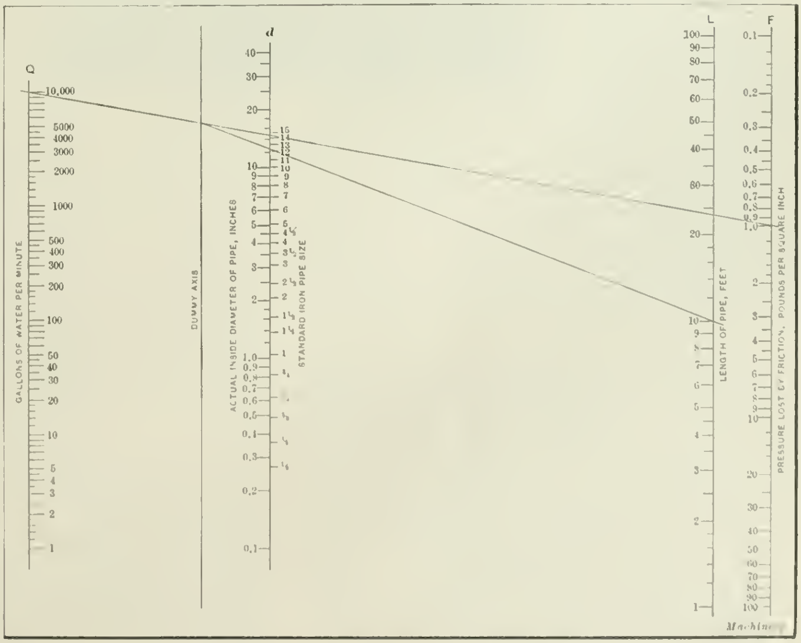

Fig. 3. Chart for determining Flow of Water in Pipes

whence:

$$\text{Log } P - \log p = \log \left[\frac{k^{(n-1)} - 1}{k^n(k-1)} \right]$$

The two known variables are P and p and their functions in the formula are logarithmic; the unknown variable is n and its function is logarithmic and is the quantity making the right-hand half of the formula. In plotting the alignment chart for this formula, the value of this function of n must be calculated for all points desired on the n scale and used for laying off these points. Table 3 gives the tabulated figures for this formula and Fig. 2 is the alignment chart. The formula gives the time in months, but the chart is marked in years. The position of the graduations on the intermediate axis of this chart were determined by finding values of P and p corresponding to the value of the function of n for maximum and minimum assumed values of n; that is, when $n = 24$, $\frac{P}{p} = 23.25$, and when $n = 300$, $\frac{P}{p} = 142.57$. As is shown in the chart, it is not necessary to graduate an axis full length—only such graduations as are desired need be used.

Example 3—Construct an alignment chart for the formula for finding the diameter of pipe for a given flow of water, *viz.*:

$$d = \sqrt[5]{\frac{Q^2L}{3333F}}$$

in which Q = gallons of water per minute;

F = pressure lost by friction, pounds per square inch;

L = length of pipe, in feet;

d = actual inside diameter of pipe, in inches.

Arranging this into the proper form for constructing an alignment chart gives:

$$\text{Log } d = \log Q^{2/5} - \log F^{1/5} + \log L^{1/5} - \log (3333)^{1/5}$$

Table 4 gives the tabulated values for this example and Fig. 3 the chart. This chart is handled in exactly the same manner as the others. From Formulas (4) and (5) and from the scale numbers of the Q, F and dummy axes is found the position of the dummy axis. Then the position of the L axis is assumed, and from the scale numbers of the L axis, dummy axis and d axis the position of the d axis is found. The d axis has an additional set of graduations, showing standard iron-pipe sizes. This use of two scales on an axis will often be found convenient; for example, an axis for velocity may be graduated both in feet per second and in miles per hour.

The lines drawn on the chart to indicate the order in which the axes are used show that Q and F values, say 10,000 and 1, are joined by a straight line, and from the intersection of this line with the dummy axis a line is drawn to the value of L, say 10; the intersection of the latter line with the d axis, which is at 12 inches, gives the required inside diameter of pipe.

The size and number of graduation marks used on the axes of a chart depend considerably on the particular chart considered. In general, it will be found desirable to have the graduations between 1 and 10 repeated between 10 and 100 and between 100 and 1000, etc. The longest graduation marks should be used for the digit numbers 1, 2, 3, . . . 9, and their ten multiples; the marks for half divisions should be about two-thirds as long, and the marks for 0.1 or 0.2 divisions should be about one-third as long.

• • •

The scarcity of coal in Sweden, due to the war's having cut off the imports from both England and Germany, has made it necessary to find substitutes to be used on the Swedish railways. It has been found that ordinary pine cones, of which there is an abundance in Sweden, form a satisfactory substitute. About two tons of pine cones are required to produce the same heat effect as one ton of coal. In order to prevent the cones from burning too fast, they are mixed with coal or coke. One of the railways has used this fuel for more than a year and finds it cheaper than wood. The price paid for the pine cones varies from \$6 to \$7.50 per ton, and boys are earning from \$1.25 to \$2.50 a day picking them in the woods. Considering the fact that coal, even when obtainable, at the present time costs about \$75 a ton in the Scandinavian countries, the pine cones constitute a cheap fuel.

A SUBSTITUTE FOR BRASS

BY MARK MEREDITH[1]

The high prices of copper, brass, zinc and tin, as a result of the war, have caused all nations to seek satisfactory substitutes. Many combinations of these metals have been made with lead, iron, etc., in an effort to reduce the cost, and there has been a large increase in the use of cast iron for bearings. This metal makes an excellent bearing if it is well fitted and has sufficient area, but when it begins to grip at any ill-fitted part, much mischief may be caused in a short time.

Metal is far from being the only material available for bearings. Various hard woods have been successfully used for the purpose, notably in the case of screw propeller shafts, which for many years have been made of lignum-vitæ. This wood is obtained principally from the West Indies, but increasing demands have rendered it so scarce that substitutes had to be sought. The Philippine Islands are famous for the quality and variety of their hard woods, of which the mancono is said to be the best and most durable. Lignum-vitæ is greenish brown in color and the sapwood is bright yellowish; its specific gravity varies from 1.17 to 1.39, its grain is fine and the wood fibers small and so twisted that it is difficult to split. Mancono has a brownish heartwood that turns purple when exposed to the air; the sapwood is narrow and of a pale reddish color. The wood weighs from 77 to 90 pounds per cubic foot, or 44 per cent more than water; it is double the weight of teak. Tests show that it is impervious to decay and is proof against the white ant and the teredo, or sea worm. In an official test, in which it was used in the stern tube of a steam launch that was constantly used for seven months, the commander of the naval station reported it to be quite equal to lignum-vitæ. There seems to be a field for mancono in ginning factories, both as bearings for the shafting and for the connecting-rods of gins. The latter may be made in any speed lathe, with the aid of a small circular saw and a revolving cutter.

A comparison of the friction of hard wood bearings with those of brass may be easily made. The coefficient of moving friction of a smooth plane wrought-iron surface on brass when kept perfectly lubricated with olive oil is 0.078, and of wrought iron on elm, 0.055. It is probable that mancono would have about the same friction coefficient, but would be more durable on account of its resemblance to lignum-vitæ. The durability of wooden bearings depends to a great extent on the smoothness of the metal in contact with them; therefore, the metal should be carefully smoothed. In shafting, a longer bearing might be used to compensate for the inferior hardness of the wood as compared with brass.

With brass castings at such high prices, it might be well worth the trouble for factory owners to experiment with wooden bearings and begin with the hard woods of the country that is nearest to them. India supplies a number of hard woods, including babul and the various ironwoods found in the jungles. It must not be forgotten that until the development of wheel cutting in steel and iron, which is of comparatively recent date, power was transmitted through wheels with wooden teeth and that these rendered very good service. Even today there are millions of carts in the world with wooden axles carrying merchandise long distances, and the Japanese, who are now making and exporting electrical plants and instruments of precision, are using machinery of wood to manufacture goods for export.

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Stellite is now used extensively in manufacturing plants. After the surface has been ground to size, the average workman has some difficulty in recognizing the tool, unless he has some identification mark on it. However, the emery wheel will easily settle that question, as the metal is composed of non-combustible elements at grinding temperatures, and therefore shows no sparks and only a very short red streak of fire, which is developed only when the sample is pressed with considerable force against the emery wheel.—*Proceedings of Steel Treating Research Society of Detroit*

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MODERN DRILLING PRACTICE—3

AUXILIARY DRILLING HEADS AND DRILL SPEEDERS—AUTOMATIC AND SEMI-AUTOMATIC DRILLING MACHINES—TURRET TYPE DRILLING MACHINES

BY EDWARD K. HAMMOND[1]

IN the operation of multiple-spindle drilling machines, where it is necessary to perform a sequence of operations in order to complete a piece of work, the development of means for attaining the highest rate of production from the machines involves taking into account the relative time required for the performance of the different operations necessary to complete drilling the work. For instance, if the piece to be machined has one short hole which can be rapidly completed and one deep hole which takes more time to drill, due consideration must often be paid to that fact in laying out the method of handling the work. If this is not done, the machine engaged in drilling the shallow hole will be idle for a substantial portion of the day, and hence will be earning only a part of the possible return on the money invested in it. An example of how provision has been made for taking care of a set of operations which vary considerably in length, is shown in Fig. 41, which illustrates a special Foote-Burt multiple-spindle drilling machine built for the Willys-Overland Co. for use in drilling two bolt holes and an oil-hole in the large end of the connecting-rods. To arrange the work so that the time required for drilling the two deep bolt holes will not represent the limiting condition, the machine was designed with five spindles and an indexing work-holding fixture.

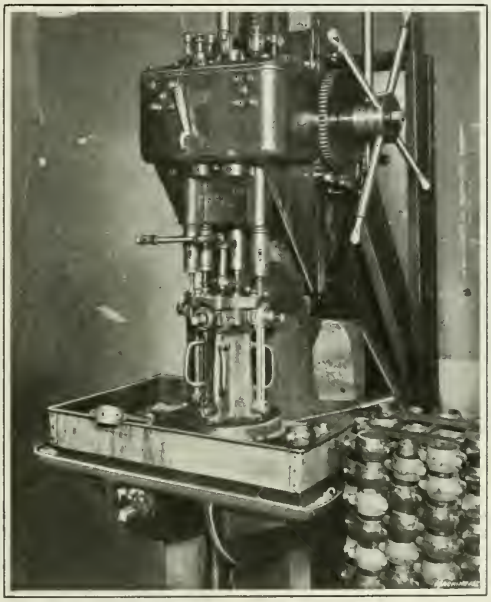

Fig. 41. Special Foote-Burt Drilling Machine built for drilling Bolt Holes and an Oil-hole in Willys-Overland Connecting-rods

A connecting-rod forging is put in place at the loading station, after which the fixture is indexed to bring this piece under the first pair of drilling spindles. These cut half way through the bolt holes, after which the work is indexed to a second pair of spindles which complete drilling these holes. The work is then indexed once more to bring it under a single spindle which drills the oil-hole, and the fourth indexing brings it back to the loading station, where the drilled piece is removed and a fresh forging substituted. It will be apparent that for each indexing movement one finished piece is drilled, and by dividing the drilling of the deep bolt holes between two pairs of spindles, a balance is secured between the time involved in drilling these holes and that required for drilling the oil-hole, so that none of the spindles on the machine are kept idle for a substantial length of time. The work is located on this fixture by pilots fitting into the two bearing holes that were drilled by a preceding operation, and a C-washer at the upper end secures the work without making it necessary to do more than loosen the bolt sufficiently to slip this washer out so that the work may be lifted over the nut. The material is drop-forgings and the connecting-rods are drilled at the rate of 720 per eight-hour day from each machine. The two bolt holes are 25/64 inch in diameter by 1 11/16 inch deep, and the oil-hole, which is for a 1/8-inch pipe tap, is 23/64 inch in diameter by 5/16 inch deep. The drilling operation is performed at a speed of 325 R.P.M. with a feed of 0.005 inch per revolution. The slow speed at which this operation is performed is due to the fact that it is necessary to hold the distance between each bolt hole center and a corresponding milled surface on the connecting-rod, and if the drills are forced, there will be danger of their "running out."

Auxiliary Multiple Drilling Heads and Drill Speeders

There should be a clear understanding of the difference between the terms "auxiliary multiple drilling head" and "drill speeder." The former type of equipment is used in connection with a single-spindle drilling machine to provide for simultaneously drilling a number of holes, and the latter is employed for speeding up a small drill which is used for drilling oil-holes or small tap-holes in large castings that are being handled under a heavy drilling machine. The use of such a machine is necessary for drilling the large holes and also to provide for reaching these small holes in large pieces of work. As the spindle speeds provided on high-duty drilling machines are too slow for the efficient operation of small drills used for drilling tap-holes, oil-holes, etc., it is necessary to provide for the performance of such operations by making use of a drill speeder, which is simply an auxiliary drill head mounted on the drilling machine spindle and provided with gearing that gives the increase of speed necessary for driving small drills at the proper number of revolutions per minute.

As compared with these conditions, auxiliary multiple drilling heads may be provided with the necessary arrangement of gearing to increase the speed of the drills, to drive these drills at the same speed as the machine spindle, or to make a variation in the speeds of different sizes of drills carried in the head. The arrangement of gearing in any drilling head will, of course, depend entirely upon the particular conditions which must be met. The spindles of auxiliary multiple drilling heads used on sensitive high-speed machines usually run at the same speed as the drilling machine spindle. The following instance is, perhaps, typical of the classes of work for which auxiliary multiple drilling heads are employed. A certain firm engaged in machining clutch rings for several different automobile manufacturers often has orders for several thousand of each kind of ring, but it may only be possible to get a few thousand drop-forgings for these rings at one time. Experience has shown that it is economical to employ single-spindle drilling machines equipped with auxiliary multiple heads for each different type of ring to be drilled. These heads can be readily interchanged to adapt the same machines for drilling different types of rings. The increased production possible with machines equipped in this way, as compared with the use of single-spindle machines, will be readily understood when it is learned that the production was increased from 290 rings per day for one man on a single-spindle drilling machine to 2700 rings per day from a machine equipped with an auxiliary multiple head. The preceding instance is typical of the use which is made of auxiliary multiple heads, namely, to enable a single-spindle drilling machine of moderate cost to drill several holes simultaneously. In cases where holes of different sizes have to be drilled at the same setting, it is necessary to have special gearing to provide for driving different drills at the proper cutting speeds. Fig. 42 shows a four-spindle drilling head built by the Sellew Machine Tool Co., which is used in the plant of the Peerless Motor Car Co. for machining motor cylinder blocks. In this case the drilling machine is rather heavy and the head is of correspondingly rugged construction.

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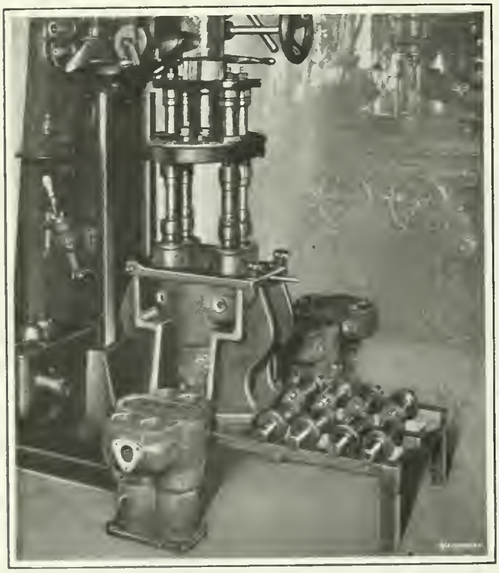

Fig. 42. Four-spindle Auxiliary Drill Head built by Sellew Machine Tool Co. for machining Peerless Motor Cylinder Blocks

Fig. 44 shows an eighteen-spindle auxiliary head that was designed and built by the Langelier Mfg. Co., for drilling and countersinking in multiples, the ninety-five holes of the center group in the radiator support shown in Fig. 43. The illustration shows a cold-rolled steel plate 1/8 inch thick by 2 9/16 inches wide and 22 1/2 inches long. The six end holes in the plate are punched and the 17/64-inch holes are drilled and countersunk with the multiple head. Fig. 43 also shows the arrangement of the spindles in the drilling head. These spindles are located to correspond with every other hole in the plate in a group of thirty holes; this staggering of the spindles was necessary in order to obtain a strong spindle construction. Each group of thirty holes in the plate is drilled and countersunk in two operations. The plate has ninety-five holes and the attachment drills them in groups of thirty holes, two operations being required to drill each group. There are three groups, and the remaining cross-row of five holes has to be drilled singly. Eighteen holes can be drilled and countersunk in five seconds. The plate is held and moved to its different drilling positions by an indexing fixture that is fastened to the table of the drilling machine. The lengthwise movement of the fixture corresponds to the shift between groups and the crosswise index to the 1/2-inch movement required for the two operations in each group. For each of the two operations on a group of thirty holes, fifteen of the eighteen spindles in the head are in operation and the drills carried by the other three spindles hang over the side of the work.

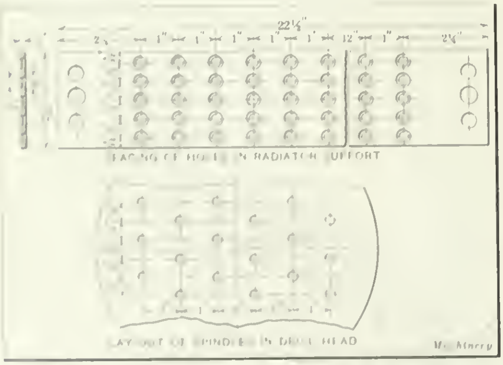
22 1/4"
2 1/4
1"
1"
1"
1"
1"
1/2"
1"
2 1/4"
SPACING OF HOLES IN RADIATOR SUPPORT
LAY-OUT OF SPINDLES IN DRILL HEAD
Machinery

Fig. 43. Radiator Support in which Holes are drilled with Langelier Head shown in Fig. 44 by traversing Work Sidewise and Lengthwise between Successive Operations. Below is shown Lay-out of Spindles in Drill Head

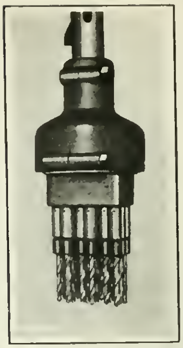

Fig. 44. Eighteen-spindle Langelier Auxiliary Drill Head

The tools used are a combined drill and countersink. The shanks are squared and fit into a square socket in the spindle collets. Adjustment of the tools for producing uniform countersinking is obtained by an adjusting screw that is tapped into the squared end of the tool and butts against the bottom of the square socket in the collet. This, of course, requires the tool to be taken out and may seem a slow method of adjustment, but it has been proved that, after they have once been adjusted, it is a simple matter to keep them so. The ends of the collets are taper threaded and split, and the tools are held in the collets by pinch nuts. The pinch nuts are tightened or loosened by a sleeve T-wrench which telescopes the tools. The drilling head is adjustable rotatively and can be set in any position in the housing without affecting its running. The housing is attached to the feed sleeve of the drill press by a clamp nut.

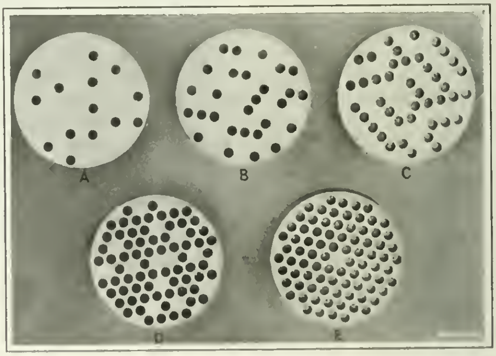

Fig. 45. Condition of Work done on Machine shown in Fig. 46 after First, Second, Third, Fifth, and Sixth Drilling Operations have been performed

Indexing Multiple Drilling Machine

In a certain type of intercooler tube plate it is required to drill eighty-four 3/8-inch holes, and as the plates in which these holes must be drilled are only 4 7/8 inches in diameter by 3/4 inch thick, it will be evident that the spacing of the holes is too close to make it possible for the work to be done on any standard type of multiple-spindle drilling machine. Fig. 46 shows a special multiple-head machine built by the Langelier Mfg. Co., which is equipped with an indexing work-holding fixture; the multiple head of this drilling machine has fourteen spindles, and by indexing the work six times, provision is made for drilling all of the eighty-four holes without loss of time in removing and resetting the work or without the necessity of spending time in laying out the holes and drilling them in a single-spindle machine. Fig. 45 shows at *A*, *B*, *C*, *D*, and *E*, respectively, the condition of the work after the first, second, third, fifth, and sixth drilling operations. The piece of work after the fourth operation has been performed on it is missing in this illustration. The distance between holes in the finished sheet is only 1¼ times the drill diameter, which shows how closely the drills have to be spaced. For holding and locating the work, the machine is provided with a three-jawed indexing fixture mounted on the table of the machine, and this fixture is laid out so that the work of indexing 1/6 revolution between each of the six successive operations may be accomplished rapidly. A machine of this kind could be built with a suitable drill head and work-holding fixture to provide for drilling other pieces where the spacing of the holes is too close to make it possible for the work to be done economically on machines of standard design.

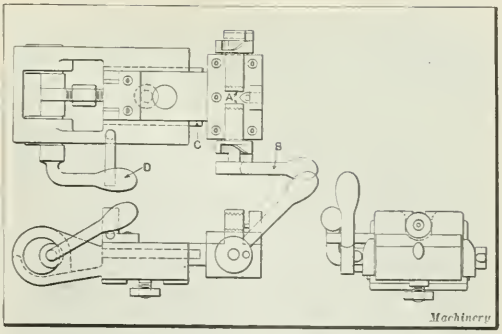

Fig. 48. Fixture for Use in drilling Deep Holes on Machine shown in Fig. 47

Results Obtained with Automatic Drilling Machines

There are many classes of work where automatic drilling machines may be used to extremely good advantage. As a general proposition, the work adapted for being drilled on automatic machines is of relatively small size, although this is not necessarily the case. With automatic drilling machines the high production secured is largely due to the possibility of effecting a great reduction in the idle time of the machine, as a result of means provided for continuous operation of the drilling machine spindle or spindles, and the possibility of having the operator constantly employed in removing drilled pieces from the work-holding fixture and substituting fresh blanks.

Fig. 47 shows a five-spindle semi-automatic drilling machine built by the Detroit Tool Co. The machine shown is used in the factory of the Willys-Overland Co., and it will be seen that two spindles are engaged in drilling a cross-hole in hood catch stems, while the other three spindles on the machine are employed for drilling a longitudinal hole in the end of torsion yoke pivot pins. In each case the work is secured in a cam-operated V-block fixture which is tightened or loosened by a single movement of the binding lever. The five spindles on this machine are controlled by a cam-actuated feed mechanism arranged in such a way that the spindles are advanced to the work in consecutive order. This makes it possible for the operator to be constantly employed removing drilled pieces and substituting blanks in the work-holding fixtures, and by the time he has reached the fixture at the right-hand end of the machine, the piece in the fixture at the extreme left has been drilled and the spindle withdrawn; consequently the operator can start right in again removing drilled pieces and substituting blanks, this order being kept up continually. On the hood catch stem the cross-hole is drilled with a No. 21 drill (0.159 inch in diameter) and the hole is 11/32 inch deep. The drills are operated at 990 revolutions per minute with a feed of 0.002 inch per revolution; the use of this low speed is necessary on account of the larger sized drills used in the other three spindles of the machine. The production is 3600 pieces in an eight-hour working day. In drilling the longitudinal hole in the torsion yoke pivot pin, the hole is drilled to receive a 3/8-inch tap and is 9/16 inch in depth. The machine is operated at the same speed and feed employed for the previous operation, although the feed is really too light for this size of drill. The production is 3600 pieces per eight-hour working day.

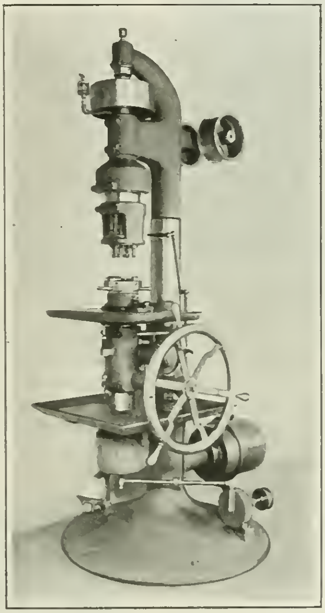

Fig. 46. Langelier Multiple Drilling Machine with Indexing Fixture to locate Work for Six Successive Operations required to drill Eighty-four Holes, as shown in Fig. 45

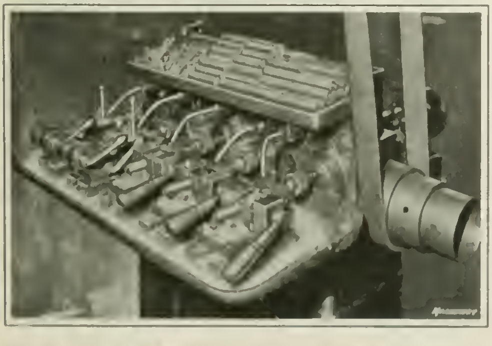

Fig. 47. Five-spindle Semi-automatic Drilling Machine built by Detroit Tool Co. Machine is shown in Operation in Willys-Overland Plant

Fixture for Increasing Feed Range

In Fig. 47 the five-spindle semi-automatic drilling machine built by the Detroit Tool Co. is shown engaged in the performance of drilling operations on two classes of pins, but it must not be inferred that the scope of this machine is in any way restricted to the drilling of cylindrical shaped pieces. Where suitable work-holding fixtures are made, this machine is adapted for drilling pieces of a great variety of shapes and sizes, and in all cases advantage is taken of the ability of keeping the operator constantly employed in loading work into the fixtures while drilling operations are being performed on pieces held in other fixtures.

Where the pieces to be drilled are of such a character that the depth of hole required is in excess of the maximum feed movement provided by the throw of the cam, provision for drilling such pieces may be made by designing a special work-holding fixture of the general type shown in Fig. 48. This particular fixture was designed for drilling staybolts which are held in jaws *A*, these jaws being quickly opened or closed by means of lever *B*. It will be seen that the body of the fixture on which the work is supported is carried by a slide *C*, and provision is made for traversing this slide in a direction opposite to the feed movement of the drilling machine spindle by means of hand-lever *D*. In operating a drilling machine equipped with a fixture of this kind, the work is first held in the fixture with slide *C* in its position farthest away from the drilling machine spindle, and in this position the drill is fed

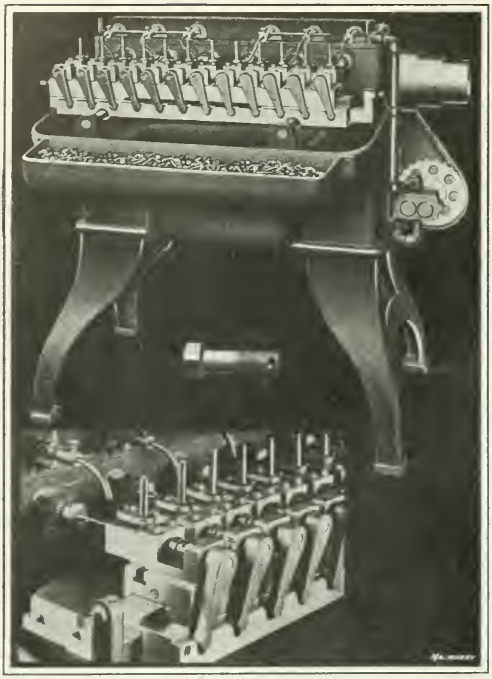

Fig. 49. National-Acme Six-spindle Semi-automatic Drilling Machine with Double Work-holding Fixture which provides for loading Six Sections of Fixture while Work is being drilled in Other Six Positions

into the work. After the hole has been drilled to the full depth in this position and the drill has been backed out of the work, slide *C* is advanced by manipulating hand-lever *D* and the fixture is secured in the forward position. Then the next time the spindle is fed forward by the cam, the drill completes cutting the hole to the required depth. Suitable fixtures of this kind can be designed to meet the requirements of a variety of classes of work where deep holes have to be drilled.

A somewhat similar type of semi-automatic drilling machine to the one previously described is shown in Fig. 49, this machine being built by the National Acme Co. It will be seen that this is a six-spindle machine, and while in general appearance it resembles the one shown in the preceding illustration, the method of operation differs considerably. On this machine all of the spindles feed forward simultaneously, and to provide for reducing the idle time of both the machine and operator, the work-holding fixture is designed to carry twelve pieces. This fixture is arranged in such a way that while six pieces of work are being drilled, finished parts may be removed from the other six work-holding fixtures and fresh blanks substituted. When the drilling operation has been completed and the drills have been automatically withdrawn from the work, the operator rocks the work-holding fixture over on its oscillating support so that the fresh blanks are brought into the drilling position. He can then remove the drilled pieces and substitute blanks in the manner previously described. Some remarkably high rates of production are secured on these machines. For instance, at the plant of the Ford Motor Co. machines of this type are employed for drilling cross holes in bolts of the form shown in Fig. 49. In drilling a 1/8 inch hole through a 3/8 inch bolt body, the machines are operated at 1500 R.P.M., and the rate of production is 10,000 bolts per eight hour working day. Another job performed on this machine consists of drilling a 1/8-inch hole, 9/16 inch deep, through the head of a bolt. Running the spindles at the same speed, the production is 6000 bolts per eight hour day.

Semi-automatic Drilling Machine with Indexing Fixture

In the two preceding types of drilling machines the spindles are advanced and withdrawn automatically, but the operator is required to manipulate the work-holding fixture by hand. In Figs. 50 and 51 there are shown two machines built by Baker Bros., which are equipped with an automatic indexing fixture. Near the top of the machine there will be seen a cam drum on which cams are mounted to provide for automatically feeding the drills into the work and withdrawing them, the amount of feed motion being regulated by the cams according to the work on which the machine is engaged. Extending down from this feed drum on the left-hand side of the machine, there will be seen a shaft which is driven by a pair of spur gears. This shaft transmits motion to an indexing mechanism located beneath the table and work-holding fixture, and by this means provision is made for continuously indexing the work-holding fixture to bring a fresh blank or blanks into the operating position to be drilled during the time that the drills are being raised ready to start the next downward stroke. With an equipment of this kind it is merely necessary for the operator to stand at the front of the machine so that he can remove finished pieces and substitute fresh blanks to be drilled.

Fig. 50 shows a machine engaged in drilling external brake-band anchors in the plant of the Willys-Overland Co. The operation consists of drilling eight 13/64-inch holes, which are approximately 3/16 inch in depth. Four holes are drilled at one end, after which the piece is reversed end for end in the fixture, to provide for drilling the other four holes. In each case the work is located in the fixture by a pilot that enters the large central hole, but alternate stations on the fixture are designed to locate the work by different methods, according to whether the first four holes have or have not already been drilled. When the piece is first set up in the fixture, it is slipped over the pilot entering the center hole, after which the lever *A* is turned to operate an "equalizer" that lines the work up properly; then wing-nut *B* is tightened, which results in raising a clamping lever that secures the work in place on the under side of the jig-plate that forms the top of the work-holding fixture. In this position the first four holes are drilled, and when the piece has again come around to the front of the fixture, the operator releases the clamps, and after taking this piece out of the fixture, sets it up again in a work-holding fixture located on the next station. In this position the work is located by a pilot entering the large center hole and by a small pin that enters one of the holes which

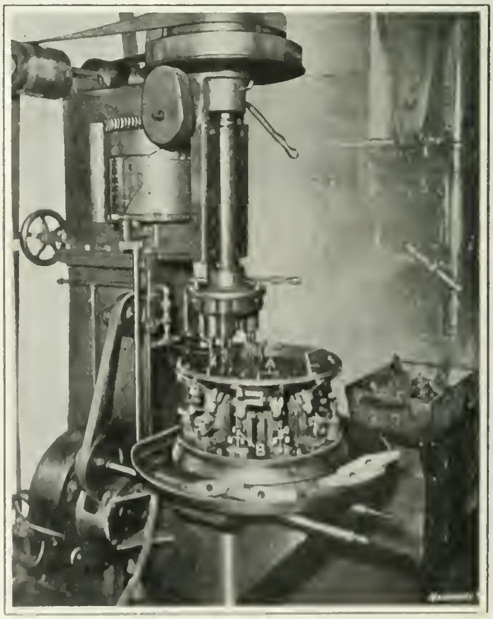

Fig. 50. Baker Bros. Semi-automatic Drilling Machine with Station Type Work-holding Fixture which is automatically indexed

have just been drilled. Then, by tightening the wing-nut *B*, the piece is clamped in place. At each downward movement of the spindle of the drilling machine eight holes are drilled—four in a piece which has already had the first four holes drilled and four in a fresh blank—so that one drilled piece is obtained for each traverse of the spindle. From this it will be apparent that the index mechanism is arranged so that the work-holding fixture is indexed through two stations on the fixture each time that the spindle of the drilling machine is raised. The machine is operated at such a speed that the drills run at 1100 R.P.M., with a feed of 0.002 inch per revolution; and operating under these conditions, 576 pieces are drilled in an eight-hour working day. The material is malleable iron.

Fig. 51 shows another application of the Baker Bros. semi-automatic drilling machines in the plant of the Willys-Overland Co. This illustration shows the operation of drilling two holes 3/8 inch in diameter by 0.372 inch deep, and 25/64 inch in diameter by 1.120 inch deep, respectively, in the rear axle external brake-band lever. The material is malleable iron and the operation is performed at a speed of 650 R.P.M., with a feed of 0.003 inch per revolution. The production is 600 pieces per eight-hour working day. It will be seen that the drilling machine is equipped with a three-spindle auxiliary head, but that only two of the spindles are provided with twist drills. This is not due to the fact that use is being made of a three-spindle head, but because of the necessity for drilling both right- and left-hand brake-band levers. In drilling levers of the opposite hand, the drill shown in the right-hand spindle is removed and set up on the spindle at the left hand of the central position. In the work-holding fixture used on this machine, the end of the work is located by means of a V-block, and clamping is effected by means of wing-nuts *A* which bind the outer V-block against the end of the work. Supporting pads on the fixture prevent the work from springing.

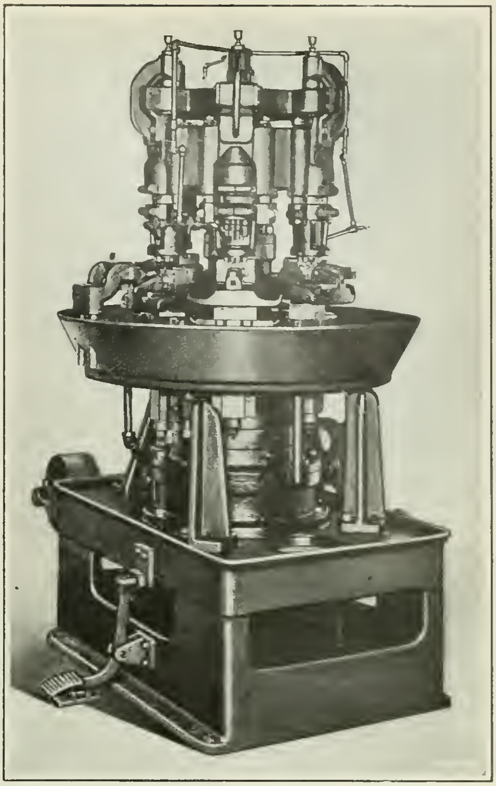

Fig. 52. Langelier Multiple-head Drilling Machine which provides for drilling Parts containing practically Any Number of Holes without Loss of Time for Ejection of Drilled Pieces or setting up Fresh Blanks

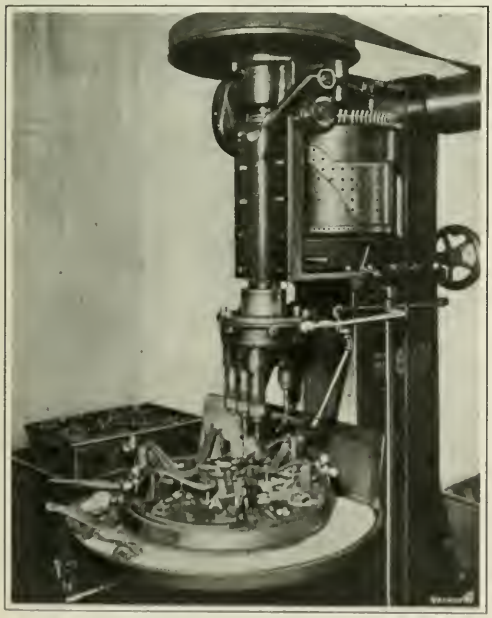

Fig. 51. Baker Semi-automatic Drilling Machine. Both this and Machine shown in Fig. 50 are in Operation in Willys-Overland Plant

Cotter-pin Hole Drilling Machine

Fig. 53 shows a machine known as the No. 1 semi-automatic continuous-feed drilling machine, which is built by the Langelier Mfg. Co. This machine is particularly adapted for drilling small holes, such as cotter-pin holes in long pins, balls, screws, nuts, and work of a similar nature. It is built for various sizes of work, with any number of drilling heads up to and including ten. In the illustration, eight heads are shown, each head having two drilling spindles, located one above the other, making a total of sixteen drilling spindles. The piece drilled was a pin 5/8 inch in diameter, having two 1/8-inch cotter-pin holes crosswise through the ends, the distance between the holes being 1 21/32 inch. The drilling spindles feed outward as they travel around the center of the machine, the two spindles in each head drilling the two holes in the pins at the same time. Each of the drilling heads has a vise which opens and closes automatically as it passes the operator, or may be closed by the operator with a foot-pedal, the instant he puts the work in the vise. Seven of the drilling heads are drilling continuously, while the eighth one is in the loading position, where the operator removes the finished piece and replaces a blank which is to be drilled. The drill is withdrawn as it passes the loading position and the corresponding vise opens automatically for the operator to remove the work and replace it with a blank. The operator can either sit or stand, as desired, while inserting fresh blanks in the vises. The vises are closed either automatically or by means of a foot-treadle.

All that the operator has to do is to remove the finished pieces and insert blanks in the vises, which can be made to hold pieces of various sizes and shapes. Either vertical or horizontal vises may be used, the style being determined by the class of work upon which the machine is to operate. When long pieces are to be drilled, the vises are made to hold the work in a vertical position, the work extending up any reasonable length that can be operated upon. On some classes of work an automatic ejecting device can be used to advantage, so that when the jaws open automatically the work will be forced out. With a machine equipped in this way, all that the operator has to do is to place fresh blanks in the vises.

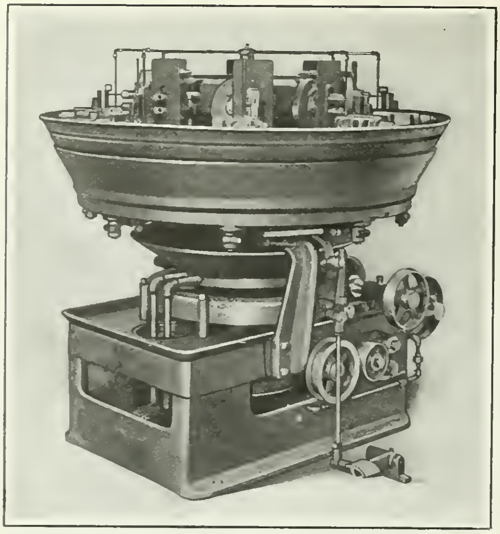

Fig. 53. Langelier Semi-automatic Continuous-feed Drilling Machine equipped for drilling Cotter-pin Holes

The maximum feed travel is 1½ inch, and the chucks will take drills up to 1/4 inch in diameter. The feed cam that operates the spindles is easily removed, so that cams to give different ranges may readily be substituted. When deep holes are to be drilled, the cams are made to withdraw the drills frequently, thus breaking and clearing the chips from the holes. The feed of the drills can be changed to suit the depth of holes and the sizes of drills. Provision is made for ample lubrication of the drills, the lubricant being forced between the vise jaws and the work, thus keeping the work flooded at the point of drilling so that the highest possible feed and cutting speed may be employed. A circular pan surrounds the drilling heads, this pan having ample capacity for holding the drilled work and chips. The oil is strained and drained into the base, where it is pumped back to the work by a circulating pump. An idea of the productive capacity of the machine will be obtained from the following example: Automobile chain pins 1/2 inch in diameter are drilled with 0.121-inch drills running at 2200 revolutions per minute, the production being 12,000 pins per ten-hour day. The capacity of the machine for round pieces with two sets of vise jaws is from 1/4 to 1 inch, the first set taking from 1/4 to 5/8 inch and the second set from 5/8 to 1 inch. The jaws carry a drill guide bushing which centers the drill accurately. These jaws can be quickly changed when it is required to operate the machine on some other class of work.

Six-head Continuous-feed Drilling Machine

Fig. 52 shows a six-head continuous-feed multiple drilling machine, with which parts containing practically any number of holes may be drilled continuously, without any loss of time for the ejection of drilled pieces or inserting blank ones. It is built by the Langelier Mfg. Co. The rate of production attained with this machine will be readily grasped upon noting that the work was drilled by an average unskilled operator at the rate of fourteen completely drilled pieces per minute, or a total of 8400 pieces or 42,000 holes in ten hours. The work is a forging 3/16 inch thick, and there are two holes 0.199, two holes 0.261, and one hole 0.098 inch in diameter. The speeds for these three sizes of drills are 585, 455, and 1200 R.P.M., respectively, with a feed of 0.0018 inch per revolution. If it had been necessary that the pieces be drilled with more than five holes each, the total number of holes drilled in ten hours would have been still greater, because all the holes in each piece, no matter how great the number, are drilled in practically the same time that it would take to drill a single hole. The machine works on six pieces simultaneously and continuously.

Each head is fitted with a "steady" jig for supporting and accurately starting the drill ends. The jig is adjustable vertically to compensate for the shortening of the drills by grinding, and is also under spring tension so as to exert pressure on the work while it is being drilled. The pieces to be drilled are located and held in position by a three-point supporting pressure lever fixture, the fixture body being screwed to the table permanently. Each type of work has a separate fixture seat of its own that can be quickly removed and replaced. The pieces to be drilled are gripped by a short fulcrumed lever under spring tension, the longest end being depressed to release the work by passing under a segment cam that is located directly in front of the operator and fastened to the rim of the oil-pan. The segment cam is stationary and is adjustable vertically so as to give just the proper amount of opening. The machine consists of a box base having a vertical stationary post at the center, around which revolves a member carrying the six drilling heads and tables upon which the work-holding fixtures are fastened. Each drilling head with its table revolves in unison. The drilling feed is accomplished by the upward movement of the tables; and at the lower extremity of each table slide there is a roller having contact with a circular feed cam that is fastened to the base of the machine. The drilling is done against the tension of a spring, as a safeguard against very dull drills and incorrect chucking of work in fixtures by the operator. Tension springs pulling downward on the tables insure them having contact with the feeding edge of the cam at all times, especially on the return.

The revolving member carrying the drilling heads and tables is actuated by a Hindley worm and gear located inside of the central circular flange supporting the feed cam. The work shaft, in turn, is belted to the clutch shaft, on one end of which is a pair of miter gears that receive motion from the main driving pulley inside the box base. The drilling heads are driven by a large central gear keyed to the vertical main driving pulley shaft extending up through the central post. The driven gears on the main spindles of the drilling heads are made of compressed cotton (Fabroil gears) so as to avoid unnecessary noise and insure smooth running. A large stationary chip- and oil-pan, supported by the standards, is fastened to the base that surrounds the machine. On the outer

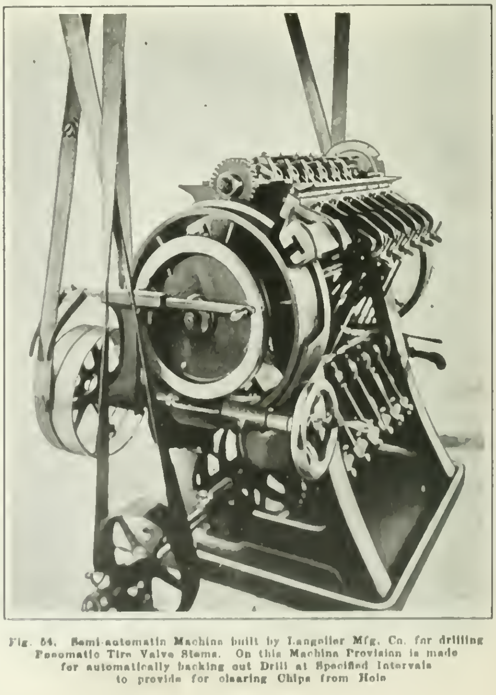

Fig. 54. Semi-automatic Machine built by Langelier Mfg. Co. for drilling Pneumatic Tire Valve Stems. On this Machine Provision is made for automatically backing out Drill at Specified Intervals to provide for clearing Chips from Hole

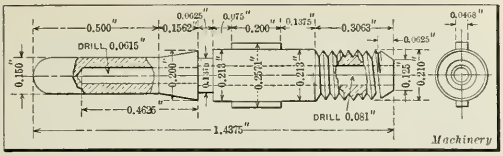

Fig. 55. Type of Brass Pneumatic Tire Valve Stem drilled on Machine shown in Fig. 54

end of the miter gear shaft is mounted a Johnson clutch that is operated by a foot-lever which is conveniently located for the operator. This clutch is used to make the circular feed of the machine independent of the driving of the drilling heads, so that it can be instantly stopped by simply unlocking the foot-lever by a side thrust of the foot.

The cutting lubricant is a special mixture that is pumped up through a tube passing through the main driving pulley shaft and then led to each drilling head by branch piping. After being used, it flows to the bottom of the circular oil-pan, where it is freed from the chips. It then passes to the top of the base, where it is filtered before entering the reservoir located in the bottom half of the base. This machine, with slight modification, can be used for drilling a large variety of pieces having one or more holes.

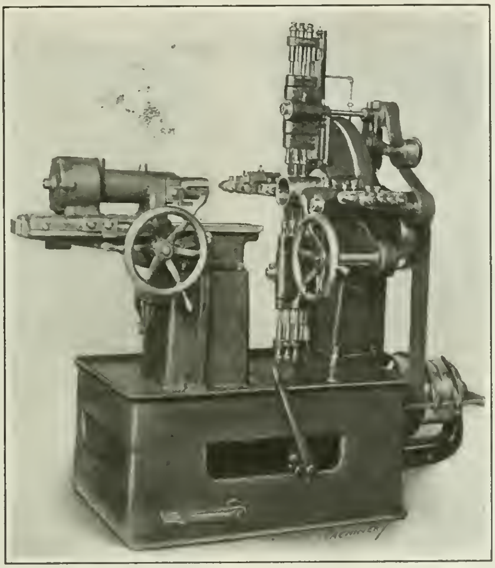

Fig. 56. Langelier Drilling Machine with Four Sets of Three Opposed Spindles for drilling Twelve 1/6-inch Oil-holes in Willys-Overland Motor Valve Sleeve

Semi-automatic Twelve-spindle Machine for Drilling Pneumatic Tire Valve Stems

On a machine built by the Langelier Mfg. Co. for drilling the brass stems of pneumatic tire valves, a shaft to which six fixtures are fastened is mounted in a pan supported by legs at a convenient height for the operator. These fixtures are triangular in shape, having their apexes flattened sufficiently to receive split chucks for holding the valve stems. These chucks are kept closed by springs, and are opened by small levers of such shape that when the chucks are opened by resting the palm of the hand on the levers, the work may be inserted or removed by the fingers of the same hand. The machine is shown in Fig. 54, and Fig. 55 shows the work to be drilled. The spindles, which are provided with chucks for holding the drills, run in bushed bearings in brackets attached to the outside of the pan, six on the back and six in front, and project through the pan at an angle of 30 degrees below the horizontal, thus being in line with the chucks that hold the work in the apexes of the triangular fixtures on the shaft above. There are also two larger brackets attached to the pan diagonally opposite each other, and extending out over drums at each end of the machine. These brackets support slides provided with rolls to engage with cam-plates secured to the faces of the drums. Long bars, which are attached to the slides, extend through the spindle brackets, and carry a wedge for each spindle. When these bars are drawn forward by the revolving cams engaging with the rolls on the slides, the wedges come in contact with bushings on the spindles, and force the drills inward toward the work. The wedge bars are returned to their normal position by springs, and the wedges are separately adjustable, so that the points of the drills may be kept in line.

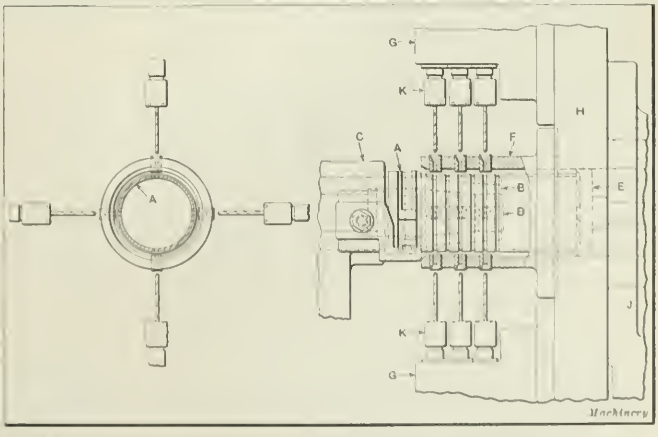

Fig. 57. Close View of Work-holding Fixture and Drilling Spindles of Machine shown in Fig. 56

The two cam drums are driven by a worm belted directly from the countershaft. At every revolution of the cam drums, a wedge under the run of the right drum withdraws a spring lock-pin from a notch in the index plate on the right end of the shaft, carrying the triangular fixtures, while a toothed sector on the left drum engages with a pinion on the left end of the shaft, turning it one-third revolution, where it is locked by the pin springing into the next notch in the index-plate. A lever is provided for unlocking the fixture shaft by hand, and the cam drums may be revolved by the handwheel on the worm shaft. When the machine is in operation, the pan into which the spindles project is filled with oil, so that the drills and work are completely submerged. The oil lubricates the spindles. A large pipe with a stop-cock is provided by which the oil may be quickly drawn off into a pail placed on the floor. The whole machine stands in a large pan, which insures cleanliness, though the drills never throw the oil, and it could only be splashed out of the upper pan by the carelessness of the operator. The valve requires to have a hole 0.081 inch in diameter drilled to a depth of 7/8 inch, and then a hole 0.0635 inch in diameter is drilled 1/4 inch farther. The cam plates on the faces of the drums are so made that the drills are fed into the work about 1/8 inch, then entirely withdrawn, and after the oil has cooled, lubricated and cleared the drills of chips, they are fed in 1/8 inch farther, and so on until the required depth is reached. The large drills are in the spindles on the back of the machine, and the small ones in front. The triangular fixtures run from front to back.

The operation of the machine is as follows: A valve stem is placed in each of the six chucks in the upturned apexes of the fixtures, then the fixture shaft is turned one-third revolution toward the back, where it is locked by the spring-pin in position for drilling the large holes. While the large drills are operating, the six chucks, now upturned, are filled with stems, and when the large holes are completed on the first set of stems, the fixture shaft turns one-third revolution, presenting the first set of stems to the small drills, the second set to the large drills, and the third set of chucks to the operator to be filled with stems. The machine is now fairly under way, and need not be stopped, except for accident, until working hours are over, as the operator has only to remove finished stems from the chucks, and insert blanks, while the drills are operating on the other two sets of stems. The drills make 8000 revolutions per minute, and at this speed the machine drills six valve stems every minute, or 3600 in a day of ten hours. Although designed and built for a special purpose, this machine may be adapted for a great variety of work.

Motor Valve Sleeve Multiple Drilling Machine

For use in drilling at one operation the twelve 1/8-inch oil-holes in the outer sleeve of a Willys-Overland motor valve, the Langelier Mfg. Co. designed the multiple drilling machine illustrated in Fig. 56. A similar machine was built for use in drilling four 1/8-inch holes in the inner sleeve, and the output of each machine is 3 1/2 sleeves per minute, or 2100 per day. The material is cast iron and the holes are approximately 3/16 inch deep. The machines are of exactly the same design, except that one is equipped with twelve drill spindles, while the other has only four spindles.

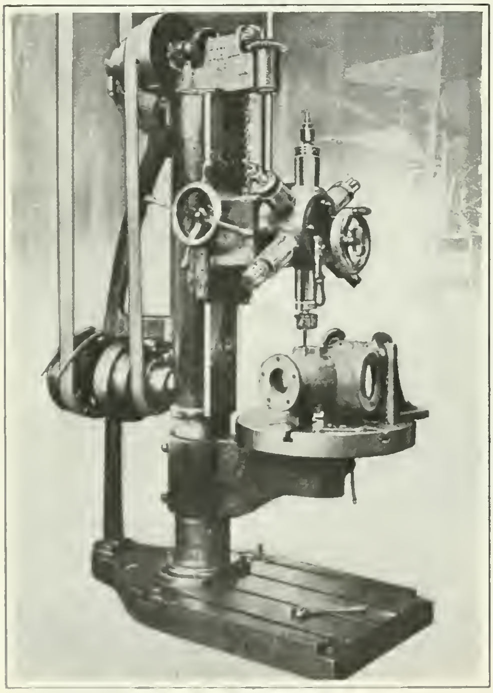

Fig. 58. Turret Type of Drilling Machine built by A. E. Quint in which Turret revolves in Vertical Plane

Fig. 57 shows a cross-sectional view through the drill jig on the machine for drilling the outer sleeve, in which the work is shown in the drilling position. Referring to this illustration in connection with the following description, the method of operating the machine will be clearly understood. Sleeve A is held and located in the drilling position by an internal expanding arbor B mounted on tailstock C, which slides upon ways in line with the axis of the machine. Expanding arbor B is opened or closed automatically by means of compressed air. The construction consists of a split sleeve that is attached directly to the piston in the compressed air cylinder, and inside this sleeve there is a fixed arbor D with a tapered end that is attached to the cylinder head. A slight travel of the sleeve on this tapered portion of the fixed arbor causes the sleeve to expand and hold the work securely, extra movement being avoided by a stop collar on the sleeve and tapered arbor.

Admission of air to the cylinder is controlled by a small piston valve that is attached to the tailstock C at the rear and operated by contact with a fixed stop attached to the tailstock slide. The tailstock is shown in its outer or loading position in Fig. 56, movement of the tailstock slide being secured by means of the handwheel at the front of the machine. The drilling position is obtained by the sleeve to be drilled coming into contact with a stop E located inside drill jig F; this stop can be adjusted at the left-hand end of the machine. The tailstock is also automatically locked when in a drilling position, and is unlocked by the foot-treadle shown at the front of the bed; this lock is adjustable and can be set to suit the requirements of the work being drilled.

Drilling heads G are located radially 90 degrees apart upon a circular faceplate H that is mounted on column J attached to the bed of the machine. Drilling spindles K are driven by spiral gears, the drives extending to the rear and having pulleys on their ends. The thrust is taken up by ball thrust bearings. Feed of the drill spindles is operated by a handwheel at the right-hand side of the machine, which has a spur gear connection to a rim gear located inside and concentrically with faceplate H. The rim gear carries a segment feed cam for each head that has roller contact with the feed yoke of each drill head. These yokes have a clamp connection to the sleeve on the outer end of the drilling spindles, and this clamp connection provides ready means of adjusting the feeding position of the drill spindles.

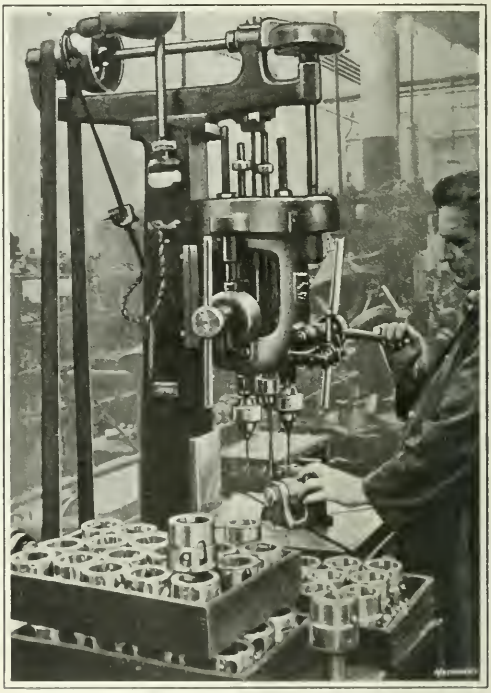

Fig. 59. Turret Type of Drilling Machine built by Turner Machine Co. in which Turret revolves in Horizontal Plane

Turret Type Drilling Machines

Turret type drilling machines fill the same place in the drilling machine group that is occupied by turret lathes in the lathe group. From this, it will be obvious that turret drilling machines are employed for the performance of a sequence of operations on a piece of work without requiring the setting of the work to be changed. Fig. 58 shows a machine, built by A. E. Quint, in which the required series of drills, counterbores, taps, etc., are mounted in spindles carried by a turret which can be revolved to bring the required spindles into successive operation. On this machine, the design has been so worked out that the only spindle which revolves is the one carrying the tool that is in the operating position. One of the chief claims made for this type of machine is that time is saved through avoiding the necessity of resetting the work for performing a sequence of operations, and by having the entire equipment for performing these operations contained in a single unit an economy is effected in both floor space and the required investment in machine tool equipment. Fig. 58 shows one of these machines in operation, and attention is called to the fact that different types and sizes of machines are provided for the performance of various classes of work.

In the turret type drilling machines built by the Turner Machine Co., a different principle is employed for bringing the required sequence of tools into operation. Fig. 59 shows one of these machines in operation at the plant of the Greenfield Tap & Die Corporation, where it is engaged in the performance of a series of operations on threading dies. This machine is shown drilling one hole to two different diameters, and it is necessary to ream one section of the hole. It will be apparent from this illustration that the method of bringing the different tools into operation is different from that of the machine shown in the preceding illustration. Here the turret is carried on a vertical spindle, about which it revolves horizontally to index the different spindles into the working position. Only the spindle in the operating position revolves. Machines of this type are built in different sizes, so that a suitable size may be selected for handling work covering a considerable range. These machines are designed with a turret case that holds the turret rigidly against side play, and a detent and socket positively lock the turret against rotary movement. Different styles in which these machines are built provide for driving tools fitted with Nos. 2, 3, and 4 Morse taper shanks, so that machines of this type may be used for the performance of machining operations in a wide range of work.

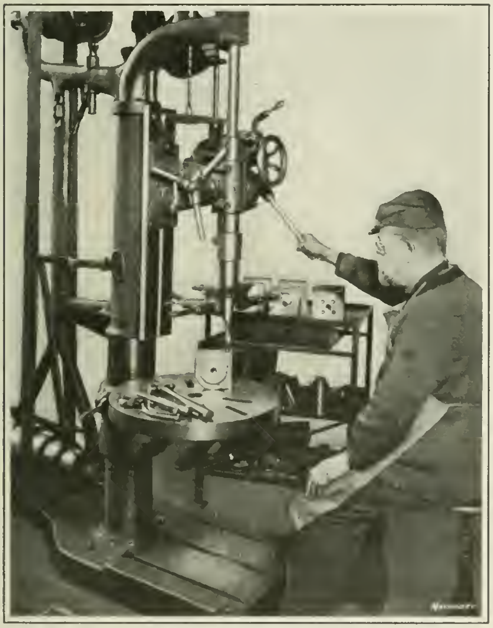

Fig. 60. Auxiliary Turret Head built by Newman Mfg. Co. to adapt Single-spindle Drilling Machine for Rapid Performance of a Sequence of Operations

Another equipment of somewhat the same general type is built by the Newman Mfg. Co.; the difference between this equipment and the two preceding types is that, in the present case, a turret head is provided for use on a single-spindle drilling machine. Fig. 60 shows a machine equipped in this way, from which it will be seen that the turret head is furnished with spindles for carrying the required sequence of tools. The drive is so designed that the only tool which rotates is the one in the operating position. The different spindles are held in place by a locking mechanism and may be quickly changed to bring successive tools into the operating position. A sleeve on the head is attached to the quill surrounding the drilling machine spindle, and provides for locking the head at the proper height. These drilling machine turret heads are made in two sizes for No. 2 and No. 4 Morse taper shanks; they are also made to hold straight shanks, if so desired.

* * *

INEQUITY OF THE INCREASE IN SECOND-CLASS POSTAGE

If the heavy increase in the postage on periodicals and the establishment of zones having different rates incorporated in the War Revenue Bill (the repeal of which is proposed in the new Smoot Bill) were based on known costs of service, there would be a measure of defense for the increase. It would then have been accurate from the bookkeeper's point of view, even if inexpedient; but according to the facts, it is neither.

It has been shown that the new postage rates on magazines and periodicals like Machinery are in some instances 30 per cent higher than the express rates—although these include returns on capital invested and the profits of the express companies. Yet, the post office was not established for profits and earning power, but to serve the needs of the country. Hence, as regards the cost of service, the new rates—from 50 to 900 per cent higher than the old—are indefensible.

As regards expediency, what greater harm could be done to the nation at the present time than to stifle the means of spreading accurate information on vital subjects? The mechanical world freely acknowledges its indebtedness to Machinery for the vast amount of definite technical information this periodical has collected, verified and published on the manufacture of war munitions; and new articles relating to the making of war material are constantly being published. Information of this kind aids mechanics all over the country in making munitions that will win the war; but the post office would prevent this information from reaching as large a number of readers as possible, by the creation of prohibitive rates on magazines transmitted through the mails. One department of the government thus appears to undo what other departments in this hour of need are doing their utmost to accomplish.

The section of the Revenue Bill establishing the new second-class mail rates and zone system should be repealed. No tax should be levied on the information that reaches the producers of the country through the trade and engineering press. Machinery does not believe in the policy of bombarding members of Congress with frantic appeals to do or not to do this, that or the other; but this is a government of the people through their chosen representatives, and the people must bestir themselves to make their wishes known. Here is a blow aimed at an institution which means more to democracy than any other—an efficient periodical press circulating freely among the people of this great nation. The zone system of postage rates sets up barriers between different sections of the country when the whole purpose of our lawmakers should be to cement the people into one solid indivisible American democracy.

* * *

Machinery has been ordered and a site selected in southwestern Virginia for the new government nitrate plant. Outside of this source of supply, provisions have been made to secure a steady inflow of nitrate from Chile, and it is intended to have a large reserve of this vital raw material. Five of the enemy's steamers, which were seized when war was declared, are to be used exclusively for the shipment of nitrates.

A BRASS RECLAIMING PLANT

BY R. W. B.

The problem of reclaiming metal from the casting shop ashes and floor sweepings of the large brass manufacturing companies has been a serious proposition from the beginning of the brass industry. For a long time and up to the present some of the companies have depended on the old type of pounding mill which served the purpose to a certain extent. The real saving, however, of the modern plant, which was not taken care of by the old type of mill, is derived from what forms a large part of the "fill" or made ground in the yard of almost any brass mill in the country today. The writer has been connected with the erection and running of a modern reclaiming plant, a general lay-out of which is shown by the accompanying diagram. Considerable trouble was experienced for a year or more after the plant was installed, but after all the equipment was properly arranged and the feeds and water supply had been correctly adjusted and regulated, to obtain the proper mixture for all the machines, the final results were considered highly satisfactory, as there was a daily average of 5000 pounds of metal reclaimed. This was a very favorable showing in comparison with the old mill which was running up to the time the new mill was in operation.

While the old mill reclaimed an average of 1100 pounds of metal in twenty-four hours with a working force of eight men, or four men for each twelve-hour shift, the new mill reclaimed the 5000 pounds in ten hours with a working force of six men. The amount reclaimed by the new mill included an average of 900 pounds of fine concentrates that was a total loss in the old pounding mill, which did not take care of the "fines." Nine hundred pounds of fines from a total of 5000 pounds of material, or approximately 22 pounds of "fines" per 100 pounds of material reclaimed, means a loss of 220 pounds of fine concentrates for every 1000 pounds of metal reclaimed in the old mill. With fine concentrates valued at twenty cents a pound, this would mean a saving of $220 a day in the new plant, which would pay the operating expenses, including labor, power and supplies for eight days. The above figures are taken from the actual cost and production, and are not assumed from our running condition.

By referring to the lay-out of the mill, the course of the material in the reclamation process can easily be followed. The ashes or material to be reclaimed is fed from bin *A* into elevator *B*, which carries it to the coarse screen *C*, where the coarse material is separated from the "medium fine." The coarse material passes over "picking belt" *D*, where a man picks out the coal that is large enough to be burned at the casting shop. The fine material is carried by conveyor *G* to storage bin *H*. The coarse material, after leaving picking belt *D*, is carried to jaw crusher *E*, which crushes it fine enough to be taken by elevator *F* to storage bin *H*. The material is taken from storage bin *H* by an automatic feeder *I* to a wet grinder *J*. From the grinder it is conveyed to fine screen *L* by elevator *K*. At fine screen *L* the important separation takes place, the "middlings" passing over jigs *S*, *T*, *U* and *V* and the "fines" passing to the classifier *M* and to the settling tank *N*. The concentrates from jigs *S* and *T* are discharged to bin *W*, whence they are taken to a rotary dryer. After leaving the dryer the concentrates are passed over a magnetic separator where any foreign matter that would be detrimental to a good brass mixture is removed. From the separator the concentrates are sent back to the casting shop where they are melted over, the amount used being proportioned according to the grade of the mixture.

Middlings too large to move on with the "tailings" are passed off through jigs *U* and *V* back to the grinding mill. Tailings from jigs *S*, *T*, *U* and *V* are passed off through jig *V* and elevator *X* to water extractor *Y*, where the water is removed and the tailings are discharged to bin *Z*, whence they are taken, mixed with bituminous coal, and burned in the boilers or in any furnace that takes bituminous coal. After the "fines" leave the fine screen they pass off through classifier *M* and settling tank *N* to vibrating tables *O* and *P*. Here the very fine metal is separated from the coal and slag and the metal passes to bins *Q* and *R* for the finished material, while the tailings are carried to water extractor *Y* by elevator *X*. The "fines" are refined and cast into billets; they are then sent back to the casting shop to be remelted. As the tailings are used as fuel, the only loss is in the ash and dirt that float away from the water extractor. The particular advantage of the water extractor is in the saving of water, as the jigs are supplied from the water taken from the tailings. This is a great saving where water is "metered" or where a city supply is limited. This reclaiming plant, with a few alterations, could be used on any material where grinding and separation are necessary. It was the aim to reduce the metal contents of the tailings as much as possible, which we were instructed by a well-informed mining engineer would be, at best, about 1 per cent. The reclaiming plant, however, did better than was anticipated. While the tailings have at times varied from 1 to 1½ per cent metal, the general average is from 0.3 to 0.5 per cent, which may be considered a highly gratifying result.

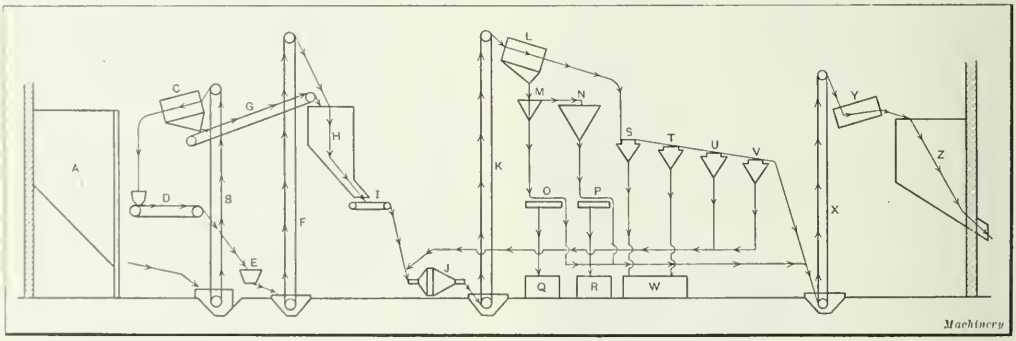

Diagram of Brass Reclaiming Plant, showing Course followed by Material

* * *

REPORT OF THE BUREAU OF STANDARDS

The annual report of the director of the Bureau of Standards, just issued, indicates that since the war began all branches of the bureau have been conducting researches on technical problems of military application. The regular work, however, has not been overlooked. In fact, the variety and importance of the results obtained during the year in scientific and technical researches are of unusual interest. The standardization work has comprised the making of 155,000 tests of weights, measures, measuring instruments and materials. Among the many tests, those applied to gage standards for testing munition gages are of special value to the mechanical industries. In addition, a large number of researches in the physics of materials have been made. The regular growth of the scientific bureau and its special expansion on account of war work has resulted in the construction of several new laboratories and in an increase of about 60 per cent in the staff.

HAND SCRAPERS

BY C. C. MARSH[1]

Owing to the growing demand, especially in the automobile and airplane industries, that all parts be finished all over, the hand scraper has become a most important tool for the machinist. These scrapers may be easily made to suit the work, but care must be taken to have them free from sharp corners and nicks on the cutting edge. As soon as a nick appears, the tool should be reground. Nicks may be caused by improper hardening, sand on the casting, dropping the tool, or grinding on too coarse a wheel. A hook scraper should not be bent over so far that it will chatter when used.

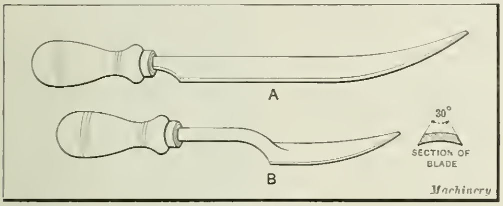

Fig. 1. Bearing Scrapers

A bearing scraper may be made from an old file, provided the temper has been drawn after hardening; a good grade of tool steel is better, however, as the temper will draw more evenly and the edge will last longer. To avoid scratching, the point should have a slight radius, about 1/32 inch. The scraper may be ground on a fairly fine wheel, but a fine water grindstone is preferable. Care should be taken to have the cutting edge even and prevent it from being burned on the wheel. The scraper should not be rubbed on a whetstone, as this is likely to give an uneven edge, especially as it is difficult to whet a curved surface equally. Bearings of soft metal, such as white brass or babbitt, can be properly scraped only by a tool that has not been rubbed on a whetstone. For grinding a scraper it is a good plan to use a holder similar to that used for grinding drills. When sharpening it is unnecessary to regrind the bottom face if it has been properly ground when making the tool. All sharpening should be done on the side edges.

Various widths of scrapers are required for different work. For bearings less than three inches in diameter, the scraper should be one-third the diameter of the bearing. For bearings three inches and more in diameter, a one-inch scraper should be employed, as the use of larger scrapers will be found impracticable.

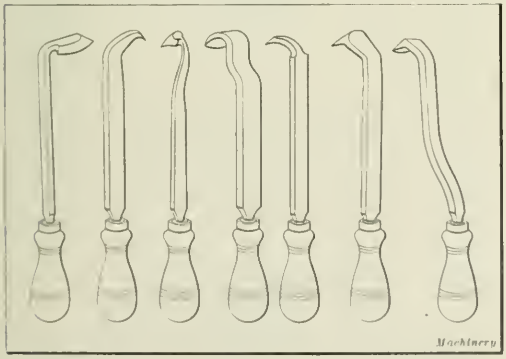

Fig. 2. Fillet Scrapers

There are practically only two kinds of bearing scrapers on the market. The first, shown at *A*, Fig. 1, costs about 50 cents and may be made from worn-out half-round files. It is curved upward at the cutting end, after being heated to the proper temperature, shaped by rough-grinding, and then rehardened. The other bearing scraper, shown at *B*, has a much shorter blade and is usually hand-forged. This tool seems to be the only one generally offered by dealers; the larger one is made only by small manufacturers. Both of these scrapers come rough and are ground by the user. The shorter scraper works much better if it is hollow-ground on the flat or under side; in fact, it is very important that this hollow be ground, as a good cutting edge is obtained much more easily and quickly than when the bottom is forged round and left rough. The curve for the hollow-grinding should be evenly made, so that it leaves a regular edge when the sides are ground. The edges should taper so that the blade is wider on the under side and should have an included angle of about 30 degrees as shown. The handles of bearing scrapers should be set firmly, but should not be too long.

Flat-plate scrapers were probably the first type used by the machinist. They are made from old flat files or forged from hexagonal or round bar stock, using the same hardening and tempering processes as are used for the bearing scrapers. They are not usually bent, though sometimes bending may be necessary for certain kinds of work. They may be whetted on the flat sides and the edges. These scrapers are used for scraping the pads and ways on various machine tools and for spotting plates and surfaces. The different designs vary in width and length, and may have rounded or square ends. The cutting edge is usually on the end. It requires more practice and skill to use these scrapers than to use the bearing scrapers.

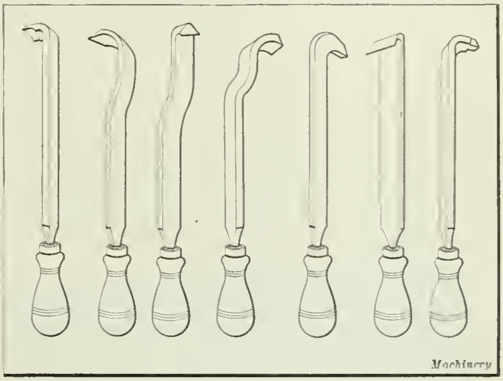

Fig. 3. Scrapers with Straight and Large Radius Cutting Edges

A third class of scrapers consists of any number of styles of almost any shape, depending on the work in hand. This class may be used on such work as crankcases for gasoline motors, transmission cases, gear housings, pump housings sheet-metal work and automobile bodies. The sand-blast finish on castings for these parts will not be uniform unless the surfaces are first scraped or polished, for all the surfaces cannot be reached by polishing. The rough and uneven surfaces should be smoothed and the scratches and marks caused by the foundry cleaning removed in order to obtain the proper results after sand-blasting. Since the practice in airplane motor construction requires that so many parts be finished all over, and since a great many pieces are so shaped that they cannot be directly machined or polished on all the surfaces, such as crankcases, gear housings, covers, etc., it is necessary for much scraping to be done. The necessity of scraping in all the corners and pockets in castings calls for an unlimited design of tools. It is impossible to design a combination of scrapers that will be suitable for all classes of work of this kind, but there are some scrapers that, properly designed, will answer many requirements. There should be a set of, say, ten fillet scrapers of various shapes. Some of these are shown in Fig. 2. The shapes shown have been used by the writer, though others would have to be designed to suit a different line of work. These sizes should vary to fit fillets of from 1/8 to 5/8 inch radius, inclusive, each size being 1/16 inch larger than the next smaller size. Some of these scrapers can be bent to reach an inside fillet and to give enough freehand movement in scraping.

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[1] Address: 1338 Barth Ave., Indianapolis, Ind.

Another combination of this class should consist of bent-hook scrapers with larger radii on the cutting edges. These are for circular surfaces, such as the openings in unfinished holes, and various concave surfaces; there should also be tools with convex cutting edges for the outsides of such openings. The last combination of this class should consist of both flat and narrow square-end scrapers with both short and long hooks. Types of each of these two combinations are shown in Fig. 3. Another type of scraper is the triangular or three-cornered tool. This is similar to a three-cornered file and may be made from the latter by simply grinding the three faces hollow. This scraper is used only for burring and cleaning out a hole or a closed bearing.

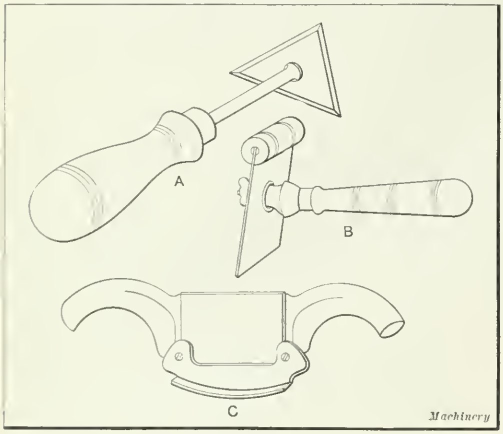

Fig. 4. Scrapers for Woodworking

On all types of scrapers that are drawn toward the operator, when in use, the handles must be securely fastened to the tool. One good way is to thread the shank and use a wing-nut on the end after the handle has been slipped on. Though rather expensive, this method has the advantage that the handles, if made of hard wood, are not so likely to split.

Scrapers for the woodworking industry are shown in Fig. 4. That shown at *A* is used by the butcher for scraping his meat block, while at *B* and *C* are shown the packing-box and cabinet-makers' scrapers. The hand scraper for the woodworker is much more developed than is the machinist's scraper; that is, many efficient types of wood scrapers are more easily obtained from tool manufacturers, because the requirements have become known through an ever-increasing demand from the woodworking trades. It was only a few years ago that cabinet and furniture makers used pieces of broken glass to smooth the surfaces on various kinds of work. Now such a thing would be ridiculed. There is no doubt that within a short time metal hand scrapers also will become standardized, as far as requirements will permit, because of the growing demand for a final finish.

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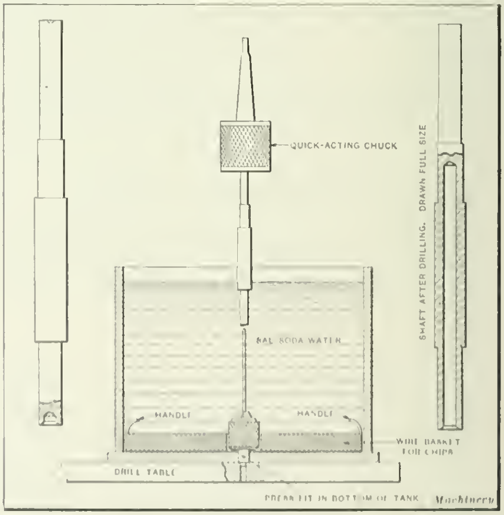
A new pyrometer has recently been developed for measuring temperatures above the range for which the thermo-couple is suitable. The pyrometer, as described in the *Electrical World*, consists of tin contained in a graphite bulb and which has an opportunity to expand through a graphite capillary tube. The expansion of the graphite is almost negligible in comparison with that of tin, and as the tin does not appreciably evaporate until a temperature of probably 2000 degrees C. (about 3600 degrees F.) has been reached, high temperatures can be negotiated with accuracy. A steel tube which contains an insulated contact is lowered into the capillary tube until it makes a contact with the surface of the tin and thus completes a circuit through an electric buzzer or sounder. The height of the tin is indicated by the position of the upper end of the steel tube, which holds a pointer moving over a scale. It will be noted that this pyrometer makes use of the principle of the ordinary thermometer.

INVERTED DRILLING OF ARMATURE SHAFTS

Deep-hole drilling is defined by one maker of drilling machines as the drilling of any hole that has a depth exceeding five times the diameter. Any drill point sunk to a depth greater than five times its diameter is likely to give more or less trouble because of the chips clogging and the difficulty of getting lubricant to the point. Deep-hole drilling as often carried out is a rather slow and costly operation. On the other hand, it is sometimes done in a very simple and efficient manner. A case in point is the practice of the Robbins & Myers Co., Springfield, Ohio, builder of electric motors, in whose plant the drilling of a 3/16-inch hole to a depth of 4⅜ inches in a small armature shaft is done simply and effectively. The 3/16-inch hole is drilled longitudinally in the armature shaft in order to feed oil to a bearing, a cross-hole being drilled to admit the oil from the longitudinal hole to the bearing. To drill this deep hole in an automatic screw machine or speed lathe would be a troublesome and costly operation that would be bound to break many drills and spoil many shafts, but the following method gives very little trouble, and the drilling operation is reduced to a low cost.

The drilling is done on a Leland-Gifford sensitive drilling machine, which is provided with a cast-iron tank as shown in the accompanying illustration. This cast-iron tank has a hole bored in the bottom for the mandrel of a Jacobs drill chuck. Surrounding the chuck is a shallow wire screen basket which is provided to catch the chips and facilitate their removal. The tank is filled to within about one inch of the top with the sal-soda solution and the shaft is immersed in the solution when being drilled. The chuck holds a 3/16-inch drill in an inverted position and the chuck and drill thus are beneath the water level. The armature shaft is held in a Wahlstrom quick-acting drill chuck.

The operator chucks the shaft in the drill chuck, the same as though it were a drill, and feeds it to the drill with the hand-lever, pumping up and down until the full depth is reached. A short experience enables him to avoid breaking drills, as he becomes expert in feeling the slight additional stress when the drill begins to heat and clog with chips. The spindles are drilled at the rate of one every one and a half minute, or forty per hour.



Drilling Armature Shafts with Drill held Stationary in an Inverted Position

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During the ten months ending October 31, this country imported $2,504,033,908 worth of merchandise, or nearly $500,000,000 more than in the corresponding period of 1916. Its exports during this period were valued at $5,150,689,085, a gain of over $700,000,000.

MANUFACTURE OF A SELF-LUBRICATING BEARING MATERIAL

PRODUCTION OF "GRAPHALLOY" BY A METALLIZING OR IMPREGNATING PROCESS WHICH COMBINES EITHER A WHITE METAL OR BRONZE WITH GRAPHITE

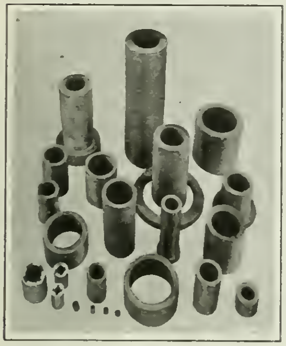

Fig. 1. A Group of "Graphalloy" Bearing Bushings

THE advantages of the oilless or self-lubricating bearing for many classes of service have led to the development of several different types, each of which doubtless has its advantages when applied under suitable conditions. One type consists of wood impregnated with wax, oil or paraffin. Another is made of bronze and has graphite inserts. Still another type is formed of graphite impregnated with some bearing metal such as a white metal alloy or bronze. For many years the attempt has been made to mix or alloy graphite with metal. This proved to be difficult on account of the great difference between the specific gravity of graphite and that of any metal. Within the last few years this problem has been solved by a commercial process of impregnating porous solid graphite forms with molten metal by the application of enormous air pressures. As this process is unique, a brief description of it will be given. The product known as "Graphalloy" is manufactured by the Graphite Metallizing Corporation, Yonkers, N. Y., and is used both for bearing bushings and for brushes and contacts in connection with electrical machinery.

The first important step in the production of "Graphalloy" is the selection of the graphite, which is obtained in the form of solid bars and plates. The bars are used for making bearings and the plates for the production of brushes and contacts for electrical apparatus. These bars or plates are not pure graphite (except in the case of bearings intended for unusually light service), but contain a small percentage of carbon to strengthen the graphite and make it more durable. It is essential to secure graphite which is uniform in texture and of a porous nature. The amount of carbon in the graphite stock is varied somewhat according to the intended use.

The next step in the manufacture of "Graphalloy" bearings or other parts is cutting or grinding the bars or plates to whatever form is required. It might be well to explain that "Graphalloy" bearings are encased in a housing, so that the bearing proper is in the form of a bushing. These bushings are machined approximately to the required size before they are impregnated with metal, because it is much easier to cut the graphite stock than the metallized graphite. Standard machine tools are employed for this work. For instance, the graphite rods may be drilled, bored, and turned to size in a turret lathe or screw machine and grinding machines are also used to advantage in connection with this part of the work. After bearings or other parts have been metallized, they are then finished accurately to whatever sizes may be required. Grinding machines are used almost exclusively for these finishing operations. A group of bearings of various sizes is shown in Fig. 1. Some of these have been finished to size, whereas others have been metallized but not ground. The three bushings shown in the lower left-hand corner are of the encased type having a metallized graphite lining which is surrounded by a white-metal casing to enable the bearings to withstand greater shocks.

Metallizing or Impregnating Process

The graphite bushings or other parts to be impregnated with metal are first heated in a crucible in one of the two oil-burning furnaces illustrated in Fig. 3. This preliminary heating is done at a relatively low temperature, and while one furnace is used for this purpose the other is melting whatever metal is to be used. As soon as this metal is molten, it is poured into the crucible containing the heated graphite parts. The crucible contains a perforated plate which is placed on top of the pieces to be impregnated and serves to keep them submerged in the molten metal. As soon as the metal has been poured in, the temperature of the furnace is increased to the maximum in order to superheat the metal. For instance, copper which has a melting point of about 1940 degrees F. is heated to approximately 3000 degrees F., so that it will remain in a molten condition and not become sluggish during the metallizing process.

When the metal has been heated sufficiently, the crucible is lifted out of the furnace by an electric hoist and is placed upon a small car which conveys it to the hydraulic press shown in Figs. 2 and 3. The crucible is placed on top of a hydraulically operated plunger (see Fig. 3), which is immediately elevated, thus lifting the crucible up into a chamber in the upper part of the press. The hydraulic plunger, which is simply used to lift the crucible and then close the lower end of the chamber to make it air-tight, is provided with a copper ring or gasket which bears against the lower end of the chamber. Practically all the air is next exhausted from this chamber, the vacuum gage recording about 28 inches. The object of exhausting the air from the enclosed chamber prior to the metallizing process is to expel the air from the pores of the graphite to insure thorough impregnation.

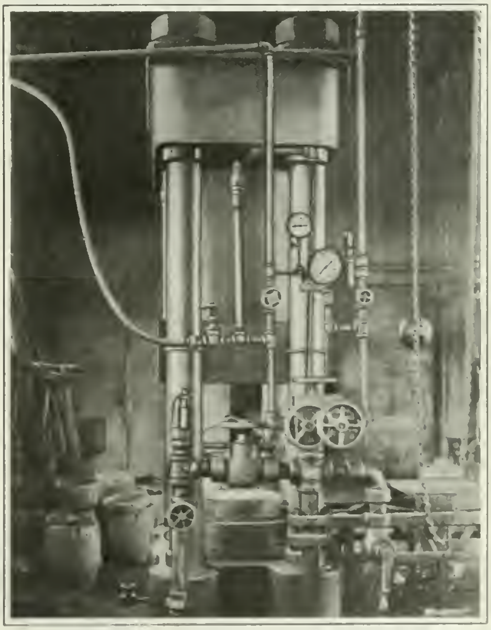

Fig. 2. Detail View of Press, showing Control Valves

In two or three minutes, the valve connecting the chamber with the vacuum tank and pump is closed, and air compressed to 5000 pounds per square inch is admitted to the chamber. This tremendous pressure forces the molten metal into the graphite so thoroughly that it permeates every part of a bushing or other piece. So far as we know, this is the highest pneumatic pressure that is used in a commercial way. The air is compressed in a four-stage machine (see Fig. 4) equipped with suitable intercoolers. The air pressure of the four stages is, respectively, 60, 275, 1300, and 5000 pounds per square inch. The air pressure is also applied to the lower side of the hydraulic plunger, as otherwise it would be forced downward. The metallizing process is completed in about five minutes, which includes the time for exhausting the air and applying the pressure. The crucible is removed from the press by lowering the plunger, and then the metallized contents are either immersed in water for rapid cooling or covered with sand to obtain a more gradual cooling. The latter method is employed except in the case of very small parts which are not likely to crack as the result of sudden cooling.

The metallized parts are next finished to whatever size may be required and, as previously mentioned, this is done by using some form of grinder. In the case of bushings, the work is done on internal or cylindrical grinders, whereas such parts as brushes and contacts of electrical apparatus are finished by means of a disk grinder or a surface grinder, the exact method varying according to the size of the work and the nature of the machining operation. If necessary, the parts can be threaded or tapped the same as pieces made of brass.

The metal used for impregnating the graphite depends upon the class of work. All parts such as shaft bearings are impregnated with a white-metal alloy or babbitt metal of special composition. The parts used in connection with electrical apparatus are impregnated with a copper alloy which is also utilized for such parts as steam turbine packing rings, etc., which must withstand high steam temperatures. The use of copper for the electrical work is essential because of its electrical conductivity.

The extent to which the graphite is impregnated with the metal is indicated by the fact that the weight of the graphite is 0.057 pound per cubic inch, whereas the weight of the metallized product is 0.145 pound per cubic inch when impregnated with babbitt, the increase of weight due to the metallizing process being practically 150 per cent. The metal in "Graphalloy" is about 60 per cent by weight, or 25 per cent by volume. The specific gravity is 4 and the compressive strength, approximately 14,000 pounds per square inch. One important fact regarding "Graphalloy" is that it is not injured by the application of lubricant. In fact, the use of an applied lubricant is recommended when the bearings are used for rather heavy service.

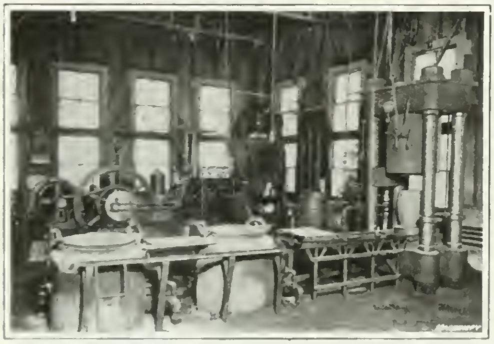

Fig. 3. Furnaces for heating Metal and Graphite, and Press in which Graphite Parts are metallized

Classes of Service for which "Graphalloy" is Adapted

At the present time "Graphalloy" in the form of bearings is applied to light duty machinery operating at high speeds and to heavier service when the speeds are relatively low. Its use is recommended particularly where the application of oil is either objectionable, difficult, or likely to be neglected. These bearings are commonly applied to loose pulleys, vertical shaft bearings, conveyors, textile machinery, canning machinery, etc. They are recommended for loose pulleys in cotton and silk mills and have also been utilized successfully on paper machinery, shoe machinery, wrapping machines, cotton spinning frames, etc., which operate on a product that may be damaged by the use of oil. One of the important uses of "Graphalloy" is for vertical bearings, such as are found on government fans, etc.

The use of "Graphalloy" is not recommended where the combination of speed and pressure is excessive. As a general rule, a bearing pressure of 50 pounds per square inch of projected area should not be exceeded. The limitations of this material are indicated by the following rule which applies to a bearing used without a lubricating oil. The surface speed of the shaft in feet per second multiplied by the pressure in pounds per square inch on the projected bearing area should not exceed a constant of about 200. The temperature of "Graphalloy" bearings is somewhat higher than that of ordinary bearings lubricated with oil, which is principally due to the fact that "Graphalloy" is a relatively poor conductor of heat. As soon as a "Graphalloy" bearing is put into service, a graphite coating begins to form on the shaft, the thickness of the coating depending upon the smoothness of the shaft. This coating soon becomes very smooth and hard, which greatly reduces the coefficient of friction and the temperature of the bearing. It is claimed that a temperature as high as 200 or 300 degrees F. will not injure the "Graphalloy" or cause it to seize the shaft. The temperatures are moderate at high speeds, provided the bearing pressure is low. On the other hand, if the bearing pressure is relatively high and the speed low or moderate, the temperature will also be low.

F. D. J.

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IMPORTANCE OF AUTOMOBILE INDUSTRY

According to a statement of the National Automobile Chamber of Commerce, $300,000,000 worth of raw and fabricated material is used annually in the automobile industry. Part of this material is used by the 550 manufacturers of passenger and commercial cars, whose factories are located in 32 states. These manufacturers have an invested capital of $736,000,000; employ 280,000 workers, to whom they annually pay $275,000,000; and for the year ending June 30, 1917, produced 1,806,194 motor vehicles. The gross wholesale value of these cars was $917,470,938; $90,000,000 worth of these cars were shipped abroad. The remainder of the raw and fabricated material was used by the 1080 parts and accessory makers. These manufacturers have an invested capital of $336,000,000 and employ 320,000 workers, to whom they annually pay $228,000,000. During the year ending June 30, 1917, the tire manufacturers produced 18,000,000 tires, which were valued at $450,000,000; nearly one-half of these were used on cars produced during the year. On July 1, 1917, there were in the United States 4,242,800 registered automobile owners; 400,000 of the registered vehicles were commercial cars. These cars and their supplies were sold by 27,800 distributors and dealers. The 2800 distributors have an invested capital of $41,000,000 and annually pay their 28,000 employes $25,200,000. The 25,000 retail dealers have an invested capital of $184,000,000 and annually pay their 202,000 salesmen, repairmen, etc., $159,000,000. In addition, 2255 supply houses sell the automobile owners their supplies, supplemental equipment, etc.

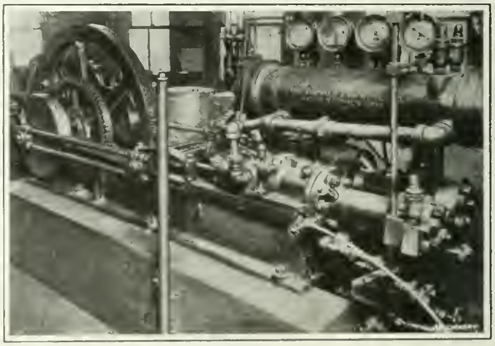

Fig. 4. Four-stage Compressor with Final Pressure of 5000 Pounds per Square Inch

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It is estimated that 25 per cent of the enameled, galvanized and tin household wear manufactured in this country this year will be required by the government

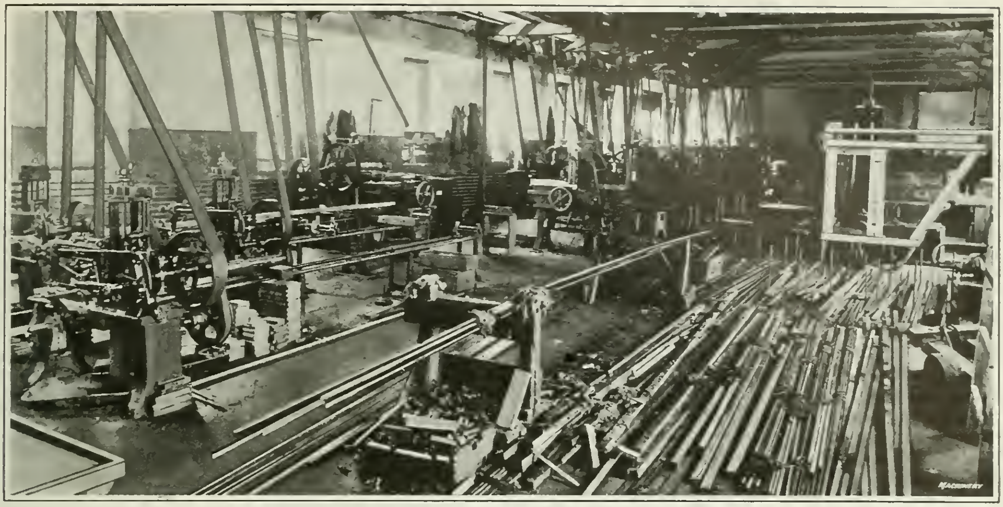

Fig. 1. General View of Department in which Keys are made

MANUFACTURE OF GIB KEYS

Cold-drawn shafting and screw stock of a variety of shapes and sizes is the principal product of the Pennsylvania Shafting Co., Spring City, Pa.; but as the manufacture of keys used for securing gears, pulleys and other machine members to shafting, is closely allied to the shafting industry, and as a superiority quality of gib keys is made from cold-drawn steel bars, this firm has a department engaged in key manufacture. The chief advantage secured through making gib keys from cold-drawn bars, is that these bars may be drawn to such a size that the machining required to complete the keys is reduced to three simple operations. The first step consists of cutting off blanks of the required length, and in order to facilitate the performance of this operation, a number of bars—usually the maximum number which can be placed in the vises of "Marvel" hacksaw machines built by the Armstrong-Blum Mfg. Co., 343 N. Francisco Ave., Chicago, Ill.—are worked on at one time. Each of these hacksaw machines is arranged with a stop so that the bars can be set up to cut blanks of the desired length without the necessity of gaging.

After the blanks have been cut off, they are taken to special manufacturing milling machines of the type shown in Fig. 3. These are simple machines with a table which runs between housings that carry the spindle and an outboard bearing for the cutter-arbor. It will be seen that the cutter is furnished with a cylindrical section *A* which mills away the stock, leaving a portion at the end which forms the head of the key. At the same operation a small angular section *B* of the cutter mills off the corner of the head to leave it of the desired form. After milling, it is simply necessary to obtain the desired taper on the key, this taper being 1/8 inch per foot for keys of all sizes. From the milling machines the keys are taken to a Pratt & Whitney surface grinder shown in Fig. 4, which is equipped with a magnetic chuck. The keys are placed crosswise on this chuck with the heads down and overhanging the edge. The chuck is blocked up at one side so that its face is at such an angle with the grinding wheel spindle that keys ground on the chuck will be given the desired taper of 1/8 inch per foot. The use of cold-drawn steel bars for the blanks from which these keys are milled, makes it unnecessary to perform a finishing operation on the sides of the keys or on the top of their heads, because a sufficiently good surface is produced during the process of cold-drawing. E. K. H.

* * *

CADMIUM FOR RUSTPROOFING

It is claimed that cadmium in combination with copper or zinc is a valuable material for preventing cast iron, wrought iron and steel from rusting. The iron or steel may be covered with a coating in the following manner: Double salts of cadmium and copper cyanide or of cadmium and zinc cyanide are dissolved in water, and the iron or steel objects electroplated in this solution; in a few minutes the objects will be covered with a coating of cadmium zinc or cadmium copper. The coating is silver-colored and permanently protects against rust. The double-salt solution may be made by dissolving 1 part of cadmium hydroxide and 1 part of copper oxide in 100 parts of water. Cyanide of soda or of potassium is added to the solution. If zinc instead of copper is wanted in the coating, zinc oxide is used instead of the copper oxide. Objects to be coated are first cleaned in a diluted acid solution, and are then placed as the negative pole in the solution. For the positive pole a zinc or copper plate is used. Five amperes for each square foot of area to be covered, with a pressure of four volts, is claimed to have been found satisfactory.

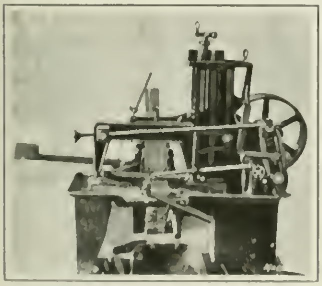

Fig. 2. Cutting off Key Blanks on "Marvel" Hacksaw Machines built by Armstrong-Blum Mfg. Co.

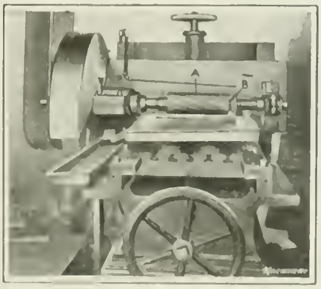

Fig. 3. Milling Gib Keys on Special Machines equipped with Cutters that complete Work at a Single Operation

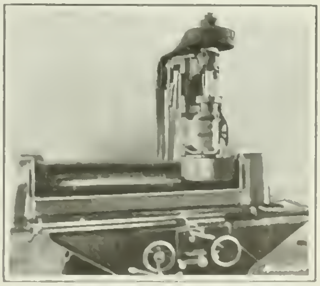

Fig. 4. Pratt & Whitney Surface Grinder with Magnetic Chuck set at an Angle to grind Taper of 1/8 Inch per Foot

GENERAL THREAD CUTTING PRACTICE IN THE LATHE[1]

IMPORTANT POINTS ON CUTTING SINGLE, MULTIPLE AND TAPERING THREADS BY MEANS OF SINGLE-POINT TOOLS AND CHASERS

BY FRANKLIN D. JONES[2]

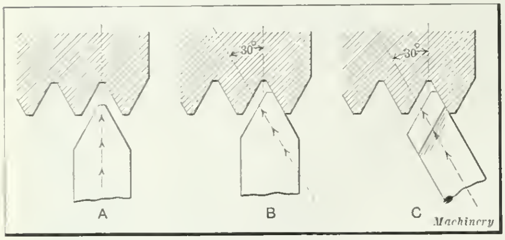

Fig. 1. Straight and Angular Methods of feeding Tool when cutting Thread in Lathe

While the use of the engine lathe for cutting screw threads is very common, a review of some of the more important features of thread-cutting practice will be presented even at the risk of covering ground that is not new to many interested in this general subject. One advantage of the engine lathe as a means of cutting screw threads is that it is adapted for a wide range of pitches and diameters. The swing of the lathe either over the bed or carriage equals, approximately, the maximum diameter of external screw thread that can be cut, and the number of pitches varies according to the change-gear mechanism, but is usually large enough for all ordinary requirements. There is also an advantage in most instances in being able to cut threads on the same machine that is used for the turning operation, because the thread is then cut concentric with other finished surfaces. A well-constructed lathe is also capable of very accurate thread cutting.

Conditions Governing Use of Engine Lathe for Screw Cutting

The conditions under which the lathe is commonly used for cutting screw threads are as follows:

1. When a part has been turned and one or more screw threads must be cut to complete it.
2. When the screw thread is not standard or is so large in diameter that the use of a tap or die is not practicable.
3. When there is not enough thread cutting to warrant the use of machines or equipment designed primarily for screw cutting.
4. When the lathe is the only means available, in which case it is sometimes applied to screw-cutting operations which could be done more efficiently in some other way.
5. When the lathe is the only machine available that will cut threads of the required standard of accuracy.

The engine lathe equipped with a single-point tool is almost invariably used for cutting screw threads on parts that are turned in it, but it is seldom used for threading operations on parts that have been previously turned in another type of machine; in fact, when threading operations are preceded by turning operations, the former are, as a rule, performed in the machine that did the turning, whether it is an engine lathe or some other form of lathe or turning machine. For instance, in the turret lathe and automatic screw machine practice, dies are used for most external thread-cutting operations and taps for internal work. As is quite evident, the object of cutting the screw threads in the same machine is to avoid a second operation on another machine, and, at the same time, secure accuracy by cutting the threads before the position of the work has been disturbed. If, for example, a piston rod has been turned in the engine lathe and a screw thread is required at the piston end for receiving a nut, the lathe, would, of course, be used for cutting that thread. On the other hand, when cutting a screw thread is the principal operation, the engine lathe may either have competitors or be out of the race entirely. If the part is simply a screw and the only operation is that of cutting the screw thread, a special threading machine of the die class or a thread milling machine might be used in preference to the lathe. If a thread-milling machine or dye type of thread-cutting machine were not at hand, the lathe would generally be used, unless the number of parts to be threaded were large enough to warrant installing a machine designed especially for screw cutting.

Position of Tool and Traversing Movement

The cutting end of a single-point thread tool is shaped to correspond to the cross-sectional shape of the thread groove in a plane intersecting the axis of the screw. The tool should be so located with reference to the part to be threaded that the angle of the thread cut by the tool will be the same as the tool angle and so that the sides of the thread will incline equally with reference to the axis of the screw. To secure the correct thread angle (assuming that the tool is properly ground), the upper face must lie in a plane coinciding with the axis of the screw; in other words, if the upper face were flat and horizontal it should be at the same height as the lathe centers. A common method of setting a tool so that each side will have the same inclination is by using the gage intended for testing the tool when grinding it. This gage (one form of which is shown at *A*, Fig. 6) is simply placed against the turned surface to be threaded, in case the thread is straight or cylindrical, and the tool is adjusted until the cutting point fits accurately into the V-shaped notch in the gage. The center line of the tool or a line bisecting the cutting end should be at right angles to the axis of the screw, regardless of whether the screw is straight or tapering, although this practice is varied in the case of a Whitworth thread. This point will be considered later.

In order to form a complete thread with a single-point tool, a number of cuts are required, the number depending upon the pitch of the thread and the corresponding depth of the thread groove. On all standard engine lathes, a gear-driven lead-screw is used to traverse the tool a distance equal to the lead of the thread for each revolution of the part being threaded. Gearing of the correct ratio may be placed in position each time a screw thread of different lead or pitch is to be cut, or the gearing may form an integral part of the machine, and be so arranged that the necessary combination can be engaged by simply shifting the controlling handles or levers. The calculation of change-gears and the adjustment of lathes for cutting threads of different pitches have been covered in so many technical books and periodicals that this part of the general subject will not be considered here.

Straight and Angular Methods of Feeding Tool Inward

The inward feeding movement of a tool for each successive cut may be either at right angles to the axis of the screw

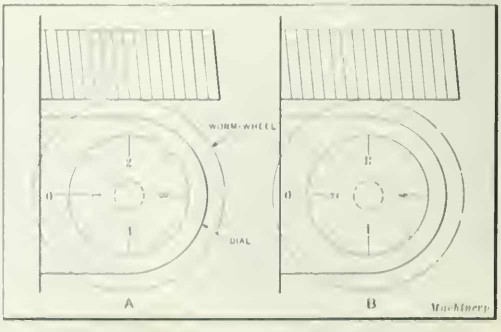

Fig. 2 Diagrams Illustrating Arrangement of Thread Chasing Dial or Indicator

thread, as indicated at *A*, Fig. 1, or at an angle of 30 degrees as shown at *B*. With the latter method the compound rest is set at an angle of 30 degrees. If the lathe is not equipped with a compound rest, the feeding movement must be, of course, as shown at *A*. The objection to this method is that the cutting action is not so good as when one edge of the tool does practically all the cutting, as at *B*, and the other edge moves parallel to the opposite side of the thread. The angular method of feeding the tool does not tend to tear the thread as when the tool is fed straight in, and a smoother thread is cut. After most of the metal has been removed by the angular feeding method, the tool may be moved straight in to take a light finishing cut.

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[1] For information on thread cutting previously published, see "Thread-cutting Attachments," in the February number of MACHINERY, and articles there referred to.

[2] Associate Editor of MACHINERY

The thread tool illustrated at *C* is intended especially for feeding in at an angle. This tool is given top rake and all the cutting is done on one side. As the illustration shows the compound rest is set at an angle of 30 degrees for cutting 60-degree threads such as the U. S. standard or sharp V-threads. The point of the tool forms one side of the thread as it feeds in at this angle and the cutting edge forms the opposite side. This form of tool cuts easily, because of the top rake or slope, and it is particularly adapted for coarse threading operations. Sometimes an ordinary thread tool is used for taking a light finishing cut after roughing out the thread by a tool of the type referred to.

Return of Tool for Successive Cuts

There are two ways of returning the lathe carriage and tool to the starting point for taking another cut after one or more cuts have been completed. One method is by disengaging the carriage from the lead-screw and returning it by hand; the other is by allowing the carriage to remain in engagement with the lead-screw and reversing the lathe or lead-screw at the completion of each cut. If the number of threads per inch on the screw being cut is a multiple of the number per inch on the lead-screw, the carriage may be disengaged and re-engaged with the lead-screw at random and the tool will always follow the original or first thread groove that was cut; when the number, however, is not a multiple of the number on the lead-screw, the tool may not engage the thread groove properly. When it is necessary to adopt some method of keeping the tool in the right relation to the work, if the screw is quite short the carriage may remain in engagement with the lead-screw until the thread is finished, but for cutting comparatively long screw threads this method of returning the carriage would require too much time and it can be returned more quickly by hand. When lathes have exposed change-gears, marks are sometimes made on the gears to insure re-engaging the carriage lock-nut with the lead-screw at the right time; most of the modern lathes, however, are equipped with an indicator or thread chasing dial for "catching the threads."

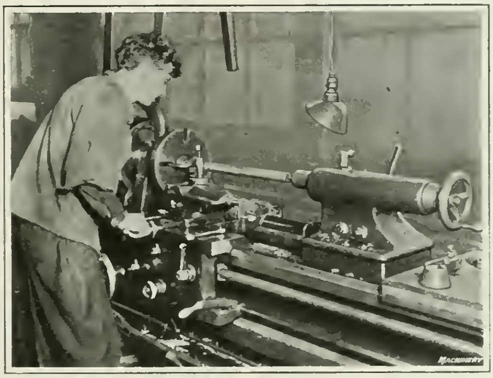


Fig. 3. Compound Rest set Parallel to Axis of Screw for adjusting Tool when cutting Multiple Thread

Principle of Engine Lathe Chasing Dial or Thread Indicator

The thread chasing dial of an engine lathe is attached to the carriage and has a worm-wheel (see Fig. 2) that meshes with the lead-screw. The vertical spindle or shaft of this worm-wheel carries a graduated dial which shows when to re-engage the carriage with the lead-screw when cutting screw threads which are not a multiple of the number per inch on the lead-screw. The number of teeth in the worm-wheel of the indicator should be a multiple of the number of threads per inch on the lead-screw, and the number of main divisions on the dial should equal the number of teeth on the worm-wheel divided by the number of threads per inch on the lead-screw. Each main division will then represent an inch of carriage travel. For instance, if the lead-screw has six threads per inch and the worm-wheel twenty-four teeth, then there should be $\frac{24}{6} = 4$ main divisions or graduations on the dial. We shall assume that 11 threads per inch are being cut and that the carriage was engaged with the lead-screw when graduation line No. 1 was opposite the zero line on a stationary part of the indicator as illustrated at *A*. If the tool were withdrawn from the thread groove and moved back a distance equal to one-sixth inch, or one lead-screw thread, it would not be opposite a thread groove on the work; the same would be true for a backward movement equal to two, three, four, or five threads on the lead-screw, but a movement of six lead-screw threads, or one inch (as indicated by *B*) would bring the tool in line with a thread groove eleven threads away from the point of disengagement; therefore, by always re-engaging the carriage with the lead-screw when one of the graduations representing an inch of travel is in line with the zero mark, the tool will follow the original cut. If in the preceding example the number of threads per inch being cut were ten instead of eleven, or any other even number, a half inch of backward movement would have located the tool directly opposite a thread groove; hence, if the four main divisions on the indicator dial previously referred to were subdivided, making eight divisions in all, any of these half divisions could also be used for "catching the thread" when cutting an even number of threads per inch. If 11½ threads per inch were being cut, those graduations on the dial representing a movement equivalent to two inches or twenty-three threads on the work would be used when re-engaging the carriage and lead-screw. For instance, suppose there are four main divisions on the dial, each representing one inch of carriage travel and numbered 1, 2, 3, and 4 as shown; then if engagement were made for the first cut when, say, line No. 1 was opposite the zero mark, either this line or line No. 3, two divisions from it, would indicate the point of engagement for succeeding cuts. Some indicator dials have a circle of graduations for even numbers of threads per inch, representing a half-inch carriage travel; another circle of graduations for odd numbers representing inches of carriage travel; and a third circle for fractional pitches (like 11½ threads per inch) representing two inches of carriage travel.

Cutting Multiple Screw Threads

When cutting multiple screw threads, the general method of procedure is about the same as for single screw threads except that the lathe must be geared according to the number of single threads per inch, or with reference to the *lead* of the thread, not the pitch, and provision must be made for locating the tool when cutting the different thread grooves. The tool may be located (1) by indexing or turning the piece being threaded a fractional part of a revolution; (2) by setting the compound slide parallel with the screw thread being cut so that the slide can be used for adjusting the tool; (3) by disengaging the lock-nut from the lead-screw while the lathe spindle is stationary, moving the carriage the required distance; (4) by engaging the lead-screw at the proper time (with the lathe in motion), as shown by graduations on the thread chasing dial or indicator.

Indexing for Multiple Thread Cutting

When the screw is indexed for locating the tool in connection with thread-cutting, it is given one-half turn for a double thread, one-third turn for a triple thread, one-fourth turn for a quadruple thread, and so on. An easy method of indexing for a double thread when the work is held between centers is simply to remove the parts from the lathe and turn it one-half revolution by placing the driving end of the dog in the opposite slot of the faceplate. The objection to this method is that any error in the location of the faceplate slot would be reproduced in the screw thread. Another common method (when using the change-gear type of lathe) is to disengage the stud gear and idler gear after marking whatever tooth happens to be in mesh, and then turn the spindle half a revolution for a double thread, one-third revolution for a triple thread, etc. If the ratio of the gearing between the stud and the spindle were other than 1 to 1, this would affect the indexing movement; moreover, in order to apply this method the number of teeth in the stud gear must be evenly divisible by 2 for a double thread, 3 for a triple thread, and so on. A convenient method of indexing multiple-threaded screws is by means of a special faceplate formed of two parts, one of which is free to rotate after loosening the clamping bolt. Graduations on the edge or periphery of one plate are used for turning the adjustable section the required amount.

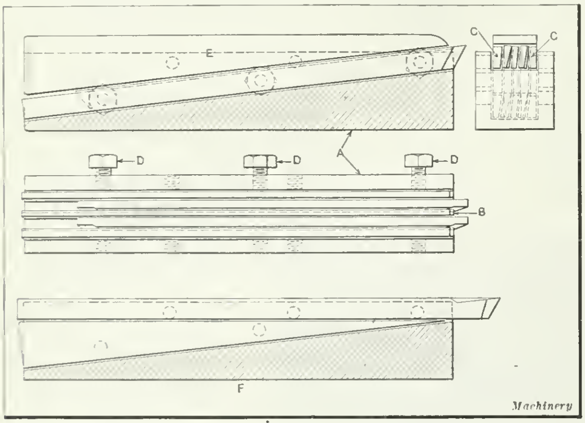


Fig. 4. Multiple Tool for cutting Both Grooves of Double Thread simultaneously

Use of Compound Rest for Adjusting Tool when Cutting Multiple Threads

When a lathe has a compound rest, this may be used for adjusting the tool when cutting the different thread grooves of a multiple screw thread. The compound rest is set parallel to the axis of the screw, as shown in Fig. 3, and after one thread groove is cut, the tool is moved a distance equal to the pitch of the thread or one-half the lead for a double thread, one-third the lead for a triple thread, etc. When the feed-screw has a graduated dial, this adjustment of the tool can easily be made. The compound rest method is very convenient and has the advantage over the use of a special faceplate that parts may be held in the chuck for internal threading operations. The accuracy of the tool adjustment and of the screw that is cut depends upon the accuracy of the feed-screw of the compound rest slide; ordinarily, the errors from this source would be so small as to be negligible.

Adjusting Tool for Multiple Thread Cutting by Shifting Carriage

When a tool is located for cutting different thread grooves of a multiple screw thread by shifting the carriage and tool, the adjustment must be such that when the tool is in the correct position, the lock-nut may be re-engaged with the lead-screw. If a double thread is being cut having a lead of, say, one inch the tool could be located for cutting the second thread groove by disengaging the lock-nut (with the lathe spindle stationary) and moving the carriage back a distance equal to the pitch of the thread, or one-half inch. If the adjustment were equal to the pitch plus the lead or the pitch plus any multiple of the lead, the tool would still be in position for cutting the second thread groove. In actually cutting a screw thread, it would, of course, be necessary to move the carriage far enough for the tool to clear the end of the work before starting another cut; for instance, if the tool were 10 inches from the starting end and a double thread having a one-inch lead were being cut, the carriage should be moved at least 10½ inches. This adjustment could also be obtained in this particular case, if the lead-screw had an even number of threads per inch, by moving the carriage and tool one-half inch (pitch of thread) and then, after re-engaging the lock-nut, turning the lathe backward to secure the necessary additional movement.

Whether or not the lock-nut can be re-engaged with the lead-screw after shifting the carriage a given distance may be determined as follows: If the carriage is moved a whole or even number of inches (not fractional), the lock-nut can, of course, be re-engaged with any lead-screw having a whole number of threads per inch. If the number representing the carriage adjustment is fractional, the number of threads per inch on the lead-screw must be divisible by the denominator of the fraction.

Use of Thread Indicator for Multiple Thread Cutting

The thread chasing dial or indicator may sometimes be used to advantage for engaging the tool with the different multiple thread grooves when cutting a screw thread of this kind. By means of the indicator, the engagement of the lock-nut with the lead-screw is so timed that the tool, after taking a cut through one thread groove will be in position to cut the other groove or grooves, as the case may be, before feeding the tool inward, instead of finishing one groove at a time. To illustrate, suppose a double-threaded screw is to be cut having a lead of ½ inch (¼ inch pitch) or two single threads per inch. We shall assume that the lead-screw of the lathe has 4 threads per inch, the indicator worm-wheel 24 teeth, and the dial 6 main divisions, representing inches of carriage travel, and 6 subdivisions representing half inches of carriage travel. Since the number of threads per inch is even in this case, the lock-nut may be engaged with the lead-screw when any division line on the dial is opposite the zero mark, and the tool will follow the original cut. After taking a cut in one thread groove and moving the carriage back to the starting point, the lock-nuts are next engaged when the zero line is midway between any two lines on the dial; the tool will then cut another groove midway between the first one, or a distance from it equal to the pitch of the thread. If there were an odd number of single threads per inch, say, three, engagement would be made on any main division line for cutting one groove of a double thread, and on any subdivision for the other groove.

Multiple Tool for Cutting Multiple Threads

The different thread grooves of a multiple screw thread may be cut at the same time by using a tool for each groove, the tools being spaced according to the pitch of the thread. The Dale multiple-tool holder is shown in Fig. 4. This particular holder is arranged for cutting square threads, although the same general type may be applied to other forms. The main part of the holder *A* is channeled or grooved to receive the cutting blades or tools. The space between these tools is regulated by the distance piece *B*, and they are held at an angle by tapering strips *C* (see end view). This inclination varies, of course, with the pitch and diameter of the screw thread. The tools and strips *B* and *C* are held in position by set-screws *D*. The tapering part *E* above the tools provides a

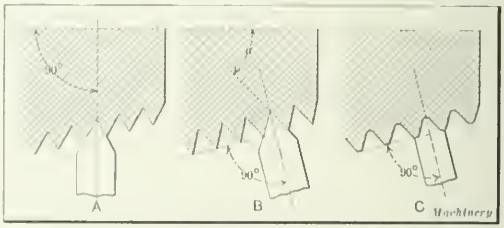


Fig. 5. Correct and Incorrect Positions of Tool for Taper Thread Cutting

horizontal surface for clamping the tools in position in the tool-holder. When this holder is used for cutting Acme or other screw threads of angular form, the tools are held in a horizontal position by inserting a tapering piece beneath them as shown at *F*. A flat plate is then applied to the top to form a bearing surface for the tool-holder clamping screw. The blades used in this holder are of the same section throughout their length to provide for repeated grinding.

Position of Tool for Cutting Taper Screw Threads

It is the general practice in this country to set a tool for cutting tapered screw threads as shown at *A*, Fig. 5, or so that the sides of the thread incline equally with reference to a line perpendicular to the axis of the screw. The principal reason why taper threads should be cut with the tool in this position is that taper taps are made in this way or with the threads normal to the axis. If the tool were set in the position shown at *B* or so that the sides of the thread incline equally with reference to the tapering surface, obviously such a thread would be a poor fit in a hole tapped with an ordinary taper tap having threads normal to the axis as at *A*. If the hole and the tapering part which screws into it were both threaded normal to the surface as at *B*, the thread would be satisfactory unless there were an unusual amount of taper. In extreme cases, angle *a* (see diagram *B*) of one side of the thread might be so small that the radial or bursting pressure on the nut would be excessive owing to the wedging action. It is the practice to cut Whitworth pipe threads and most other Whitworth threads which are tapering, with a tool set perpendicular to the side of the tapering surface as shown at *C*, because the same tools that are used for parallel threads can then be used for taper threads. If a tool used for parallel thread cutting were set at right angles to the axis, one side of the crest of the thread would not be cut to a circular form if the tool were of the shape illustrated, because the curved cutting edges would be the same distance from the axis of the screw and only one side of the circular part of the tool would cut. This difficulty is not encountered with the thread forms like the U. S. standard or V-threads.

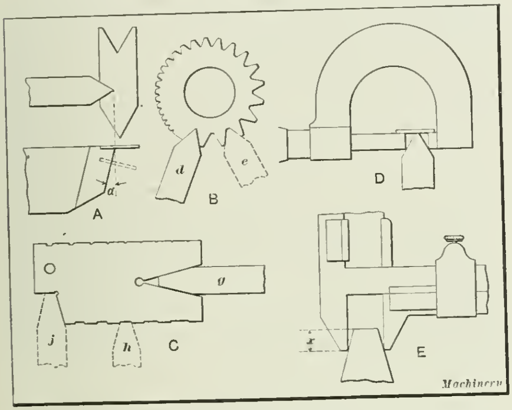


Fig. 6. Methods of gaging Thread-cutting Tools

The top cutting face of the tool should lie in a horizontal plane coinciding with the axis of the work for all taper thread cutting. It is much more important to have the tool at the same height as the lathe centers when cutting taper threads than when cutting parallel threads for the reason that a section parallel to the axis of a cone is not straight but curved; consequently, not only is the angle of the thread changed but a curved tapering thread also is produced.

Adjustment of Lathe for Taper Thread Cutting

An engine lathe equipped with a taper attachment should be used for taper thread cutting if possible. When the required taper is obtained by setting the tailstock off center, the thread will not advance at a uniform rate or form a true helix, especially when an ordinary bent-tail driving dog is used. This "drunken thread" or error is caused by the angularity between the driving dog and the faceplate, which causes the rotating speed of the work to vary during each revolution. The bearing surface between the lathe centers and the work-centers when the tailstock is offset is another cause of inaccuracy, because as the work-centers wear rapidly on account of the poor bearing surface, the angle of the taper is changed as the tailstock spindle is tightened. The amount of these errors depends upon the angle of the taper and the distance that the centers must be offset. When a plain (not threaded) gage of the required taper is available this may be used for adjusting the taper attachment accurately prior to the thread-cutting operation. The taper gage is placed between the centers (which should be in line) and a dial indicator is fastened in the tool-holder. The carriage is then traversed while the indicator is in contact with the taper gage, and the taper attachment is adjusted until the hand of the indicator remains practically stationary as it is traversed from one end of the gage to the other. This method has been employed in making thread gages of the plug form. Many tapering threads, especially when large numbers of duplicate parts are required, are cut by means of chasers or special dies.

Internal Thread-cutting Operations

The general methods of cutting internal threads in the engine lathe are: (1) by means of a single-point tool; (2) by using a tap supported by the tailstock spindle; (3) by using a single-point tool followed by a tap; (4) by using a multiple-point tool of the chaser class. The single-point tool is used for most internal thread-cutting operations. If the hole to be threaded is quite small in diameter, it is difficult to cut an accurate thread with a single-point tool, especially if the hole is quite long or deep, because of the flexibility of a tool small enough to enter the hole. On work of this kind a tap may be used or the thread is sometimes cut slightly under size with a single-point tool, and a tap having its shank or outer end held straight by the tailstock center is run through the hole for taking a light finishing cut.

Gaging Single-point Thread Tools

The accuracy of a screw thread cut in a lathe may be affected as to pitch or lead by the lead-screw, and as to the angle or form of thread by the tool used for the thread-cutting operation or its position when in use. For ordinary work the tool is ground either by hand or, preferably, by the use of a special tool grinder of the type used for sharpening turning and planing tools. When the angle of the cutting edge is being tested by a gage, the latter should be held in the same plane as the cutting edge, as at *A*, Fig. 6, and not at right angles to the front side, as shown by the dotted lines, assuming that the notch in the gage conforms to the standard thread angle. If the clearance angle *a* of a tool is 15 degrees, the angle in a plane at right angles to the front face is about 61 degrees 45 minutes, when the angle in the plane of the cutting edge is 60 degrees; hence, if the tool were ground to fit a gage held as shown by the dotted lines at *A*, the angle of the cut-

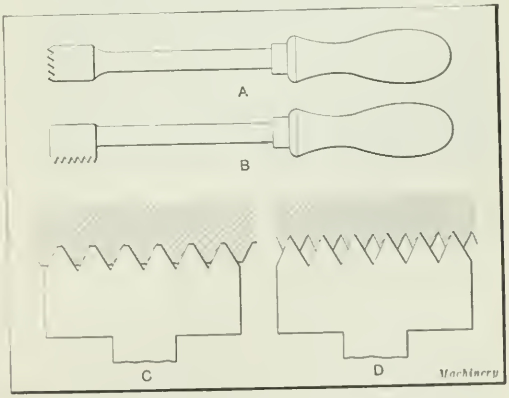


Fig. 7. Hand Chasers—Threading Tool Chasers

WIDTHS OF ENDS OF TOOLS FOR CUTTING SQUARE THREADS

Number of Threads per Inch	Width of End of Tool		
	For Taps	For Screws	For Internal Threads
2	0.2475	0.2500	0.2525
2½	0.1975	0.2000	0.2025
3	0.1641	0.1666	0.1691
3½	0.1408	0.1428	0.1448
4	0.1235	0.1250	0.1265
4½	0.1096	0.1111	0.1126
5	0.0985	0.1000	0.1015
5½	0.0894	0.0909	0.0924
6	0.0818	0.0833	0.0848
7	0.0699	0.0714	0.0729
8	0.0615	0.0625	0.0635
9	0.0545	0.0555	0.0565
10	0.0490	0.0500	0.0510
11	0.0444	0.0454	0.0464
12	0.0407	0.0417	0.0427
13	0.0375	0.0385	0.0395
14	0.0352	0.0357	0.0362

Machinery

ting edge would be too small. At *B* is shown a simple form of gage for testing U. S. standard thread-cutting tools. These tools have a flat end or edge equal in width to one-eighth the pitch of the thread. This particular gage has notches marked for different pitches. The tool is first ground to a 60-degree angle, the V-shaped notch in the gage being used as shown at *d*. The point is then ground off to the right width or until the tool fits into a notch corresponding to the required pitch, as illustrated at *e*.

An Acme thread gage is shown at *C*. This gage also has notches for different pitches. The 29-degree notch at the end of the gage is used first for testing the angular sides of the tool when grinding as at *g*. The shallow notches are used simply for testing the width of the cutting edge at the end as at *h*, the numbers opposite the notches representing the number of threads per inch. The angle between the side and the end may be tested as illustrated at *j*. The tool may also be set square with the work by placing one edge of the gage against the turned surface and adjusting the tool until it coincides with the gage, as indicated by the dotted lines at *j*. The width of an Acme thread tool equals 0.3707 × pitch — 0.0052.

Testing Width of Flat End of U. S. Standard and Acme Thread Tools

The width of the flat or end of either a U. S. standard or Acme thread tool may be measured by using an ordinary micrometer as illustrated at *D*. In measuring the tool, a scale is held against the spindle and anvil of the micrometer and the end of the tool is placed against this scale. The micrometer is then adjusted to the position shown, and for a U. S. standard thread tool 0.2887 inch is subtracted from the reading; the result equals the width of the tool point which should equal one-eighth the pitch. For an Acme thread tool 0.1293 inch is subtracted from the micrometer reading to obtain the width of the tool point. The constants (0.2887 and 0.1293) which are subtracted from the micrometer reading are only correct when the micrometer spindle has the usual diameter of 0.25 inch. The value or constant for any other spindle diameter could be obtained by multiplying twice the spindle diameter by the tangent of one-half the thread tool angle.

An ordinary gear tooth caliper may also be used for testing the width of a thread tool point, as illustrated at *E*. If the measurement is made at a vertical distance *x* of ¼ inch from the points of the caliper jaws, the values previously given for U. S. standard and Acme threads should be subtracted from the caliper reading to obtain the actual width of the cutting end of the tool.

When a tool for cutting a U. S. standard thread is accurate as to the angle and width of point or flat, an accurate screw may easily be cut by the following method. First turn (or grind) the screw blank to the outside diameter of the screw within whatever limits of accuracy are considered necessary. Before starting the thread-cutting operation, adjust the tool inward until its front edge just touches the surface of the blank, and then feed the tool inward for taking successive cuts until it has moved a distance equal to 0.6495 times the pitch of the thread. If the cross-feed screw does not have a micrometer dial for measuring the movement of the tool, it is a comparatively simple matter to gage the movement of the tool-slide by attaching a pin or block to it and measuring from a fixed pin or block. In the case of an Acme thread, the inward movement of the tool should equal one-half the pitch of the thread plus 0.010 inch.

Width of Tool Point for Cutting Square Threads

In order to provide clearance between the threads of a square-threaded screw and nut, the width of the thread groove in the nut is made somewhat greater than one-half the pitch of the thread. The width of the point of the tool for cutting external screws with square threads should be exactly one-half the pitch, but the width of a tool for cutting internal threads or the threads on taps which are afterward to be used for tapping nuts, should be slightly less than one-half the pitch so that the cutting teeth are a little wider than the theoretical standard width. The thread groove cut in the nut will then be slightly wider than the thread on the screw, thus providing the necessary clearance. An inside threading tool for threading nuts evidently should be of the same width as the teeth on the tap, or slightly wider than one-half the pitch. The widths of the points of tools for all ordinary pitches from 2 to 14 threads per inch are given in the accompanying table, which includes tools for threading taps, cutting screws and cutting the threads in nuts.

Use of Thread Chasers in the Lathe

A chaser is a form of threading tool having a number of teeth instead of a single point like the threading tools commonly used for screw-cutting in the engine lathe, although the term "thread chasing" is often used to indicate the cutting of a thread with a single-point tool. The two general classes of chasers (exclusive of those used in dies) are hand chasers and threading tool chasers. The former are hand-controlled, and the latter are rigidly held in a tool-holder and used like an ordinary lathe threading tool. Two types of hand chasers are shown at *A* and *B* in Fig. 7. Form *A* is used for chasing external threads and form *B* for internal threads. When the tool is in use, the cutting end is supported by some form of rest held in the toolpost. These hand chasers are convenient for truing up battered threads or for reducing the size of a part which has been threaded by either a die or a single-point tool. Tools of this kind are especially adapted for brass work. The chaser used in any case has teeth spaced to correspond to the pitch of the thread. This form of tool can be applied to the work quickly and without gearing the lathe for a thread-cutting operation.

Threading tool chasers which are held rigidly in the toolholder are used practically the same as a single-point tool, the lathe being geared for traversing the tool along the work in

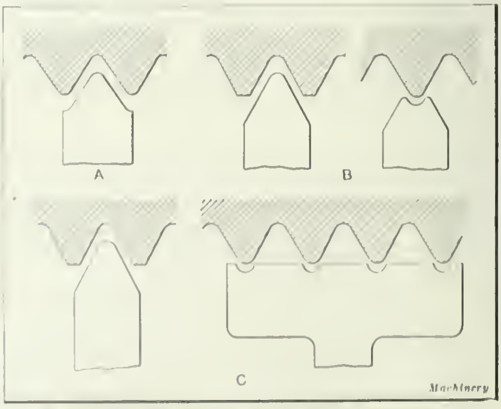


Fig. 8. Different Forms of Tools for cutting Whitworth Threads

order to control the lead of the thread. Tools of this kind cut threads rapidly and may be used for roughing out threads preparatory to finishing them with a regular single-point tool. Many screw threads are also finished completely with chasers of this type, although they are not adapted for extremely accurate work unless the teeth are ground after hardening because the pitch of the chaser teeth is affected more or less by the hardening operation. A threading tool chaser for a U. S. standard thread is shown at *C*. The spaces between the teeth extend to a sharp vee instead of having flats the same as the cutting ends, in order to provide clearance for the top of the thread.

The pitch of the chaser teeth does not always equal the pitch of the thread to be cut. For instance, the chaser illustrated at *D* has a pitch double that of the screw thread. Every alternate groove is engaged but as the lathe is geared for the pitch of thread to be cut, each tooth of the chaser follows the thread groove the same as though it were a single tool. Chasers are sometimes made as shown at *D* for cutting very fine threads, because in this way larger and stronger teeth are obtained.

Tools for Cutting Whitworth Threads

The Whitworth form of thread, or the British standard, may be cut by using a single tool of the form illustrated at *A*, Fig. 8. This tool is so shaped that it finishes the rounded crest of the thread as well as the angular sides and the root. As this tool is rather difficult to make, many Whitworth threads, especially in jobbing and repair shops, are cut by using two tools as illustrated at *B*. One finishes the angular sides and the root, whereas the other is used for finishing the crest of the thread as the illustration shows. In English machine shops, threads of ordinary pitches are often cut as indicated at *C*. After the angular sides and root of the thread have been finished by a tool having a rounded point, the crest of the thread is rounded off by using a hand chaser. The radius of both the crest and the root of a Whitworth thread equal 0.1373 times the pitch, and the depth of the thread equals 0.6403 times the pitch. The angle between the sides as measured in an axial plane is 55 degrees.

Automatic Threading Lathe

The automatic threading lathe built by the Automatic Machine Co., Bridgeport, Conn., is especially adapted for threading duplicate parts in quantity, because the movements of the lathe are automatically controlled after the work is placed in position and the lathe is started. As the forward and return movements of the carriage and the movements of the tool are controlled mechanically, the machine operates more rapidly and continuously than an ordinary engine lathe. A detail view of the machine and the work is shown in Fig. 9. The headstock is of the geared type, and is arranged for varying the forward cutting speed and for reversing the rotation of the spindle, the latter being effected automatically at the completion of the cut. The carriage has front and rear tools and, when the machine is in operation, these tools are fed in automatically to the required depth; the carriage is then traversed along the bed by a central lead-screw, and when the tools reach the end of the cut, they are automatically withdrawn and the carriage is returned to the starting point. The tools are then fed in again far enough for taking a new cut, and the cycle of operations is repeated until the thread is finished to the size for which the machine is set, when the feeding of the tools is automatically stopped. As shown, there are four positions or holders for the cutting tools. For external work two tools are used, one being at the front and the other at the rear as previously mentioned. When cutting a thread close to a left-hand shoulder, the two left-hand positions or holders are utilized and if the shoulder is on the opposite side the two right-hand holders are employed.

By using two cutting tools for external work, it is possible to have one tool cut one wall or side of the thread, while the other tool operates on the opposite side of the thread. When the tools are applied in this way, they may be ground with top rake in order to secure a better cutting action. When cutting an angular thread, such as the Acme or a worm thread, a square-nosed roughing tool is sometimes used in the rear and a form-finishing tool in the front. A finishing tool of the gooseneck or spring type is recommended. Another method of cutting a thread of similar form is to mount a single square-nosed roughing tool in advance of the front and rear tools. The square-nosed tool then cuts a rough groove which is finished by the two following tools, taking shearing cuts on opposite sides of the thread. When cutting a square thread, a roughing tool, which is about 0.02 inch narrow, is used, and the thread is finished to the required size by a tool in front. When cutting a double thread, both thread grooves may be cut simultaneously by using four tools; two parallel roughing tools operating in adjacent grooves are located at the rear, and two finishing tools at the front of the machine. For internal threading, the tool-holder may be provided with a roughing cutter followed by a finishing cutter. Cutters of the circular form type are used ordinarily. Change-gears are employed for adapting the machine to cut threads of different pitch.

One of the important features of this lathe is the back-shaft which controls the traversing movement of the carriage and the points of reversal, as well as the inward and outward movements of the cutting tools. When the carriage reaches the end of its travel at the completion of the cut, it comes against an adjustable collar on the back-shaft. The result is that the back-shaft is shifted longitudinally, and this endwise motion throws into engagement a mechanism at the headstock end of the machine, which causes the back-shaft to revolve one-half revolution. This rotation serves a double purpose in that it withdraws the two cutting tools from the work, and, at the same time reverses the motion of the lathe spindle. When the carriage reaches the end of the return movement, caused by the reversal of the spindle and lead-screw rotation, it encounters another stop on the back-shaft, so that the latter is again shifted in the opposite direction. This endwise movement again causes the back-shaft to revolve one-half revolution, which automatically moves the tools inward for the next cutting stroke. The tools are moved a little farther inward for successive strokes by a ratchet and pawl mechanism.

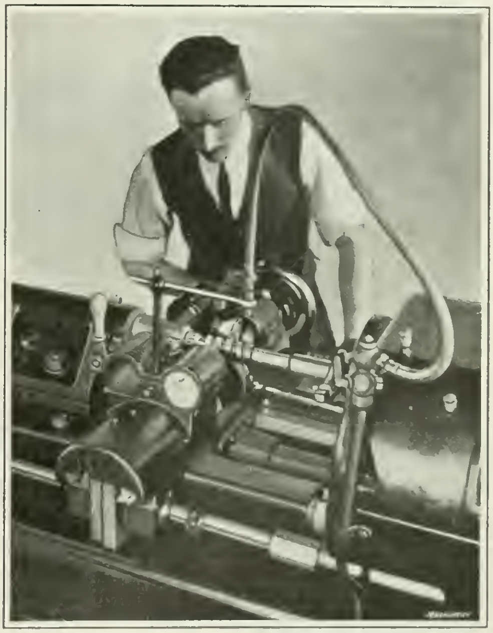


Fig. 9. Automatic Threading Lathe cutting Screw Thread

• • •

The War Department has announced that hereafter the metric system of measurement will be employed as the standard for all artillery, machine guns, and maps used by the American Overseas Forces.

WASTING NATURAL RESOURCES

Attention is called in *The Little Journal*, published by Arthur D. Little, Inc., of Cambridge, Mass., to the enormous loss to the nation due to waste of natural resources. If coal ran over Niagara Falls only to feed a great bonfire at the base, we should all be shocked, but the present loss is just as great as if that were so. Half a million or more horsepower easily available at Niagara runs to waste; meanwhile the lights are turned out on our streets to save a few tons of coal. If the water of Niagara (equivalent to from 5,000,000 to 7,500,000 tons of coal annually) was used for power and once a month the water was allowed to flow over the Falls for a day, there would still be a scenic Niagara, and probably more people would actually visit it than at the present time.

Through lack of supervision, a billion cubic feet of natural gas has been permitted to go to waste daily for long periods. Through lack of proper regulation, 500,000,000 tons of coal have been wasted at the mines annually. Three tons of phosphate rock are wasted to one that is used, and only 50 per cent of the zinc mined reaches the market as spelter. Sulphate pulp liquids still polute the streams, while a wealth of alcohol, gas, and fuel might be recovered from them. Potash is wanted at $450 a ton, but most of the cement mills waste it. Flax straw may be made into the finest quality of writing paper, but it is burned in the fields; so are also most cereal straws, which may be briquetted into excellent fuel, or baled and used for gas making. If we used all the materials that nature provides, instead of attempting to get rid of them in the easiest and most convenient manner, we would probably be able to pay for the war out of waste products and still have something to spare.

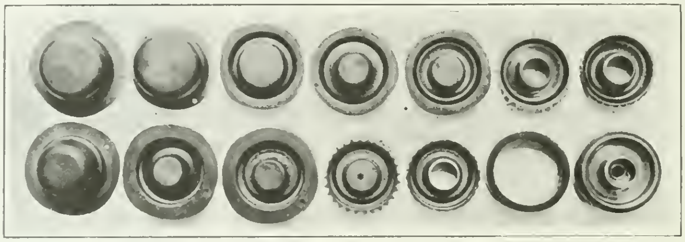


Fig. 2. Various Blanking, Drawing, and Forming Operations on Wheel Sections

* * *

Buy War Savings Stamps. If you want to be a fighter behind the lines in the war for democracy, save your quarters and invest them in Thrift Stamps. Many of us cannot go into the trenches, some of us cannot buy Liberty Bonds, but everyone can buy War Savings Stamps. If you want to do more than your "bit," help to establish War Savings Societies and induce others to do their share in achieving victory. There are only two requirements—ten or more members and the promise to save. There is a place for a War Savings Society in every business office and factory. The spirit to take part in the great war is sweeping the country. The War Savings Societies is the answer. For details, inquire at any post-office.

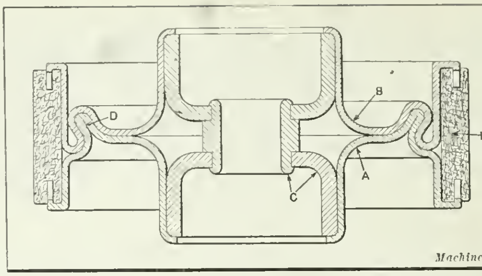


Fig. 1. Sectional View of Zamboni Interlocking Sheet-metal Roller Skate Wheel

ZAMBONI PRESSED-METAL WHEEL

The Zamboni sheet-metal wheel is interesting both as a wheel and as an example of die work. The prominent feature is the interlocking rim which binds one half of the wheel center to the other half and at the same time strengthens the wheel and makes it very rigid. The most important application of this interlocking sheet-metal wheel at the present time is in roller skates. An enlarged sectional view of the skate wheel is illustrated in Fig. 1. It is composed of two main sections *A* and *B* and an inserted hub *C*, which is designed to receive a double ball bearing. The two sections *A* and *B* are locked together by forcing the annular ridge *D* of one section into a groove formed in the other section. Before these two parts are locked together, the interlocking ridge and the groove are both parallel with the axis of the wheel. One section is then securely interlocked with the other by means of a die which presses the ridge and groove over to an angle of approximately 45 degrees, as shown. The two main sections of the wheel are drawn up from flat stock. The three-piece hub is formed of two drawn cups connected by a sleeve at the center, which is machined and riveted to each cup.

The sequence of operations for producing the main sections *A* and *B* is illustrated in Fig. 2. The order of operations on section *B* is also illustrated in Fig. 4. The operations on these two parts are practically the same, except that an annular ridge is formed on one and a groove on the other at the point where they interlock. The first operation on section *B* is performed in an ordinary combination blanking and drawing die, which forms a cup as shown at *A* in Fig. 4. This cup is next drawn to a greater depth, as illustrated at *B*, but the diameter remains the same. The third operation is performed in a drawing and forming die, which pushes the top of cup *B* (obtained from the second-operation die) downward, thus obtaining the shape shown at *C*. The punch is shaped to fit the inner part *a*, whereas the seat in the die conforms to the shape of the opposite side. The die is equipped with a knock-out, of course, which bears against the end *b*. The fourth operation is practically the same as the third, the object being to reduce the diameter and deepen the central part of the wheel center, as illustrated at *D*. For the third and fourth operations the work is not in the position illustrated in Fig. 4, but is inverted. For the fifth operation, however, the part rests in the die in the position shown at *E*. This operation is performed by a punch which is in the form of a sleeve.

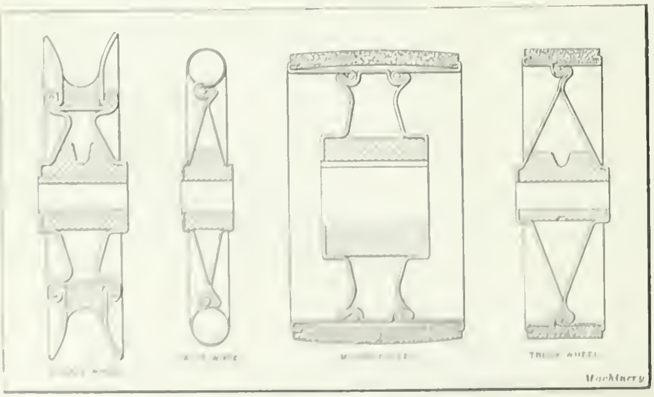


Fig. 3. Other Designs of Interlocking Sheet-metal Wheels

The punch fits over the central part *c* and engages the work at *d*. The operation is simply one of pushing down this central part to form a semicircular channel *d* around the base of the central part *c*. The knock-out or ejector is located within the punch. This completes the drawing and forming operations.

The flange of the shell is next blanked out in a die that forms V-shaped teeth around it, as illustrated by the plan view at *F*. Each time a part is blanked, a ring of scrap is pushed up onto the punch, and, in order to remove these scrap rings, there is a double-ended V-shaped knife or blade extending through the punch and projecting far enough at each side to sever the scrap rings. This scrap-cutting blade is located about 3/4 inch above the die, so that the punch is filled with scrap up to this point and the upper scrap ring is cut in two each time a part is blanked and another ring is forced onto the punch. After a hole has been blanked at *f* (see view *G*), the V-shaped teeth are next bent downward, as at *H*, so that they will be parallel to the axis of the wheel. A simple type of bending die is used for this work. The punch used in connection with this die is in the form of a thin sleeve which surrounds the wheel center and fits into the space *e*. The die has a plain hole through it, and the V-shaped teeth are bent by simply pushing the part down through the die. This completes the operations on this part. When the two wheel sections are forced together and interlocked as previously explained, a leather rim *E*, Fig. 1, is placed between them, which is gripped by the V-shaped teeth previously referred to. The reason for using this leather rim in preference to a steel ring is that it is practically noiseless, which is a desirable feature for roller skates, especially when used in skating rinks.

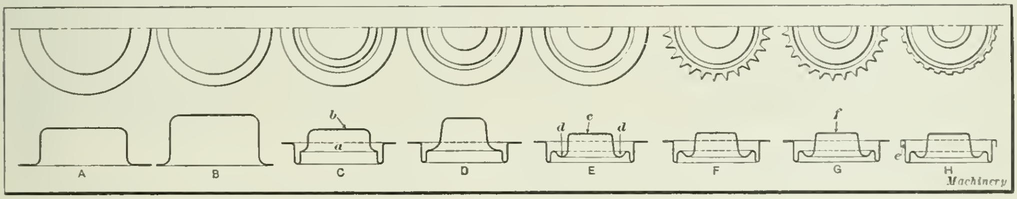


Fig. 4. Order of Operations on One Half of Sheet-steel Wheel Center

The use of this interlocking type of wheel (which is the product of the Apex Steel Corporation, 50 Church St., New York City) is not confined to skate wheels, as the same principle of construction may be applied in making sheave wheels (see Fig. 3), handwheels for valves, belt pulleys for motors, truck wheels, etc., and for many other purposes. The design of the wheel is varied somewhat, depending upon its size and width. Wheels that are comparatively small and narrow are formed of two sections that interlock directly, the same as the skate wheel, but in the case of a belt pulley or sheave of rather large size, the two main sections are connected by an intermediate section. F. D. J.

* * *

RAILWAY CONTROL IN ENGLAND

The English government, having taken control of all the railways in Great Britain on August 14, 1914, agreed to pay the stockholders the same earnings as they had received in 1913. On account of the great number of men employed in the railway service having entered the Army or other occupations not suitable for women, the number of women employes of the British railways has risen in the past three years from 15,000 to 100,000. Freight cars have been pooled without regard to ownership, and the loading and unloading of cars has been expedited by heavy penalties and fines, and even imprisonment. It has been made a criminal offense to fail to load and unload in accordance with the rules. Many passenger trains have been removed from the schedules, reservation of seats has been abolished, and the passenger rates advanced 50 per cent with a view, not to increase the revenue, but to discourage travel. The staff of each railway remained undisturbed. Wages, hours of work, and other labor questions are settled by conciliation and arbitration, and, on the whole, the management and the employes have worked in harmony.

REQUIREMENTS AND TREATMENT OF CANADIAN HIGH-EXPLOSIVE SHELLS

Canadian high-explosive shells must possess an elastic limit or yield point of 19 tons per square inch, and an ultimate breaking strength of not less than 35 tons and not more than 50 tons per square inch, with an elongation in 2 inches of not less than 14 per cent. The maximum carbon content is 0.55 per cent; and while there apparently is no minimum, the forging companies are not required to accept anything under 0.4 per cent. The minimum manganese content is 0.4 per cent and the maximum 1 per cent. Sulphur and phosphorus must be under 0.05 per cent and silicon under 0.3 per cent. The shells are forged from either rolled or cast blanks; while many of the 4.5- and 6-inch shells have been forged from cast blanks, the tendency is to produce these types from rolled stock. The 6-inch shells and under are forged with a solid base.

For the forging operation, the blanks are generally heated to a temperature of from 2000 to 2200 degrees F., either in large continuous furnaces or in smaller batteries where the shells are all brought up to a forging temperature together. The piercing, as a rule, is done in one operation and the shells are then cooled; this cooling is either retarded or accelerated according to the carbon content. Where the carbon drops to 0.4 per cent, the cooling must be retarded as much as possible. Practice in this respect varies in different plants and for the different types of shells. As a rule, low-carbon heats are stacked in the open, considerable space being left between each shell for circulation of air. High-carbon heats are stacked closely, well protected from the air, and may be covered with cinders or some similar medium to retain the heat. In no case is it permissible for the shells to be in contact with one another during cooling. Test pieces are taken from each heat after forging, and any heats failing to pass the specifications are set aside to be normalized or annealed. Rejected heats may be either too weak or too strong, and must be brought up or toned down. Failures generally occur in those heats close to the minimum and the maximum carbon content. Low-carbon heats that fail to reach the minimum breaking strength and are low in elastic limit and high in elongation should be brought to a heat slightly above the critical point and cooling accelerated. High-carbon heats that show too great a strength and a low elongation should be heated up to but not beyond the critical point and cooled slowly. It is not often that rejected heats fail to respond to the annealing treatment. Some low-carbon, low-manganese heats failing to respond to ordinary air-cooling have been brought up to strength by forcing cold air into the interior of the shell and against the exterior.

A Canadian shrapnel shell recently made contained 0.52 per cent carbon and 0.75 per cent manganese. After it was heated to 1550 degrees F., quenched in oil, reheated to 1000 degrees F., and cooled in air, its elastic limit was 42 tons per square inch, ultimate breaking strength 70 tons per square inch, and elongation 15 per cent in two inches. In the heat-treatment of these shells the temperatures vary from about 1450 to 1600 degrees F. for quenching, and from 800 to 1100 degrees F. for tempering, depending on the carbon content. Ordinarily twenty minutes is about the average time required to heat the shells for quenching, but a little longer time is needed for tempering.

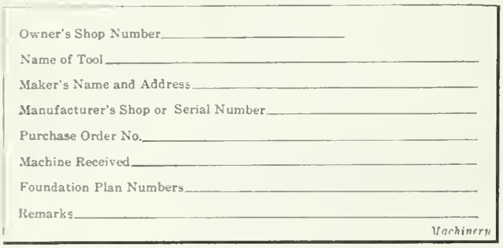
* * *

Canadian manufacturers now produce 800,000 complete shells every week, which is more than was produced, before the war, by any nation except Germany.

ORDERING PARTS FOR MACHINE TOOL REPAIRS

BY W. G.

When it becomes necessary to obtain repair parts for machine tools, the man who has charge of repairing does not always specify exactly what is wanted. For instance, if some part is required for a planer, the requisition may simply refer to a planer built by the Blank Mfg. Co. This requisition is sent to the purchasing department and the order received by the planer manufacturer will probably read "One gear for planer of your make." Now the Blank Mfg. Co. may have been in the planer business for fifty years, and during that time machines have been constructed in perhaps twenty different sizes, to say nothing of the various designs of each size; consequently the first question that confronts the Blank Mfg. Co. in attempting to fil the order for a repair part is what particular planer this gear or other part is for. As the order is very indefinite, it is necessary for the planer manufacturer to obtain additional information. Perhaps one week has already elapsed since the break-down occurred, thus putting the machine out of commission.



Owner's Shop Number__________

Name of Tool__________

Maker's Name and Address__________

Manufacturer's Shop or Serial Number__________

Purchase Order No.__________

Machine Received__________

Foundation Plan Numbers__________

Remarks__________

Machinery

Card Record used when ordering Repair Parts from Manufacturer to enable Machine to be identified readily

The present-day practice of some manufacturers is to attach to their machines a brass nameplate on which is the manufacturer's address, his shop or serial number on which the machine was built, and possibly the following instructions: "When ordering repair parts refer to this number." When this practice is followed the manufacturer has definite information as to what particular machine repair parts are needed for, and unnecessary delays are avoided. This custom of attaching a plate is comparatively new, so that what benefits will be derived therefrom remains to be seen.

In any one shop, such, for example, as an average-size railroad shop, there are likely to be several different machines of the same general type but of different makes, and these may have been purchased during a period of, say, twenty or thirty years. If no record is kept of the machines obtained from time to time, mistakes and delays will often occur in securing repair parts, especially if the shop engineer or whoever has charge of repairs is a new employe and is not familiar with changes that may have been made in the machine after it was purchased from the manufacturer. In order to enable a manufacturer to identify any machine readily, it is suggested that a card record of the new machine be kept for future reference. This card might be arranged as shown in the accompanying illustration. Each part could be numbered to correspond with the owner's shop number of the machine and contain, in addition, the name of the tool, the manufacturer's name and address, and the other information indicated on the sample card.

Frequently the owner of a machine tool changes the construction somewhat or adds a special fixture or attachment, and when this is done a record of the changes should be added to the record card under the heading "Remarks," in order to avoid the possibility of ordering repair parts from the manufacturer to replace parts that were incorporated in the design of the machine by the owner and not by the original manufacturer. Suppose, for example, that a planer was purchased in 1900 and that since that time there have been several foremen of repairs, so that the man now in charge simply knows that this particular planer is in the shop. Suddenly something happens to the machine and inspection shows that it will be necessary to obtain some parts from the manufacturer. Even if there is a nameplate on the machine or other means of identification, the plate or symbol may be invisible because of grease or dirt and the repair foreman will not know where to look for it. If the practice of designating each tool with a shop number and with a record card kept in the office has been followed, the foreman can, without loss of time, obtain information that will enable him to write out a definite requisition for repairs.

While it is easy to compile such a record at the time machines are purchased, obtaining the necessary information and data for machines that have been in use some time will require some little investigation, but the effort and cost may be slight as compared with the advantages. One method of obtaining a record of machines already in use is as follows: A list is made out of the machines of any one manufacturer, containing the name of each machine, the different sizes or general dimensions, and any other information which is considered essential in enabling the manufacturer to identify each particular machine. This list is sent to the manufacturer, who is requested to send the shop or serial order number of each machine and any other useful data.

Within the last two or three years there have been more than the usual number of machine tools sold as second-hand, and many of these machines have needed immediate repair. When repair parts have been ordered for these machines it has been the exception rather than the rule for the owner to give the manufacturer a definite order that would enable the machine to be identified readily. When ordering parts for a second-hand machine, the owner should mention the fact that the tool was bought second-hand and give, if possible, the name of the original owner. Sometimes the original owner of a tool which has been sold second-hand has put a plate onto it on which is marked the shop number. If this plate is not removed when the tool is sold again, the number on it is occasionally used when ordering repair parts from the manufacturer, who, of course, knows nothing about the number or what it refers to.

* * *

CANADIAN CRIPPLED SOLDIERS

In an article in *American Industries* attention is called to the fact that too exaggerated a picture of the number of maimed soldiers that will return from the front has probably been drawn. Canada has sent about half a million men into the field in three years. A considerable number of these went into the war at the very beginning. During the first three years of the war the number of men returned who had undergone amputation was less than 900, and the total number blinded was 32. About 90 per cent of all wounded who have returned are capable of going back to their old jobs. In France it is stated that 99 per cent of the wounded return to their previous occupations. The same percentage may be expected in Canada when all the wounded have returned, because so far only those more seriously disabled have been sent home.

Of the 200,000 men that have been sent by the Province of Ontario, about 9000, or 2 per cent, had returned up to October, 1917, because of being incapacitated for service by wounds. Of these, only 1 had lost both hands, 101 had lost one arm, 4 were blinded, 72 had lost one eye, 13 had lost one hand, 12 had lost one foot, 6 had lost both legs, and 3 were still more seriously maimed. It is believed that there are more men seriously injured annually in the American industries than may be expected in a year's war. Hence it may be that the problem that will confront the country after the war with regard to maimed and crippled soldiers is not as serious as has been expected. In this, modern warfare probably differs from former wars; it kills rather than maims.

* * *

Great Britain now receives $400,000 a month for the "waste" of its army kitchens in Great Britain and France. From this waste is made, besides candles and fertilizer, enough soap for the army, navy, workhouse, asylums and other public institutions, and enough glycerine to provide the propellant for 17,000,000 shells per year.

LETTERS ON PRACTICAL SUBJECTS

WE PAY ONLY FOR ARTICLES PUBLISHED EXCLUSIVELY IN MACHINERY

CRANKSHAFT TURNING FIXTURE

A heavy crankshaft is a difficult job of machine work, unless the proper fixtures are provided to hold it firmly and to facilitate setting up. Figs. 1, 2 and 3 show a crankshaft turning fixture for an engine lathe that I used successfully a few years ago when working on heavy crankshafts. The fixture consists of two parts, a plate and a sliding head. The plate is made with a projection on the back that fits into a counterbore in the faceplate of the lathe. The front face of the plate is made with two T-slots, and a center groove runs the full length. The sliding head is provided with a tongue that fits into the center groove, and it is held firmly in place by four bolts engaged in the T-slots. The side of the head is graduated, and it is set at zero when the shaft is centered in the faceplate. The head is bored to some size, say six inches, if that happens to be the size of the crankshaft to be clamped. If the fixture is used for shafts smaller than six inches, a split cast-iron bushing may be used as a reducer.

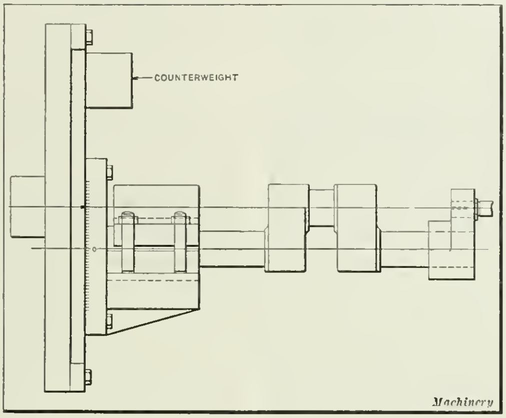


Fig. 1. Crankshaft Fixture in Offset Position for turning Crankpin

When the fixture is set up to turn the crankpin, the four bolts are loosened and the head is dropped to the required throw, using the graduation on the side to set the crank center at the required position. The outer end of the crankshaft is swung on a false center in a bracket that is clamped to the shaft. The fixture, because of its rigidity, serves to locate the bracket and the center accurately and makes a lay-out unnecessary. When offset, a weight is required on the faceplate to counterbalance the shaft.

It will be found that by turning the crankshaft with this fixture it is unnecessary to drill or slot out the metal between the crank web, as it can be turned out much more quickly on the lathe than by any other method known to the writer. Fig. 3 shows the fixture clamped in the center of the lathe faceplate, ready for boring to fit the crankshaft; Fig. 2 shows the shaft clamped in position for turning the bearings; and Fig. 1 shows the fixture offset for the required crank throw.

Springfield, Ohio — C. W. Francis

METRIC SYSTEM IN WATCH INDUSTRY

If the metric system of measurement is to replace the present system with the inch as a unit, the change should be made with the least amount of confusion possible. This can be attained by using the centimeter as the unit of measurement in general machine practice and not the millimeter, as is the custom in Europe and South America. After being accustomed to the inch as a unit, to change abruptly to so small a unit as the millimeter is not practicable. But adopting the metric system as it is used in the watch industry in Waltham, Elgin, Lancaster, etc., need cause no confusion, but merely an adjustment in tools and measuring instruments. The millimeter is not referred to, but is called one-tenth of a centimeter, that being the unit of measurement. For instance, the diameter of the famous French 75's will not be spoken of as 75 millimeters, but as 7.5 centimeters. Reduced to its simplest form, measurements are stated in tenths, hundredths and thousandths of a centimeter, instead of an inch, thus eliminating all common fractions and the tenths of thousandths of an inch used on the English micrometer. As the screw of the metric micrometer is of finer pitch, much closer work can be done without the sensitive touch necessary when using the English micrometer in tenths of thousandths.

Another difference between the European and the watch-industry use of the metric system is in threads. For instance, the watchmaker speaks of, say, ten threads per centimeter, the European usage is to speak of a one-millimeter thread, or a decimal thereof. One other point in favor of the adoption of this system is that the measurements are finer, so that

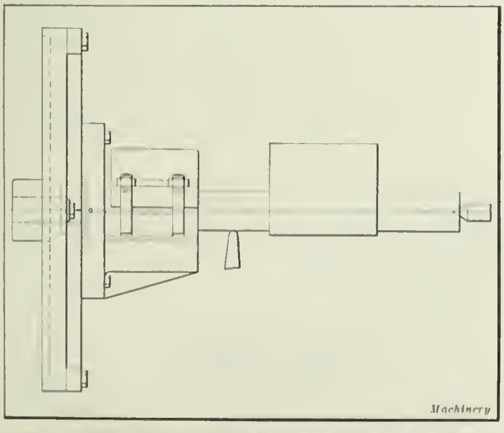


Fig. 2. Crankshaft Turning Fixture in Position for turning Bearings

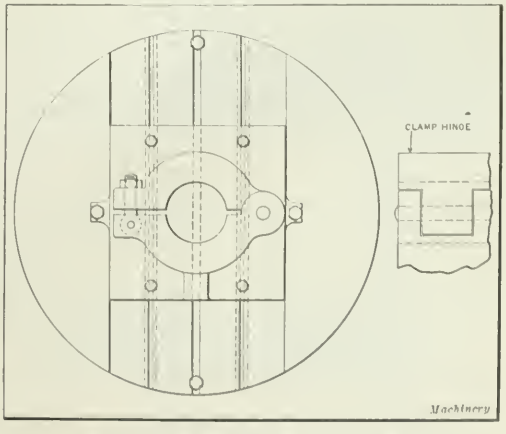


Fig. 3. End View of Crankshaft Fixture, showing Hinge and Clamp

reamer and mandrel sizes run closer together, making possible almost any English measurement; this is a great convenience in repair work. Reamers should vary by 0.005 centimeter up to 0.5 centimeter in size; then by 0.01 centimeter up to 1 centimeter; by 0.05 centimeter up to 2 centimeters; and by 0.1 centimeter up to 5 centimeters. Mandrels should be developed on the principle of a continuous taper; they will then fit almost any hole whether it is measured by the English or the metric system.

To one who has never employed the metric system, as used in the watch industry, the utility and simplicity of its measurements are equivalent to a lost art; the system must be used to be appreciated. By its extensive use, the numerous number gages, such as Stubbs, wire, paper, music-wire, and others, will be eliminated.

Jersey City, N. J. **Warren H. Dunbrack**

FINDING CONTENTS OF CYLINDRICAL TANKS

The writer is in the employ of a company manufacturing cylindrical oil and gasoline tanks that range in capacity from 10 to 40,000 gallons. With each tank a wooden gage stick is furnished for measuring roughly the contents of the tank. These gages are divided into from twenty to one hundred parts; depending on the size of the tank in which they are to be used; the graduations read in even number of gallons. The method of using these gages is shown in Fig. 1. It can readily be seen that the graduations on the gage will in no place be of equal length; even the divisions on each side of the center are not symmetrical unless the total capacity of the tank is exactly divisible by the number of gallons by which the graduations advance. The task of computing the lengths of the graduations for these gage sticks will be realized when it is stated that 20,000 computations were necessary to meet all these conditions, and when the lengthy, complicated equation for the solution of a segment of a circle is recalled.

The writer thought that a graphic method of deriving these graduated lengths would be sufficiently accurate and require less time than the analytic method. So the simple curve of Fig. 2 was plotted and found to be so broad as to be applicable to any depth in any tank of any diameter and any length, when supplemented by two settings of the slide-rule. It was also found that to construct a chart that would give the entire solution without recourse to the slide-rule would be a task almost as large as that of the original problem.

The curve can be constructed in an hour's time, by the use of the tables found in any handbook giving the area of segments, to any scale depending on the desired accuracy of the results. The original was constructed as follows: A tank thirty inches in diameter was assumed, and the total number of gallons in a section of this diameter and one inch thickness was computed thus:

$$\frac{\pi \times (\text{radius})^2 \times \text{length}}{231} = \frac{\pi \times \left(\frac{30}{2}\right)^2 \times 1}{231} = 3.06 \text{ gallons}$$

there being 231 cubic inches in a gallon.

The abscissa of the chart was laid off to 30.6 inches (scale 0.1 gallon = 1 inch), and the ordinate to 30 inches, the diameter of the assumed tank. This gave a chart nearly square in its dimensions. Next, the heights to which the liquid would reach for thirty conditions were computed, and a curve constructed through the points laid off with these values. Thus it was desired to locate the point on the curve for 30 per cent of the total capacity. As 30 per cent of a section, one inch thick, through the tank is 3.06 × 0.30 = 0.918 gallon; $\frac{0.918 \times 231}{1} = 212$ square inches in segment of circle. Then, $212 \div d^2 = 212 \div 30^2 = 0.2355$. The rise of this segment divided by the diameter is equal to 0.34, which is also the percentage of the diameter, which locates the point 30 × 0.34 = 10.2 inches above the abscissa. In this manner thirty points were obtained and a smooth curve drawn through them.

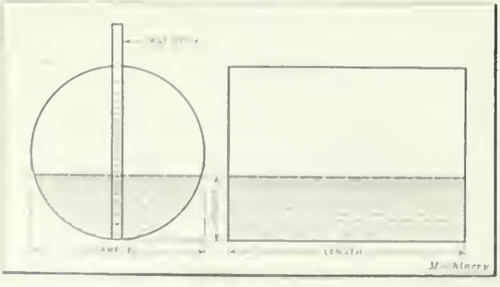


Fig. 1. Use of Gage Stick in Cylindrical Tank

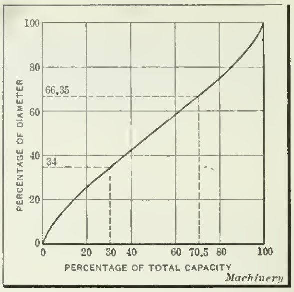


Fig. 2. Chart for graduating Gage Sticks

Example—Lay out a gage stick for a tank 50 inches in diameter and 100 inches long, having a total capacity of 850 gallons, the gage to be graduated by 20 gallons. For example, to what height in the tank would the first 600 gallons reach? Dividing 600, on the slide-rule, by 850 shows this to be 70.5 per cent of the total capacity. This 70.5 per cent ordinate intersects the curve at the same point as the horizontal line for 66.35 per cent of the diameter. Multiplying, with the slide-rule, 50 by 0.6635 gives 33.175 inches as the length on the gage stick at which 600 gallons will be indicated. In this way each value can be quickly found. This curve may also be used for computing the area of a segment of a circle by merely considering the abscissa as the percentage of the total area instead of total capacity.

Fort Wayne, Ind. **Carlo M. Eyster**

TO FIND ECONOMICAL LENGTH OF STOCK FOR FOUR-SPINDLE SCREW MACHINE

Frequently, in multiple-spindle screw machine work, four bars of unequal length are in the machine and one bar of stock remains to be cut. The problem then arises of cutting this bar into four pieces of such lengths that all the stock will be finished at the same time, yet none of the spindles will be running empty while the others are finishing.

This can be solved by finding the difference in the lengths of the bars in the machine and then finding the amount that must be added to the longest bar. For example, the remaining bar is eight feet long. The difference between the longest and the next longest bar is nine inches; between the longest and the third longest bar is fourteen inches; and between the longest and the shortest bar is seventeen inches.

If x = number of inches to be added to longest bar;
$x + 9$ = number of inches to be added to next longest bar;
$x + 14$ = number of inches to be added to third longest bar;
$x + 17$ = number of inches to be added to shortest bar;

$4x + 40$ = amount to be added to all the bars.

As the remaining bar is 96 inches long, $4x + 40 = 96$; $4x = 96 - 40 = 56$ and $x = 14$. So the lengths into which the bar should be cut are $x = 14$ inches; $x + 9 = 23$ inches; $x + 14 = 28$ inches; and $x + 17 = 31$ inches.

Chicago, Ill. **Charles G. Kehoe**

USING TAPER WEDGES IN CUTTING SQUARE THREADS

The writer often has occasion to cut either left- or right-hand square threads on spindles of ⅝ or ¾ inch diameter, eight threads per inch. At first there was trouble in not

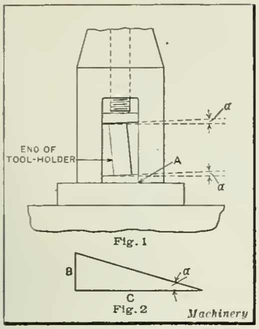


Fig. 1. Use of Taper Wedges in Toolpost. Fig. 2. Method of deriving Angle of Wedge

giving the tool sufficient clearance and it was likely to catch and break, as a 1/16-inch wide threading tool with the sides ground away for clearance is not very stiff. For cutting these threads the writer now uses an Armstrong cutting-off tool-holder, with inserted tool-steel strips which are about 1/16 inch thick. If wedge *A*, Fig. 1, is placed under the tool-holder, it will give the correct angle to the tool for the required clearance. The same tool can be used for cutting either left- or right-hand threads, it being necessary only to change the direction of the slope of the wedge. The angle of this slope is the same as the helix angle of the thread and is found as shown in Fig. 2.

B = pitch of thread in inches;

C = external circumference of thread;

$$\frac{B}{C} = \tan \alpha = \text{helix angle.}$$

In the case of a ¾-inch diameter screw with eight threads per inch the calculations would be as follows:

$$B = 0.125 \text{ inch}$$

$$C = \tfrac{3}{4} \times 3.1416 = 2.3562 \text{ inches}$$

$$\tan \alpha = \frac{0.125}{2.3562} = 0.05305$$

$$\alpha = 3 \text{ degrees (approximately)}$$

A slight side clearance is ground on the tool to allow for any difference between the helix angle and the angle of the wedge, and to prevent the tool from rubbing against the side of the threads.

Worcester, Mass. C. Anderson

STRAIGHTENING RODS AND TUBING

In a certain shop an everyday job is to straighten ⅛-inch steel rods from 18 to 26 inches long, the rods being either tempered spring wire or drill rod, much like knitting needles, which is so hard that a tool will not cut it. These rods are commercially straight, but are required to be within 0.0015 inch true, and up to the present time no maker of straightening machines has been of assistance. The springy nature of the material, the degree of accuracy, and the fact that accuracy is particularly desired near the ends have been the stumbling blocks. As a consequence, men are doing hand work on these rods. A square cast-iron block, 3 by 3 by 24 inches, is planed on all four sides and set up so the top is level with the eyes when seated. The men roll the rods on these blocks and straighten by the use of a four-ounce hammer. The best straighteners are men past fifty years of age. Much of the work is done at night with a sheet of white paper for a background and a light back of it. As many as 185 spring steel rods per day of nine hours are straightened, and about 140 drill rods.

The same method is used to straighten brass tubing in lengths a little longer. A typical size is ⅜ inch outside diameter with 0.040 inch wall thickness. The blocks are made slightly concave in the direction of their length, and on this the tube is hammered straight. Some will think that this dents the tube, and it does, but not any more than the amount the tube is out of round as it is drawn, which is only a few thousandths inch. The thick wall helps to preserve the shape. Another method was used to straighten steel tubing 1¼ inch outside diameter, with a 1/64-inch wall, that was used for printing press work. A mandrel was made to be just pushed into the tube, and when the high spots had been determined it was forced in with a mallet and the tube carefully hammered on those spots. This was a good scheme, because it was known that the tube was straight when the mandrel was jarred out. However, on the tubes that were to be inking rollers the little flat spots left by the hammer were objectionable, and the only alternative was to sort the stock. D. A. H.

REMOVING IRON PLATE RUST

In the October, 1917, number of Machinery, page 155, in the article entitled "Removing Iron Plate Rust," the following statement was made: "It consists in applying to the surface of the iron a mixture of two parts of finely crushed sodium bisulphate (sodium acid sulphate, Na_2SO_4, H_2SO_4, $3H_2O$) and one part of common salt, which is moistened just enough to make it cohesive." There is an error here, as the chemical formula given is not that of sodium bisulphate or sodium acid sulphate. Sodium bisulphate is a definite chemical salt having the formula $NaHSO_4$. It is a weak, unstable compound, decomposing in the presence of moisture into sodium sulphate and sulphuric acid. The formula given in the October number of Machinery is not a salt, but a mechanical mixture of sodium sulphate and sulphuric acid, which is the same as the decomposition products of sodium bisulphate, and identical with the product known in the chemical trade as "salt-cake," the residue remaining after the treatment of sodium chloride with sulphuric acid in the manufacture of hydrochloric acid. The action of either the sodium bisulphate or the mixture mentioned would be the same, with the exception that the bisulphate would act more slowly. The cleansing action is due to the fact that the sulphuric acid acting upon the common salt (sodium chloride) liberates chlorine in the form of hydrochloric acid, which has a remarkable affinity for iron. For this reason it is commonly used as a cleaning dip for iron and steel. The sodium sulphate is a stable compound, inactive under the circumstances, and may be considered simply as a vehicle. Either sodium bisulphate or salt-cake would probably produce the effect desired in the way of removing rust, so that the error in the previous article is merely that of giving to the bisulphate the formula for salt-cake.

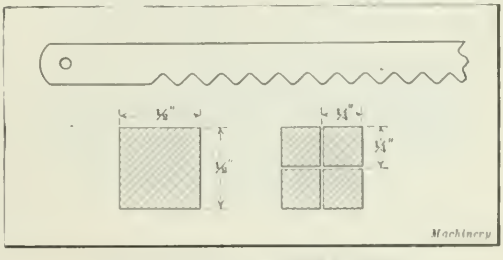
Rutherford, N. J. A. Schleimer

CUTTING AN OILSTONE

After completing the machining and hardening of two dozen small dies to be used for drawing purposes, lapping these dies was the next operation. The writer generally used a ¼- by ¼- by 4-inch india oilstone for this purpose, but discovered that he did not have a stone of this size on hand. He did have some ½- by ½- by 4-inch stones, but anyone who has worked hour after hour lapping dies with a ¼-inch stone and then is called upon to lap a set of dies much smaller in size than those he has worked on, with a stone that is double the size of the one that he has been accustomed to use, will realize that the change is a handicap in producing good work and, perhaps, a waste of more than half the stone.

The writer experimented. The oilstone was cut with a hacksaw, but not with the ordinary commercial blade. Teeth the shape shown in the illustration were ground on a 9-inch thin blade on an emery wheel. A lubricant of one-third water and two-thirds turpentine was used, a few drops at a time. The saw was made and the first stone cut in forty minutes; the cutting of the remaining stones was done by an apprentice.

Kenosha, Wis. M. E. Duggan

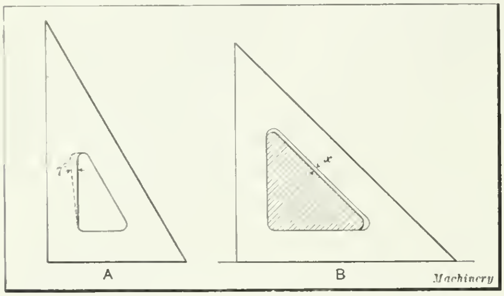


Hacksaw Blade and Cross-sections of Oilstone

IMPROVED TRIANGLE — SPACING BLOCK FOR CROSS-SECTIONING

An improvement that can be made upon the draftsman's 30- by 60-degree triangle is indicated at *A*. The inner edge on one side is given an inclination of 7 degrees, as indicated by the dotted line. This 7-degree angle is used almost universally for the draft of drop-forgings and it is also extensively used on pattern drawings. As the illustration shows, this change does not injure the triangle by weakening it.

A kink for cross-sectioning drawings was published in the November number of Machinery on page 249. In the December number on page 347, this method was criticized and the writer believes that the criticisms were well taken. Few companies will tolerate the use of the method suggested, because of the time required. In fact, some companies eliminate the cross-sectioning entirely. Occasionally there is a demand for work of extreme neatness, as when illustrations are required for catalogues and folders, and then some method of uniform cross-sectioning is desirable. The wooden block shown at *B* in the illustration is recommended as a simple method of making neat and uniform section lines. This block is about 3/16 inch thick, and in using it the triangle is held with the thumb and the block with the fore-finger. The block and triangle are moved alternately, thus giving a uniform spacing. The space *x* should be about 3/64 inch if the section lines are to be 1/16 inch apart. This block does not have the disadvantage of sliding over the lines drawn. C. A. C.



(A) Triangle having a Seven-degree Edge for drawing Draft Lines. (B) Spacing Block for Uniform Cross-sectioning

STOCK BIN FOR CASTINGS

A flexible stock bin for castings or forgings is shown in Fig. 1. It can be made of any height by adding boards, and the size of any compartment can be increased by removing the boards of the adjacent compartments. The bin is easily made and stands considerable wear. It consists of thick boards held in place by channels riveted together as shown in Fig. 2. Angle-irons are placed across the upper ends of the channels to form the front and back, and these sides are held together by iron bars, across the top, the ends of which are twisted at right angles to the body and secured by the same bolts that secure the upper corner iron at every other section.

Flint, Mich. C. C. Spreen

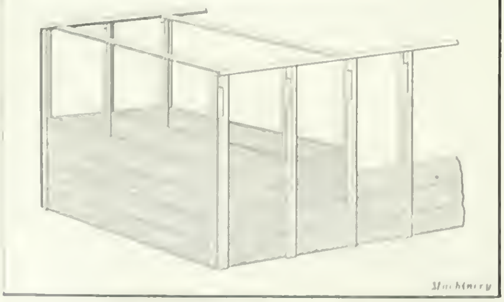


Fig. 1. Flexible Stock Bin for Castings or Forgings

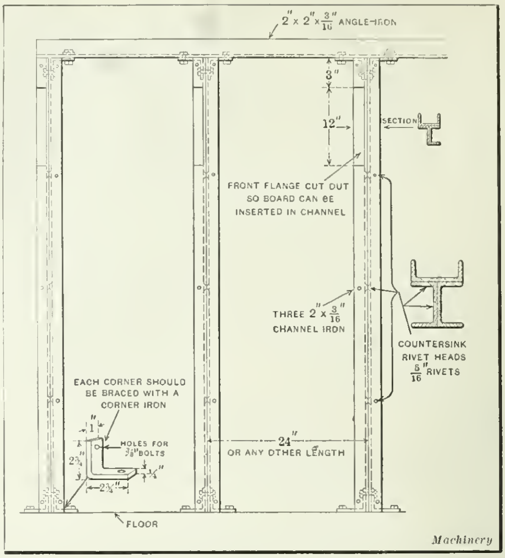
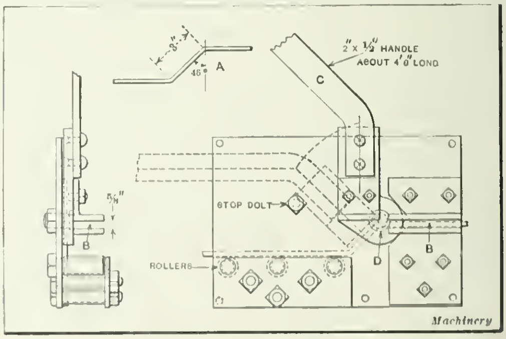

2" x 2" x 3/16" ANGLE-IRON
3"
12"
SECTION
FRONT FLANGE CUT OUT SO BOARD CAN BE INSERTED IN CHANNEL
THREE 2" x 3/16" CHANNEL IRON
COUNTERSINK RIVET HEADS 5/16" RIVETS
EACH CORNER SHOULD BE BRACED WITH A CORNER IRON
1"
HOLES FOR 3/8" BOLTS
2¾"
1/4"
2¾"
24" OR ANY OTHER LENGTH
FLOOR
Machinery

Fig. 2. Details of Flexible Stock Bin

BENDING CONCRETE REINFORCING RODS

The illustration shows a machine that has been useful in bending reinforcing rods for concrete. These rods are ⅜ and ½ inch square, range from ten to forty feet long, and may have any number of offsets as shown at *A*. The rods are placed between two angle-irons at *B*, and handle *C* is pulled down to the position indicated by the dotted lines, thus forming the two bends at one operation as indicated. When the rods are small, three or four may be bent at one time. The handle rotates about a hardened pin and hardened bushing at *D*. This machine was made from scrap material, and was therefore inexpensive.

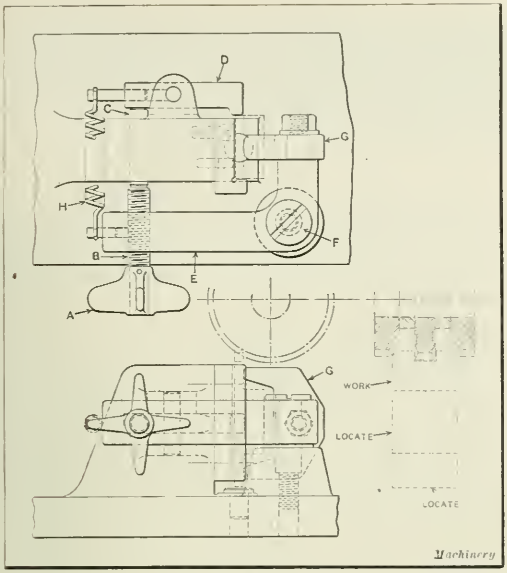


Bending Concrete Reinforcing Rods

St. Joseph, Mo. L. M. Hamlet

RAPID CLAMPING DEVICE

The writer recently designed the three-point binding clamp shown in the illustration. By turning the winged nut *A*, which is pinned to stud *B*, pin *C* is forced against clamp *D*, causing it to clamp the work at the other end. As soon as clamp *D* begins to bind, the clamping arm *E*, being pivoted by pin *F*, rides back on stud *B*, causing the equalizing clamp

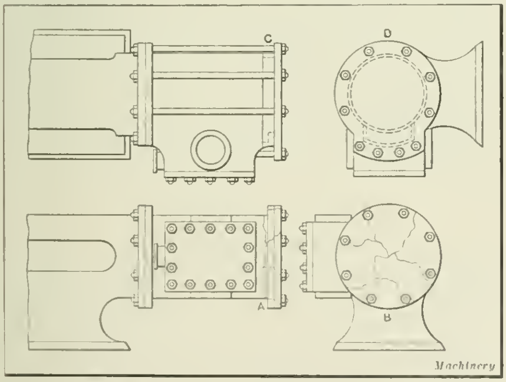


Three-point Binding Clamp

G to hold the work in front at the top and bottom. By turning nut *A* in the opposite direction, the clamps are loosened and spring *H* pulls clamp *D* back so that the work may be easily removed. B. A. C.

STEAM ENGINE CYLINDER REPAIRS

The accompanying illustration shows what happened to an old 14- by 18-inch slide valve steam engine when the piston-rod pulled out of the piston while the engine was running at full speed, and on the return stroke shattered the rear cylinder head, cylinder flange, and cylinder barrel up to the inner edge of the counterbore as shown at *A* and *B*; the illustration also shows how the repairs were made. Immediate repairs were necessary, and so the cylinder was taken to the shop and bolted onto the faceplate of a 40-inch lathe. The broken end of the cylinder was faced off to the inner edge of the counterbore, which, of course, exposed the steam port but gave a smooth face about ¾ inch wide around the cylinder barrel and steam port. A pattern was made for a casting (shown at *C* and *D*) that would form the head and that part of the barrel taken up by the counterbore. It was bored out to the original size of the counterbore and faced off. Dowel-pins were set to locate it true with the cylinder and to facilitate the assembly. Holes were drilled through the flange to coincide with the tapped stud holes in the front cylinder flange, with the exception of those directly in line with the steam chest where holes were drilled for studs which were tapped into the steam chest wall. The tapped stud holes in the front cylinder flange fortunately came outside the cylinder barrel, and these were drilled large enough to admit long stud bolts that extended from the flange on the engine frame, through the front cylinder flange, and back through the new casting flange, giving a sort of squirrel cage effect. An annealed gasket of 1/32-inch copper was made for the new joint, and with a new piston-head, rod, and connecting-rod strap, the engine was assembled and put into operation without any trouble being experienced. Jay

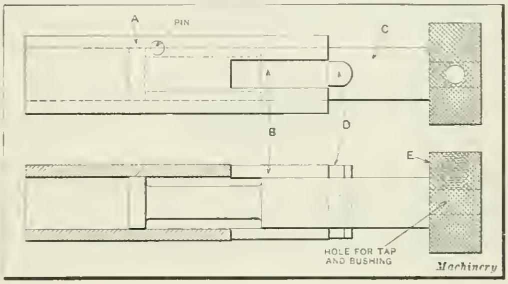


Broken Cylinder Parts and New Pieces

SMALL TAP-HOLDER FOR TURRET LATHE

In doing small jobs on a turret lathe that was too large for the work, considerable difficulty was experienced in tapping with small taps, as the tap-holders were lacking in sensitiveness, which resulted in an unusual amount of breakage. The size of the tap used in this particular work was 1/16 inch. To eliminate this excessive breakage, a releasing tap-holder was designed which is here illustrated. It consists of a tube or sleeve *A*, having a slot milled as shown at *B*. The inside member *C* holds the tap and is pulled out of the sleeve by the tap. The pin *D* slides in the slot *B* and prevents the inside member from rotating until the tap has entered the work so far that the pin no longer engages the slot, this distance being regulated by a stop on the turret. The tap then rotates with the work and ceases to advance. It is withdrawn by reversing the lathe and grasping the knurled head *E* with the fingers.

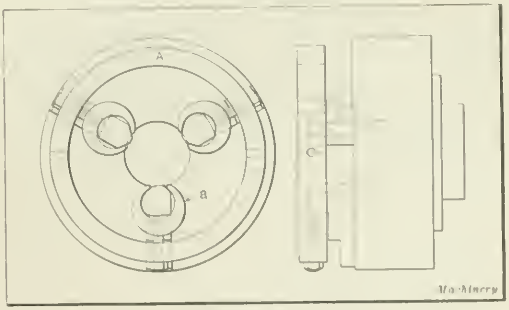
Boston, Mass. John A. Shand



Tap-holder for Use on Turret Lathe

LATHE-CHUCK TRUING DEVICE

The truing device here shown is a simple, inexpensive, accurate method of truing lathe-chuck jaws. It consists of a large ring *A*, three small eccentric rings *B*, and three ordinary cap-screws. In the large ring, holes are drilled so that three or four screws may be set equidistant from one another, the holes being drilled a free fit for the screws. The eccentric rings *B* are milled out to fit on the inner angle of the jaws and tapped opposite the opening for the cap-screws. The fixture is placed



Inexpensive Method of truing Chuck Jaws

on the chuck and the jaws tightened to give them the proper stress; in this way the grinding wheel can pass the entire length of the jaws. This device can be used equally well on four-jaw chucks by using four eccentric rings *B* instead of three, as here shown. The outside of the jaws can be ground by placing plain rings on the different steps or by wrapping ordinary soft wire around the outside so that it will be in the corrugations, and then reversing the tension of the jaws.

Detroit, Mich. O. F. Schweitzer

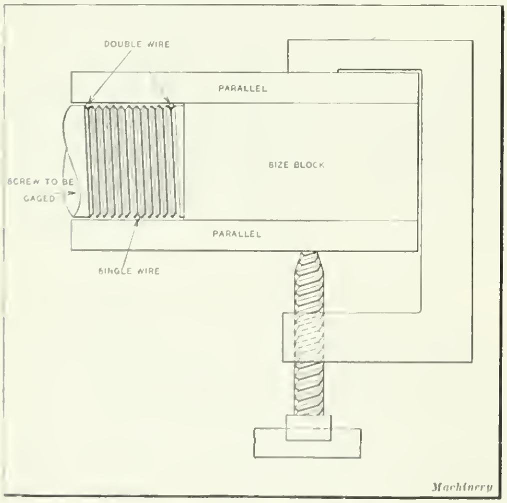
SIMPLE SECTION LINER

In the November number of Machinery was given a kink for cross-sectioning drawings by means of a triangle. The following suggestion may also be of interest: Two screws 6 inches long, ½ inch in diameter, with sharp V-threads, were turned up, one having 32 threads per inch and the other 16 threads per inch. On a small drawing, by using the 32-thread screw in the proper location and exerting a slight pressure, each section line is evenly and properly located. Then with a 45-degree triangle the lines may be drawn rapidly in the usual manner, thus giving a neat, even appearance. For large drawings the 16-thread screw is used.

North Plainfield, N. J. John B. Gray

MEASURING DIAMETERS OF SCREW THREADS

The diameters of screw threads are usually measured by using the regular Brown & Sharpe thread micrometer or by means of three wires used with the regular flat-anvil micrometer. Of these, the thread micrometer is the more reliable. However, by substituting a sizing block for the micrometer in the three-wire system an accurate measurement can be obtained. First the diameter of the screw, including the wires to be used, is found. Then a sizing block is made to the dimension obtained; also a pair of parallels, hardened and ground, about one fourth by one half inch and one inch longer than the block. A C-clamp for holding the parallels and block together completes the outfit, and a measuring surface at least five times greater than that of the micrometer is obtained. The screw to be gaged is placed between the projecting ends of the parallels, and by placing two wires, as far apart as possible, in the threads of one side of the screw there is no danger of measuring out of square with the screw. On the opposite parallel, the single wire can be moved from one thread to another and any variation can be easily detected.



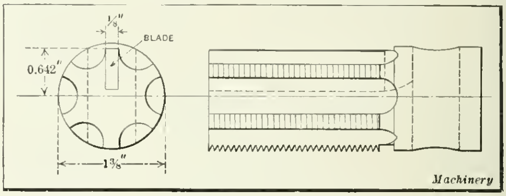
Device for measuring Diameter of Screw Threads

If, in placing the screw, block, and parallels on the surface-plate, the center of the screw is found to be higher than the parallels, it will be necessary to pack up the block and parallels enough to bring the center of the block about the same height as the center of the screw. The placing of pieces of thin packing, such as tin foil, tissue paper, etc., between one of the parallels and the size block will enable the screw to be measured if it should be over size.

Derby, Conn. F. W. Shrier

TAP WITH INSERTED "DUTCHMAN"

A lot of Whitworth thread taps were found to be cut a trifle too deep, so that the root diameter of the tapped hole was too small and would not allow the thread gage to enter. Rather than junk them, they were annealed and a block was inserted, as shown in the illustration, and ground to the root radius. All holes that were too small were then reamed, by this blade, to the proper size.



Tap with Inserted "Dutchman" for correcting Root Diameter

Boston, Mass. John A. Shand

COST PLUS TEN PER CENT

The editorial entitled "Cost Plus Ten Per Cent" in the January number of Machinery was of interest to the writer, who has been engaged in munition work for some years past with a number of different concerns. After being pushed to the limit in shops with regular contracts in an effort to get a greater production and meet delivery dates, it was a relief to get into a cost-plus shop in the capacity of chief tool designer. We were supposed to tool up for the production of 20,000 three-inch shells per day in the least possible time, but, strange to say, everyone seemed to take life easy. Not once during the time he was there was the writer asked to crowd the job, to get a little more out of his men, or to work overtime. This showed plainly that no particular effort was being made on the part of the management to hurry production, as would have been the case had the shop been working on the regular contract basis. D. B.

TANKS ANTICIPATED

That there is nothing new under the sun is exemplified once more by the discovery that the famous British tanks so effectively used in Flanders were anticipated by that universal genius of the Renaissance, Leonardo da Vinci. Writing to Ludovico Sforza, Duke of Milan, more than four centuries ago, he offered to make known various engineering secrets that he thought would be useful in war. His sixth item was: "I can also construct covered wagons, secure and indestructible, which, entering among the enemy, will break the strongest body of men; and behind these the infantry can follow in safety and without impediment." Among other devices that Leonardo mentions are bombs, mines, and "powders or vapors for the offense of the enemy."

South Orange, N. J. Max J. Herzberg

MACHINE LEG DESIGN

It would be a good thing if manufacturers of machines that stand on legs would make the legs A-shape and have the crosspiece not over six inches from the floor. Anyone who has tried to move a thousand-pound machine with a bar when the nearest point of contact available is a foot above the floor will appreciate this. D. A. H.

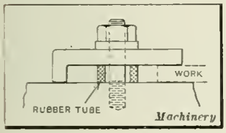
SHOP AND DRAFTING-ROOM KINKS

STORING DRILL RODS

The writer has found that the following system of keeping drill rod is quite satisfactory. The drill rod is cut into 3-foot lengths, and each size is kept in a can made of sheet tin. These cans are all 3 feet in length, but vary in diameter from 1½ to 5 inches. The size is stenciled plainly on the lid.

New York City E. J. Higgins

RUBBER TUBING FOR CLAMPING DEVICES



Use of Rubber Tubing in Place of Spring on Clamping Device

The accompanying illustration shows how a piece of rubber tubing was used in place of a metallic spring on a clamping device. This plan has been found to give very satisfactory results.

Newark, N. J. Nils Atterberg

SAVING TIME IN MAKING DRAWINGS

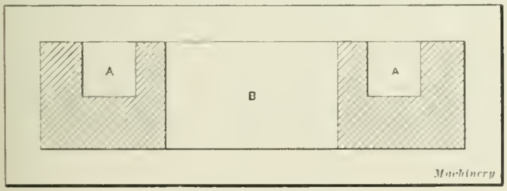
The writer has used successfully in two drafting-rooms what is called unprepared "Albanene" tracing cloth. Some concerns use bond and tracing paper for permanent drawings to save money and time; but paper in a short time and with ordinary usage becomes torn and the drawing has to be replaced. Drawings can be laid out directly on the cloth, and the prints obtained from it are good, if a relatively soft pencil, say a 3H or 4H, is used. The writer has also found that a triangle placed under a tracing facilitates the erasing of a line, and if a shield is used, a hole is seldom made.

When a number of circles must be drawn from a common center, if a piece of celluloid about as thick as ordinary drawing paper is fastened by shellac over the center, a large hole will not be made in the tracing or drawing. Some people use horn centers, but these make holes in the tracing. The celluloid comes off easily by lifting with a knife. It has another advantage, that the center lines can be seen.

Roselle, N. J. M. B. Perlman

SOLDERING FORM FOR ROTORS

In soldering the brass end-plates to the brass rods on three-horsepower squirrel-cage rotors, an electrical foreman rigged up a soldering form as shown in the illustration, which consists of a cast-iron ring containing a recess *A* sufficient in size to accommodate the work. The end of the rotor shaft is slipped through the center hole *B* of the form, and the brass end-plate fitted into the recess *A*, which is filled with molten solder. This is an appreciable time-saver over other methods in use.



Cast-iron Ring for soldering

Cincinnati, Ohio Joseph Ploomann

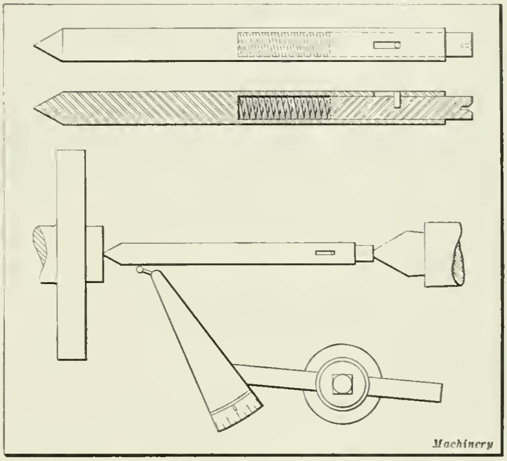
HIGH-SPEED COUNTERBORES

At the present prices, it is seldom that purchasing agents will buy high-speed steel for use in counterbores. But in a large number of shops there can be found hollow-mills that are worn down too much for use on screw machines; these can be made into very good counterbores. They already have the teeth cut, so that all they need is to be fitted with a shank, from which the teat that passes through the hole in the mill projects. Sometimes they may need turning to the right diameter, but as these mills have different sized holes and diameters, it is usually possible to select those that need very little work before being ready for use.

Providence, R. I. Alfred E. Carter

CENTERING TOOL FOR LATHE WORK

For work that is laid out by the center points, such as holes in dies, the tool here shown is convenient for use in conjunction with a test indicator as illustrated. The device is so simple as to need no description.

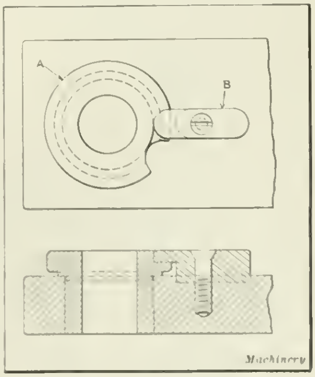


Centering Tool for Lathe Work

New York City E. J. Higgins

SLIP BUSHING WITH RETAINING DEVICE

In the September, 1916, and April, 1917, numbers of Machinery locks for slip bushings were described. The accompanying illustration shows a slip bushing with a retaining device, which was used in drilling and reaming operations. The flange of the bushing *A* was milled through to the diameter of the key *B*. The bushing was then given a slight turn and the flange again milled to half its height. The key was secured to the jig by a screw. In order to remove the bushing, the knurled flange is given a slight twist until the flange can be withdrawn past the key by means of the milled groove. If the drill rotates counter-clockwise, the location of the key in the bushing will be in the opposite direction to that shown.



Slip Bushing with Retaining Device

Ruelle (Charente) France C. Jouve

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

QUARTER-TWIST BELTS

B. C. S.—I should like a good rule for quarter-twist belts, one that can be used for any case when the shafts are not parallel.

Answered by John R. Beckett, Somerville, Mass.

Here is a rule the writer has never known to fail: Have the pulleys so lined that the leaving faces are plumb. By "leaving faces" is meant the faces from which the belts leave the pulleys.

SEASONING CASTINGS

D. A. B.—High-speed production and the need of getting out special machines in the least possible time does not allow much time for seasoning of castings. A short time ago, the writer had occasion to make some special drilling machines that required beds, or cast-iron ways, ten feet long. The contract for making these machines was given to a company that has a reputation for fine tools and special machine work. When the question of seasoning the castings came up, the chief tool designer of this company said that the same effect could be obtained by thoroughly pickling the castings before machining as is obtained when the castings are rough-machined and then allowed to season in the regular way, before being finish-machined and scraped. Is this contention true?

This question is submitted to the readers.

NUMBER OF BALLS THAT CAN BE PLACED IN A CUBICAL BOX

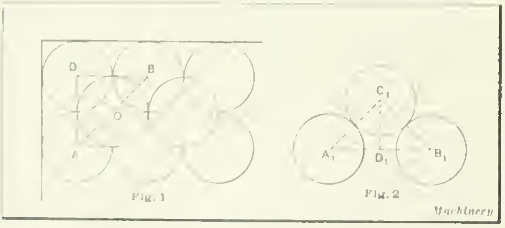
L. A. O.—How many balls, each 1 inch in diameter, can be placed in a box 12 inches by 12 inches by 12 inches, inside measurements?

Answered by J. J. Clark, Scranton, Pa.

A.—If the balls are arranged in layers, as indicated in Figs. 1 and 2, it is evident that 12 × 12 = 144 balls will constitute the first layer and 11 × 11 = 121 balls, the second layer. The distance between the plane of centers of the first layer and the plane of centers of the second layer is represented by the altitude C_1D_1 of the triangle $A_1C_1B_1$, Fig. 2. The side A_1B_1 is equal to AB, Fig. 1, and as $DA = DB = 1$ inch, $AB = A_1B_1 = \sqrt{1^2 + 1^2} = \sqrt{2}$ inches. $A_1C_1 = B_1C_1 = 1$ inch. Hence, $C_1D_1 = \sqrt{1^2 - (1/2\sqrt{2})^2} = \sqrt{1/2} = 1/2\sqrt{2} = 0.707$ inch. The centers of the first layer of balls must be 1/2 inch from the bottom of the box, and the centers of the top layer must be at least this distance from the top of the box. Therefore, the number of layers must be at least equal to

$$\frac{12 - 0.5 - 0.5}{0.707} = 15,$$

to the nearest integer. If there are fifteen layers, eight will contain 144 balls each and seven will contain 121 balls each. The distance between the plane of centers of the first layer and the plane of centers of the fifteenth layer is 14 × 0.707 = 9.898 inches. The distance from the bottom of the box to the plane tangent to the tops of the balls in the fifteenth layer is 9.898 + 0.5 + 0.5 = 10.898 inches. Consequently, another layer of 144 balls can be laid on top of the fifteenth layer, thus making nine layers of 144 balls each and seven layers of 121 balls each. Hence, the total number of balls that can be placed in the box is 9 × 144 + 7 × 121 = 2143 balls.



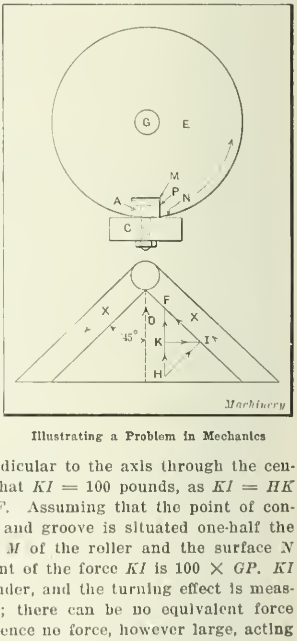
Figs. 1 and 2. Diagrams for determining Number of Balls that can be placed in a Cubical Box

A PROBLEM IN MECHANICS

A. B.—A force of 200 pounds is exerted behind the rod *C* in the direction *D*, as indicated, and is transmitted through the roller *A* to the cylinder *E* by a groove *X* cut in the periphery of the cylinder, the angle of which, in respect to line *D*, is 45 degrees. (1) What per cent, if any, of the 200 pounds will be delivered by the cylinder *E* at its center *G?* (2) How much power must be exerted at *G* to bring *C* back to its original starting point? Distance of travel is 16 inches; weight is 20 pounds.

Answered by J. J. Clark, Scranton, Pa.

A.—It is not possible to answer the questions as they stand; not only is insufficient information given, but conditions that do not exist have been assumed. Let HF represent the force of 200 pounds, and resolve this into two components, one, IF, acting parallel to the groove, and the other, HI, acting perpendicular to the groove. Then, in the triangle HIF, $HI = HF \times \cos 45$ degrees $= 200 \times 1/2\sqrt{2} = 100\sqrt{2}$. Resolving HI into the two components HK, which is parallel to the force D, and KI, which is perpendicular to the force D, $KI = HI \times \sin 45$ degrees $= 100\sqrt{2} \times 1/2\sqrt{2} = 100$ pounds, which is the tangential force acting on the cylinder E in a plane perpendicular to the axis through the center G. It is easy to see that $KI = 100$ pounds, as $KI = HK$ and HK is one-half of HF. Assuming that the point of contact P between the roller and groove is situated one-half the distance between the end M of the roller and the surface N of the cylinder, the moment of the force KI is $100 \times GP$. KI acts only to turn the cylinder, and the turning effect is measured only by its moment; there can be no equivalent force acting at the center G. Hence no force, however large, acting at G will have any effect in producing a movement of the roller as long as there is no lateral movement of the cylinder E.



Illustrating a Problem in Mechanics

ANGLE BETWEEN CAMS OF A FOUR-CYLINDER ENGINE

W. M. T.—A four-cylinder engine having a firing order of 1-3-4-2 is so timed that the inlet valve is opened 15 degrees after the upper dead center is past and is closed 41 degrees after the lower dead center is past; the exhaust valve is opened 45 degrees before the lower dead center is passed and is closed 18 degrees after the upper dead center is passed. What should be the size of angles *A*, *B*, *C*, and *D*, in the accompanying illustration, and also of the angle between the first inlet and first exhaust cams?

Answered by M. V. Terry, Flint, Mich.

In answering this inquiry, certain assumptions must be made, because sufficient information has not been given. The first assumption is that the questions relate to a four-cycle engine; in this case, the camshaft makes one revolution for every two revolutions of the crankshaft. The inlet valve is

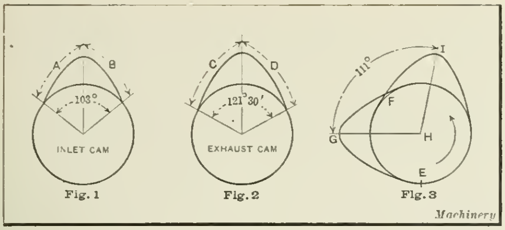


Fig. 1 Fig. 2 Fig. 3

Figs. 1 to 3. Angles of Cams of Four-cylinder Engines

open from 15 degrees past the upper dead center to 41 degrees past the lower dead center, or a total of 206 degrees of the crankshaft circle. The theoretical, or effective, inlet cam angle is, therefore, one-half 206 degrees, or 103 degrees, as shown in Fig. 1. Similarly, as the exhaust valve is open from 45 degrees before the lower dead center until 18 degrees after the upper dead center is passed, it is open for 243 degrees of the crankshaft circle. The theoretical, or effective, exhaust cam angle is, therefore, one-half of 243 degrees, or 121 degrees 30 minutes, as shown in Fig. 2. In most cases, cams are made symmetrical; therefore, angle A = angle B = one-half of 103 degrees, or 51 degrees 30 minutes, and angle C = angle D = one-half of 121 degrees 30 minutes, or 60 degrees 45 minutes.

The actual total angles of the inlet and exhaust cams should be greater than 103 degrees and 121 degrees 30 minutes, respectively, by twice the clearance angle of the cams. The clearance angle depends on the base circle of the cam, the shape and size of the cam follower, and the actual clearance or play, in thousandths of an inch, allowed between the cam follower and the valve. As none of these data are given, it is impossible to calculate the clearance angle, which may vary from 2 to 6 degrees.

As the exhaust stroke of a four-cycle engine immediately precedes the inlet stroke, the exhaust cam leads, or precedes, the inlet cam in the direction of rotation. According to the conditions given, the exhaust valve opening point E, Fig. 3, is 240 degrees (= 45 + 180 + 15 degrees) ahead of the inlet valve opening point F, as measured on the crankshaft circle. This gives an angle of 120 degrees on the crankshaft, which would have been the angle between the center lines of the two cams, were it not that the exhaust cam angle is 18 degrees 30 minutes wider than the inlet cam angle, for 121 degrees 30 minutes — 103 degrees = 18 degrees 30 minutes. The angle between the center lines of the cams is, therefore, 120 degrees minus one-half 18 degrees 30 minutes, or approximately 111 degrees. This is apparent from the construction.

Incidentally it may be pointed out that the practice of opening the inlet valve before the exhaust valve is completely closed, which is known as crossing of valves, is very poor practice. It has been successfully done on some racing engines intended to operate at high speeds only, but on ordinary engines at low speeds crossing results in pre-ignition due to the mixing of the exhaust gases and the fresh charge. In the example given, the crossing of valves amounts to 3 degrees.

TENSION IN A LOADED CABLE

N. A. S.—What is the tension in a cable having a span of 1200 feet when the sag is one-twentieth of the span and the load in the middle is 8 tons? Referring to the illustration, what is the necessary weight W? Is it customary to use a smaller ratio of sag?

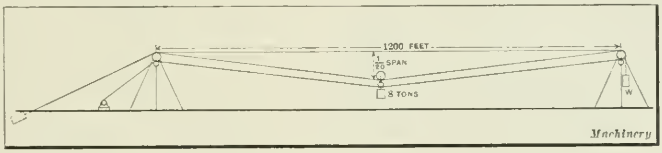
Answered by J. J. Clark, Scranton, Pa

A.—The conditions you give are very unusual, and it may be doubted whether the scheme is practicable. It is impossible to derive a formula that will give exact results, but under ordinary conditions, the following formula works well in practice:

$$T = L\left(\frac{S}{4H} + \frac{4HL}{S^2W + 2SL}\right) + \frac{S^2W}{8H} + HW$$

in which T = tension, in pounds;
S = span, in feet;
H = sag, in feet;
L = load to be carried, in pounds;
W = weight of rope per foot of length, in pounds.

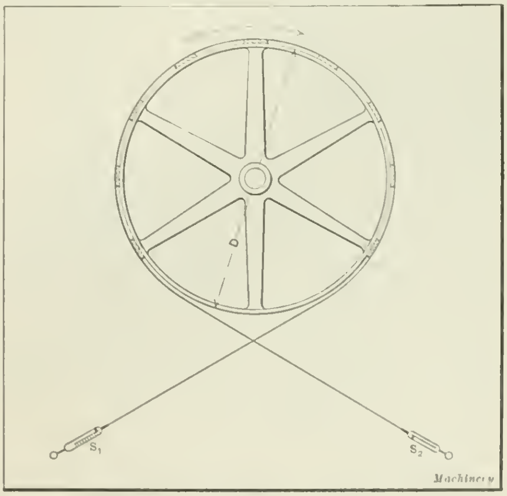
Since W is unknown, the first step is to reject all terms except the first in the right-hand member of the equation, which then reduces to $T = \frac{LS}{4H}$. In the present case, $L = 2000 \times 8 = 16{,}000$ pounds, $S = 1200$ feet, and $H = 1200 \div 20 = 60$ feet. Substituting these values in the second expression for T, $T = \frac{16{,}000 \times 1200}{4 \times 60} = 80{,}000$ pounds = 40 tons. Referring to page 404 of Machinery's Handbook, a 2¾-inch crucible steel wire rope of six strands and a hemp center, with nineteen wires to the strand, has a safe working load of 42.2 tons, with a factor of safety of 5. Such a rope weighs 11.95, say 12, pounds per foot. Substituting 12 for W in the main formula, $T = 16{,}000\left(\frac{1200}{4 \times 60} + \frac{4 \times 60 \times 16{,}000}{1200^2 \times 12 + 2 \times 1200 \times 16{,}000}\right) + \frac{1200^2 \times 12}{8 \times 60} + 60 \times 12 = 117{,}823$ pounds. Referring to the second table on page 404 of Machinery's Handbook, the breaking strength of a plow-steel wire rope, 2¾ inches in diameter, six strands, nineteen wires to the strand, is 275 tons = 550,000 pounds; its weight is practically the same as the crucible steel rope. If such a rope is used, the factor of safety is 550,000 ÷ 117,823 = 4.66, which is ample for the present case. The weight W equals the tension in the rope, or 117,823 pounds. A sag equal to one-twentieth of the span seems to be a reasonable allowance, since the smaller the ratio the greater is the tension in the rope; on the other hand, too much sag would be a disadvantage.



Tension in a Loaded Cable

MEASURING HORSEPOWER OF A PULLEY

E. B. J.—The illustration shows an arrangement that has been suggested to us for measuring the horsepower transmitted by a pulley. S_1 and S_2 are spring balances, and increasing or de-



Measuring Horsepower of a Pulley

creasing the distance between them alters the tension in the brake-band encircling the pulley. Please state rule for finding the horsepower. What is the horsepower when S_1 is 14 pounds, S_2 is 238 pounds, diameter of pulley is 8 feet, and the pulley makes 225 revolutions per minute? Does the thickness of the wooden blocks attached to the brake-band have any effect?

Answered by J. J. Clark, Scranton, Pa.

A.—If the force equivalent to the friction between the band and the pulley is represented by F, it is evident that when the pulley is revolving in the direction of the arrow, the pull S_2 must be equal to F plus the pull S_1; that is, $S_2 = F + S_1$, or $F = S_2 - S_1$ = force acting on pulley. This force acts each minute through a distance equivalent to the circumference of the pulley multiplied by the number of revolutions per minute. In other words, the work done on the pulley is $\pi DN(S_2 - S_1)$ foot-pounds per minute, where D is the diameter of the pulley, in feet, and N is the number of revolutions per minute, and this divided by 33,000 gives the horsepower. This must evidently equal the horsepower transmitted by the pulley. Hence, the required formula is:

$$\text{Horsepower} = \frac{\pi DN(S_2 - S_1)}{33{,}000}$$

Substituting in this formula the values given, we have:

$$\frac{3.1416 \times 8 \times 225 \times (238 - 14)}{33{,}000} = 38.38 \text{ horsepower}$$

The thickness of the band or blocks makes no difference, as the friction is applied only to the circumference of the pulley. Further, in so far as the horsepower transmitted is concerned, it makes no difference whether or not a lubricant is used between the blocks and the pulley.

A PROBLEM IN STATICS

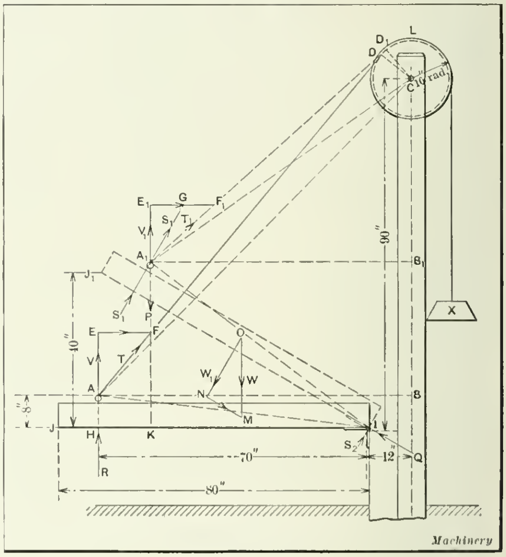
E. H. S.—The illustration shows a beam of uniform density throughout, weighing 116 pounds; it is hinged at one end and supported near the other end by a rope attached to an eyebolt, which passes over a sheave L and has a weight X attached to the other end. What weight is required to hold the beam in a horizontal position? What vertical force P is required to keep the beam in the dotted position under the pull of weight X?

Answered by J. J. Clark, Scranton, Pa.

A.—Neglecting friction and the force due to bending of the rope, the tension T in the rope when the beam is horizontal is equal to the weight X. Let $AF = T$; then, resolving this force into the vertical component V and the horizontal component EF, the force V acting at A is equivalent to a vertical reaction R acting, at H, directly under A. To determine this reaction R, take I as the center of moments; then $R \times 70 = W \times \frac{80}{2}$, or $R \times 70 = 116 \times 40 = 4640$, where W is equal to the weight of the beam. Hence, $R = V = 4640 \div 70 = 66\ 2/7$ pounds. $AB = 70 + 12 = 82$ inches, and $CB = 90 - 8 = 82$ inches; whence angle $CAB = 45$ degrees, and $CA = 82 \times \sqrt{2} = 115.966$ inches. DAC is the angle the sine of which is $10 \div 115.966 = 4$ degrees 56 minutes 49 seconds, and $DAB = 45$ degrees + 4 degrees 56 minutes 49 seconds = 49 degrees 56 minutes 49 seconds = EFA. Therefore, $T = X = AF = V \div \sin EFA = 66\ 2/7 \div \sin 49$ degrees 56 minutes 49 seconds = 86.597 pounds. When the beam is in the position indicated by the dotted lines, the weight W of the beam, which acts downward at the center O, may be resolved into two components, $ON = W_1$ perpendicular to the beam and NM parallel to the beam. The beam may then be considered as held in equilibrium by the parallel forces S_1, S_2 and W_1, and the force Q; $S_1 + S_2 = W_1$, and Q is parallel and equal, but opposite, to NM. The force P acting in combination with W, the weight of the beam, just balances the weight X; and $T_1 = A_1F_1 = T = X = 86.597$ pounds. Angle $NOM = JIJ_1$; $W_1 = W \cos NOM = 116 \times 1/2\sqrt{3} = 100.459$ pounds, since $\cos NOM = \cos JIJ_1 =$

$$\sqrt{1 - \sin^2 JIJ_1} = \sqrt{1 - \left(\frac{40}{80}\right)} = 1/2\sqrt{3}.$$

Hence, $JIJ_1 = 30$ degrees. Again taking I as the center of moments, $S_1 \times 70 = 100.459 \times 40$, or $S_1 = 57.405$ pounds. Denoting the vertical component of T_1 by V_1 and of S_1 by $V_2 = S_1 \times \cos (E_1A_1G = NOM) = 57.405 \times 1/2\sqrt{3} = 49.714$ pounds. To find V_1, it is first necessary to find the angle $E_1F_1A_1 = B_1A_1D_1 = B_1A_1C + CA_1D_1$. Angle $A_1IJ = JIJ_1 + AIH$. Tan $AIH = \frac{8}{70}$, or $AIH =$ 6 degrees 31 minutes 11 seconds. $AI = \sqrt{70^2 + 8^2} = 70.456$ inches. In triangle A_1IK, angle $A_1IK = 30$ degrees + 6 degrees 31 minutes 11 seconds = 36 degrees 31 minutes 11 seconds, and $A_1K = 70.456 \times \sin 36$ degrees 31 minutes 11 seconds = 41.928 inches. Also, $KI = 70.456 \times \cos 36$ degrees 31 minutes 11 seconds = 56.623 inches. Whence $B_1C = KC - A_1K = 90 - 41.928 = 48.072$ inches, and $A_1B_1 = 56.623 + 12 = 68.623$ inches. Then, $\tan B_1A_1C = 48.072 \div 68.623$, or $B_1A_1C =$ 35 degrees 0 minutes 44 seconds. $A_1C = B_1C \div \sin B_1A_1C =$ $48.072 \div \sin 35$ degrees 0 minutes 44 seconds = 83.785 inches. $\sin CA_1D_1 = 10 \div 83.785$, or $CA_1D_1 = 6$ degrees 51 minutes 17 seconds. Therefore, $D_1A_1B_1 = E_1F_1A_1 = 35$ degrees 0 minutes 44 seconds + 6 degrees 51 minutes 17 seconds = 41 degrees 52 minutes 1 second, and $V_1 = E_1A_1 = T_1 \times \sin E_1F_1A_1 =$ $86.597 \times \sin 41$ degrees 52 minutes 1 second = 57.795 pounds. Finally, $P = V_1 - V_2 = 57.795 - 49.714 = 8.081$ pounds. It will be noticed that the calculation is quite long and that the chances of making mistakes are numerous. A much easier method, and one sufficiently exact for practical purposes, is to calculate V and S_1 and determine all other values graphically.



A Problem in Statics

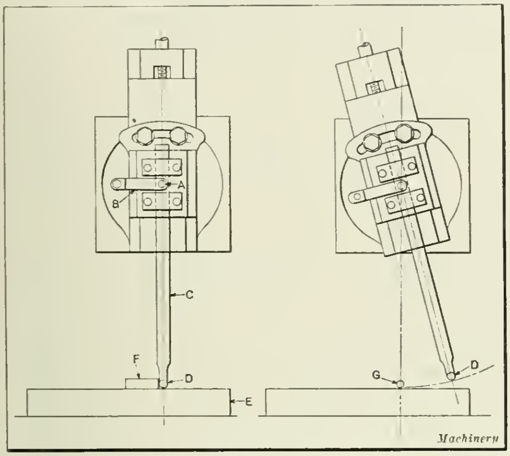
TO GRADUATE A PLANER HEAD WITHOUT SPECIAL APPLIANCES

E. J. R.—Can any reader of MACHINERY suggest a way to graduate the head of a 36-inch planer in a shop where there are no milling machines or graduating machines?

Answered by G. H. G.

One method of graduating a planer head, which is very crude, is to swing the head in a lathe and use a tool held in a toolpost for scribing the graduation lines, and a change-gear on the lead-screw as an index plate. The results are what might be anticipated. Another scheme is to grip the head in a graduated planer chuck. This necessitates locating the axis about which the head revolves in exact coincidence with that of the chuck. This method is preferable to the first one mentioned, but it is far from perfect. A third plan that is sometimes employed is as follows: The head is swung in the lathe, and a point in its axis of rotation is determined by "indicating" the arcs on the head which are to be graduated. Next the head is transferred to an angle-plate, leveled up by its slides and is then turned (plate and all) through 90 degrees.

What is to be the zero point is next located at the height of the center, and, after figuring how far above or below the zero line the other graduation lines should be, the latter are scribed with a height gage. One objectionable feature of this method is that the zero line is located by leveling up from the finished surfaces of the head, which might not be exactly parallel with the vertical travel of the tool-slide. The products obtained by multiplying the radius of the scribed arc by the tangent of the angle included between two consecutive graduations has an awkward way of coming out as a mixed number of thousandths, to which it is impossible to set the height gage.



Method of setting Planer Head for graduating by Application of Sine-bar Principle

The method recommended is an application of the familiar principle of the sine bar. The revolving part of the head is swung in a lathe and its axis of rotation is brought into coincidence with that of the lathe. A button *A*, carried by a bracket *B*, is centrally located relative to the swiveling member. This bracket *B* is bolted to the "wing", and it is bent so that the projecting end carrying the button is high enough to clear the tool-block. A bar *C* having at one end of a plug *D*, ¼ inch in diameter, is clamped to the tool-block and so adjusted that the center-to-center distance between *A* and *D* is 18 inches. The tool-block should be so set that its center of rotation practically coincides with that of the head. An accurate centering of the tool-block is an advantage, although not absolutely necessary.

The head is now returned to its place on the cross-rail and, before tightening the clamping nuts, it is carefully adjusted until the travel of the tool-slide is vertical with or perpendicular to the planer table, as indicated by the continuous contact of plug *D* with the blade of a square, the stock of which rests on the table. When this adjustment is made, the head is clamped and the zero graduation line is scribed. The clapper-box is next turned (the head remaining fixed) until the centers of button *A* and plug *D* coincide with a line that is perpendicular to the table. The nuts holding the clapper-box are then tightened and the tool-slide readjusted so that the center distance from one button to another is 18 inches. The handle should be removed from the tool-slide feed-screw and the gibs of the slide tightened to insure that there will be no movement of this part during the subsequent operation.

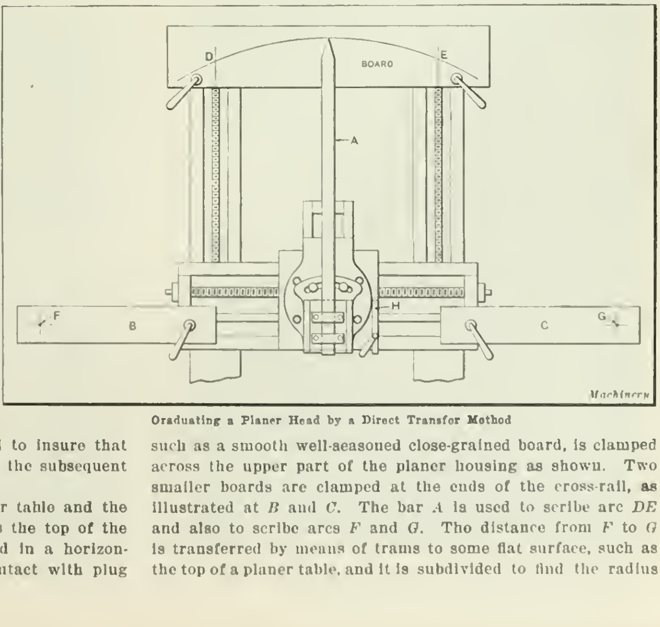
Two parallels *E* are now laid on the planer table and the cross-rail is lowered until plug *D* just touches the top of the parallels. Another parallel *F* is next clamped in a horizontal position across the parallels *E* and in contact with plug *D*. The head is now swung slightly to the right, and a plug of the same diameter as *D* is clamped in contact with the top parallel *F*. The latter is then removed so that this plug occupies the position illustrated at *G* in the view to the right, this position corresponding to that of plug *D* in the view to the left. Everything is now ready for setting the head to the successive angles desired, in order to scribe the graduation marks on the flange. The head is set in each of its angular positions by measuring the distance between plugs *G* and *D* with a vernier caliper, the proper distance between their centers for any angle being equal to 36 times the sine of one-half the required angle.

The reason for having plugs *G* and *D* of such small diameter is because the setting for the one-degree position could not be obtained with plugs of much larger size. Obviously, when the desired graduations on one side of the zero point have been made, the head can be set by the same method for scribing the graduations on the other side of the zero line. The reason why it is preferable to have the axis of rotation of the clapper-box coincide quite accurately with that of the head is because of the greater accuracy of determining small angles than larger ones by the sine-bar method. Thus, if these two axes were in exact coincidence, it would be possible after graduating, say, 20 degrees, to return plug *D* to the starting point (by turning the clapper-box backward), the head remaining fixed. The head could then be set with slightly greater accuracy for graduating the angles above 20 degrees.

The work performed by a planer graduated in this way compared favorably with similar work from a planer that was later installed, which had a head graduated by the manufacturers. While it is true that the required distances between the plugs (like those for the height-gage method previously outlined) were fractions to which the caliper could not be set exactly, this was of little importance, owing to the comparatively large radius of the 18-inch sine bar.

Answered by Martin H. Ball, Watervliet, N. Y.

The accompanying illustration shows a method of graduating a planer head by hand, the assumption being that E. J. R. has no dividing head of any kind. The plan is to secure a long bar *A* having a pointed end as shown, and fasten the opposite end of this bar under the tool clamps. The clapper-box should be wedged to one side to take up any lost motion that it may have, and the head should also be adjusted as closely as possible and still allow it to rotate. Some piece having a surface large enough to scribe a 60-degree arc on, such as a smooth well-seasoned close-grained board, is clamped across the upper part of the planer housing as shown. Two smaller boards are clamped at the ends of the cross-rail, as illustrated at *B* and *C*. The bar *A* is used to scribe arc *DE* and also to scribe arcs *F* and *G*. The distance from *F* to *G* is transferred by means of trams to some flat surface, such as the top of a planer table, and it is subdivided to find the radius



Graduating a Planer Head by a Direct Transfer Method of arc *DE*. This radius is then used in laying off a 60-degree section *DE* on the board at the upper part of the housing. This 60-degree arc is next divided into 30-degree sections, which are further divided into 15-degree sections, and this work of subdivision is continued until the arc is divided into 1-degree sections. This can be done quite accurately by using small trams and dividers. A small block *H* is clamped to the saddle of the planer head and is used as a guide in scribing the graduation lines, as the end of bar *A* is placed opposite each of the 1-degree divisions. This same method can be used to graduate more than 60 degrees if necessary.

Answered by William C. Betz, New Britain, Conn.

A 36-inch planer head can be graduated in an engine lathe. The lathe must be so geared that the last gear of the indexing train will have 360 teeth passing a given point for each complete revolution of the machine spindle. On a lathe having a simple gear train, with the spindle and the stud gears running equal, or 1 to 1, the following method, illustrated in Fig. 1, may be used:

With a 90-tooth gear on the stud meshing with a 30-tooth gear on the idler, there are three complete revolutions of the idler gear to one revolution of the spindle (any pair of gears with a ratio of 3 to 1 may be substituted); hence it follows that if another gear with 120 teeth is fastened or keyed to the 30-tooth gear, this gear, making three times as many revolutions as the spindle, will have 360 teeth passing a given point at its periphery for each spindle revolution. This would involve two large gears which might not be available, due to the size, so this multiplication of gears may be broken up. Assuming that the spindle gear runs equal with the stud gear, the operation of gearing is as follows: Select any two gears that will run 2 to 1, using for illustration 80 and 40, as in Fig. 2. By placing the 80-tooth gear on the stud and the 40-tooth gear on the idler, the idler gear will run twice as fast as the stud gear. If, now, a 90-tooth gear is placed on the same shaft, keying or otherwise fastening it to the 40-tooth gear, it is evident that twice 90 teeth pass a given point at the periphery of this gear. Now, there are 180 teeth to one revolution of the lathe spindle, and as 360 teeth are required, again multiply 180 by 2, or, in other words, use a gear having half as many teeth, or 45, to mesh with the 90-tooth gear. This again produces a ratio of 2 to 1. If a gear with 90 teeth is fastened to the 45-tooth gear, the result will be twice 180, or 360, teeth passing a given point at the periphery of this last 90-tooth gear of the train.

If the lathe is geared 2 to 1, that is, if there are twice as many teeth in the spindle gear as there are in the stud gear, the first example can readily be changed by using a 45-tooth gear on the stud, instead of the 90-tooth gear, and the same results will be obtained. In the second example, two gears of the same size on the stud and idler will also produce 360 teeth. Other combinations of gears can be worked out with the same results by changing the ratios and the gear combinations. In indexing, the spindle should be rotated in one direction only, and a hard wood wedge should be driven lightly between the cone pulley and the lathe head casting to prevent backlash. To index, a small angle-iron is clamped to the idler gear yoke and to this iron an indexing piece shaped to the gear tooth space is fastened with a clamp.

For graduating, the tool-slide of the planer head is removed from the saddle casting and mounted on the lathe faceplate so that the tool-slide center and that of the lathe run true. The graduating tool, preferably one of 60 degrees, is set central with the spindle so that it will cut when the tool-slide is moved from the center toward the periphery of the faceplate and toward the front of the machine. The carriage stop is set to give the tool a certain depth of cut, and the cross-slide is limited by the thread stop to produce marks of a uniform length. After going over the saddle once, the cross-slide stroke should be lengthened a little, every fifth mark made longer to make calculating easier, and every tenth line marked from 0 to 90 on both sides of 0, as it is only necessary to graduate one half of the saddle.

The saddle should be set so that the lower edge or side nearest to the platen is at an angle of 90 degrees with the cross-slide and the index piece set in the tooth space in the indexing gear and clamped to the angle-iron. The tool is brought into contact with the saddle and the first line marked; the tool is then moved away, the index piece withdrawn from the tooth space, and the spindle rotated by hand to bring the next tooth space in line with the index piece, which is clamped and the next mark made. This operation is repeated until all the graduations are marked on the saddle.

A witness line is scribed on the tool-slide casting after assembling on the machine by using an indicator and an accurate angle-iron. The iron is clamped to the planer platen, and the indicator clamped in the toolpost and brought into contact with the iron. The indicator is worked up and down by means of the tool-slide and screw until the slide is adjusted to a vertical plane and until the indicator shows no movement of the needle. The witness lines may then be scribed and marked 0 on both sides of the slide.

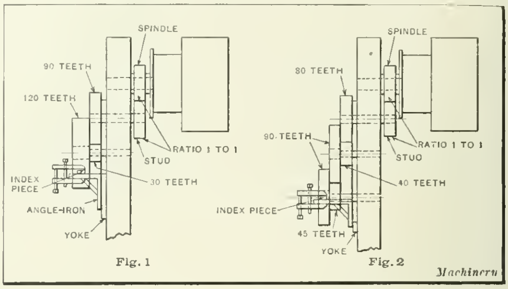


Fig. 1 Fig. 2

Figs. 1 and 2. Gear Combinations for indexing when graduating Planer Head

* * *

COST PLUS TEN PER CENT

As a result of the publication of an editorial entitled "Cost Plus Ten Per Cent" in the January number of MACHINERY, a communication has been received from the Ferro-Concrete Construction Co., Cincinnati, Ohio, stating that for several years this company has done building work on a "Profit Sharing" or "Cost-Plus-Fixed-Sum" form of contract, similar to that suggested, and that most of the present business is now on that basis. The details of the contracts vary with the nature of the work, but the following example will illustrate the general features: After describing the work to be performed, the contract reads:

> The owner shall pay the contractor the actual cost of the work plus a fixed sum of $10,000. It is agreed that in case the total cost, including the fixed sum mentioned above, is more than $102,660, fifty per cent of such excess cost shall be paid by the owner and fifty per cent by the contractor; provided, that the total cost to the owner, for the work covered by this contract, and exclusive of authorized extras, shall in no case exceed $107,660. It is further agreed that in case the total cost, including the fixed sum mentioned above, is less than $102,660, fifty per cent of the saving shall be added to the contractor's fixed sum.

Of course the great advantage of such a form of contract is the mutuality of interest, but it has other advantages for the owner in protecting him against excessive charges for extras and in permitting him to make an advantageous contract before detailed plans are completely developed.

* * *

The War Trade Board has decided that goods placed alongside a vessel, but not loaded upon it, are delivered. Frequently shipments arrive alongside a steamer before the export license has expired, but, owing to the inability of the steamer to load the contents of the lighter promptly, the shipment is held until the license expires. In order not to cause any unnecessary inconvenience to shippers and to help in avoiding any congestion that might be due to shipments of this kind, the Bureau has ruled that the time of the arrival of the lighter alongside of the ocean going vessel or steamship dock will be the deciding factor should any dispute arise as to the validity of the license.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

IN THIS NUMBER

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METALWOOD HYDRAULIC SHELL-TESTING PRESS

THE hydraulic shell-testing press to be described is used in connection with tests for determining whether heat-treated shells have the elastic limit required by specifications and are free from forging defects or piping through the base. The inside of the shell is subjected to hydrostatic pressure, and any permanent set or increase in shell diameter over the specified allowance indicates that the elastic limit is too low. This press is the product of the Metalwood Mfg. Co., Leib and Wight Sts., Detroit, Mich. The size shown is designed primarily for shells known as the "75-millimeter high-explosive projectile Mark I." The shell to be tested is first filled with water and then is securely held between the upper clamping ram of the press and a lower member, against which the nose of the shell bears.

Fig. 1 is a view of the press; Fig. 2 shows a detailed view of the top part; and the front and side elevations shown in Fig. 3 illustrate the general arrangement. There is an intensifying cylinder of correct proportions and a pull-back cylinder under constant line pressure to build up the required internal test pressure within the shell and resistance head. A cylinder of the proper size also exerts an excess over pressure between the shell nose and resistance head beneath the shell which has a fluid-tight joint. This press is guaranteed to deliver a maximum intensified pressure within the shell chamber of 18,500 pounds per square inch, with variations down to a minimum pressure of 2000 pounds per square inch. The sealing pressure exerted by the upper clamping cylinder is approximately 50 per cent in excess of the opposing intensified pressure. The arrangement is such that the objectionable pre-filling and emptying of shells outside of the machine is dispensed with. The shell is filled by immersion in the tank, which is clearly shown in Fig. 2. The shell is held in an inverted position or with the open end downward. When held in this way, there can be no uncertainty or difficulty due to confusing "water sweat" resulting from porosity, with a leakage or drip through a defective seal or joint, as when the open end or nose is at the top. In order to avoid any confusion or mistakes of this kind, the shell is placed in the inverted position as explained. The objectionable trapping of air within the shell is avoided, since all parts of the high-pressure head remain under water and all displacement due to the intensifying ram takes place beneath the water column. Absolute fluid pressure readings are obtained only by the elimination of such air pockets within the shell or gage ducts.

The clamping pressure has been carefully calculated to avoid any undue column stress on the shell structure. The detailed view, Fig. 4, shows the method which has proved successful for making the sealed joint at the open end or nose of the shell when the intensified ram pressure is applied within the shell chamber. The hardened tool-steel ring *A* has a V-shaped annular bead or ridge that engages the end of the shell; the latter, in turn, is held downward by the over-pressure from

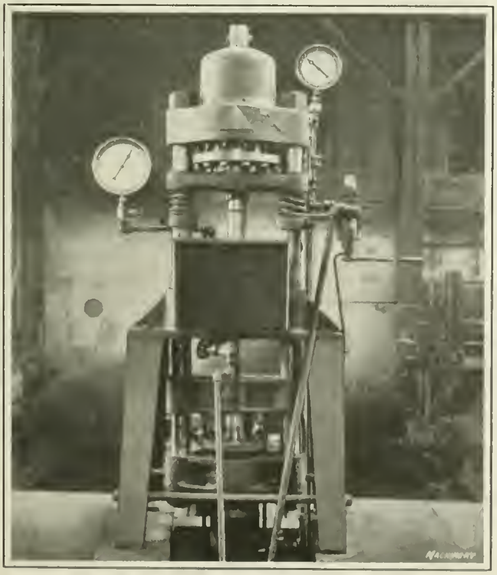


Fig. 1. Metalwood Hydraulic Shell-testing Press

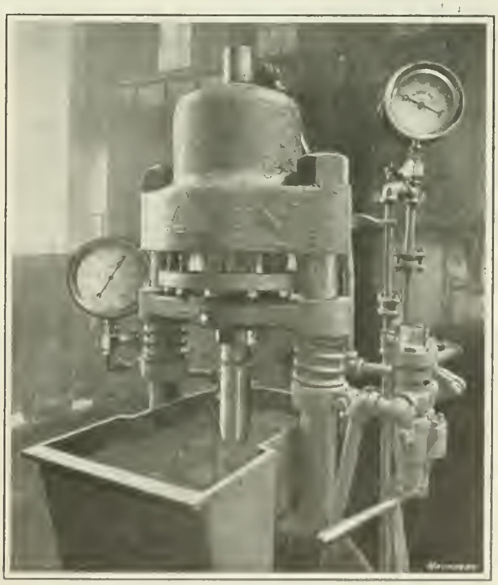


Fig. 2. Upper Part of Shell-testing Press

the clamping ram above. This pressure is partially balanced by the intensified column pressure due to the area within the sealing ring. Beneath ring *A*, which is supported by the high-pressure head *C*, there is a copper gasket *B*, which makes a tight joint between the high-pressure head *C* and ring *A*. The nose of the shell is centered by ring *D*. The plunger *E* or the intensifier ram, as the result of hydrostatic pressure of the lower cylinder, causes the built-up pressure within the shell chamber.

The standard equipment consists of a complete plant, which is installed where no hydraulic power is available. This plant includes the internal test press referred to; a triplex single-acting pump; a multiple-yoke type of accumulator; and a positive-control by-pass valve to release excess pump delivery. When testing a shell the pressure should be applied for a period of fifteen seconds, according to the Ordnance Department specifications, and then the capacity of the press is over two shells per minute, or an average of 800 to 1000 shells for a ten-hour period. The absolute rate of production depends upon the ability of the operators to handle the shells in placing them in and removing them from the press. The displacement of water due to one operating stroke of the press is 0.6 gallon.

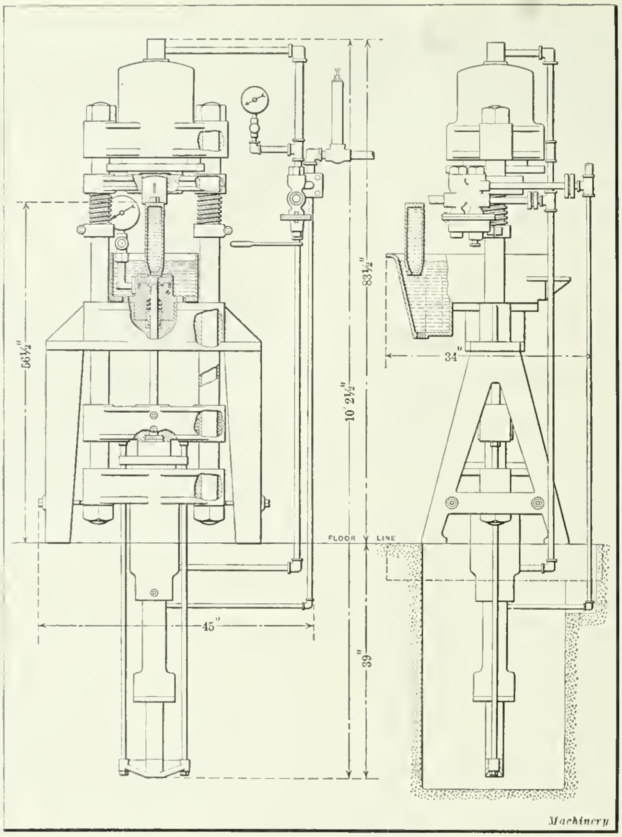


Fig. 3. Front and Side Elevations of Shell-testing Press

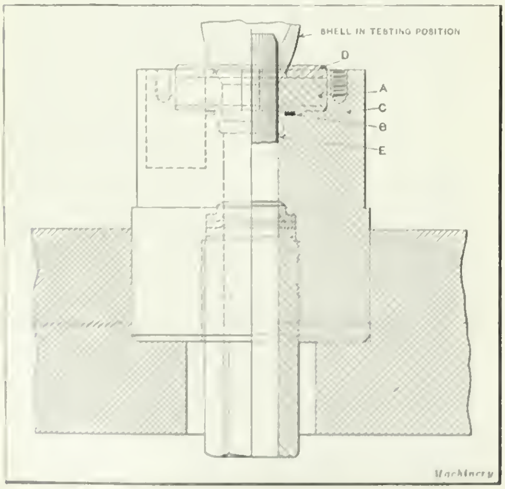


Fig. 4. Method of sealing Joint at Nose or Open End of Shell

The working cylinders are alloy steel castings having polished bores; they are tested to 3000 pounds per square inch. The pull-back cylinder is a steel casting; the lower and upper main rams are 40 per cent semi-steel, ground and polished; the intensifier plunger is of tool steel, hardened and ground; and the crosshead carrying the intensifier shell plunger is a semi-steel casting with bronze bearings. The main packings consist of boxes and glands suitable for square hemp, or, preferably, hydraulic packing. The resistance head is provided with packings suitable for fluid-tight pressures ranging up to 18,500 pounds per square inch maximum. The machine has a cast-iron base and a cast-iron pre-filling tank.

In addition to the No. 1 size of press described in the foregoing, which has a capacity for all 3-inch common steel shells as well as the 75-millimeter size within the department specifications, the Metalwood Mfg. Co. also builds a No. 2 press which will test 4.7-inch shells and corresponding 5-inch sizes, and also a No. 3 press having a testing capacity for 155-millimeter shells and 6-inch gun and howitzer shells (Mark I and II). The handling of shells corresponding to the 3-inch and 75-millimeter sizes is accomplished manually where the average 10-pound weight is well within the capacity of the operator. The 6-inch and 155-millimeter shells are conveyed by a light differential hoist and monorail carriage. The filling and emptying of the shells with water is manipulated by a segment clamp trunnion provided with an offset hand-fulcrum. The method of handling 155-millimeter shells with this device is illustrated by the views shown in Fig. 5.

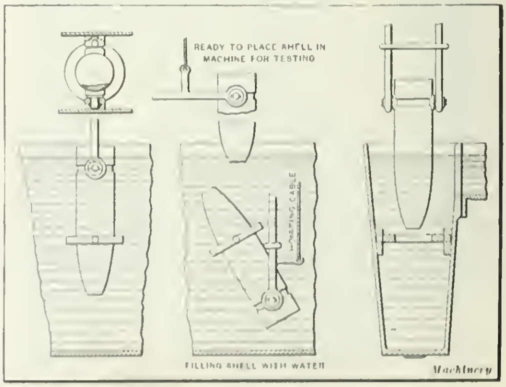
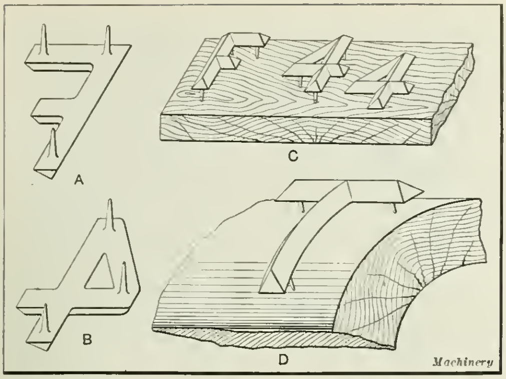


Fig. 5. Method of handling 155-millimeter Shells



Maughlin Pattern Letters and Method of applying to Flat and Curved Surfaces

MAUGHLIN PATTERN LETTERS

The H. P. Maughlin Co., Columbus, Ohio, has placed on the market a pattern letter having a number of points on the under side, so that it can be attached permanently to a pattern. These letters are made of a hard aluminum alloy to withstand severe usage and prevent the surface from being marred, as, for example, when they are being driven into the pattern or in case they come into contact with the molder's vent wire. The points are of even length and the letters or figures can be located temporarily while determining the proper arrangement, alignment, spacing, etc., either on flat or curved surfaces.

The under side of a letter and a figure are shown at *A* and *B* in the accompanying illustration. The method of applying letters and numbers to a pattern is illustrated at *C*, one figure being shown as permanently attached. The lower view *D* shows how a letter can be applied to a curved surface. The points that are driven into the pattern are so located that they hold all parts of the letter or figure firmly in contact with the pattern surface. When attaching a number of letters or figures at a time, they may be slightly pressed into the pattern with the fingers after being properly aligned; then a blow from a hammer will serve to drive one or more letters at a time without dislodging the rest.

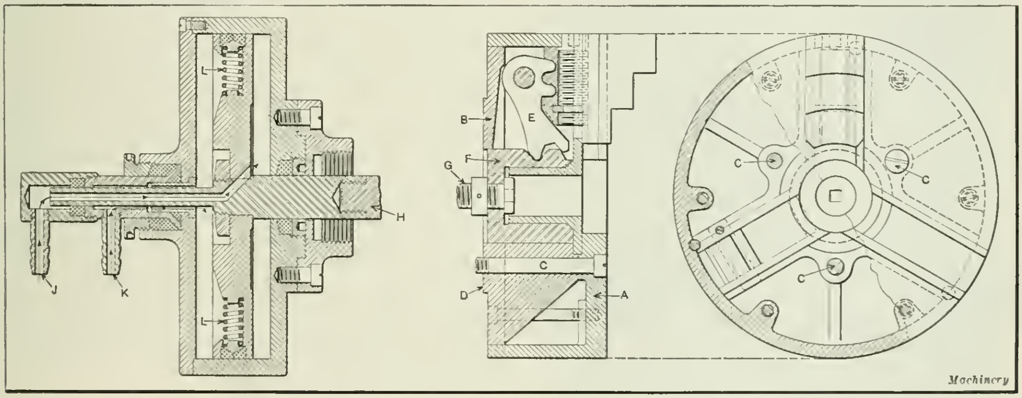


Fig. 1. American Double-acting Air Cylinder and Three-jaw Universal Chuck

AMERICAN AIR-OPERATED CHUCK

An air-operated chuck to be known as the "American" has recently been placed on the market by the American Pneumatic Chuck Co., 9 S. Clinton St., Chicago, Ill. This chuck has been designed along the lines of a standard combination lathe chuck having the universal and independent operating features. Fig. 1 shows a cross-sectional view of the three-jaw chuck (see right-hand view). The body of this chuck is formed of two principal parts, namely, the housing *A* and the back-plate *B*. These parts, after being machined, are forced together and held by screws. The housing may be either a steel or a semi-steel casting, as desired, and it is designed and proportioned to give ample strength at those points where experience has proved that strength is required. The back-plate is fitted to the finished surface inside the housing. The spindle faceplate is fastened to the chuck back-plate by three screws *C*, which extend through the chuck body as shown. These bolts, in conjunction with the shoulder *D* on the chuck, which fits into a corresponding recess in the faceplate, hold the chuck securely in position and provide a rigid construction.

Each jaw connects with a sector *E*, which, in turn, is engaged by a cam bushing *F* attached to the draw-rod spindle *G*, the latter extending to the air cylinder that operates the chuck. A sectional view taken through the pin on which sector *E* swivels is shown in Fig. 2. This illustration also shows the arrangement of the chuck jaw and its slide. There is no open space around the inner part of the chuck-jaw slide, which has a rigid backing. The jaw slide *N* throughout its entire length rests on both the milled tongue in the wall of the chuck housing and the milled seat in the back-plate; as the latter extends to the hole in the center of the chuck, the jaw slide has a complete bearing when the chuck jaw is set at different positions. These jaws are reversible, and master slides for false and special jaws can be furnished. The arrangement of the jaw slide for holding the chuck-jaw adjusting screw for independent movement is a noteworthy feature. The jaw slide is in the back-plate only and does not project through into the chuck housing. The adjusting screw has bearings at both ends of the slide, so that it is solidly and rigidly supported.

The double-acting air cylinder used in conjunction with this chuck is illustrated at the left in Fig. 1. This air cylinder is attached to the rear end of the machine spindle, and it is connected to the chuck by draw-rod *H*, which extends through the hollow spindle and is screwed onto the threaded end of rod *G*, Fig. 1. This is a 10-inch cylinder having a stroke of 1 inch. The air inlets are located at *J* and *K*. The piston is provided with self-contained springs *L* to keep the piston packing against the surface of the spindle and eliminate hand adjustment as well as leakage, so that the full air pressure is utilized and the air consumption reduced to a minimum. The design is such that all parts re-

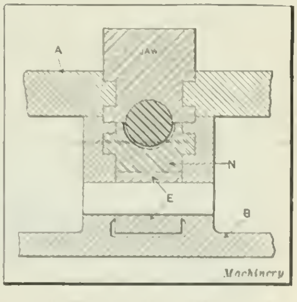
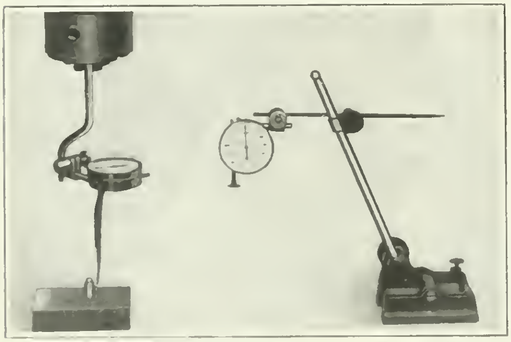


Fig. 2. Section through Chuck Jaw on Line with Center of Sector Pin

quiring packing are easy of access. When air is admitted to the cylinder, cam bushing *F* (Fig. 1) is drawn back and, as sector levers *E* travel with it, they operate the three jaws universally. The gripping power due to the 3 to 1 leverage of the sectors is considerably increased by the wedging action of the cam surfaces acting upon the ends of the levers. When the chuck jaws are properly adjusted for a given diameter of work, each sector lever is forced up the face of the cam until it reaches the straight surface of the cam bushing, when the jaws are locked upon the work and the latter is held firmly, even though the air pressure may be released. The chuck has been so designed that if it is not desired to operate it pneumatically, the air mechanism can be locked and the chuck used as an independent hand-operated type. This style of chuck is also made in the two-jaw design, which is operated in the same way as the three-jaw type. Both designs are made in standard sizes of 6½ inches, 8 inches, 10 inches, 12 inches, and 15 inches in diameter. The Neidow & Payson Co., 9 S. Clinton St., Chicago, Ill., is the selling agent for the American Pneumatic Chuck Co.'s products.

GATES DIAL INDICATOR

The dial indicator which is made by B. L. Gates, 125 S. Wells St., Chicago, Ill., is intended for setting up work on machines and for the other purposes which indicators of this class are generally used for. This indicator is so arranged that the dial is always visible to the workman, so that it is unnecessary to walk around a machine when setting a jig button or other part in alignment with a spindle to which the indicator is attached. The view to the left in the accompanying illustration shows the position of the dial while it is being used for truing a button. As the dial is in a horizontal position, it remains visible as the spindle revolves and a looking glass is not required to show variations in the movement of the indicating hand. The dial is graduated to read to thousandths inch, the graduation figures giving a direct reading up to 0.120 inch. This indicator may, of course, be applied to a surface gage as the illustration shows, or it may be used in conjunction with limit gages and other forms of measuring tools.



Gates Dial Indicator applied to Machine Spindle and to Surface Gage

COOPER UNIVERSAL JOINT

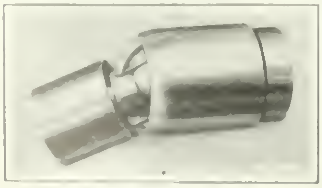


Fig. 1. Cooper Universal Joint

The universal joint shown in Fig. 1 is manufactured by the Cooper Flexible Transmission Co., Inc., 8th Ave. and 18th St., Brooklyn, N. Y. This joint was designed for the general machine trade, and it is manufactured in various stock sizes. There are no sharp corners or projections on this joint, and the parts are all concentric with the shaft. The construction will be more apparent by referring to Fig. 2. The drive from the ball to the socket is by means of two "cross-heads," each of which has a pin which fits into a hole extending through the ball. The main purpose of these pins is to guide the cross-heads and to keep them central. These pins are subjected to some load, but the main drive between the ball and cross-heads is where the flat under side of each cross-head rests on the face at the side of the ball. The cross-heads engage the slots in the socket when the joint is assembled.

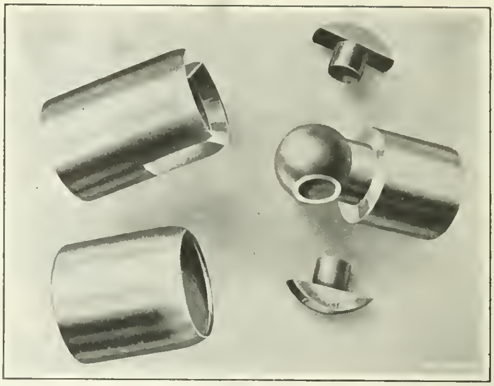


Fig. 2. Component Parts of Cooper Universal Joint

One half of the ball is engaged by the socket at all angles, which allows for any thrust that may be encountered. The cross-heads are subjected only to the torsional stresses, so that the thrust is transmitted directly from the ball to the socket, there being no intermediate parts to be strained. The four parts of the joint are held in position by an outer shell, which is forced into place after assembling the joint, and no screws or rivets enter into the construction. The outer sleeve is secured by pressing the end into a groove previously turned in the socket member. This construction enables the joint to resist any tension ordinarily encountered. The most important function of the outer shell is the forming of an oil receptacle to insure adequate lubrication when the joint is in a vertical position or inclined from the horizontal. All wearing parts are heat-treated and casehardened by the most approved methods. The angle is limited to 30 degrees, as it has been found by experiment that any angle exceeding 30 degrees causes absorption of power and wear out of all proportion to the results obtained.

HEINKEL GEARLESS MULTIPLE-SPINDLE DRILLING HEADS

Multiple-spindle drilling heads of the gearless type, as shown in Figs. 1 to 3, inclusive, are now being manufactured by the

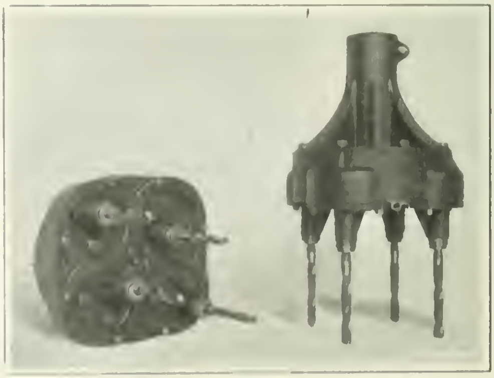


Fig. 1. Heinkel Four-spindle Adjustable Drilling Head

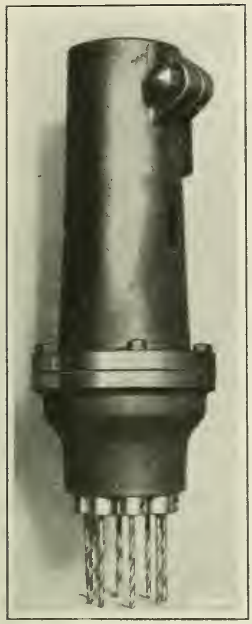


Fig. 2. Eight-spindle Drilling Head of Fixed-center Type

Heinkel Machine Tool Co., Sandusky, Ohio. Fig. 1 shows two views of a four-spindle drilling head of the adjustable type. The spindles may be adjusted to any center distance within the range of the head while the machine is running, so that the operator has a better opportunity for accurately locating the drills in jig bushings. When this head is adjusted, it may be locked rigidly in position.

Fig. 2 shows an eight-spindle drilling head of the fixed-center type. This design is intended for drilling large numbers of duplicate parts. The construction of the fixed-center type is illustrated by the sectional view in Fig. 3. The head is fastened to the sleeve or quill of the drilling machine by clamp screw *A*, and it is prevented from slipping upward under the drilling strain by stop *B*, which bears against the bottom of the rack. The annular ball bearing *C* provides extra support for the head and the drill press spindle. The drive from the machine spindle is through the hardened and ground taper shank *D*, which has a crank on the lower end. This crank has an annular ball bearing *E* mounted on it. Bearing *E* is contained within the driving plate *F*, which is carried around or oscillates when the taper shank revolves. The hardened and ground steel bushings *G* are inserted in the driving plate *F*, and the hardened and ground cranks *H* are a running fit in these bushings. The spindles *J* on which cranks *H* are formed are provided with a bronze bearing *K* and also an annular ball bearing *L*. In addition, a ball thrust bearing *M* is mounted on each spindle and is locked in place with the proper degree of end clearance by the nut *N*, which cannot slip and cause tightening of the thrust bearings. The oscillating motion of the driving plate *F*, resulting from the rotation of the crank on taper shank *D*, causes spindles *J* to revolve, the driving plate serving practically the same purpose as a connecting-rod. The hardened steel plug *P* is used for driving the taper shank tight into the drilling machine spindle.

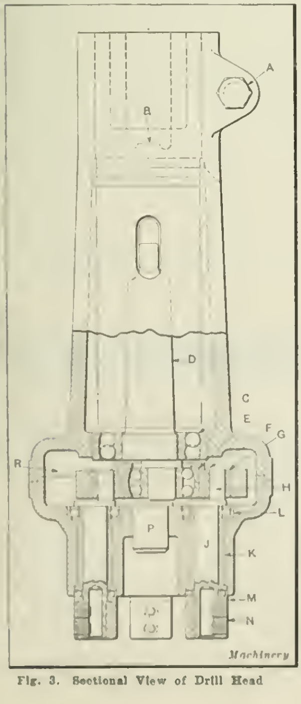


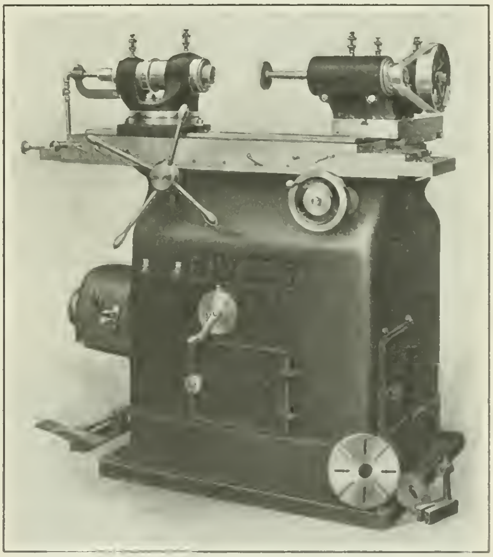
Fig. 3. Sectional View of Drill Head

The head is oil-tight and entirely enclosed to prevent the entrance of dirt or dust. It is packed with grease in chamber *R* and needs only occasional attention from the operator, as, for example, when chamber *R* needs refilling. The lubrication is automatic, as the ball bearings *L* convey grease from the chamber to the bronze bearings *K*, which are provided with oil-grooves. These grooves, in turn, allow sufficient lubricant to pass down to the thrust bearings. This drilling head was made as simple in design and construction as possible, in order to eliminate the breaking of parts and reduce the wear and upkeep expense to a minimum. The claim made for the crank method of driving is that it is absolutely positive; eliminates gears entirely; provides for closer center distances, quiet operation, lighter and smaller heads, both in over-all length and diameter, and a smaller loss of driving power through bearing friction.

RIVETT NO. 106 INTERNAL GRINDER

The Rivett Lathe & Grinder Co., 20 Riverview Road, Brighton, Boston, Mass., is now manufacturing a heavy-duty large capacity internal grinding machine which is designed along the same general lines as the No. 103 internal grinder. The new machine is known as the "No. 106 automatic internal grinder," and it is suitable for manufacturing purposes where the work is comparatively heavy and the amount of metal to be removed above the average. This grinder is also particularly adapted for precision work in the tool-room or experimental department, as the necessary adjustments for handling a large variety of work can be made readily.

This machine is driven by four belts, which are used to drive the wheel-spindle, the work-carrying head, the internal mechanism of the machine, and the water pump. The main belt connects with a three-step cone pulley, which, in conjunction with a set of change-gears having six combinations, gives a variety of eighteen speeds for the work-carrying table. The reciprocating motion of the table is derived from a heart-shaped cam which gives a variable rate of travel with a maximum at both ends of the stroke and a minimum at the center. The object of this varying rate of travel is to overcome any tendency of the machine to grind holes bell-mouthed. The wheel-spindle is carried by a heavy bracket, which is adjustable for position on a cross-slide, and this is mounted on a cross-slide table. This bracket also carries the wheel-spindle countershaft. The proper belt tension is maintained by a self-adjusting belt tightener.



Rivett No. 106 Internal Grinder designed for Heavy Duty and for Manufacturing Purposes

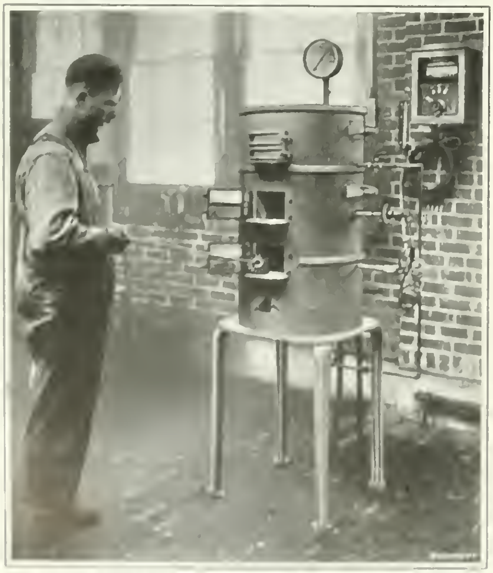
The grinding wheel may be adjusted for depth of cut either by hand or by the automatic cross-feed mechanism. Both the grinding wheel and the countershaft spindles are provided with ball bearings, so that they are suitable for high speed operation. The work-carrying head is mounted on a sliding shoe and arranged to swivel up to 90 degrees. This head is driven direct from a drum on the overhead countershaft. The spindle construction is exceptionally heavy, and adjustable taper steel bearings are provided. Rivett chucks of the collet or step types may be used in addition to a faceplate or chuck-plate for holding either a standard three- or four-jaw chuck or some special chucking fixture.

The length of the stroke of the work-carrying table is regulated by means of a crank on the front of the base, which provides stroke adjustments varying from 1/4 to 8 inches. To facilitate measuring or gaging the work, the table may be disconnected at any time from the reciprocating mechanism and be returned to its original position without interfering with any adjustment. The grinder is provided with a rack and pinion, and is equipped with a pilot wheel for rapid movements of the work-table. This machine will swing a diameter of 14½ inches over the table, and it has a grinding capacity for diameters varying from 1/4 to 8 inches. The net weight of the machine is 3000 pounds. The regular standard equipment includes a complete water attachment, an overhead ball bearing countershaft, a heavy work-head or wheel-spindle with three arbors, a light work-head or wheel-spindle with three arbors, a bracket for a diamond holder, a 5-inch chuck-plate, six canvas belts for the wheel-spindle, and a gallon can of special spindle oil.

TRIAD COMBINATION HARDENING, PREHEATING AND TEMPERING FURNACE

The advantage of preheating both carbon and high-speed steels is constantly being more generally recognized both in this country and abroad. The general method of treating high-speed steel tools is to first preheat the steel in a furnace to about 1500 degrees F. The steel is then removed and placed in another furnace already heated to a temperature varying from 2200 to 2350 degrees F. The steel is next quenched and cooled from a high temperature and then the temper is drawn by means of an oil bath, lead bath, or dry heat. This process requires the installation and operation of three separate heating units, and even though the primary cost of installation is not considered, the extra cost for the fuel consumed by these three units is an item which should not be ignored.

The Triad furnace, which has been developed and placed on the market by the Bennett Metal Treating Co., Elmwood, Conn., serves a threefold purpose in that it is adapted for preheating, high-temperature heating, and heating for drawing the temper. This furnace operates with but one burner, and is so constructed that the three heating processes can be carried on simultaneously. It has three chambers located one above the other. The high-temperature heating is done in the lower chamber, the preheating of steel in the intermediate chamber, and the tempering in the top chamber. With this arrangement, it is claimed that the fuel consumed for heating all three compartments is scarcely greater than would be required for a single high-speed steel furnace, since the waste heat is utilized for preheating and tempering. The furnace operates satisfactorily with either fuel oil or gas.


Triad Furnace which is adapted for Preheating, High-temperature Heating and Heating for drawing Temper

The furnace is cylindrical in shape, to insure uniform temperatures and obviate cold corners. The interior of the furnace is about 12 inches in diameter. The lower compartment has a base brick and a double-lined wall of firebrick, each having a thickness of 4 inches. The intermediate chamber is approximately the same shape and size as the lower one, and has top and bottom slabs and insulating walls, which are also 4 inches thick. This chamber is intended for temperatures up to 1500 degrees F. and, as previously mentioned, is used for preheating. One important advantage in having the preheating compartment so close to the high-temperature compartment is that the work may be transferred quickly from one part of the furnace to the other without injuring it by oxidation. The heat arising from the open door of the lower compartment serves to protect the heated steel as it is transferred from the intermediate or preheating chamber down to the lower one.

The bottom of the upper or tempering chamber consists of a steel plate located one inch above the top firebrick slab of the intermediate chamber. The excess heat from the preheating chamber passes through the upper slab and heats the plate referred to. As the excess heat is frequently greater than is required for tempering, this is regulated by a valve and mercury air gage. It is claimed that sufficient heat for hardening tool steel can be obtained in the lower compartment of this furnace in ten minutes from the time the cold furnace is started. The time specified for obtaining a hardening heat for high-speed steel from a cold start is twenty minutes. When heating a 3- by ¾-inch milling cutter, the time required to increase the temperature from a preheat of 1500 degrees F. to 2250 degrees F. is two minutes, thirty seconds.

According to the manufacturer, steel may be heated in either the intermediate or lower chamber under absolutely reducing atmospheric conditions, thus preventing pitting or scaling. The temperatures in both the intermediate and lower compartments are determined by a pyrometer. The drawing temperature in the top compartment is indicated by a thermometer. As the illustration shows, the two upper sections of the furnace are equipped with handles. These are provided so that if the lining of the lower compartment should require repair or renewal, the upper sections may readily be removed without waiting for the furnace to cool. The doors of the different compartments are in sections, so that a narrow or wide opening may be obtained, according to the requirements. The weight of the furnace complete is 750 pounds.

NEW MACHINERY AND TOOLS NOTES

Taper Gage: Davle Tool Co., Cleveland, Ohio. Taper plugs, etc., can be tested with this gage, which has a V-block mounted on the base and an adjustable blade above the center of the V-block, which is held in the required position by means of two knurled nuts. This gage is made in various sizes, and also with stops to indicate the proper length of taper.

Quick-acting Vise: Nestor Mfg. Co., 40 W. 13th St., New York City. Vise which may be applied to drilling or milling machines or to the faceplate of a lathe. It is made in three sizes, the smallest of which has a maximum opening of 2½ inches, and the largest, a maximum opening of 6 inches. Flanges extending around the sides and end are machined square, so that the vise may be held on either the side or end if desired

Pipe Vise: Gerolo Mfg. Co., Old Colony Bldg., Chicago, Ill. Portable pipe vise which can be mounted readily wherever required on any kind of a horizontal or vertical support and without the use of bolts. Any size of pipe or conduit within the capacity of the vise is securely held by the slight push of a lever, no previous adjustment being necessary. The pipe is gripped between a double set of steel pipe jaws and a heavy close-linked steel chain.

Magnetic Brake: Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Mill and hoist motor magnetic brake made in two styles for alternating and direct-current motors. The construction of the two types is similar except for the armature lever and magnet, which is of the clapper type. When the current is turned on, the magnet is energized and the armature lever overcomes the pressure of compression springs through a toggle and releases the brake shoe grip upon the wheel.

Grinding Machine for Valves and Re-seating Tools: Currier-Koeth Mfg. Co., Coudersport, Pa. A machine adapted for truing the poppet valves of gasoline engines or for grinding the cutters used for truing the valve seats. The grinding wheel is dressed to the proper angle by a special fixture, and the axis of the valve or reseating tool is parallel with the wheel-spindle while being ground. The work- and wheel-spindles are connected by gearing having a ratio of 14 to 1. The feed is controlled by a micrometer screw.

Electrically Driven Drill and Grinder: Gilfillan Bros. Smelting & Refining Co., Los Angeles, Cal. Portable electrically driven drill provided with ball bearings throughout. It is equipped with gears and has two speeds ranging from 400 revolutions per minute on low speed to 700 revolutions per minute on high speed. This concern also manufactures a tool-post type of grinder adapted for use on lathes. It is provided with a 6- by 3/8-inch wheel and an extension mandrel for internal grinding fitted with a 1 1/2- by 3/8-inch wheel.

Storage Battery Truck and Tractor: Elwell-Parker Electric Co., Cleveland, Ohio. The truck is equipped with a revolving jib crane having a capacity of 1000 pounds and a maximum reach of 48 inches. The truck can also be used as a tractor. A tractor is also built by this company intended for medium surfaces and having a single front wheel. The tractor has a normal draw-bar pull of 300 pounds and a maximum pull of 850 pounds. The speed without load is 625 feet per minute. Both the truck and tractor have a single reduction worm drive.

Cylinder Reboring Tool: Universal Tool Co., Detroit, Mich. This tool may be hand-operated or used in conjunction with a drilling machine and it is made in several sizes, suitable for reboring cylinders of automobile engines, etc. Each tool may be adjusted for different diameters, the No. 2 size having a range of expansion from 2 1/2 to 3 1/4 inches, and the No. 5 size from 2 1/2 to 5 1/16 inches. The cutter-head is equipped with six cutters, which may readily be adjusted in unison. The feed mechanism is so arranged that the feeding movement may be varied from 6 to 30 turns to the inch.

Electric Spout Welding Machine: Thomson Electric Welding Co., Lynn, Mass. This machine is arranged especially for welding spouts that are stamped in halves. These halves are held together in a special form of copper die and the projecting edges of the spout are brought into contact with a revolving vertical die extending through the top of the machine table, which is made of copper. The current passes through this plate and then through the copper die and projecting edges of the spout and the revolving vertical die. In this way, the spout edges are rapidly heated, and a slight pressure serves to force them down practically flush as they are welded.

Electric Seam-welding Machine: Thomson Electric Welding Co., Lynn, Mass. Line of machines for welding seams in sheet iron and steel. There are two distinct types, one being driven through a motor, toothed clutch and worm, while the other is supplied with a speed reducer and crank mechanism. Both types have traveling upper dies, while practically any form of lower die or jig suitable for cylindrical or cone-shaped work can be applied. One machine is intended primarily for welding longitudinal seams on cans, flat pieces, rectangular shapes such as metal boxes, etc., and the other is used for welding cans, stove burners, match boxes, revolver magazines, and similar parts.

Universal Turret Lathe: Acme Machine Tool Co., Cincinnati, Ohio. This machine has a capacity for round bar stock up to 3 1/2 inches in diameter and for chuck work up to 17 inches in diameter. A carriage between the turret slide and headstock may be used to advantage on either chuck or bar work. The machine has centralized control, all operating levers being conveniently located. The geared head is arranged to give nine speed changes, varying from 14 to 280 revolutions per minute. These changes may be made without stopping the spindle and are controlled by two levers. The turret is the flat type and has a cross-slide. Both the side carriage and turret have power feed for the cross and longitudinal movements. The simplex roller feed for bar stock is operated by the same lever that controls the chuck. A chasing attachment is furnished with the machine and a taper attachment may be applied.

HELPING UNCLE SAM

The Ordnance Department, Motor Equipment Section, Procurement Division, 6th and B Sts., N.W., Washington, D. C., has announced that catalogues from all automobile manufacturers, as well as from automobile accessory manufacturers, are required by the section. Manufacturers, therefore, can render a service to the Government by sending such catalogues directly to the department.

The Bureau of Ordnance, Navy Department, is in need of draftsmen who have had a number of years of drafting-room experience and who are competent designers of heavy machinery, engines, or shop tools. The pay ranges from $4 to $6.88 per day, depending upon the qualifications of the draftsman. Additional information may be had by addressing the Commandant and Superintendent, Navy Gun Factory, Navy Yard, Washington, D. C. The Federal Civil Service Commission, Washington, D. C., also requires mechanical and structural steel draftsmen for the government service as ship draftsmen. There is a great scarcity of ship draftsmen to carry out the government ship building program.

The United States Employment Service of the Department of Labor, Washington, D. C., is calling for 250,000 men suitable for work in shipbuilding yards. It is desired to bring men from parts of the country and from industries where employment is scarce to the seaboard where employment is plentiful, so as to prevent one shipyard taking men from another. Men who wish to enroll as shipyard workers should notify the Public Service Reserve, Department of Labor, Washington, D. C., to that effect. The classes of men that are wanted in the mechanical fields are oxy-acetylene and electrical welders, blacksmiths, drop-forge men, flange turners, furnace men, boilermakers, chippers and calkers, electric crane operators, foundry workers, templet makers, machinists, machine hands and helpers, sheet metal workers, structural iron workers, and laborers of all kinds.

Several thousand men are also required for what is to be known as the Motor Mechanics Regiment, in which are to be enlisted automobile and gas engine men who understand manufacturing and repair work on high-class gasoline engines. This regiment will include not only gas engine mechanics but also blacksmiths, oxy-acetylene welders, wheelwrights, and skilled machinists of all classes. Men who would like to enlist in this force should apply to the nearest Army recruiting station. More than 50 per cent of the men so enlisted will rank as non-commissioned officers with rates of pay ranging up to $100 a month for those especially qualified, plus a family allowance for dependents ranging from $5 to $50 a month. The work will consist mainly in repairing airplane engines. Such men are scarce, and it is expected that most of the men who enlist will be from eighteen to twenty years of age. Men of draft age cannot enlist.

* * *

FEBRUARY MEETING OF A. S. M. E.

At the February meeting of the New York section of the American Society of Mechanical Engineers, held at the Engineering Societies Bldg., 29 W. 39th St., New York City, February 21, the subject of non-essential industries was discussed. A number of speakers representing various industries that are generally considered non-essential had been invited to present the case of their particular line of endeavor and to show how their industries might be diverted during the period of the war to the manufacture of articles that are required in the prosecution of the war. The meeting passed a resolution to request the council of the society to appoint a committee to aid manufacturers in gradually converting plants manufacturing non-essentials into plants manufacturing something absolutely necessary for the nation in war time. The difficulties of the small manufacturer in obtaining contracts for war work were pointed out, the Government preferring to give out contracts to large firms only. This keeps idle a great number of small plants that could do very useful work.

SAFEGUARDING WAR INDUSTRIES FROM ENEMIES WITHIN

The National Americanization Committee, 29 W. 39th St., New York City, has issued a number of rules which should be observed by American industries, particularly those making munitions or which are vital to the conduct of the war. The observation of these rules (given below) would be, no doubt, of value in safeguarding against the efforts of our enemies.

Take a census of the personnel and keep thereafter a current registration, dividing all workers into six groups: Native-born, naturalized, first papers, second papers, alien enemies, all others. All subjects of the Central Powers as well as all other aliens without first or second papers, including both men and women, should be classified as of "doubtful loyalty" from a safety viewpoint.

Make an analysis of the physical conditions of the plant, then chart or map the location of the vulnerable points, noting particularly places where fire and explosions will do the most damage, where lights are important, where switchboards are placed, and where water supply hydrants are located. The location of indispensable and delicate machinery which can be easily injured and which is difficult to replace should also be noted. Include in this analysis the routing of products to local shipping points, to ascertain where they can be most easily tampered with.

Ascertain how each vulnerable spot is protected and how it is manned, and then gradually shift into these places only native-born men and women, who are in sympathy with present war policies, at the best possible rate of pay.

Provide only those of native birth to act as guards and sentinels, and place them in accordance with the results of this analysis, both as to the plant conditions and the distribution of employes.

Secure only those of native birth to act as watchmen, pay them the best possible wage rates, and constantly remove all causes for dissatisfaction.

Do not issue a general tag or number to foreign-born workmen which entitles them to visit at will different departments of the plant. The man who can do little damage when carefully placed, may be a good risk, but may prove dangerous if allowed to roam about the plant. Place restrictions on bringing packages into the plant and locate lunchrooms away from danger zones or vulnerable spots.

Require credentials and verify them, and see that visitors are permitted to go only to the places intended. Escort them in, stay with them, and see them out.

Decrease the labor turnover in every possible way so as to keep down the number of new men and women taken into the plant. Find out as much as possible about all new employes and keep the information up to date.

Appoint some employe as an Americanization captain who understands the alien. Give him a committee of leaders of the foreign-born if he wants one. It will be his duty to get in touch with the foreign-born employes, take some interest in them, see that they get the information they seek on registration, the draft, the interpretation of government orders, and other special questions that come up. It will pay to keep close to the foreign-born employes and help them get the right information.

Remove as promptly as possible every possible medium of unrest that enemies can work through—such as difficulties regarding hours, wages, housing, methods of employment, minor grievances, etc.

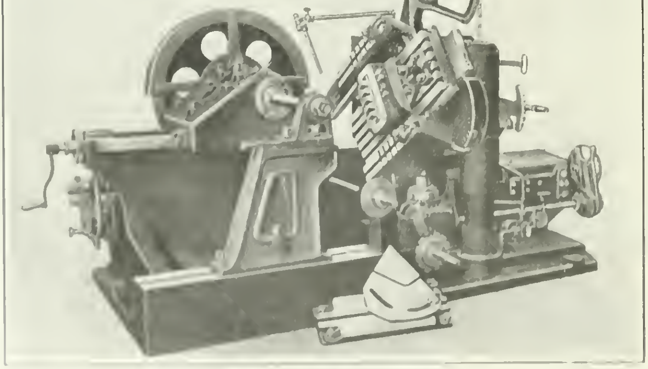


Fig. 1. Generating Planer for cutting Helical or Spur Gears

SUNDERLAND SPUR AND SPIRAL GEAR PLANERS

The Sunderland generating type of spur-gear planer which was described in MACHINERY, February, 1910, has been redesigned, and (according to a recent description in *Engineering*) is now constructed for cutting either spur or spiral gears. The spiral gear planer operates on the same general principle as the one used for spur gears, but the cutter-slide is mounted on a swiveling base so that it may be set to conform with the helix angle of the gear. A general view of the spiral gear planer is shown in Fig. 1. The gear teeth are generated by a rack type of cutter having five or six teeth ordinarily.

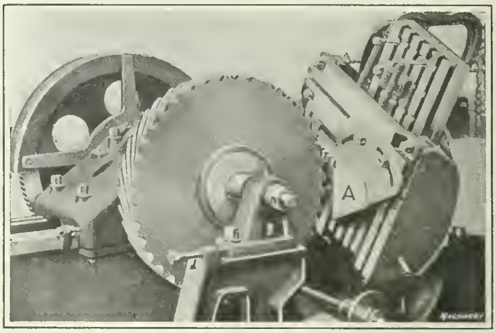


Fig. 2. Detail View of Planer cutting a Helical Gear

When the machine designed especially for spur gears is in operation, the cutter is traversed parallel with the axis of the gear blank and tangentially to the periphery of the blank by a feeding movement occurring each time a cutting stroke has been made. The blank is also given a rotary feeding movement, so that the rack-shaped cutters will generate the required gear tooth form. The movements of the cutter and gear blank are synchronized to correspond to those of a rack and gear in mesh. After a distance equal to one pitch has been cut, the movement of the cutter is arrested and the rack is indexed backward an amount equal to one pitch, after which the cutter is again moved tangentially, and so on until the gear is finished. The main shaft of the machine is driven from a pulley running at constant speed, and it makes four revolutions forward to impart the feed to the cutter tangent to the periphery of the blank and then four revolutions backward for returning the cutter to the starting position.

Helical gear teeth are generated by movements similar to those required for spur gears, except that the cutter is traversed at an angle with the axis as indicated by the detailed view, Fig. 2. The cutters used for spur gears may also be used for the spiral or helical type, provided the normal pitches of the spiral gears are the same as those of standard spur gears. When cutting large helical gears having teeth that incline considerably, or those of steep angles, cutters of greater length than the standard will be required in order to include more teeth. The detailed view, Fig. 2, shows the rim stay A moved back in order to expose the cutter. When setting up the machine, it is merely necessary to consider the pitch and the angle of inclination of the teeth. The total lead of the helix does not need to be considered as in milling machine practice. The change-gears for pitch are selected for the real circular pitch and the cutter is chosen with reference to the normal pitch. A longer stroke of the cutter is required when planing helical gears than is necessary for spur gears of equal width in order that the cutter may clear the blank at each end of the stroke. The machines arranged for helical gears may, of course, be applied to spur gears. The largest machine of this design has a capacity for gears varying from 4 inches to 4 feet in diameter with a maximum face width of 9 inches. This machine will cut gears having a maximum circular pitch of 2 inches or 1½ diametral pitch. These gear planers are manufactured by J. Parkinson & Son, Shipley, Yorkshire, England.

* * *

A TRAVELING ANTI-WASTE EXHIBIT

In a large manufacturing plant where thousands of men and women are employed, large quantities of food products and manufacturing material are wasted daily. To give the employes of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., some idea of the waste, the management devised the novel scheme of fitting up a storage battery truck as a traveling exhibit, upon which was shown a collection of wasted food, as well as a quantity of discarded manufacturing materials such as copper, zinc, lead, mica, etc., much of which could be used to advantage. It is estimated that the food stuff wasted per day amounts to between $35 and $50, the cost of which, of course, comes out of the employes' pockets; the waste of material amounting to hundreds of dollars per day, which is a loss to the company, is due largely to the thoughtlessness and carelessness of the employes.

An Exhibit of Food and Material wasted in a Large Manufacturing Plant

Above the material on the exhibition truck is a sign on which appears in large letters the word "Wasted"; over the food are the words, "Food Brought from Your Homes", and over the wasted material, "Material Belonging to the Company." This truck is driven up and down the shop aisles so that the employes can look at it and obtain some idea of the waste. Such an object lesson is valuable at this time when everyone should take all the precautions necessary to effect as little waste as possible.

* * *

ESTABLISHMENT OF INTERNATIONAL TRADEMARK BUREAU IN HAVANA

Dr. Mario Diaz Yrizar, an attorney of Havana, has been appointed director of the international bureau for the registration of trademarks to be established at Havana, Cuba. It is to be expected, therefore, that the bureau will shortly be prepared to assume the functions conferred by the convention regarding trademarks adopted at the Fourth Pan-American Conference in Buenos Aires in 1910. This convention agreed that any mark duly registered in one of the signatory states shall be considered as registered also in the other states of the union, without prejudice to the rights of third persons and to the provisions of the laws of each state governing the same. The twenty-one republics forming the Pan-American union are divided into two groups, with Havana as the center for the countries of North and Central America and the West Indies and Rio de Janeiro as the center for the South American countries. For the administration of this provision, two bureaus for the registration of trademarks are to be established. Either bureau may be established upon the ratification of this agreement by two-thirds of the countries of the respective groups. At present Mexico, Salvador, and Hayti are the only countries of the northern group that have failed to ratify it.

In order to enjoy the benefit of the foregoing, the manufacturer or merchant interested in the registry of the mark must pay, in addition to the fees or charges fixed by the laws of the state in which application for registration is first made, the sum of $50 in gold, which sum shall cover all the expenses of both bureaus for the international registration in all the signatory states.

The bureau at Havana will be supported on a pro-rata basis by all the American republics of the northern group that have ratified the agreement. Its operation will be under the direction of the Cuban government, with the consultation of the United States commissioner of patents and the new director of the international bureau, as well as with analogous officials in the other countries of the union. Until the second bureau is established at Rio de Janeiro, registration at Havana will presumably apply only to the countries of the northern group. Upon the establishment of both bureaus, however, registration in either will give full protection in all countries that have ratified the agreement.

* * *

RULES GOVERNING INDUSTRIAL PRIORITIES

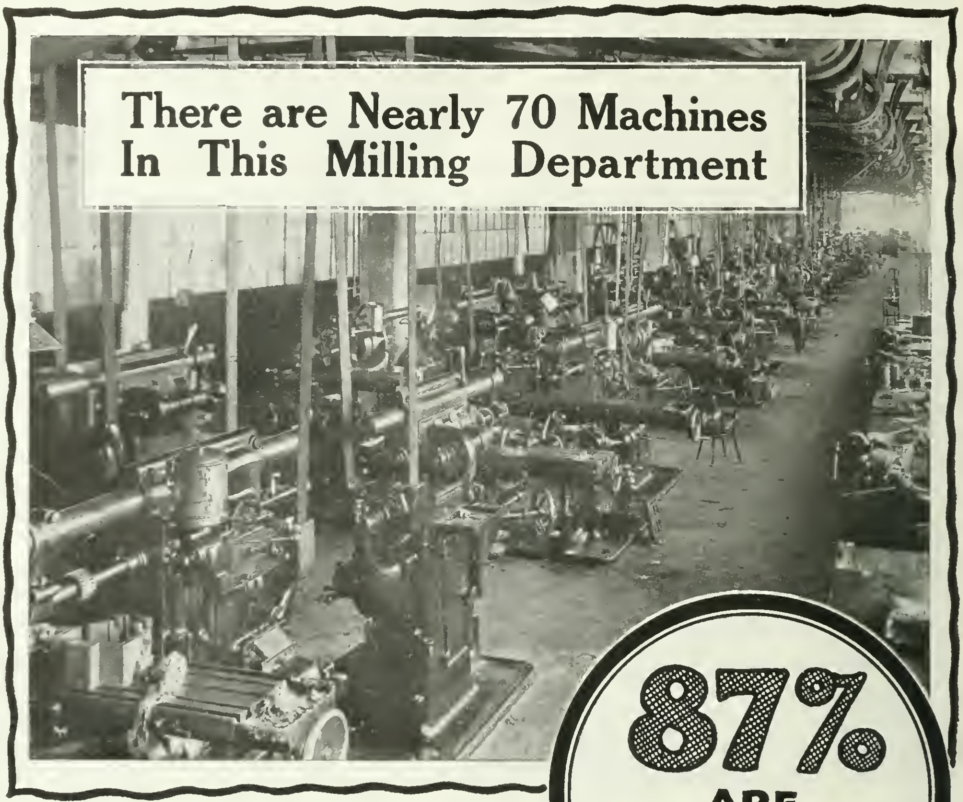
Circular No. 3 of the War Industries Board states that during the present war all orders and work done by individuals, firms, associations, and corporations engaged in the production of copper, iron, and steel, and in the manufacture of products thereof, are divided into classes AA, A, B, and C. For convenience, these are also subdivided into AA-1, AA-2, etc. Class AA comprises only emergency war work of an exceptional and urgent nature and takes precedence over all others. Class A comprises all other war work and takes precedence over all others except class AA. Class B comprises orders and work which, while not designed for the prosecution of the war, are essential to the national welfare, or otherwise of exceptional importance; it takes precedence over class C, in which all other orders and work are placed. This classification, however, does not affect the standing of priority certificates already issued.

The classification of an order simply means that it shall be given only such precedence over orders of a lower classification as may be necessary to insure delivery on the date specified in the order. It does not mean that work should cease on orders of a lower classification, or that the order should be completed and delivery made in advance of orders taking a lower classification if this is not necessary to effect delivery within the time specified. The one to whom a priority certificate is directed should make his own production plans, so as to get the maximum efficiency out of his operations, making all deliveries at the times contracted for, if possible, and where this is not possible, giving precedence to the orders taking the highest classification. In case of doubt, questions as to priority should be laid before the Priorities Committee, War Industries Board, Council of National Defence, Washington, D. C. The Priorities Committee does not issue priority orders for fuel, food, transportation, export or import, nor will it grant blanket certificates for an industry, plant, material, or commodity.

* * *

Before the war practically all the magnesium used in the United States was imported from Germany. Hence, there has recently been a great scarcity of this metal. A few months ago, however, a corporation was organized at Niagara Falls for the production of magnesium and magnesium alloys. A plant has been built which is now in operation, and sufficient quantities have already been placed on the market to reduce the price. Magnesium is used mainly in an alloy of magnesium and aluminum for airplane parts. An alloy can be produced from these metals, containing other metals in small quantities, which has a specific gravity much less than that of aluminum.

There are Nearly 70 Machines In This Milling Department



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REMOVAL OF HEADQUARTERS OF WAR DEPARTMENT AIRPLANE PRODUCTION SECTION

It has been announced by the Office of the Chief Signal Officer of the Airplane Production Section of the War Department that the headquarters of the section have been removed to Union Block, 1836 Euclid Ave., Cleveland, Ohio, and that all correspondence relative to airplanes, engines, and spare parts of airplanes should be sent to this address.

* * *

Women supervisors will be stationed by the Ordnance Department of the Army in every district where women are employed in munition plants. They will be appointed by Mary Van Kleeck, chief of the new women's division of the Industrial Service Section. This division, besides maintaining proper working conditions for the women in the munition plants, will concern itself with the housing of the women workers and the establishment of canteens where they may obtain wholesome food at cheap prices.

PERSONALS

Donald A. Baker is now chief engineer for the Anderson Drop Forge & Machine Co., Detroit, Mich.

J. B. Phillips, for eleven years superintendent of the Borden Co., Warren, Ohio, has resigned to become factory manager of the Nye Mfg. & Tool Co., Chicago, Ill.

H. D. Gates has returned to the Pangborn Corporation, Hagerstown, Md., as sales manager, which position he resigned about four years ago to take charge of the Mott Sand-Blast Co.

H. F. Finney, who covered the Chicago and St. Louis territories for the Independent Pneumatic Tool Co., Chicago, Ill., has been placed in charge of the company's branch offices at Pittsburg, Pa.

C. H. Davies has been made publicity manager for S. F. Bowser & Co., Fort Wayne, Ind. Mr. Davies has been in the employ of the company for several years and was recently manager of the New York store.

Leslie A. Holman, superintendent of the American Watch Tool Co., Waltham, Mass., is now in Montreal, Canada, designing special machinery. The plant of the American Watch Tool Co. was recently sold at auction.

George L. Hedges has resigned his position with the Kelman Electric & Mfg. Co., Los Angeles, Cal., to report at Washington, D. C., for active duty as First Lieutenant in the Officers' Reserve Corps, Ordnance Department.

Charles O. Watson, formerly of the Niles-Bement-Pond Co., has become associated with Young, Corley & Dolan, Inc., 115 Broadway, New York City, in the capacity of assistant manager of the Machine Tool Department.

R. T. Scott, formerly office manager of the Pittsburg branch of the Independent Pneumatic Tool Co., Chicago, Ill., has been made eastern manager of the company with headquarters at 170 Broadway, New York City.

Earl E. Eby, who was manager of the Pittsburg office (Industrial Bearings Division) of the Hyatt Roller Bearing Co., Newark, N. J., for the past two years, has been appointed assistant sales manager, with headquarters in the Metropolitan Tower, New York City.

F. J. Hull, who was connected with the Pangborn Corporation, Hagerstown, Md., as engineer about five years ago, and who has been more recently in the employ of the Mott Sand-Blast Co., has returned to the Pangborn Corporation in the capacity of assistant engineer.

S. W. Brainard, formerly mechanical engineer for the Cleveland Pneumatic Tool Co., superintendent of the Niagara Fire Extinguisher Co., and general superintendent of the Automatic Sprinkler Co. of America, has been appointed factory manager of the Borden Co., Warren, Ohio.

H. B. Hammond, formerly of the Industrial Department of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has now become associated with the firm of Young, Corley & Dolan, Inc., 115 Broadway, New York City, as manager of the Electric and Railway Department of Sales.

F. C. Hossie has purchased all J. R. Stone's holdings in the General Mfg. Co., Detroit, Mich., and sold all of his holdings in the J. R. Stone Tool & Supply Co., with which he has been identified for a number of years. Mr. Hossie will devote his whole time to the interests of the General Mfg. Co.

R. S. Cooper, vice-president of the Independent Pneumatic Tool Co., Chicago, Ill., who was for many years manager of the eastern branch of the company in New York City, has assumed the duties of general sales manager, as well as those of vice-president, and will maintain his headquarters at the general offices of the company, Thor Bldg., Chicago, Ill.

Charles T. Bird, who has been identified with the Production and Engineering Departments of the Pangborn Corporation, Hagerstown, Md., has been transferred to the Sales Department with headquarters at Hagerstown. His territory will include eastern Pennsylvania, southern New York, New Jersey, Delaware, Maryland, District of Columbia, and Virginia.

G. F. Evans, formerly with the W. C. Moore Co., Columbus, Ohio, has been appointed supervising engineer by the National X-Ray Reflector Co., Chicago, Ill. Mr. Evans' territory will comprise the state of Ohio (with the exception of Toledo and Cincinnati), West Virginia, and western Pennsylvania, and his headquarters will be at 825-826 Columbus Savings & Trust Bldg., Columbus, Ohio.

Waldo H. Marshall, formerly president of the American Locomotive Co. and now associated with J. P. Morgan & Co., has been appointed assistant chief of the Division of Production of the Ordnance Department. Mr. Marshall is first vice-president of the Merchants' Association and was on the staff of Edward R. Stettinius (now surveyor general of supplies in the War Department) in the Munitions Department of J. P. Morgan & Co.

Sir Harry Smith, chairman of the board of management of the Keighley National Shell Factories, has received an appointment of knighthood in the British Empire Order, as a fitting recognition of the valuable work that he has done in the efficient organization and conduct of the Keighley shell factories. Sir Harry has been president of the Keighley Chamber of Commerce and is a representative of the Ministry of Munitions. He is also one of the owners of the firm Dean, Smith & Grace, Ltd., which, since the outbreak of the war, has been engaged night and day in the manufacture of lathes for all kinds of munitions. There has been a general expression of satisfaction throughout the British machine tool trade in consequence of the recognition that has been given to Sir Harry.

Eliot A. Kebler has become president of the Fawcus Machine Co., Pittsburg, Pa., succeeding the late Thomas Fawcus. Mr. Kebler was, for many years, with the Cincinnati Pipe Co. and their successors, the Addyston Pipe & Steel Co., starting in first as a chemist and later as secretary of the company, during which time he had charge of the building of the new plant. When this company was merged with the U. S. Cast Iron Pipe & Foundry Co., he remained with the Matthew Addy Co., of Cincinnati, Ohio, devoting his time principally to the sale of pig iron. He was one of the incorporators of the Fawcus Machine Co. and has been secretary and treasurer of that company from its incorporation. As president of this company, he will still remain special representative of the Matthew Addy Co.

OBITUARIES

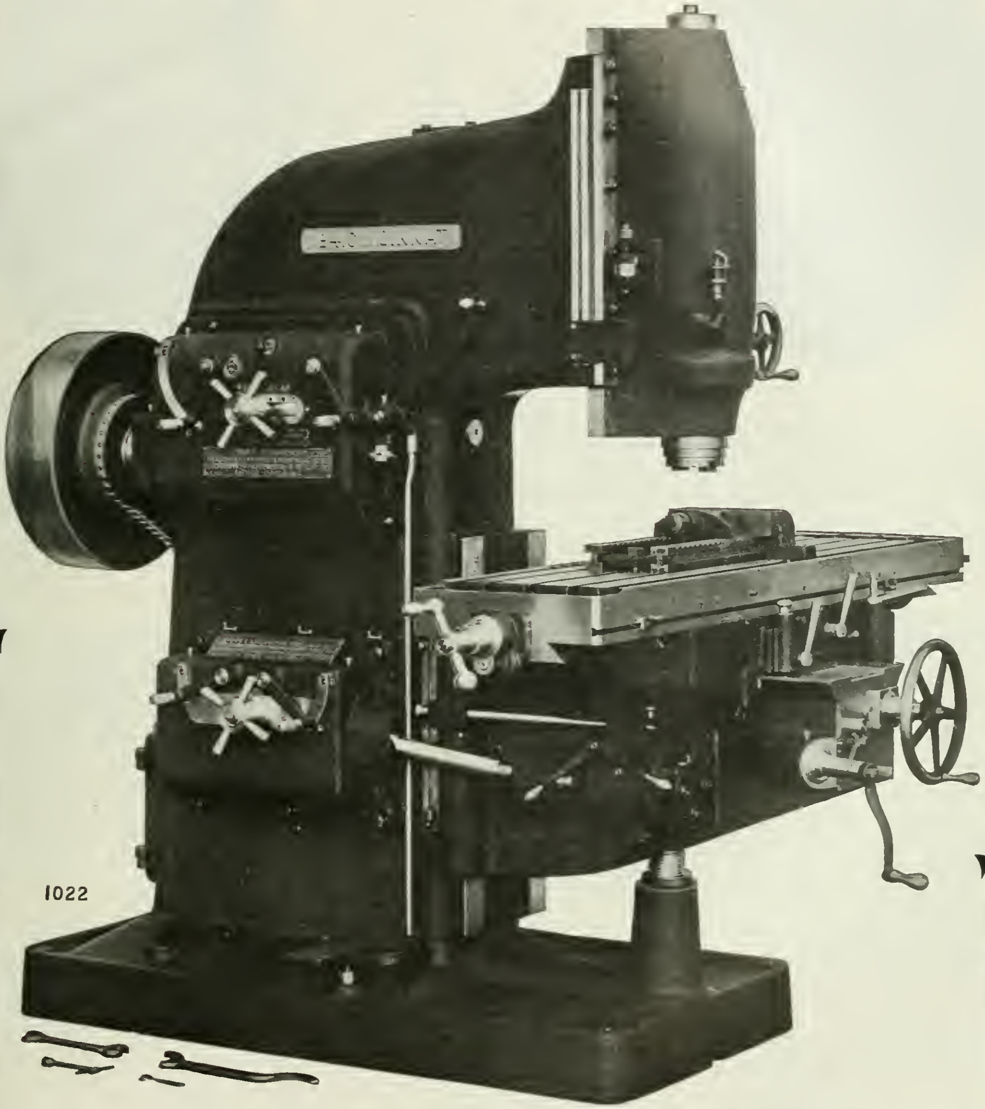
George J. Althen, treasurer of the Driver-Harris Co., Harrison, N. J., died February 15. Mr. Althen was born in Newark, N. J., in 1857, and for the past four years has been connected with the Driver-Harris Co. He was well known on account of his affiliation with the National Credit Men's Association, and was a member of the executive committee, representing New Jersey.

Thomas Fawcus, president of the Fawcus Machine Co., Pittsburg, Pa., died January 22, aged fifty-two years. He organized the Fawcus Machine Co. in 1900, and, due to his executive and inventive ability, the growth of the business was rapid. In 1912 he started to design and develop the Fawcus herringbone gear-cutting machine, which is covered with patents in the United States and foreign countries.

ARTHUR IRVING JACOBS

Arthur Irving Jacobs, president of the Jacobs Mfg. Co. and the Rhodes Mfg. Co., Hartford, Conn., died February 16, at St. Francis Hospital, in Hartford, after a brief illness. Mr. Jacobs was born in Hebron, Conn., in 1858. His educational advantages were meagre during his boyhood, and after his ninth year his schooling was limited to a short period in the winter; but he was early trained in habits of industry, working with his father, Zalmon Luman Jacobs, in mechanical work until he attained his majority, when he secured employment in the Knowles Loom Works at Worcester, Mass. There his mechanical bent soon became manifest and in a short time he made such improvements in manufacturing methods on a contract for the making of harness chains for looms that he was able to earn a good profit where others had previously failed. Mr. Jacobs remained at the Knowles Loom Works until 1887, during which period he invented and built a book-sewing machine of which several were purchased by Boston book binders. The Smyth Mfg. Co., of Hartford, Conn., which also manufactured such machines, became interested in his invention, purchased his patents, and engaged Mr. Jacobs to come to Hartford. He

Cincinnati Verticals



Unusual Spindle Power.
Heat Treated Alloy Steel Hardened Gearing.
Massive Spindle Head Construction.
Handy—Can mill around a rectangle without stopping feed or speed.

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THE CINCINNATI MILLING MACHINE CO.
CINCINNATI, OHIO, U. S. A.

Arthur Irving Jacobs

remained with the Smyth Mfg. Co. until 1901, during which period he invented and developed several machines for bookbinding; among these were two machines for making book covers and for cutting cloth for book covers, which marked a great advance over methods that had formerly been employed.

In 1902, he invented the drill chuck that is known as the "Jacobs improved drill chuck," patent on which was allowed September 16, 1902. The Jacobs Mfg. Co. was incorporated in 1903; manufacturing was started in rented quarters, but the business now occupying a large modern factory on Park St., built to suit the company's needs. Mr. Jacobs married in 1880, Lucy Ann Backus, of Hebron, Conn., who died in 1908. He later married Marguerite Serrell, of Park Ridge, N. J., who survives him. Mr. Jacobs is also survived by three children in his first marriage; one son, Raymond Backus Jacobs, secretary of the Jacobs Mfg. Co. and the Rhodes Mfg. Co., and two daughters, May Louise and Clara Bell, the latter the wife of Louis E. Stoner, treasurer of the Jacobs Mfg. Co.

H. H. HODELL

Henry H. Hodell, president of the Van Dorn & Dutton Co., Cleveland, Ohio, gear specialist, and of the Cleveland Galvanizing Works Co., manufacturer of weldless wire chain, and a director of the Van Dorn Electric Tool Co., died February 10, aged sixty-eight years. Mr. Hodell was born in Alsace-Lorraine and came to America with his parents as a small boy. After having finished his early education, he learned the pattern-maker's trade, but it was not long before his business ability was recognized by those with whom he came in contact. As a result, in the early eighties he entered the galvanizing business, and from a very modest beginning, he soon built up one of the largest custom galvanizing businesses in the country. He was also a pioneer in the weldless wire chain business, one of the best known link-chains bearing his name. Later he became one of the founders of the Van Dorn & Dutton Co. and of the Van Dorn Electric Tool Co., both of Cleveland, Ohio. He leaves a widow and two sons, F. G. Hodell, and H. H. Hodell, who were associated with him in his many enterprises.

Henry H. Hodell

COMING EVENTS

March 20-22—Annual meeting of the American Railway Engineering Association, 910 Michigan Ave., Chicago, Ill.

March 28—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

April 10-12—Sixth annual meeting of the Chamber of Commerce of the United States of America, at the Congress Hotel, Chicago, Ill.

April 18-20—National Foreign Trade Council conference in Cincinnati, Ohio; Gibson Hotel, headquarters. Secretary, O. K. Davis, 1 Hanover Square, New York City.

April 24-25—Annual convention of the National Metal Trades Association at the Hotel Astor, New York City. Homer D. Sayre, secretary, 1021 Peoples Gas Bldg., Chicago, Ill.

May 15-17—Joint convention of the National Supply and Machinery Dealers' Association, Southern Supply and Machinery Dealers' Association and the American Supply and Machinery Manufacturers' Association in Cleveland, Ohio. Secretary of the American Supply and Machinery Manufacturers' Association, F. D. Mitchell, Woolworth Bldg., New York City.

June 20-22—Fifth annual convention of the American Drop Forge Association held at the Iroquois Hotel, Buffalo, N. Y. E. B. Horne, "The American Drop Forger," 108 Smithfield St., Pittsburg, Pa., secretary.

NEW BOOKS AND PAMPHLETS

The Collapse of Short Thin Tubes. By A. P. Carman. 36 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the University of Illinois, Urbana, Ill., as Bulletin No. 99.

The Hydrometallurgy and the Electrolytic Precipitation of Zinc. 28 pages, 6 by 9 inches. Published by the School of Mines and Metallurgy, University of Missouri, Rolla, Mo., as Bulletin No. 1 of the Technical Series, Volume IV.

Specific Heat of Liquid Ammonia. By Nathan S. Osborne and Milton S. Van Dusen. 35 pages, 7 by 10 inches. Published by the Government Printing Office, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 313. Price, [illegible].

Latent Heat of Vaporization of Ammonia. By Nathan S. Osborne and Milton S. Van Dusen. [illegible] pages, 7 by 10 inches. Published by the Government Printing Office, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 315. Price, 10 cents.

Engine Guarding and Engine Stops. Published by the National Safety Council, Continental and Commercial Bank Bldg., Chicago, Ill., as Safe Practices Bulletin No. 9. Price, 10 cents.

This bulletin describes safety devices and methods of guarding engines and engine stops; it contains information on safe speeds for flywheels, various materials for flywheel rims, causes of flywheel accidents, care of safety stops, piston clearances, engine piping and drains, lubrication of air compressor cylinders, etc.

Shafting, Couplings, Pulleys, Gearing. Published by the National Safety Council, Continental and Commercial Bank Bldg., Chicago, Ill., as Safe Practices Bulletin No. 8. Price, 10 cents.

This is one of a series of pamphlets that will be sent to the 3470 industrial, railroad, and other members of the National Safety Council, and that will be accepted as standard safe practices to protect the lives and limbs of workmen. Bulletin No. 8 describes safety devices for shafting, couplings, pulleys, and gearing.

Combined Table of Sizes in the Principal Wire Gages. Published by the Bureau of Standards, Department of Commerce, Washington, D. C., as Circular No. 67.

This table combines in one series the sizes in the American (B. & S.), steel Birmingham (Stubs), British standard, and metric wire gages, arranged in order of diameters of wires. It gives the diameters of all the gage numbers in these five systems in mils, inches, and millimeters, as well as the cross-sections in square mils, circular mils, square inches, and square millimeters.

Industrial Arts Index. 558 pages, 7 by 9 inches. Published by H. W. Wilson Co., 958 University Ave., New York City.

This is the 5th annual cumulation, giving subject index to a list of engineering and trade periodicals for 1917. The work, which indexes articles that have appeared in practically all the leading trade journals, should be of considerable value to investigators of special industrial subjects, libraries, authors, and others who require a comprehensive index to all the information that has been published on any one subject during the past year.

Finding and Stopping Waste in Modern Boiler Rooms. 274 pages, 5 by 7 inches, numerous illustrations. Published by Harrison Safety Boiler Works, Philadelphia, Pa. Price, $1.

This book may be considered as a reference manual to aid the owner, manager, and boiler-room operator in securing and maintaining plant economy. The subject matter was originally intended as an appendix to one of the catalogues of the Harrison Safety Boiler Works, but has grown into a separate volume with information of great value to those responsible for the operation of boiler plants. At the present time, when the saving of coal has become so important, anything relating to the economical operation of a boiler plant is of great value. The book contains five separate sections on fuels, combustion, heat absorption, boiler efficiency and testing, and boiler plant proportioning and management.

Location of Airplane Power Plant Troubles Made Easy. Chart arranged by Lieutenant Victor W. Page. Published by Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, 50 cents.

This is a large wall chart showing a typical airplane engine partially in section, with all the important components indicated. The chart can be conveniently folded up to be put into the pocket. It is printed on tough paper and will stand considerable handling. In addition to showing clearly the construction of an airplane engine, the chart outlines possible troubles likely to be met with in the operation of these engines, and deals with the cooling, lubrication, carburetion, and ignition, as well as with defects in the engine itself. The chart has been prepared by an expert on airplane engines, and is based on practical experience gained in the Government aviation service. It has been arranged with special reference to the needs of the student and the aviator who is not an expert in mechanics.

Machine Shop Practice. By William B. Hartman. 246 pages, 4½ by 7 inches; 182 illustrations. Published by D. Appleton & Co., 35 W. 32nd St., New York City. Price, $1.10.

This book may be termed a primer of machine shop practice, the object being to set forth the elementary principles only. The subject has been treated in a simple manner and arranged in logical order. Measuring tools are first illustrated, then hand and machine cutting tools are described, and finally machine tools are dealt with. The book is divided into twelve chapters dealing specifically with machine shop work, covering such subjects as measuring tools; chipping, filing, and scraping; drills and drilling machines; the lathe; straight turning; taper turning; thread cutting on the lathe; general lathe work; planer and shaper; boring mill; milling machine; and milling machine work. A special chapter on the automobile is included and also a number of useful tables.

Efficiency Methods. By M. McKillop and A. D. McKillop. 215 pages, 5 by 7 inches. Published by D. Van Nostrand Co., 25 Park Place, New York City. Price, $1.50.

This book may be considered as an elementary text-book on scientific management. It contains a review of the subject of management and refers to many of the books and articles on the subject that have been published in the past. It deals specifically with the different departments organized under the scientific management system—the planning department, the cost department, the stores department, and the tool-room. Other chapters deal with the functions of foremen, time study and motion study, fatigue study, and task work. Methods of remuneration under scientific management and its relation to welfare work, trade unions, and education are also treated. On the whole, the book may well be recommended to anyone who wants to obtain a preliminary knowledge of the principles of scientific management.

Transmission Gears. By Edward Butler. 164 pages, 6 by 9 inches; 125 illustrations, including 9 folding plates. Published by J. B. Lippincott Co., Philadelphia, Pa.

The object of this treatise is to present in a concise form such information relating to mechanical, electric, and hydraulic transmission mechanisms as is especially useful to engineers, designers, and

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BORING, DRILLING AND

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others engaged in the application of internal combustion engines for automobile, marine, and other general purposes. The book deals specifically with friction clutches; speed change-gear mechanisms; transmissions between gear-box and road wheels; transmissions used in street railway cars, gasoline railway cars, and oil locomotives; marine reversing gears; reversible screw propellers; and electric, hydraulic, and compressed-air variable-speed transmissions. The relative adaptability of gradually variable transmissions—hydraulic and electric—have been explained in order to point out means for avoiding some of the inherent faults of step-by-step gears. The subject of friction clutches has been dealt with as exhaustively as possible, because of the importance of the subject and the difficulty of obtaining satisfactory designs. The book should be of value to those interested in the various types of transmission mechanisms that have been employed on automobile and marine internal combustion engines.

Aviation Engines. By Lieutenant Victor W. Page. 589 pages, 5½ by 8½ inches. 253 illustrations. Published by Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $3.

Considering the scarcity of good literature on airplane engines written from the practical point of view, this book should prove of considerable value to the great number of people who, at the present time, are engaged in air engine work. On account of the rapidly developing art, it is, of course, difficult to outline in a book all the latest forms or to describe current engineering practice, completely, but the book nevertheless appears to be accurate in its engineering information. Special attention has been paid to instructions on tool equipment, use of tools, and engine repairs. Theoretical considerations have been avoided, except when deemed absolutely necessary in order to secure a proper understanding of the action of the engine. The writer's efforts have been confined mainly to the preparation of a practical series of instructions that would be of particular value to those who must acquire quickly a diversified knowledge relating to internal combustion engine operation and repair. The writer's experience as assistant engineering officer in the Signal Corps Aviation School at Mineola, N. Y., has made it possible for him to determine quite accurately the kind of information relating to airplane engines that is most needed for instruction purposes, and the book is especially adapted for men in the aviation service of the Signal Corps, and for students who wish to become aviators or aviation mechanics.

Taylor System in Franklin Management. By Major George D. Babcock, in collaboration with Reginald Trautschold. 245 pages, 5½ by 8½ inches. Published by the Engineering Magazine Co., 6 E. 39th St., New York City. Price, $3.

The principal author of this book, who is production manager of the H. H. Franklin Mfg. Co., has in this work recorded the application of the Taylor system and the results obtained in the plant of this company. The work is one that those interested in the details of scientific management will study with interest. It is divided into ten chapters headed as follows: Factory Conditions in 1908; Investigation of the Taylor System; Classification and Standardization; Establishing Control; The Schedule; Control Boards, and Pneumatic Despatch Tubes; Employment and Rate Fixing; Organization Classification; Changes in Product and Method; Changes which have Affected the Men; The Results Graphically Depicted. Two appendices are also added, one giving wage rates in the Franklin shops, and one containing examples of the application of scientific management. Two features of the work might particularly be mentioned—the description of the control boards devised by Major Babcock, beginning on page 63, to which are largely due the remarkable increases in production which have been obtained, and the detailed description of the Franklin wage formula in the appendix, which has enabled the company to reduce its labor turnover to a most remarkable extent. The results obtained from the inauguration of the Taylor system are graphically described in the chapter beginning on page 147 and will be reviewed with interest by anyone confronted with management and production problems.

NEW CATALOGUES AND CIRCULARS

Baldwin Locomotive Works, Philadelphia, Pa. Record 88, descriptive of the Santa Fe type locomotives.

Baldwin Locomotive Works, Philadelphia, Pa. Record 89, treating of the development of the eight driving wheel locomotive.

Stevens Institute of Technology, Hoboken, N. J. Annual catalogue for 1918-19, containing calendar, courses of instruction, etc.

Cooper Flexible Transmission Co., Inc., Eighth Ave. and 18th St., Brooklyn, N. Y. Price list of Cooper patented machine universal joint.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue E, illustrating "Brownhoist" buckets and tubs in operation on various classes of work.

Nile E. Goodactive, Box 250, Chicago, Ill. Catalogue of the "Goodactive" belt shifter for cone belts, which is applicable to any machine with cone belt drive.

Link Belt Co., Chicago, Ill. Book 350, entitled "Chain-driven Motor Trucks and Tractors," illustrating installations of Link Belt chain in trucks and tractors.

National Machinery Co., Tiffin, Ohio. National Forging Machine Talk No. 81, treating of forging motor truck shafts on a National heavy-pattern forging machine.

Heinkel Machine Tool Co., Sandusky, Ohio. Circular descriptive of Heinkel silent multiple drilling heads designed for use in connection with single-spindle equipment.

Wright Roller Bearing Co., 1420 Chestnut St., Philadelphia, Pa. Catalogue of Wright taper roller bearings, describing and illustrating in detail the construction of this type of bearing.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Folder illustrating Shepard electric cranes and hoists and their installation in twenty-four plants for various classes of work.

Link-Belt Co., Chicago, Ill. Booklet 354, describing and illustrating the gravel washing and sand drying plant of the Absecon Sand Co., which was designed and equipped by the Link-Belt Co.

Newman Mfg. Co., 717-721 Sycamore St., Cincinnati, Ohio. Circular of "Spotlight" factory brackets, illustrating the different types and their application on various types of machines and giving price lists.

Charles F. Elmes Engineering Works, 222 N. Morgan St., Chicago, Ill. Classified collection of loose-leaf circulars, illustrating presses, oil machinery, accumulators, pumps, valves, fittings, gages, etc.

Gisholt Machine Co., 1200 E. Washington Ave., Madison, Wis. Pamphlet entitled "Increasing Production with Gisholt Machines," showing some interesting work that is being done on Gisholt turret lathes and tool grinders.

Fulflo Pump Co., Cincinnati, Ohio. Circular illustrating essentials in the construction of the Fulflo pump, which should be of interest to purchasers of coolant pumps. Letters of recommendation from a number of users are reproduced.

National Tube Co., Pittsburg, Pa. Circular showing a piece of 8-inch National line pipe, which resisted without fracture a twisting force of 713,000 inch-pounds. The circular also contains other illustrations showing the ductility of National tubing and pipe.

Cleveland Galvanizing Works Co., Cleveland, Ohio. Circular descriptive of a new swivel repair link, designed to facilitate the work of repairing chains. The "One-minute" swivel repair link is made in three sizes for use with different sizes of welded, weldless, or flat-link chain.

Cleveland Automatic Machine Co., Cleveland, Ohio. Pamphlet containing reprints of thirty-one articles by J. P. Brophy which have been published in various magazines. The articles deal with mechanical information, municipal problems, politics, human qualities, humor, war, and general business administration.

E. R. Senn & Co., 52 Vanderbilt Ave., New York City, has issued the first number of a house organ called "The Belt-ol Scrap Book" which will contain information on power efficiency and the use of Belt-ol for increasing the transmission efficiency of belts. The intention is to include each month items covering practical methods and experiences of prominent production and power plant managers.

Greenfield Tap & Die Corporation, Greenfield, Mass. Catalogue of the Wells self-opening die, treating of the advantage of self-opening dies and describing the construction of the Wells die. Dimensions of the pull trip, rim trip, and face and lever trip types are included. The book is illustrated with halftone and line engravings, making the construction clear to the non-technical man as well as to the engineer.

Walton Co., Hartford, Conn. Circular 70, describing the Walton tap extractor for removing broken pieces of taps. The device consists essentially of prongs or fingers suitably mounted, which are pushed into the flutes of the broken tap; the tap can then be easily screwed out. The prongs are made of a special crucible steel, having considerable strength, which is neither as hard nor as brittle as the tap.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Pamphlet A-2132, containing information on bakelite micarta-D gears. The distinctive features of this material for noiseless gears and pinions are listed, together with its physical properties. Methods of turning, drilling, and cutting gears in bakelite micarta-D are described and illustrated. The book also contains other information of value to those who are interested in the use of noiseless gears.

Fellows Gear Shaper Co., Springfield, Vt. Booklet entitled "The Stub-tooth Gear." This treatise explains in simple terms the advantages of the combination of a short gear tooth with an increased angle of obliquity. The treatment is very clear and complete, covering some fifty, 6- by 9-inch pages, and profusely illustrated with line engravings and halftones. The treatise is divided into five chapters: Development of Gear Teeth and Gear Tooth Proportions; Graphical Analysis of Gear Tooth Wear and Durability; Comparative Strength of 14½- and 20-degree Stub-gear Teeth; Advantages of the Stub-tooth Gear, and Graphical Method of "Generating" an Involute Gear Tooth. Treatises of this kind are a valuable addition to mechanical literature.

TRADE NOTES

Maaf Grinding Wheel Corporation, Chester, Mass., has opened an office at 15-17 S. Clinton St., Chicago, Ill., in charge of Hoffman & Meyer, where a large stock of grinding wheels will be carried on hand.

Special Tool Co., Whitman, Mass., has recently taken over all the assets, including machinery, stock, patents, good will, etc., and liabilities of the Worcester Flexible Tubing Co., Worcester, Mass.

Murray-Mylrea Machine Co., Antigo, Wis., has bought the disk grinder business conducted in the past by the Ransom Mfg. Co., Oshkosh, Wis. The Murray-Mylrea Machine Co. will continue the manufacture of the disk grinders.

Crescent Tool Co., Jamestown, N. Y., is preparing plans for a power station and concrete coal storage bins and will shortly be in the market for a 1000-kilowatt steam turbine generator set and boilers, and a 1500-horsepower gas producer for supplying gas engines, forges, and furnaces.

High-Speed Tools Corporation, manufacturer of cast high-speed steel tools and alloyed steels, has removed its offices to 43 Exchange Place, New York City. The company is enlarging the capacity of its factory considerably, and expects to be able to assure its customers of the earliest possible delivery.

Hetherington-Jones Co., 523 W. Miami St., Piqua, Ohio, has been succeeded by the Hetherington Co., chartered under the laws of Ohio with a capitalization of $25,000. The new company will continue the business of manufacturing emery wheel dressers and cutters, and other specialties in metal lines.

Trimont Mfg. Co., 55-71 Amory St., Boston, Mass., is constructing an addition to its plant. Part of the increased space will be given up to the office and the remainder will be used as an assembling room for the "Trimo" line of wrenches made by this company. The addition will be ready for occupancy in May.

General Mfg. Co., 93 Meldrum Ave., Detroit, Mich., manufacturer of tools, jigs, and fixtures, announces a change of officers due to a transfer of stock holdings. The new officers are F. O. Hossie, president; M. G. Hossie, vice-president; and H. Wild, secretary and treasurer. The business will be conducted along the same lines as heretofore.

Spartan Saw Works, 41 Taylor St., Springfield, Mass., manufacturers of hacksaw blades, have been formed by H. F. Strout and J. W. McQuillan, both of whom were formerly engaged with the Massachusetts Saw Works, the latter as general superintendent and president. Orders for hacksaws are now being received and a few orders have already been filled.

Ransom Mfg. Co., Oshkosh, Wis., manufacturer of grinding machinery, has sold its disk grinder business to the Murray-Mylrea Machine Co., Antigo, Wis., which will continue the manufacture of the disk grinders. The Ransom Mfg. Co. will confine itself entirely to the manufacture of motor-driven and belt-driven grinding machines and water tool grinders.

Driver-Harris Co., Harrison, N. J., announces that on January 31 its Insulated Wire and Electrical Cord Departments were completely destroyed by fire. However, the company's business in the production of resistance materials, castings, cold-rolled strip, nickel sheet, and other products has not been interfered with in the least, and business will continue as usual.

W. K. Millholland Machine Co., Indianapolis, Ind., manufacturer of turret lathes, whose factory was recently destroyed by fire, has leased the plant of the Climax Machinery Co. in Indianapolis and has resumed manufacturing, some shipments having having already been made. Plans have been completed for a 90- by 300-foot fireproof building, on which construction work will be started at once.

Automatic Machine Co., Dayton, Ohio, designer and manufacturer of automatic and special machinery, tools, dies, and fixtures, which was organized about eighteen months ago, with M. O. Kepler as president and J. S. Kepler as vice-president and manager, has moved into the company's new building on W. Second St. This is a two-story and basement brick building with exceptionally good light. The new equipment secured for this building will double the company's present capacity.

Whitman & Barnes Mfg. Co., Akron, Ohio, maker of drop-forgings, elected the following officers at its annual directors' meeting: A. D. Armitage, president; W. H. Eager and A. R. Hall, vice-presidents; W. E. Rowell, secretary; and E. A. Fisher, treasurer. Mr. Armitage has been connected with the company for twenty-five years. He started as a mechanic in the Akron factory in 1892, and in 1915 he was elected vice-president and manager of the Chicago and Canadian factories, with charge of sales at those offices.

Ott Grinder Co., Indianapolis, Ind., the shops of which were completely burned January 13, has secured the plant formerly occupied by Stutz Auto Parts Co., at 217-221 W. 10th St., Indianapolis, and will occupy the entire building, which is of three-story modern concrete construction. The new factory is being rapidly equipped with an entirely new equipment, and regular deliveries will be made about March 15. The company has increased the sizes of the No. 2 universal grinder to 10 by 30 inches, and of the No. 8 plain grinder to 5 by 18 inches.

Fulton Steel Corporation, 165 Broadway, New York City, announces that its Heroult electrical plant at Fulton, N. Y., devoted to the making of alloy steels of different kinds, is now in successful operation. The plant has a capacity for melting about seventeen tons of steel per day. Irving R. Valentine, metallurgist of the corporation, who has personal supervision over the steel melting, worked for six years in the research laboratory of the General Electric Co., and has for several years been in charge of the Heroult electrical plant of that company.

Williams & Thomas Machinery Co., Inc., has been formed to handle a complete line of machine tools and railway and shipyard equipment. The company will have offices at 829 Commercial Trust Bldg., Philadelphia, Pa., and 1226 Fulton Bldg., Pittsburg, Pa. The president of the new concern is R. F. Williams, who has been connected for the past seven years with Manning, Maxwell & Moore, Inc., and more recently with Sherritt & Stoer Co., Inc., Philadelphia. George P. Thomas, who was formerly president of the Thomas Spacing Co., of Pittsburg, is secretary treasurer.

APRIL MACHINERY 1918

Loading and Assembling Time Fuses[1]

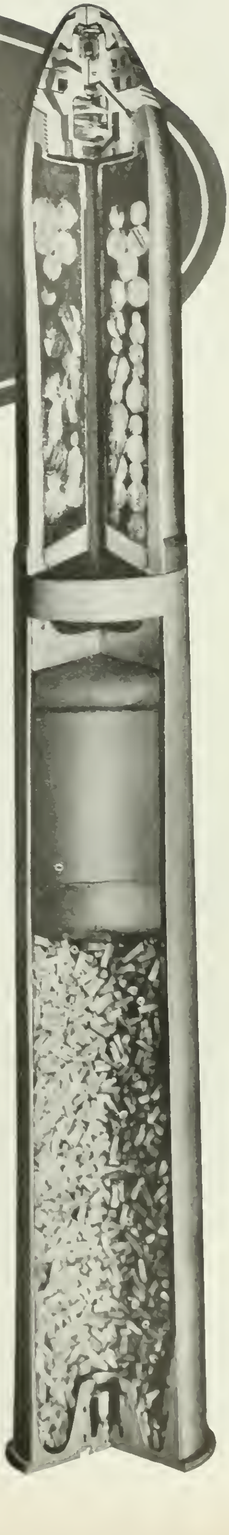
by G. C. WHITE[2]

The time and percussion fuse must be made very accurately and must be carefully adjusted to insure absolute reliability; this requires the use of special gages, fixtures, and testing apparatus. The complete equipment of a fuse loading and assembling plant is described in this article, which first explains in detail how a fuse operates and then takes up each step relating to fuse loading in the order in which the work is actually done.

WHILE much has been written about the machining operations involved in the manufacture of time fuses, the assembling and loading has not received so much publicity. The practice in a loading plant may not seem to be as interesting, from a mechanical viewpoint, as manufacturing the different parts; but, as a matter of fact, the various operations and tests performed in a fuse plant must be done carefully and accurately and require the use of some very ingenious mechanical equipment. Before considering in detail the successive steps in the loading of time fuses, the particular design of time fuse (No. 80, Mark VII) to which this article refers will be described.

This fuse, which is shown in Figs. 1 and 2, is the combination time and percussion type such as is used on shrapnel shells. The fuse is so arranged that it regulates the length of time that elapses between the instant that the shell is fired and the explosion. The main body *A* of the fuse is provided with a cap *B* and two timing rings *C* and *D*. Within the cap there is a time pellet *E*, which contains a detonator and is held in the position shown, before firing the shell, by the flanges *F* on the stirrup spring. Just beneath the detonator there is a needle or firing point *G*. At the instant that the shell is fired, time pellet *E*, owing to its inertia, flies backward relative to the other parts of the fuse, so that the detonator strikes pin *G* and is discharged. Instantly the flame passes out through the flash hole *H* in the fuse body and the flash hole *I* in the upper ring (which contains powder) and ignites a train of powder which is tightly compressed in the groove or channel *J* of the upper ring. When this train of powder has burned around to a point opposite flash hole *K*, another powder train *L* in the lower timing ring is ignited. As soon as this second powder train has burned to a point opposite hole *M*, which is filled with a powder pellet, the flame is rapidly transmitted to the base charge, and thence, through a central tube, to the bursting charge in the base of the shell.

The time that elapses between the firing of the shell and its final explosion may be varied by changing the position of the



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[1] For additional information relating to the manufacture of time fuses, see "Manufacturing Time Fuse Rings," in MACHINERY, March, 1918, and articles there referred to.

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lower timing ring relative to the main fuse body and the upper ring. If we assume that flash holes *H* and *I* are in direct line with *K* and *M*, the fuse would then be set for the minimum length of time and the explosion of the shell would occur almost at the instant of firing. By turning the lower timing ring *D* so that the flash hole *K* is some distance from holes *H*, *I*, and *M*, it is necessary for the train of powder in channel *J* to burn around in one direction until hole *K* is reached, and then back in the opposite direction to opening *M* before the shell explodes. This adjustable timing ring is set by means of graduations which indicate seconds of time. For instance, if it is estimated that the shell should explode within ten seconds after firing, the lower timing ring is turned until the index line on it is opposite the ten-second graduation line on the flange of the fuse body.

If for any reason the timing arrangement should fail to operate, or if the shell should accidentally strike some object of sufficient mass to arrest its motion suddenly, the shell would be exploded upon impact by the percussion pellet *N*. This pellet, like the one previously referred to, contains a detonator, and it is normally held in the position shown in the illustration by spring *O* and the flanges *P* on the stirrup spring. At the same time that the pellet strikes the needle *G*, flanges *P* of percussion pellet *N* are straightened out by the ferrule or sleeve *Y*, which, by reason of its weight or inertia, is forced backward over flanges *P* at the instant the shell is fired. The percussion pellet is now ready to be effective whenever the flight of the shell is retarded sufficiently to enable the pellet to overcome the resistance of the coil spring *O*. For instance, if the movement of the shell were suddenly arrested, the momentum of pellet *N* would carry it forward, thus firing the detonator as it came into contact with the end *Q* of the firing pin. The flame then passes down through the center of the pellet to the base charge and central tube previously referred to and then to the base of the shell. It should be mentioned that the channels *J* and *L* in the timing rings do not form complete circles. When the solid portions between the ends of the channels are opposite holes *H*, *I*, and *M*, the fuse is then set in the safety position; the line on the lower ring is then opposite the + on the body flange. Beneath the flange of needle *G* a lead washer is provided to make sure that the flash or flame will not pass straight through the fuse to the base charge and cause a premature explosion. The felt washers *U* and *V*, which are placed between the rings, serve as gaskets.

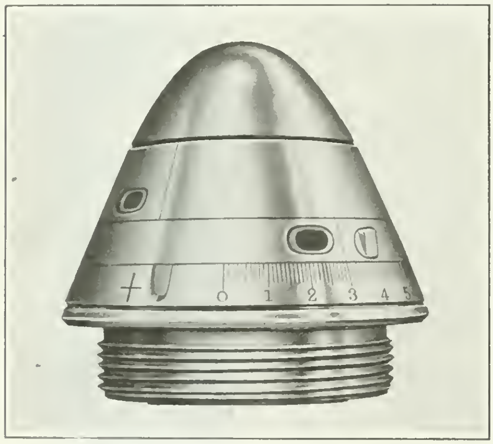


Fig. 1. Time and Percussion Fuse

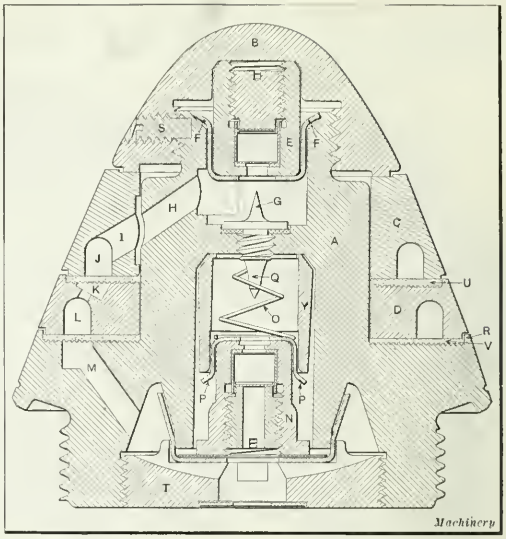


Fig. 2. Sectional View of Time and Percussion Fuse

Each time ring has an escape hole and vent which connects the initial end of the powder train with the exterior or the atmosphere. The oblong slots seen in the rings of the fuse illustrated in Fig. 1 are the escape holes. Each of these holes contains a powder pellet, which is covered and enclosed by a thin brass disk. When the initial end of the powder train in the upper ring is ignited, the powder pellet in the escape hole burns rapidly until the pressure is great enough to blow out the disk. The train of powder is then in direct communication with the atmosphere, so that it burns and does not explode. If there were no vent, the powder composition in the groove would explode and the timing quality of the fuse would be eliminated.

Drilling and Routing Operations on Rings

The operations performed at the loading plant are principally on the top and bottom timing rings (*C* and *D*, Fig. 2), and for that reason these rings will be considered first. Before loading with powder, certain machining operations are performed which will be described. The rings are first drilled at points corresponding to the ends of channels *J* and *L*, and a hole is also drilled in each ring, which is used as a locating point for all subsequent operations. The jig used for drilling these holes in the upper timing ring is illustrated in Fig. 3. It is necessary to have these holes in a certain relation to the elliptical escape hole in the side of the ring, and the work is held in the right position by a plunger *A*. This plunger engages the escape hole and the end is rounded off and made tapering so that it will easily enter the hole. When loading the jig it is turned over. Nut *B* is loosened and wing *C* is swung back, thus allowing the timing ring *D* to be inserted. Girls can drill 300 rings per hour. The diameter of the hole is 0.138 inch, and the depth, 0.188 inch. The drill spindle runs at 3000 revolutions per minute. It is necessary to regrind the drills after drilling from 800 to 1000 rings. The

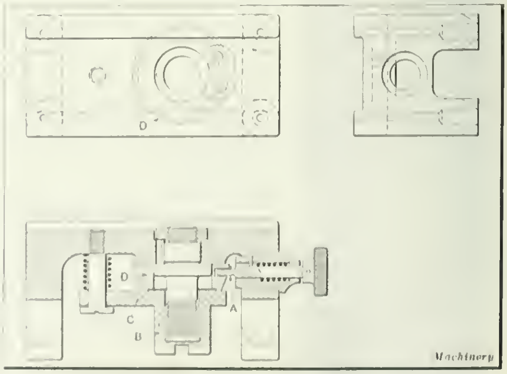


Fig. 3. Jig for drilling Holes at Ends of Powder Train Channel and also "Locating Hole"

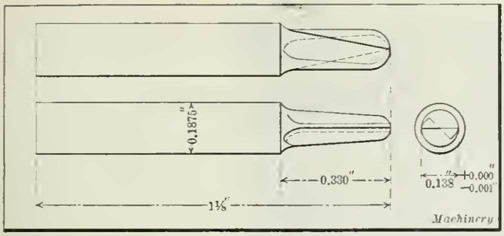


Fig. 4. Cutter used for milling Powder Train Channels

drills have been found to cut better if the lips are ground so that they will have no rake.

Any burrs that may have been formed, especially by dull drills, are next filed off and the lighting lines are scribed or cut. These lighting or index lines will be in line with the centers of the flash holes; the flash holes are drilled later. The line on the upper ring is used to locate it when drilling holes for the "securing pins" which hold this ring permanently in one position. The line on the lower ring is used for setting the fuse. Bench milling machines are used to cut these lines, the rings being mounted upon angle-blocks and fed under a fine cutter. The channels or grooves in the timing rings are next formed by a routing operation. One operator runs two Gorton machines and the channel is cut to the full depth in one passage of the cutter. The cutters used for this work are made of drill rod and are of the form illustrated in Fig. 4, which shows two views of the same cutter. This cutter is used to rout a groove of a width not less than 0.137 inch and not greater than 0.139 inch. No cooling compound is used for this operation and the average life of a cutter is 300 rings. The spindle speed for this routing operation is 8000 revolutions per minute.

The composition channels are now covered with a lacquer consisting of 1 pound of shellac, 8 ounces of turmeric, and 8 pounds of methylated spirits. The burrs caused by the routing operation are removed from the face of the rings by a disk grinder. The timing rings are now inspected for diameter, concentricity, and width and depth of the channel formed by routing. The gage used for testing the depth is illustrated at *A* in Fig. 5. The pin which does the gaging passes through an adjustable bushing that is provided to compensate for wear. It is surprising how fast a gage of this type will become worn. The adjustment of the gage is necessary after testing approximately 90,000 rings. The gage used for testing the position of the index line on each timing ring is illustrated at *B*. The timing ring is located in the right position relative to the gage by the pin shown, which engages the locating hole previously drilled by means of the jig shown in Fig. 3. The labor cost for preparing each ring for loading is 0.7237 cent, and is distributed as follows:

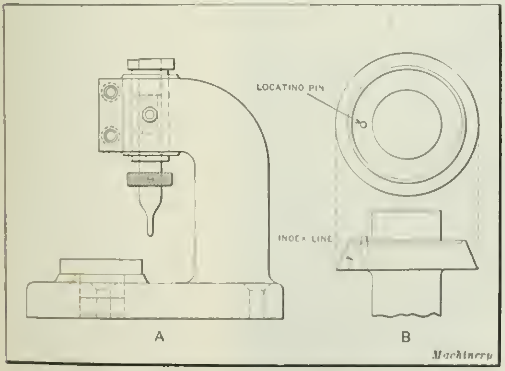


Fig. 5. (A) Gage for testing Depth of Powder Train Channel. (B) Gage for testing Location of Index Line on Fuse Ring

Operation	Cost, Cent
Drilling (three holes)	0.1125
Marking	0.0225
Routing	0.2250
Grinding	0.0225
Cleaning	0.0375
Inspecting	0.1575
Drilling land	0.0225
Mechanics (two operating)	0.0750
Mechanic (repairs)	0.0375
Compound man	0.0112
Labor cost per ring	0.7237

Preparation of Powder for Fuses

After the preliminary machining operations referred to, the rings are sent to the loading department, which is kept at approximately a constant temperature by means of humidifiers in conjunction with refrigeration and heating plants. Bristol recording thermometers are used to keep a record of the temperature, in order to see that the required temperature is maintained. This should be 70 degrees F. and the humidity 45 per cent. The temperature may be reduced as much as 20 degrees when a new lot of powder is brought into this department. The powder is kept in a separate building connecting with the blending department by a tunnel. All the employes in this department wear rubber soled shoes, and steel parts are eliminated as much as possible. All surplus powder is collected by means of vacuum machines, the fan motors of which are located outside to avoid danger from any sparking of the motor. The powder for the fuses is tumbled and mixed in a wooden box which contains wooden balls; then it is passed over riddles, and smaller quantities are placed in covered receptacles made of copper or brass. The samples obtained in this way are next tested for burning and the results carefully noted and recorded.

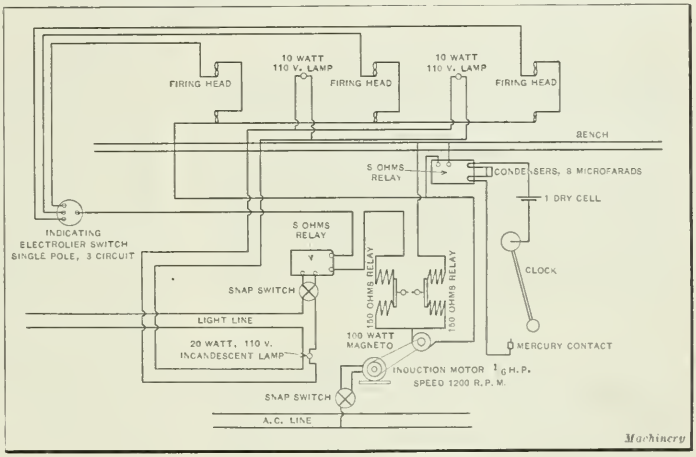


Fig. 6. Wiring Diagram of Fuse-testing Plant

Testing Burning Time of Fuses

To test the powder, sample timing rings are loaded and the fuse is assembled. An apparatus known as the "chronoscope" (manufactured by F. G. Street, 60 Broadway, New York City) is used to obtain and record the burning time of the fuses. This apparatus consists of the recording machine illustrated in Fig. 7 and the firing heads shown in Fig. 8. Two of these firing heads are located at a reasonable distance from the recording machine and are connected to it by electric wiring.

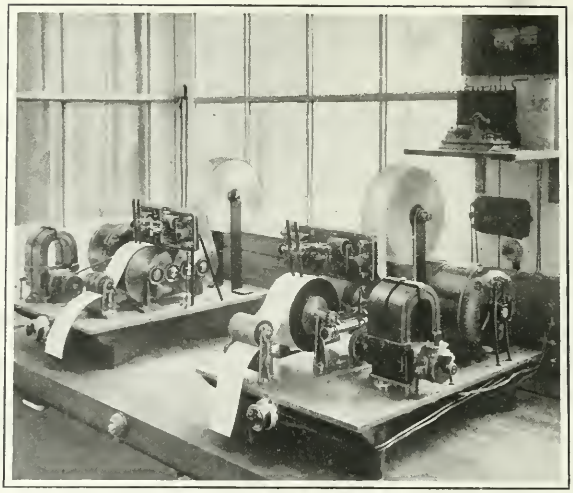


Fig. 7. Machine used to record Burning Time of Fuses

A laboratory clock is also connected by wiring with the recording machine. The fuse to be tested is placed in a firing head. The fuse cap (*B*, Fig. 2) has a hole bored through it to permit inserting a steel plunger that can be used for exploding the detonator. The fuse is screwed into the firing head beneath a suspended weight, which falls at a given instant by the releasing of a clutch. When the weight falls and strikes the steel plunger, the detonator explodes and instantly the paper tape of the recording machine begins to pass through the machine and the clock records on this tape each second of time. The explosion of the detonator also ignites the powder train in the upper timing ring, and, when the bottom ring escape hole disk blows out, it strikes a conveniently arranged plate which breaks the contact, thus giving a record of the burning time for the upper ring. This record is on the paper tape referred to. The lower timing ring burns until it ignites the magazine charge, which breaks another contact, so that a record of its burning time is also obtained. A fuse may be tested in approximately one minute, and it is claimed that the burning time obtained is within 1/100 of a second of the exact time. The time of burning is scaled off from the tape and corrections are made for atmospheric conditions. The wiring diagram of the fuse-testing plant is illustrated in Fig. 6.

Loading Fuse Rings

If the tests are satisfactory, a certain number (or "lot") of fuse rings are sent to the loading department. The ten men in the loading gang load approximately 4000 rings in nine hours. The presses used in connection with this work have a capacity of 75,000 pounds and are located at the curved end of the U-shaped loading table. The work is divided into assembling and disassembling the loading tools and distributing the powder. All powder is blended in accordance with the results obtained by the tests, and is sent to the loading rooms in relatively small brass-covered containers. The distribution of the powder into the channel is accomplished by means of the funnel shown at *A* in Fig. 11 This operation is important, as the powder must be uniformly distributed and of the exact quantity required, which is determined by using a measure that holds the correct amount. If the powder, which is fine like flour or meal, as the case may be, is packed or heaped up too much in the measure, there will be a variation in the loading, because the presses are set to compress to a certain load, which depends upon the amount of powder. Variations in distribution will produce hard and soft spots of powder, or broken trains, etc. The total scrap from this operation is about 3 per cent. The powder funnels should preferably be made of nickel, because the powder will not adhere to the sides of the funnel.

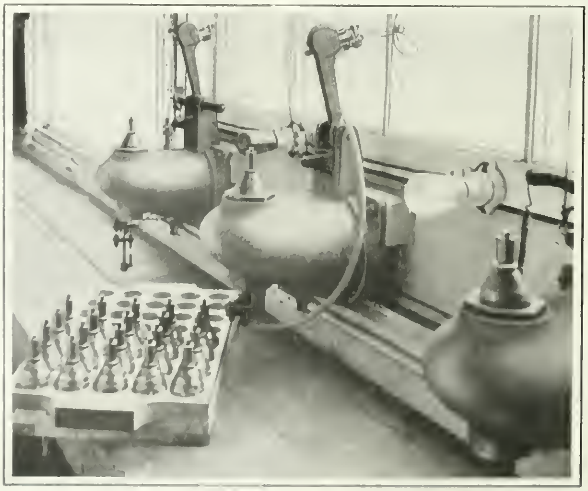


Fig. 8. Firing Heads used in Conjunction with Recording Machine illustrated in Fig. 7

The powder train in the upper timing ring is subjected to a pressure of 40,000 pounds when loading, and the train in the lower ring, to a pressure of 46,000 pounds. An Olsen testing machine arranged for this work is shown in Figs. 9 and 10. This machine applies the necessary pressure, and it has a scale or weighing mechanism to indicate the weight. The ring which is to have its upper train compressed is inserted in a loading tool, which is inserted in the press through the opening at *A*, Fig. 9. The machine shown is arranged for hand feeding, but some of the presses for fuse loading are equipped with automatic feeding mechanisms. The loading tool is inserted beneath a yoke which is forced downward by screws. These screws are rotated through a train of gearing and a silent chain drive connecting with the motor shown in Fig. 10. When the loading tool is properly located beneath the yoke that applies the pressure, the operator engages a clutch by means of hand-lever *B*, Fig. 9, and when the weighing scale shows that the required pressure has been applied, this driving clutch is disconnected. The automatic press feeder (manufactured by F. G. Street, 60 Broadway, New York City) is controlled by two small levers at the outer edge of the table. If both these levers are not compressed, the die or loading tool is not carried under the press. After the die is inserted in the carriage of the feeding mechanism, the operator's hands, after leaving the die, compress the two levers, thus releasing the carriage, which conveys the die to the proper position in the press. After pressure has been applied, the carriage moves outward and remains in the outer position until another die is placed in it, when the operation is repeated. The opening through which the die passes is automatically opened and closed by a safety door.

The loading tool used in conjunction with this press is illustrated in Fig. 12. This tool is, in reality, a box which encloses the timing ring in order to prevent any distortion of the ring or unevenness in pressure on the powder train. Pressure is applied to the part *A*, which is shaped at the lower end to correspond to the groove or channel in the timing ring. The ring *H* to be loaded is pressed over a central plug *B* in an arbor press. This prevents distortion of the bore. The part *C* has a locating pin in it, which is shown at *D* in the detailed sectional view. This locating pin is the

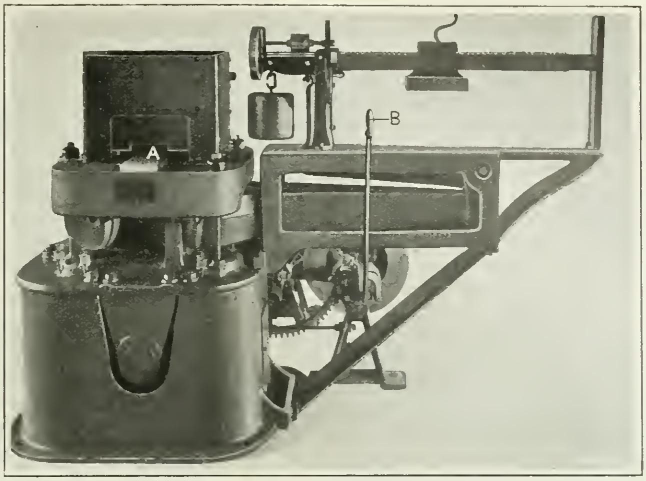


Fig. 9. Olsen Testing Machine adapted for applying Pressure to Powder Trains of Fuse Rings

means of guiding the sleeve *A* so that it does not shear the ends of the composition channel. The outer casing of the loading tool is held in place by a bayonet lock at *G*, which permits it to be removed quickly.

After the rings are loaded, they are faced off, because the powder may be either slightly above or below the surface of the ring. Garvin or other suitable shaving machines are used for this work and the rings are held in place on pull-back collet chucks. These chucks (see Fig. 13) are so constructed that they are not easily broken, and they have eliminated considerable trouble wherever used. The ring is gripped by loose leaves or segments *B* that are held in place by drill-rod pins *A*. These segments are expanded for gripping the work by a central tapering plug which is drawn backward in the usual manner. These shaving machines revolve at 1000 revolutions per minute, giving a surface speed of approximately 600 feet per minute, which is not sufficient to ignite the powder. The chips of brass and the powder dust are drawn away by an exhaust pipe and conveyed to a water tank which "kills" the powder. If the powder is not properly pressed into the composition channel, or if the tool is not in good condition, the composition, when turned or shaved off, will have a pitted appearance, which is permissible if not excessive. It is interesting to note that stellite, when used as a cutting tool, will not generate a spark like high-carbon steel, and its cutting qualities are satisfactory.

After the facing operations, the rings are gaged. One type of gage that is used to test the concentricity of lip *R*, Fig. 2, with the bore of the ring is illustrated at *B* in Fig. 11. This is a double-ended gage having pilots which fit closely into the bore. The particular gage shown is for testing the bottom ring, which must enter one side of the gage, but not the other. The rings are next varnished by using a sable brush, 3/8 inch wide, and a mixture of orange shellac, methylated spirits, and a small percentage of Venice turpentine. This mixture should be evenly applied.

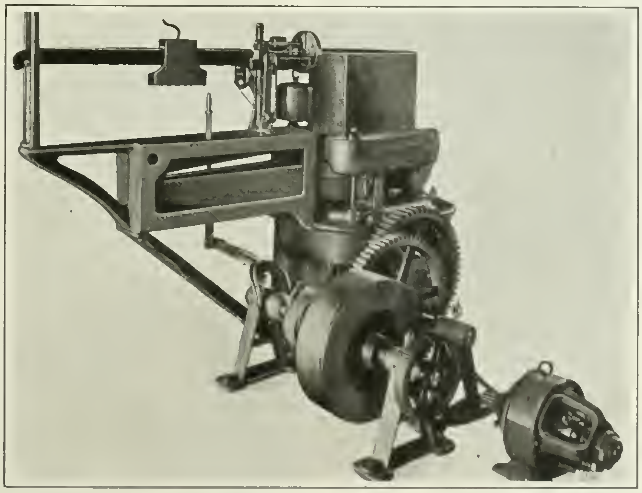


Fig. 10. Rear View of Testing Machine, showing Driving Mechanism

The burning time of the powder is perhaps the most bewildering part of fuse loading, because the test will show one result today and another that is quite contradictory tomorrow. It has been demonstrated, however, that careful attention to the various details involved in fuse loading is manifest later by the uniform and more satisfactory results obtained. A few points will illustrate the necessity of carefully watching the details. For instance, if the escape hole disks are fastened in very tight, or if the hole connecting the escape hole and the composition channel is not drilled, the burning will be very rapid, practically an explosion. If the flash hole in the top ring is drilled in the wrong location, the burning will also be affected. If the powder is broken away while drilling the vent hole, the results are likely to be erratic. The burning in the top rings is more uncertain than in the bottom ones.

Operations on Loaded Timing Rings

The assembling department which now receives the loaded rings is divided into sections, each of which is capable of turning out 10,000 rings in a nine-hour day. All the component fuse parts are conveyed and handled in lots of a hundred or multiples of a hundred, and the trays in which they are placed are standardized. This system simplifies the storekeeping. The sections of the assembling department are divided into top-ring, bottom-ring, and body benches. These benches are 4 feet wide and have a partition in the center. A 6-inch strip across the top of the partition forms a convenient shelf for holding trays, etc. The total length of each bench is about 36 feet.

The first operation is to ream the bore of each ring, which has been closed in slightly in the loading operation. A Henry & Wright drilling machine is used for this purpose; the fixture for holding the rings while reaming is shown at *A*, Fig. 14. The tapering seat in this fixture which receives the ring is semicircular, as shown by the plan view, and is open on the front side so that a ring can easily be inserted or removed. The ring is held downward by fingers *a* and *b*, which are connected to the fork-shaped handle *c*. This particular fixture is intended for the upper timing ring. The burr caused by facing the ring after pressing in the powder is next removed from the locating hole, after which a vent hole is drilled in the powder at the end of the composition channel. A rather unusual form of jig (shown at *B*) is used for this operation. This jig consists principally of a base *d* and the jig plate *e* to which the handle is attached. The ring to be drilled is held in place by plug *f* (which fits into the bore) and pin *g*, which enters the locating hole. After a ring has been placed on this combined handle and jig plate, the latter is pushed back into the V-shaped notch in plate

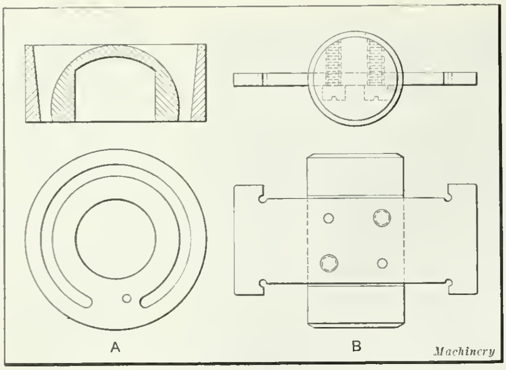


Fig. 11. (A) Special Funnel used for loading Fuse Rings. (B) Concentricity Gage for Fuse Rings

h, thus locating guide bushing *j* under the drill. This type of jig can be loaded and unloaded very rapidly.

The flash holes and the holes connecting the end of the composition channel with the escape hole are drilled in succession. The jig used for drilling the flash hole in the top ring is illustrated at *B* in Fig. 15. The method of testing the accuracy of the hole in the jig is illustrated by the detailed sketch *A*, Fig. 15. The end of a close-fitting rod or plug which projects through the jig hole should just make contact with a wire having a diameter of 0.0934 inch. The flash hole in the bottom ring is drilled on a double-spindle drilling machine. The counterbored part *K* (Fig. 2) is first formed. The wing *A*, Fig. 16, which carries the drill bushings is then swung back out of the way, and the small hole is drilled after moving the jig *B* along the base *C* to a position beneath the second spindle of the machine as determined by stop *D*. The jig for drilling the hole connecting the end of the composition channel and the escape hole is of the same general type as the one illustrated in Fig. 15, except that the guide bushing for the drill is in a projecting part of the jig body which extends out over the ring. The drill enters through the escape hole. The rings are now gaged to test the accuracy of the drilling. The form of gage used for testing the diameter and depth of the flash hole in the bottom ring is illustrated in Fig. 17. The step at *A* indicates the maximum and minimum depths.

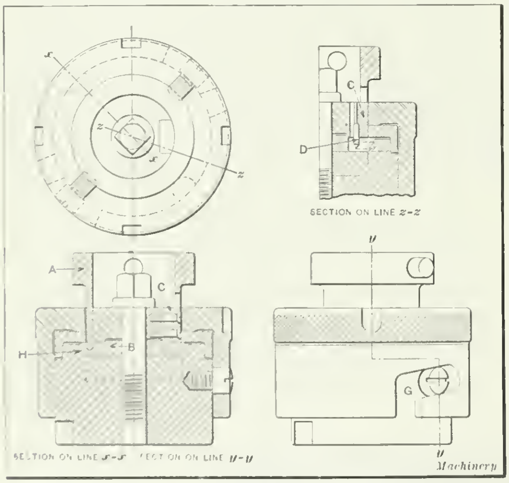


Fig. 12. Fuse Ring Loading Tool

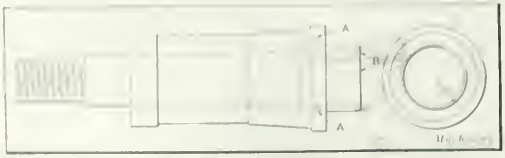


Fig. 13. Expansion Collet Chuck for holding Loaded Fuse Rings while facing

Powder pellets are next inserted in the escape holes, and the escape hole disks are put into place and "stabbed," which is accomplished by holding the ring at the correct angle and stabbing it with a die held in a Baird kick press. A small spring plunger holds the disk in place until the cutting face of the die strikes it. The shellac which is now applied to the ring acts as an adhesive for the paper washers which are put on before the shellac has time to dry. The faces of the rings should not be handled prior to this operation, because this will prevent the paper washers from sticking. These washers are applied to the lower faces of each timing ring, and their purpose is to exclude moisture from the powder. The washer which adheres to a ring is smoothed out on a felt-covered board. After the shellac has been given a little time to dry, the top or serrated face of the lower timing ring is shellacked and a felt washer is placed over it. This washer is shown at *U* in Fig. 2, and, as will be seen, there is another washer between the lower timing ring and the fuse body. When these washers are placed in position it is important to see that the hole in the washer left for the flash exactly coincides with the hole in the timing ring or fuse body, as the case may be. The gage used for testing the position of the felt washer on the bottom timing ring is illustrated in Fig. 18. The flash hole is seen through hole *A* in the gage. This gage also checks the position of the flash hole and its relation to the index or lighting line, which should coincide with the beveled edge *B*.

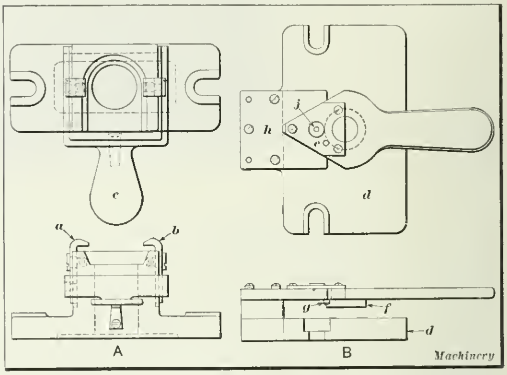


Fig. 14. (A) Fixture for holding Fuse Rings while reaming. (B) Jig for drilling Vent Hole in Powder at End of Composition Channel

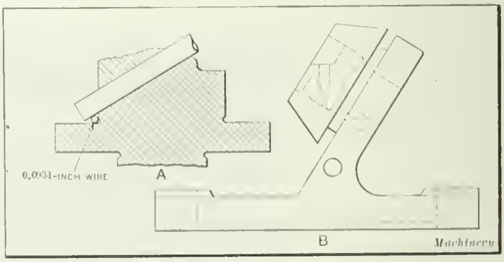


Fig. 15. Jig for drilling Flash Hole in Top Fuse Ring

A pressure of one hundred pounds is now applied to each ring by using a small arbor press. The application of this pressure makes it unnecessary to allow time for drying. The paper washers are waxed by lightly rubbing them over an electrically heated wax-covered plate, and the rough edges of paper are removed with a knife. The excess shellac is next removed from the flash holes, and either powder pellets or mealed powder is inserted. The insertion of mealed powder is a slower operation than inserting pellets, and consequently

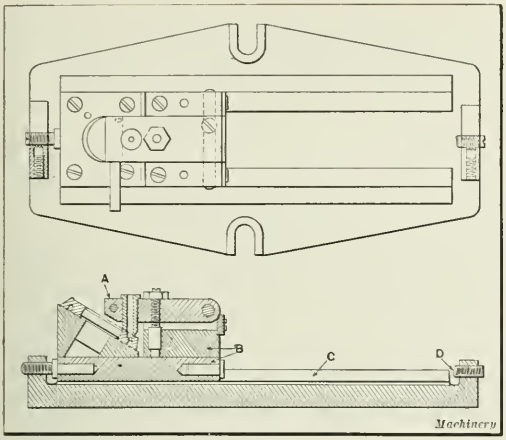


Fig. 16. Jig for drilling and counterboring Flash Hole in Bottom Ring

the former is not used much. Inspectors are located wherever necessary along the assembling benches, which eliminates any congestion, because if the work is not being done properly, it is stopped immediately.

General Assembling Operations

The assembling operations on the body of the fuse are similar to those described for the bottom timing ring in so far as applying the felt washers is concerned. These washers, by the way, are kept in an electric heater until required, so that they will not absorb moisture. Some fuse manufacturers place the rings in an electric heater after lacquering them as a precaution against the absorption of moisture. After the felt washer is placed on the fuse body, the timing rings are set roughly in place and a drilling machine operator spots them accurately and drills the two securing pin-holes. The jig for drilling these pin-holes is illustrated in Fig. 19. The end of the spring plunger *A* engages the key slot in the body of the fuse, and pointer *B* is set on the index line, which is spotted by tapping the end of the pointer with a wooden mallet. The top or jig plate *C* is next put into place and the holes are drilled. These holes are half in the stem of the fuse body and half in the upper timing ring. Pins are afterward inserted into them to serve as keys.

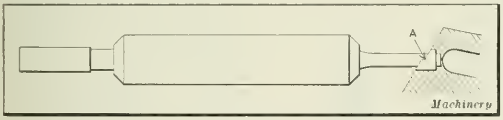


Fig. 17. Gage for testing Diameter and Depth of Flash Hole in Bottom Ring

The drilling operation just described is not performed as quickly as the others, so that some of the work is conveyed to the opposite side of the bench by means of a mechanical conveyor and automatic distributor, which is illustrated diagrammatically in Fig. 20. This conveyor is equipped with a canvas belt which operates between wooden strips along the side, as shown. The fuse bodies are carried along by the belt in the direction indicated by the arrow. Some of the fuse bodies are required to go down the chute *D*, whereas others move straight along to the right-hand end of the conveyor. The path followed by the fuse body depends upon the position of the distributing arm which is pivoted at *E*. Whenever a body strikes the arm at *A* it moves straight along, but turns the distributor about pivot *E* so that the next fuse body comes into contact with arm *B* and slides down the chute *D*, thus striking arm *C*, which returns the distributer to its original position. After the rings have been removed and the burrs formed by the drilling operation have been filed off, the entire fuse is reassembled and the securing pin inserted.

Screwing on Fuse Caps and Testing Friction of Timing Ring

The cap *B*, Fig. 2, is next put on and tightened down with the tensioning fixture illustrated in Fig. 21. The base *A* of this fixture, which holds the fuse body, is free to revolve when subjected to a load that will permit the bottom ring to be turned when the turning moment is equivalent to 144 inch-ounces within 12 inch-ounces plus or minus. When the cap is being screwed down to secure the right amount of friction for the timing ring, it is engaged by two pins *B* in the fixture, which enter small holes previously drilled in the cap. When the cap has been tightened sufficiently to lift the weight *C*, the fuse is removed from the fixture and allowed to stand over night.

The next operation is testing the tension or friction which is done by using the fixture illustrated in Fig. 22. This fixture is arranged to hold the base of the body stationary in holder *G* and revolve the lower timing ring. The ring is revolved twice to remove any high spots on the wax or felt washer before testing the tension. While the ring is being turned in this way, the catch *A* is in the position shown in the illustration. This catch is then released so that the spindle which holds the fuse is free to turn except as it is restrained by the weight *C* attached to the end of the arm or lever shown. The amount of friction or tension between the ring and the fuse body is indicated by the height to which this weight is lifted, as determined by graduations on the housing of the fixture and a finger attached to the lever arm. The cup-shaped member *E* on the end of the crank spindle has projecting lugs *F* which engage a small pin on the lower timing ring. A small spring pin or clip *B* engages the U-slot in the body of the fuse and prevents it from turning relative to the holder *G* of the fixture. The cap-tightening or friction-setting fixture illustrated in Fig. 21 also has a similar pin for holding the fuse body against rotation. The bottom ring is now lined up to safety with the index mark on the top ring and the fuse is gaged to see that the top and bottom ring lines coincide with the left-hand side of the key slot. A simple form of gage is used for this purpose.

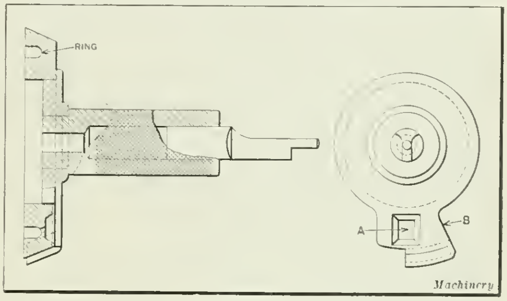


Fig. 18. Gage for testing Position of Felt Washer on Lower Timing Ring

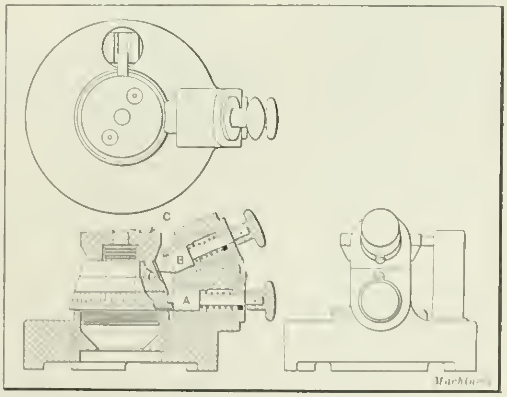


Fig. 19. Jig for drilling Holes in which Pins are Inserted to hold Upper Fuse Ring in Position

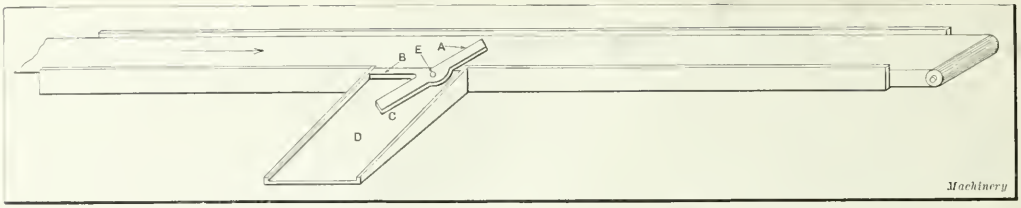


Fig. 20. Diagram illustrating Principle of Mechanical Conveyor and Automatic Distributor used in Fuse-loading Plant

One of the important points in connection with the tensioning test is to make sure that the stem or central part of the fuse body is at right angles to the platform or flange on which the timing ring rests and that the central stem is concentric with the projecting lip *R* (see Fig. 2). The concentricity gage, which is shown at *A*, Fig. 23, is a very simple form. This gage, which has "Go" and "Not go" ends, is simply inserted over the central stem of the fuse body; the latter is accurate as to size, and the gage enters the projecting lip of the body platform at one end, but will not enter at the other if the fuse body is properly made. This insures that the bottom ring will not catch. The gage for determining whether or not the stem is at right angles to the platform or flange is shown at *B*, Fig. 23. This gage is placed over the central stem of the fuse body, and the alignment between the lower ends of the gage and the flange of the fuse body is noted. This gage was used because the serrated surface in some cases was formed by a separate operation. If the tool used for this serrating operation were not properly set, or if this surface were not square with the central stem, the friction or tension of the adjustable ring would be uneven, and if the inaccuracy were considerable, the burning time of the powder train might be seriously affected by an excess amount of air entering between the felt washer and the ring face.

Putting in Base Charge

The hole for set-screw *S*, Fig. 2, which holds the cap in position, is next drilled and the screw inserted. The percussion pellet *N* and the other parts connected with it are now inserted, after which the base plug *T* is screwed into place. The base charge is then put into the fuse through the filling hole. This is done by placing a convenient number of fuses in a suitable frame, which is carried by a cradle over which are suspended the same number of funnels as there are fuses to be filled. These funnels contain the correct amount of powder which is deposited in the fuses when the cradle is jolted by a cam which lifts it and allows it to fall, striking the bench. Some concerns use pneumatic vibrators for this work but these are very noisy as well as costly. The funnels may conveniently be filled with powder by having a horizontal tube with a rotary lining, which, as it revolves, permits the powder to fall through holes into the hopper beneath. After the filling-hole screws are driven into place, a waterproofing material is rubbed into the junctions of the ring, cap, and body. This material is composed of the following parts by weight: beeswax, 2 parts; mineral jelly, 1 part; French chalk, 2½ parts. This composition is put on with a flat stick, while the fuse is rotated with the hand fixture illustrated at *A* in Fig. 24. The end of the spindle of this fixture has a hole which is threaded to suit the fuse body. Any excess composition is removed with a rag.

Testing Weather Covers

The next operation is that of soldering the weather covers in place. These covers must be air-tight, and they are tested previously by using a special vacuum testing apparatus having a barometer tube which connects three valves to a block that carries a rubber washer. The cover to be tested is placed on this washer and is connected to the vacuum chamber. The gage glass is first connected to the vacuum chamber, which causes the mercury column to rise, the cover at this time being disconnected from the vacuum. The vacuum chamber is next disconnected from the tube and the cover is connected with the vacuum. If the cover is tightly jointed, the column of mercury will fall to a definite level and remain there, whereas any leaks will be indicated by the fact that the mercury continues to fall. As some time elapses before the column of mercury comes to rest, it has been found that if ten covers and ten tubes are used, by the time the last cover is placed in position the first mercury column will be ready for reading.

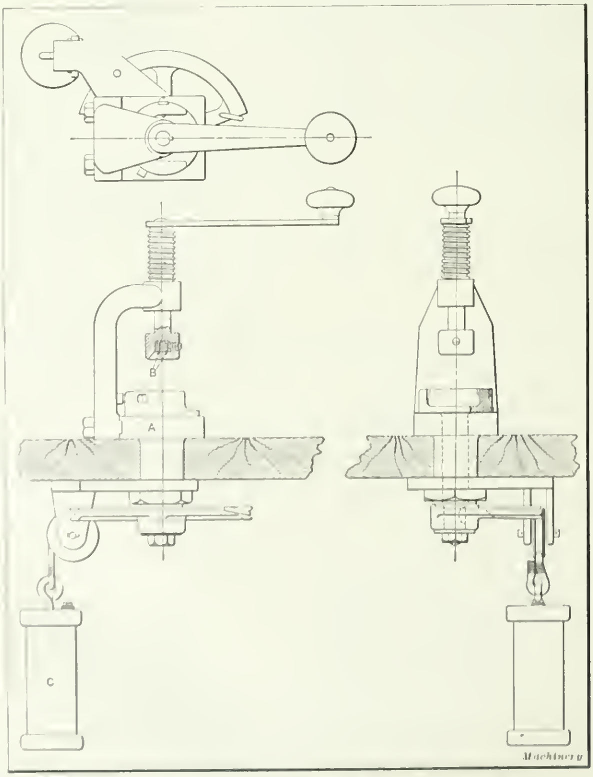


Fig. 21. Device used for screwing on Fuse Caps, which is arranged to regulate Friction or Tension

Minor Operations on Fuses

There are a few minor operations which a loading plant generally performs on the body and smaller parts which make up the fuse. One of these operations is assembling the time and percussion pellets *E* and *N*, Fig. 2; this includes inserting the detonator and the screw plug which holds the detonator in position. The hand fixture *B*, Fig. 24, is used for screwing these plugs into place. The pellet is held in the split clamp *a*, which is opened or closed by a screw connecting with hand-lever *b*. The spindle carrying the screw driver *c* is pressed down by hand when inserting a screw and then is automatically withdrawn by the spring shown. These screws are fastened into place by a "stabbing" operation, which is done in an ordinary kicker press having a dial feed. The lot numbers and dates are also stamped on the bases of the fuse bodies in a kicker press which has the foot-lever removed, the ram being lifted by hand and allowed to drop freely. A blow was found necessary in order to stamp the figure properly. An operator is capable of stamping 6000 fuse bodies in nine hours by this method.

The felt washers *U* and *V* (see Fig. 2) are cut out on a punch press equipped with an automatic roll feed having only one roll at the pushing end and two rolls at the pulling end. The felt is supported on vulcanite while being cut. One press cuts 30,000 washers per day of nine hours. As the washers and blanks are not separated completely from the felt stock on account of small threads which hold them, the felt is passed over an arm attached to the housing of the press. This arm has a projection on it which is jolted by the descending press ram striking it, and this serves to shake the blanks free from the stock. The linen washers are punched from four thicknesses of stock with a gang punch, which cuts over 200,000 in nine hours. These washers are punched through a hard die by punches which were left soft so that they were trimmed or shaved to the proper shape by the die.

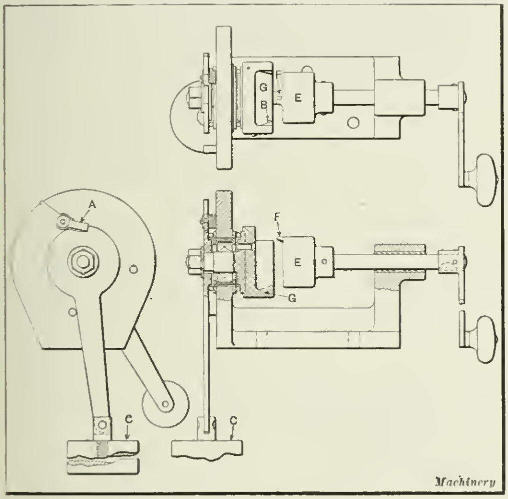


Fig. 22. Apparatus for testing Tension or Friction of Adjustable Timing Ring

The lead washers which are inserted under the needle *G*, Fig. 2, caused trouble at one time, owing to the metal clinging to the clearances of the die. A small percentage of antimony and tin was added with satisfactory results. These washers are first drawn to a cup shape, so that when they are afterward flattened out beneath the flange of the needle or firing pin, the recess beneath this flange will be completely filled, thus forming a tight joint. If there is any escape of the time pellet explosion past this washer, a premature explosion will occur, often with serious results.

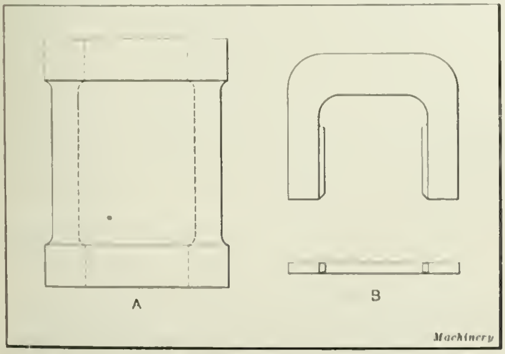


Fig. 23. (A) Gage for testing Concentricity and Diameter of Fuse Body Platform or Flange. (B) Right-angle Gage for testing Position of Flange Relative to Central Stem of Fuse Body

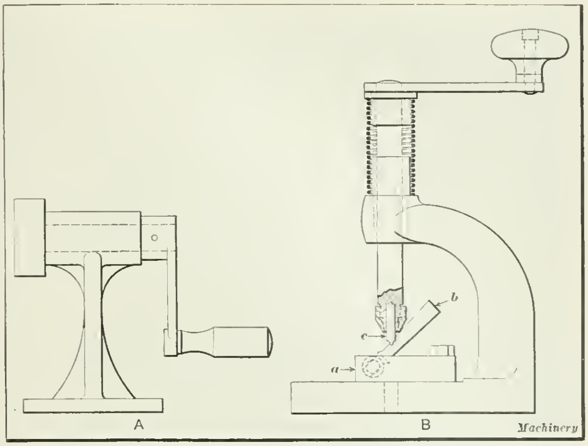


Fig. 24. (A) Fixture for rotating Fuse while applying Waterproofing Composition. (B) Hand-operated Fixture for inserting Screw Plugs that hold Detonators in Time and Percussion Pellets

The rate at which these small parts are assembled is indicated by the following figures representing one girl's production in nine hours for each of the respective operations: 600 needles inserted in the fuse body; 800 ferrules painted with shellac; 5800 detonators put in the percussion pellet; 5800 detonators put in the time pellet; 5800 disks put in the detonators; 5800 screws driven in the pellets; and 12,000 pellets stabbed.

The making of the powder pellets for the flash and escape holes is performed in an isolated department. Formerly power presses equipped with accumulators were used, but the operation was slow, only 16,000 pellets being produced in nine hours by three machines. Hess & Barker pill-making machines are now used for this work, and one machine produces 6000 powder pellets per hour. These machines are automatic in their operation.

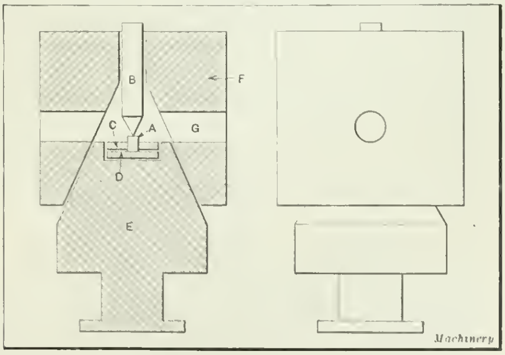


Fig. 25. Part of Detonator Testing Apparatus

Testing Completed Fuses

The fuses which are selected for the proof test are treated as follows: The percussion mechanism is removed from ten fuses, which are then fired in the electrical testing machine to determine the mean or average time of burning when the fuse is at rest. When the time fuse is set for the greatest length of time, the mean time of burning, when corrected for the barometer, should be 22 seconds plus or minus 0.2 second.

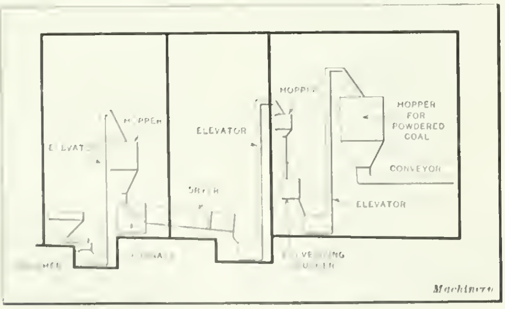
The constant used when correcting for the barometer is at the rate of 0.023 of the mean time of burning for every inch the barometer is above or below 30 inches. This value is added when the barometer is above 30 inches and subtracted when it is below that point. The burning time of each fuse is tested while the fuse is revolving at 2500 revolutions per minute, and the time must be within the limits specified. The fuses are also subjected to time and percussion tests by attaching them to shells and firing from a gun. The detonators are tested by a falling weight, and if they fail to explode, the entire lot is rejected. A part of the detonator testing apparatus is illustrated in Fig. 25. The detonator is in contact with a steel needle *B*, upon which the weight falls. The detonator is surrounded by a strawboard washer *C* about 1/8 inch thick and a copper disk *D* about 1/16 inch thick. The base *E* and the part *F* which encloses the pin and detonator are made of steel. A hole *G* is drilled through part *F*, so that the one making the test can see whether or not the needle is resting properly on the detonator. The weight which strikes the needle is held up by an electric magnet, which allows the weight to fall when the current is shut off. The falling part weighs three or four ounces and drops from heights varying from six to ten inches, depending upon the kind of detonator tested. These detonators are made from a mixture of chlorate of potash, sulphide of antimony, and fulminate of mercury. They are highly explosive when scratched or rubbed even very slightly, and for this reason the precaution is taken to have the benches on which the detonators are handled divided from the adjacent ones by glass partitions to guard against flying particles of copper.

* * *

SOLUTION OF THE FUEL PROBLEM

BY G. C. W.

Now, when the conservation of our natural resources is necessary and when transportation facilities are uncertain, the fuel problem is becoming more difficult to solve; but is it the shortage of coal that is troubling us as much as the question whether we are using what we do receive to the best advantage? Ordinarily, large users specify the number of British thermal units, the quantity of ash, moisture, etc., that the coal shall contain, but existing conditions do not permit this to be done. It might, however, be possible to make a change in the quality of the coal or to rearrange the furnace or apparatus, paying particular attention to the personal factor, and make complete tests. The analysis of the coal, the kind of grate and draft, size of coal, etc., are also contributing factors.



Coal Pulverizing Plant

A great deal of thought is being given to the burning of dust, sweepings, culm, slack, screenings, strip pit products, as well as lignite, peat, and the larger sizes of coal when dried, pulverized, and burned in suspension. Burning in suspension develops every contained heat unit just where it is wanted and not up the stack, etc. An accurate control of the air blast, which is not dependent on the condition of the atmosphere, grates, fuel bed, or wind velocity, supplies only the air necessary for complete combustion and the whole heat of the fuel is available at once. The air pressure should be 1 ounce at the nozzle and 4 to 6 ounces in the coal feed. Preheating the air to 500 degrees F. saves 20 per cent of the fuel. This preheating is easily accomplished by passing a few lengths of blast-supply pipe through a chamber heated by the waste gases.

Coal containing as little as 28 per cent volatile combustible matter, 11 per cent ash, and 2.7 per cent sulphur is being burned successfully, except in cases where it is important that the composition of the material being worked is not affected by the sulphur. The moisture content should be below 1 per cent and preferably below 0.5 per cent. As powdered coal absorbs moisture at the rate of 0.01 per cent per minute for 50 minutes, when the rate decreases, care must be taken to keep it covered. The drier the coal, the easier will it grind and the easier can it be handled, for it will not then tend to form lumps and clog the conveyors. This moisture is not so much that produced by ice, snow, rain, etc., but it is, rather, the inherent moisture of the coal, and in drying coal the more moisture it contains the more expensive will be the drying operation. When the moisture in the coal exceeds 10 per cent, it cannot be reduced to 0.5 per cent by drying.

COST OF OPERATING AVERAGE PULVERIZING PLANT

Capacity of Plant, Short Tons per Hour	Cost per Ton, Cents	Capacity of Plant, Short Tons per Hour	Cost per Ton, Cents
2	35 to 60	10	22 to 40
4	30 to 55	25	20 to 30
5	24 to 45	..	....

Machinery

It is important that 95 per cent of the pulverized coal should pass through a 100-mesh sieve and 80 per cent should pass through a 200-mesh sieve. The feed-controlling element and the size of the burner are important and should be varied according to the size of the furnace.

In the pulverizing plant shown in the accompanying illustration, the cars of fuel are run upon a siding at one end of the milling building and empty the coal into a concrete pit beneath the tracks. This pit contains a hopper, 8 feet square and 6 feet deep, made of 3/8-inch steel plates that feeds into a standard 6-inch U-shape cable conveyor that has adjustable cast-iron supports. This conveyor takes the coal to a crusher, which is able to break 8-inch lumps into 3/4-inch cubes; these are then fed into the pulverizer. Crushers are sometimes provided with means for allowing foreign substance to go through without breaking the machine.

From the crusher, the coal is elevated 35 feet by a bucket conveyor to a 60-ton bin, which has a hopper bottom, from which it is fed to the dryer by a 12-inch standard screw conveyor. This dryer is composed of two concentric shells made of heavy steel plates; the inner shell, or flue, is connected with the ouside cylinder at the center by six heavy cast-iron arms riveted at both ends. The shell is 48 inches in diameter and 20 feet long. It is supported by rollers and is revolved by spur gearing at a speed of six revolutions per minute. The flue is connected with a furnace and the hot air passes through to the space between the inner and outer shells. A belt-driven, centrifugal, exhaust fan connected to the dryer removes the spent gases from the shell and discharges them through a centrifugal dust collector, which gathers all the fine particles of coal dust taken up in passing through the dryer. An elevator now carries the coal to a dry-coal bin, from which it passes to the pulverizing mill. The coal is then stored in the powdered-coal bin. The dryers and pulverizers should be located in separate buildings on account of the liability of explosions.

A general average of the cost of operating pulverizing plants is given in the accompanying table. The initial outlay is not so great if one is familiar with what is required, as all the appliances are rough work, consisting of boiler plate, piping, etc. The location of the plant in relation to the source of supply is of the utmost importance when considering the installing of a pulverizing plant, as on it depends the amount of saving that will be effected.

TWISTING AND BENDING MOMENTS IN SQUARE AND RECTANGULAR BARS[1]

BY VICTOR M. SUMMA[2]

The section modulus for square bars is $Z = \frac{a^3}{6}$, in which a is the length of the sides, and the polar section modulus is $Z_p = 2/9\,a^3$. Calling M and T the bending and twisting moments, respectively, the stresses are:

$$S = \frac{6M}{a^3}, \text{ and } S_s = \frac{9T}{2a^3} \qquad (a)$$

The values are then substituted in

$P_1 = 1/2\,(S + \sqrt{S^2 + 4S_s^2})$ and $P_2 = 1/2\,\sqrt{S^2 + 4S_s^2}$ (which are given in "Combined Twisting and Bending Moments," December, 1917) in which:

S = unit stress in tension or compression;

S_s = unit stress in shear;

P_1 = greatest unit stress in tension or compression produced by the simultaneous stresses S and S_s;

P_2 = greatest unit stress in shear produced by the simultaneous stresses S and S_s.

The results are:

$$P_1 = 1/2\left(\frac{6M}{a^3} + \sqrt{\frac{36M^2}{a^6} + \frac{4 \times 81 \times T^2}{4a^6}}\right)$$

$$= 1/2\left(\frac{6M}{a^3} + \frac{1}{a^3}\sqrt{36M^2 + 81 \times T^2}\right)$$

$$= 1/2\left(\frac{6M}{a^3} + \frac{6}{a^3}\sqrt{M^2 + 2.25T^2}\right)$$

$$= \frac{3}{a^3}\left(M + \sqrt{M^2 + 2.25T^2}\right)$$

$$= \frac{M + \sqrt{M^2 + 2.25T^2}}{\frac{a^3}{3}}$$

Divide the terms of the above fraction first by 2 and then by 9/2; the results are:

$$P_1 = \frac{1/2M + 1/2\sqrt{M^2 + 2.25T^2}}{\frac{a^3}{6}} = \frac{1/2M + 1/2\sqrt{M^2 + 2.25T^2}}{Z} \qquad (1)$$

$$P_1 = \frac{2/9M + 2/9\sqrt{M^2 + 2.25T^2}}{2/9 \times \frac{a^3}{3}} = \frac{2/3M + 2/3\sqrt{M^2 + 2.25T^2}}{Z_p} \qquad (2)$$

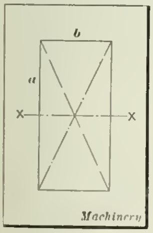


Diagram for obtaining Section Moduli of Rectangular Bars

Since P_2 is nothing else than P_1 minus the term outside the radical:

$$P_2 = \frac{1/2\sqrt{M^2 + 2.25T^2}}{Z} = \frac{2/3\sqrt{M^2 + 2.25T^2}}{Z_p} \qquad (3)$$

For rectangular sections $Z = \frac{ba^2}{6}$ or $\frac{ab^2}{6}$ and $Z_p = 2/9\,ba^2$ or $2/9\,ab^2$, according to the fibers being investigated along side a or side b as illustrated. Under flexure about axis X-X, the portion of the material that is most strained is along side b, and the moduli to be used are $Z = \frac{ba^2}{6}$ and $Z_p = 2/9\,ba^2$. Substituting as in Formulas (a):

$$S = \frac{6M}{ba^2} \text{ and } S_s = \frac{9T}{2ba^2}$$

By comparing these values with Formulas (a) it will be noticed that the only difference is in the denominators. Therefore, substitute ba^2 for a^3 in Formulas (1), (2), and (3) and the following equations result:

$$P_1 = \frac{1/2M + 1/2\sqrt{M^2 + 2.25T^2}}{\frac{ba^2}{6}} = \frac{1/2M + 1/2\sqrt{M^2 + 2.25T^2}}{Z}$$

$$P_1 = \frac{2/9M + 2/9\sqrt{M^2 + 2.25T^2}}{2/9 \times \frac{ba^2}{3}} = \frac{2/3M + 2/3\sqrt{M^2 + 2.25T^2}}{Z_p}$$

$$P_2 = \frac{1/2\sqrt{M^2 + 2.25T^2}}{Z} = \frac{2/3\sqrt{M^2 + 2.25T^2}}{Z_p}$$

Remembering the distinction between either Z or Z_p for square and rectangular sections, the following formulas give the maximum stresses of both:

$$P_1 = \frac{1/2M + 1/2\sqrt{M^2 + 2.25T^2}}{Z} = \frac{2/3M + 2/3\sqrt{M^2 + 2.25T^2}}{Z_p}$$

$$P_2 = \frac{1/2\sqrt{M^2 + 2.25T^2}}{Z} = \frac{2/3\sqrt{M^2 + 2.25T^2}}{Z_p}$$

The user of these formulas should not forget their derivation, not only with reference to the cross-section of the bar under investigation, but also to the two expressions of section moduli of non-circular members.

* * *

TIME EFFECT IN REHEATING STEEL

According to a paper read before the American Institute of Mining Engineers by A. E. Pellis, metallurgist of the Springfield Armory, the time effect in reheating certain steels below the critical range is very marked. Increasing the drawing time increases the machineability, ductility, and resilience; though the elastic limit and tensile strength are lowered, this loss is slight compared to the relatively great increase in ductility and impact strength. It was found that at least a two-hour reheating is necessary to produce satisfactory machineability in a steel containing 0.54 per cent carbon, 0.05 per cent sulphur, 1.22 per cent manganese, and 0.065 per cent phosphorus. Untreated, this steel has an elastic limit of 69,800 pounds per square inch, a tensile strength of 128,700 pounds per square inch, an elongation of 15 per cent, and a reduction of area of 35.2 per cent. At the end of one hour's reheating the steel has an elastic limit of 124,250 pounds per square inch, a tensile strength of 137,000 pounds per square inch, an elongation of 17 per cent, and a reduction of area of 42.2 per cent. Twelve hour's reheating decreases the elastic limit to 98,750 pounds per square inch and the tensile strength to 116,500 pounds per square inch, and increases the elongation to 22 per cent and the reduction of area to 57.2 per cent.

* * *

LOST TIME THROUGH ACCIDENTS

A report recently issued by the United States Bureau of Labor Statistics on accidents in the machine building industry indicates that, in spite of all that has been done to prevent accidents, there are still too many industrial casualties. The bureau investigated 194 plants and found that on an average each worker lost 5.6 working days out of 300 in a year, due to accidents. Yard labor shows the highest percentage, with 29 days lost per worker due to accidents in a year. Boiler shops also show a high rate of lost time due to accidents, primarily as the result of insecure trestles and scaffolding. The high rate of accidents in yards is due to general neglect of safe location and construction of transportation systems, coupled with a lack of safety precautions and instructions. Accidents from falling objects are more frequent, apparently, than any other, the annual rate being fourteen per one thousand workers. Cranes and hoists appear to cause the most serious accidents, if the average time lost through accidents due to this cause is considered as a measure of the severity of the injury.

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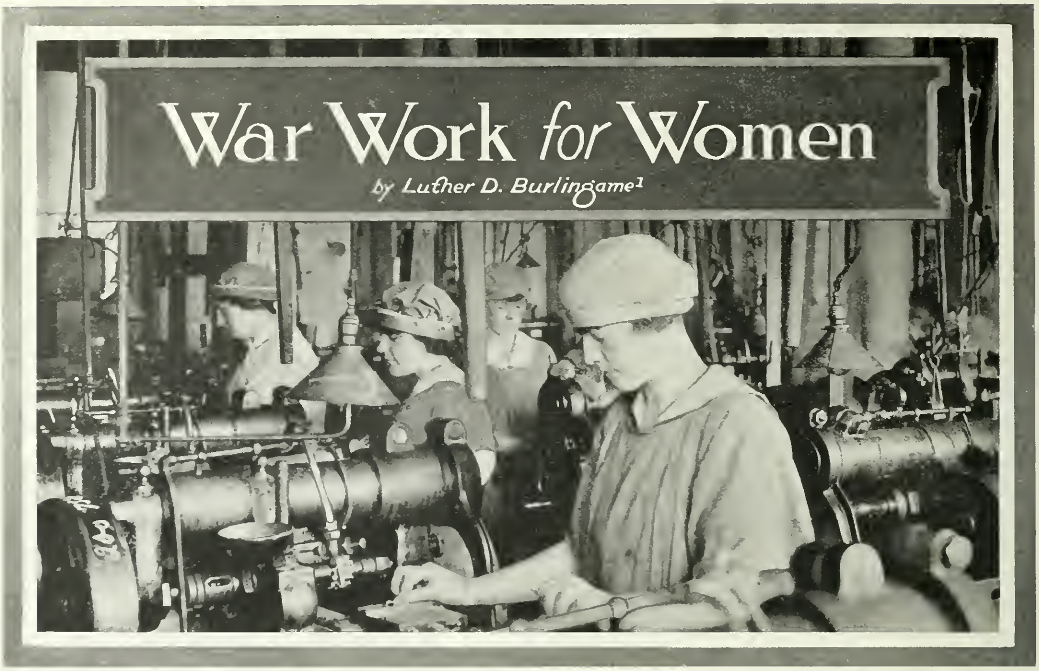
[1] See also MACHINERY, August, 1914, "Compound Stresses"; March, 1916, "Formulas for Combined Bending and Torsional Stresses"; and December, 1917, "Combined Twisting and Bending Moments."

[2] Examining Engineer, American Brake Co., St. Louis, Mo.

War Work for Women

by Luther D. Burlingame[1]



At the time when the industrial inventory was taken by the Naval Consulting Board in order to ascertain the resources of the nation for war purposes, a question which was put squarely up to each manufacturer was: "To what extent can women be employed in your factory to replace men?" This brought widely varying answers. On the part of those who had informed themselves as to the extent to which women were being successfully employed in England and on the continent, the answer to this question was very different from what it would have been a year or two earlier, before the success of women in such work had been demonstrated. Even these employers, however, had little realization of how quickly and effectively women's work would be able to fill the gaps made in the working forces in our machine shops. The estimates made at the time of taking the industrial inventory as to the extent to which women can be used are now being put to the test, and it is being learned that women, under proper supervision and training, can quickly fit not only into the lines of work which it had previously been thought they were adapted for, but also into many lines which it had been felt could be performed only by trained mechanics.

The consideration given by the officials of the Brown & Sharpe Mfg. Co. to the matter of the employment of women at the time of filling out the inventory referred to had paved the way, so that as soon as America entered the war, steps were taken to make use of women's services in the machine shop. Up to that time no women had been employed by the company for machine shop operations or for any work connected with the machine shop, the employes holding clerical positions throughout the shop, as well as tool-room attendants, and those employed in the packing and shipping departments having been men. At the present time about 750 women are employed in shop positions. The first step toward the employment of this class of help was to prepare locker and rest rooms at accessible points throughout the factory, with suitable provision for their convenience, a serious problem being to find space when every available inch was required for production. These accommodations were finally arranged for with comparatively little curtailment of manufacturing space, one of the largest of these rooms being located on the roof of a one-story building, reached by a covered passageway.

It is estimated that in order to provide satisfactory accommodations of this kind for women employes the average cost is about $25 and the space required about ten square feet per employe. Figs. 3, 4, and 5 show the furnishings and the equipment provided. A gas stove is placed in each rest room, as shown in Fig. 5.

It was felt, in order to secure and retain the services of the class of girls desired, not only that the legal provisions as to such accommodations for employing women should be met, but also that the condition of the factory should be maintained at a specially high standard as to cleanliness, orderliness, safety, and discipline. The success of efforts in this direction was indicated by a remark of one of the girls who stood talking with her foreman. Picking up a key she had accidentally dropped, she said, "I must not lose that; it is my key to heaven." The foreman asked her what she meant by calling that her "key to heaven," and she said: "It is my locker key. Having a locker all to myself is so much better than any provision I have had in any other place where I have worked that I call it my key to heaven."

From our experience in the employment of women, we believe that by starting in on a small scale, beginning in departments where the work is most directly adapted to their employment, and gradually extending the work to new departments, much better results can be obtained than by waiting until the emergency is so great that, in order to carry on the work at all, large numbers must be hired during a short period, without allowing time for the individual attention needed.

The method pursued by the company for introducing the employment of women into their machine departments was to first set aside one corner of a room for training. Six girls were employed and each taught a different operation, selecting, first, operations which seemed most suitable for such employes. When they had become sufficiently proficient so that their production was on a commercial basis, they were transferred to the departments of the shop where such work as they had been taught was being done and occupied places among the regular workers. Within a few days a second girl was put beside each of these, and this gave not only a sense of companionship but served as a stimulus to both girls; to the first to set the pace, and to the second to keep up or excel. The ice thus being broken, additional girls were added as rap-

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[1] General Superintendent, Brown & Sharpe Mfg. Co., Providence, R. I.

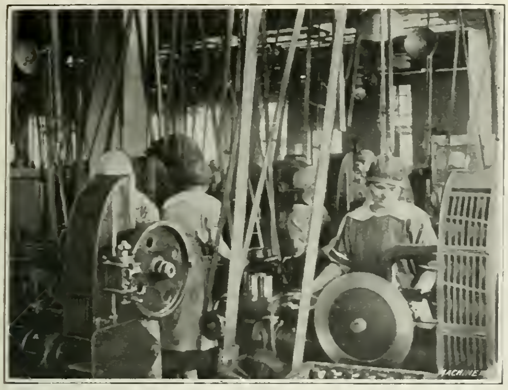


Fig. 1. Automatic Gear-cutter Work in which Girls are taught to set up and measure

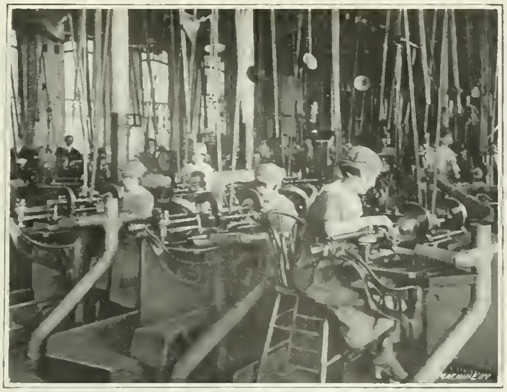


Fig. 2. Sharpening Cutters on Tool Grinding Machines, showing Exhaust System for carrying off Dust, and Comfortable Chairs for Girl Operators

idly as they could be assimilated, and their employment has since spread to all parts of the shop, so that now there are few departments, except the foundry, that do not employ women.

Comparison between Men and Women Workers

In our own experience, without doubt, much more attention has been given by foremen and fellow-workmen to the supervision of women's work than has been given to the average male employe in the past, the assumption being that a woman, having less mechanical background and intuition than a man, required more training and more specific instructions. This has been the reason advanced by some foremen in explaining why women were doing better work and had "broken in" more quickly than men, and they have added, "If we had given the same kind of attention to each new man employed, he would have done just as well as the girl"; this is, after all, an admission on the part of the foreman that he had not in the past helped all he could, and an indirect compliment to the girl having much significance. It may be noted, however, that at the time when such comparisons were made, the average man who could be secured was of an unsatisfactory and irresponsible class, as so few trained or competent men were available for positions in the industries, while, on the other hand, in hiring girls, a selection from a large number of applicants could be made, so that it was possible to obtain a much better average having the qualities to make successful workers.

Many of the theories which some officials and foremen had held regarding the troubles and problems which would arise in the employment of women have been exploded when put to the actual test. For example, it was believed by some that the best results would not be obtained by having men and women work together in the various departments, but that there should be separate departments for each. Experience has shown that there are advantages in having both in the same department, as it tends to hold the same standard of workmanship and speed for women as for men, while it is believed that having a separate department for women may establish a separate and lower standard, the tendency being to make more allowance for women because of sex. The results seem to show that it is not at all necessary that separate standards should be established and that in some lines of work even more can be expected of women than of men because of their nimble fingers and quickness of motion. As to questions of discipline, where the two sexes are employed in the same workroom, little or no difficulty is experienced under capable foremanship.

Actual results have proved that the fears in the minds of some that there would be opposition on the part of foremen and workmen to the employment of women in the shop were ungrounded. A foreman remarked to a visitor: "See that girl working beside the man assembling speed indicators. She is working with him so as to learn all the requirements, and he knows that she is to have his job as soon as she has become sufficiently proficient, but he is helping her in every way possible. Of course, we shall find other work for the man; and often, with the present shortage of help, such a change of work can be in the line of promotion." This illustrates the spirit which is practically universal throughout the shop, and which has been an important factor in bringing about the success of the plan.

While the money question—the earning power—is uppermost in the minds of the majority, many of the women show also a distinct ambition to equal or excel men in the work they do. Soon after the employment of women was begun in the gear department, a girl who was cutting sprockets on a gear-cutting machine became discouraged and said she was afraid

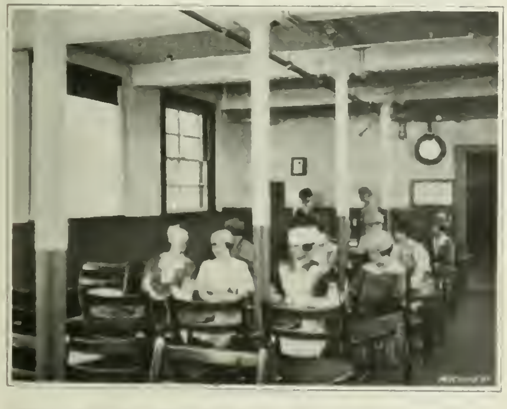


Fig. 3. Girls' Rest Room, showing Facilities for Cooking—Gas Stove in Rear. Medicine and First-aid Cabinets are on Wall in Rear of Room

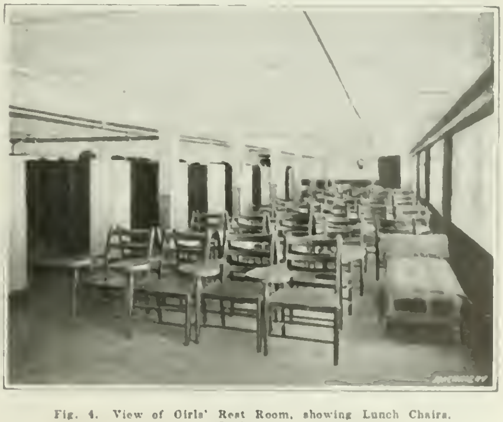


Fig. 4. View of Girls' Rest Room, showing Lunch Chairs, Lockers, etc.

she could not make a success of the job. Her foreman was surprised and said to her, "We have not made any complaint as to your work, have we?" "No," she said, "but the man who worked on the night job turned out 105 pieces, while the best I could do was only 85 pieces in a day." Her foreman asked if she realized that the man on the night force was working three hours more per day than she was, and after learning this, she felt less discouraged with the results she had obtained.

It was thought when girls were first employed that practically all the setting-up work would have to be done by men, and that the girls would simply act as operators. It has been found, however, even in the short time in which the plan has been in operation, that an increasing amount of the work of setting up can be performed by the women employes. Whenever one goes through the shop, girls may be seen sharpening their own tools, and resetting them in the machines after sharpening.

In the gear department where a number of girls have been "broken in" in operating gear-cutting machines (see Fig. 1), the foreman said that they had taken hold as quickly as the average man, and some of them are doing exceptionally good and intelligent work. This has partly resulted from the girls being thrown as rapidly as possible on their own resources, being taught to set up their machines, working from a blueprint, to measure their work, and do everything that had previously been required of the operator. A criticism has recently been made of some of the departments to the effect that the foremen were giving so much supervision to the women's work that they were not thrown sufficiently on their own resources, and thus were not trained to be responsible for the work in hand. This again speaks well for the women, as showing that there is a growing appreciation of their ability to do more advanced work than had at first been expected.

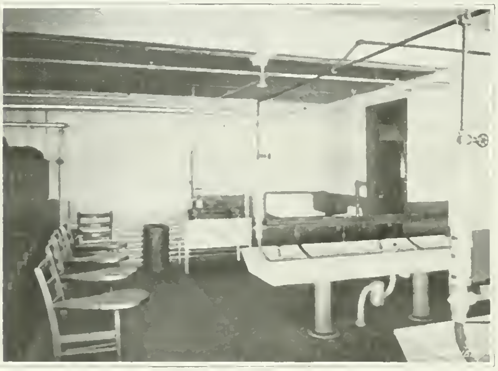


Fig. 5. Showing Gas Range and other Accommodations in Girls' Rest Room

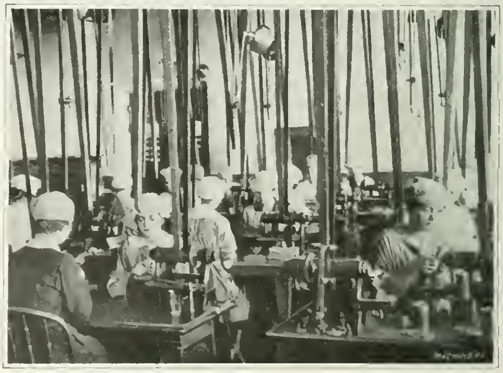


Fig. 6. Operating Polishing Machines. Girls are started on Polishing Work and advanced to Hand Tooling as they become Proficient

In inspection work, a field has been found for women in which they are making an exceptionally good showing. The chief inspector was asked whether women were learning to read the micrometer caliper. He replied that they learned to read it and read it accurately, in a very short time, and that the work passing through their hands showed much discrimination as to the points criticized. He pointed to a pile of work rejected by one of the women inspectors and said, "I have just had a man go over this work, and he has found that while the work failed to pass inspection for many reasons, they were all good reasons." He said further that in inspecting grinding work, he was surprised at the quickness with which some of his women inspectors would pick out batches of work identifying them as coming from particular workmen whose work was known to be above the average. In another department, in inspecting measuring tools, a similar condition was noted by the foreman, and he stated that one of the girl inspectors recently told him that she liked to inspect the work of Mr Blank, because it required so few rejections. "Yes," remarked the foreman, "she sized the situation up just right." He also showed the writer the notes attached to a number of tools which had been held out by the woman inspector for corrections, these criticisms showing much discrimination on her part, and as good a degree of judgment as would have been expected from the experienced inspectors who had previously been doing the work. It is thus found that in the class of inspection work where women are employed the standard is not lowered because of their employment.

Suitable Kinds of Work

The lines of work felt to be best adapted for women in the machine shop and those in which they were first given employment at the Brown & Sharpe works have been referred to. These lines have been extended to include the clerical departments of the shop, such as the routing department, stockrooms, and shipping rooms; positions as tool-room attendants; also light bench work, including riveting, filing, fitting, assembling; the operation of bench and speed lathes, drilling, milling, and grinding machines, including surface grinders; and even general machine work, such as operating engine lathes, screw machines, gear-cutting machines, etc. Their employment in some of these various lines of work is shown in Figs. 1, 2, 6, 7, and 8. Already several women are employed in the toolmaking department. One of these employes, who was operating a lathe turning out tool-steel blanks for bits and reamers, doing her own setting up and measuring, evinced enthusiasm for machine shop work, showing, in reply to questions, that her work was opening up a new field in which she took especial interest; and she remarked, "No more housework for me," with such feeling that it was evident her interests strongly leaned in a mechanical direction. Girls in the toolmaking department are working on universal milling machines, surface grinders, etc., as well as lathes. Some of the younger girls throughout the works are employed as messengers.

It was noted that the girls in one department were doing the same type of lathe work as that on which apprentices are "broken in," and the foreman was asked as to their success on this work. His reply was that they were doing just as well and learning as fast as the average boy; he then added, "Around the corner we have a girl running a planer," and from the way he spoke it was evident she was making a success of the job. This was later confirmed by the old-time mechanic who was running the adjoining planer and who was acting as her instructor.' In the drafting department about twenty girls are employed, although not as draftsmen. Their duties there consist of clerical work in connection with the filing and handling of drawings, and work in the blueprint and photostat departments.

Special Methods and Equipment for Women

It is sometimes desirable in order to obtain the best results in the employment of women to reorganize, both in methods and equipment. Thus in the screw machine department, where a man had formerly been operating four automatic screw machines, a reorganization by which he is put in charge of seven machines with a woman to help gives the required supervision, due to his experience, and at the same time trains the woman assistant in a knowledge of the machine and its operation. In the same department it is found of advantage to use pneumatic chucks for certain screw machine operations, this being of special importance where women are employed, as it avoids the physical work of adjusting the chucks by hand, the average woman being at a disadvantage when performing such work through being shorter in stature and having a shorter reach than the average man, aside from the question of her physical endurance.

It has been found that girls who have had experience working in mills or doing other work where they have acquired qualities of endurance are better adapted for this line of work. In fact, some such previous experience, or the bringing up in a home where the father or brothers are mechanics or have had mechanical experience, gives a background which makes it more probable that a girl will adapt herself to and be successful in any line of machine shop work. A case of this kind was noted by one of our foremen; his attention was attracted by the intelligent and practical suggestions made by one of the girls as to the methods of doing her work, and, on inquiry, he learned that her father was a good mechanic and had at one time worked in our shop. As a rule, the women we have hired have had some previous experience in working for a living, although very few of them have been engaged in mechanical work. Many have been recruited from department stores. The screw machine department probably requires as much physical strength and endurance as any of the work which women have so far undertaken in our factory, and for that reason, selection of employes in this department is from those who have previously been accustomed to work requiring physical strength. It is also the job where the greatest protection is needed against accidents and also against oil and dirt.

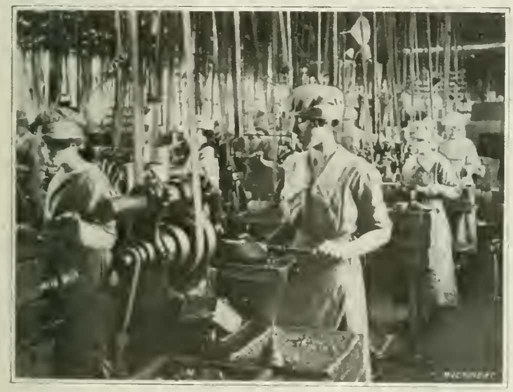


Fig. 7. Women operating Hand Milling Machines for Manufacturing Work

The screw machine department is the only one so far where skirts have been discarded. The question of wearing bloomers was presented to the employes by the foreman and they were adopted by their own decision. These garments are pronounced a success by those wearing them. In order to protect the hair, caps are worn by all machine operators. As these are of soft material, however, and do not always cover the side hair, it is not felt that they are a sure protection against the hair being caught. Experiments are being made with a very light hat frame of starched material, with wire rim, which guards the protruding hair dictated by modern fashion. The various costumes are furnished to the wearers at cost, and can be obtained through the supply department of the factory, in sizes fitted to the wearer. Short sleeves are required where the nature of the work indicates the need of such precautions for safety.

Aside from the matter of costume, it is felt that additional guarding should be used on machinery, to protect women workers. Steps are being taken to add guards in places where they were not thought necessary before. It has been strongly impressed upon each employe that there are points of danger in the machine shop, and that she should be alert and watchful to avoid them; although, in order that she may not be unduly alarmed, it is sometimes pointed out that statistics show that the shop is not so dangerous a place to work as the home. Owing to this special effort in the line of instruction, perhaps as well as to the fact that women are not employed on the whole in as hazardous operations in the machine shop as men, the accident record so far shows that they have had but four-fifths as many accidents, proportionately, as the men, and that, therefore, they have not proved to be an added hazard, as it was predicted by some that they would be. An up-to-date dispensary gives aid in cases of accident or illness to both men and women, and first-aid departments are established in all parts of the works, including the rest rooms.

Methods of Training in Different Parts of the Country

With the pressure of war work, many steps are being taken to train workers for the industries through various lines of intensive industrial training. By the "vestibule" plan, machinery is installed at the factory in an instruction room and working conditions are simulated as nearly as possible in order to train inexperienced workers so that when they take their places in the shop they will be able to show a degree of skill from the start. Technical and industrial schools are also adopting similar plans of intensive training. The needs are so great that it will be hardly possible to overdo this matter of training. Where there is opportunity, however, for assimilating workers directly in the shop on the jobs to be done, the most direct and satisfactory results can be obtained. There is no quicker way for developing skill and making competent workmen or workwomen than on the job itself under the supervision of the foremen and workmen who have in the past been doing the work, provided they cooperate.

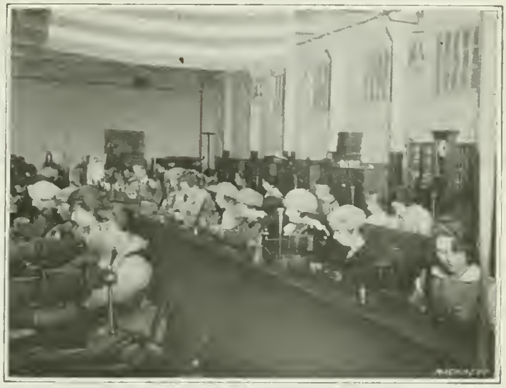


Fig. 8. Bench Work in Small Tool Department, where Skill in Filing, Riveting, and other Hand Operations is developed

When showing a visitor interested in the employment of women about the works, upon coming to a number of manufacturing milling machines being operated by girls, the foreman called the visitor's attention to a particular girl and asked what he thought of the way she was working. The visitor, after watching the girl complete a cycle of operations, spoke rather enthusiastically of the efficient way in which she was handling the work, and the foreman said to him, "That girl started in new this morning."

In order for the schools to meet the needs, they also should provide, as nearly as possible, shop conditions, hours of work, discipline, regard for safety, care of machines, and all those details which, once learned, will relieve the foremen later of such elementary training. It is believed that if there are practical schools open to girls for whom there might not be a place in the shop at the moment, so that they can be trained for particular lines of work, one girl learning to operate a drilling machine and sharpen drills, another to do hand riveting, another to operate a punch press, another to attend a tool-room, and as a part of her duties to become acquainted with the sharpening of cutters and the reading of the micrometer caliper, so as to measure drills, stock, etc., after a short training, such girls can be recommended to the shops and will be in demand by foremen. This method should also reduce the turnover by avoiding misfits, evident failures being weeded out in the training period.

In commenting on the need of industrial training for war work before the New England manufacturers of munitions, at a recent conference, the writer expressed the thought that there are today millions of intelligent women in our American homes, either idle or inefficiently employed, who, if they felt the spur of duty and inspiration of loyalty and were led to believe that they had a part in this great movement, would quickly respond for service in the industries, to fill gaps made by the men who must go for services which the women cannot render. And with the needs now existing and in prospect, steps to more fully utilize such help should not be delayed.

Discipline

The employment of women introduces new questions of discipline into the factory. It is important to adopt a policy from the beginning which will set and maintain a high standard, as a small number of objectionable employes of either sex can do much to offset the advantages which would otherwise be obtained from the employment of women. While it is believed to be important to have men as foremen throughout the shop, to be responsible for and instruct in mechanical work, it is also important to have matrons in each department, who will have direct supervision over groups of girls and who will act not only as counselors and helpers for them, but also be alert to prevent objectionable features creeping into the shop, by cooperating with the foremen in matters of discipline. These matrons can be occupied as producers when not otherwise engaged. For example, it was found in one department that young men were coming from other departments and stopping to visit the girls, and when steps were taken to break this up, it was found that this had been begun on invitation from the girls, who, after becoming acquainted with a young man employe, would say: "I work in such and such a department. Come and see me." This is harmless in itself, and in isolated cases, but the extension of this practice would be quickly demoralizing to shop efficiency. It is felt, also, that girls have more of a tendency to compare notes as to the pay they are receiving, as to whether they like or dislike their foremen, and other matters, and, after getting their heads together, trouble is sometimes caused which would be avoided if each attended to her own affairs. It is appreciated that these are not exclusively feminine traits.

It will be seen by reference to the accompanying table that up to the present time a slightly smaller proportion of the women who leave have been discharged than of the men who leave. When, however, the number of discharged as compared with the number hired is made the basis of the comparison, the women are materially better, as only 11 per cent of the women hired during the last year were discharged, while 17 per cent of the men were discharged. A smaller percentage of women also, as compared with the men, have been discharged on account of matters of discipline or character, which speaks well for the girls. On the other hand, the largest percentage of women are discharged because of lateness and absence, about one-half of all the girls discharged having been dismissed for this reason, which shows a lack on their part of a sense of responsibility as to regular attendance. Unsatisfactory work has been the cause of discharge of only about one-third of the total number who were discharged. Last year, out of the total number of women leaving, only 25 per cent were discharged, this being but 9 per cent of the total number employed.

Reasons for Leaving	Men, Per Cent	Women, Per Cent
Discharged		
Because of unsatisfactory work	9.0	8.8
Lateness and absence	7.9	12.3
For reasons of discipline	7.7	3.0
Miscellaneous	1.8	1.3
Total discharged	26.4	25.4
Leaving voluntarily		
For other positions	36.0	22.0
Dissatisfied with work or pay	20.0	16.0
On account of poor health	6.0	12.0
Leaving the city	7.7	3.2
Change of vocation (returning to school)	1.5	5.3
Marriage		5.0
Miscellaneous	2.4	11.1
Total leaving voluntarily	73.6	74.6
Percentage of those hired in 1917 leaving for all causes	63.5	42.5
Percentage of those hired in 1917 discharged	17.0	11.0

Turnover of Force

Although women seem to be more ready to lose time than men, they have on the whole shown more stability and have not been so ready to change their place of employment, this greater stability being shown even when taking into account the question of matrimony, where a larger percentage of women than men would naturally be expected to leave at the time of marriage. Of the total number of women hired during the last year, 57½ per cent still remained with us at the end of the year, while of the men hired during the same period, only 36½ per cent remained. Of those who left, three-fourths went within the first three months—many after a few days' or hours' employment only; this applies to both men and women. Being employed for such short periods gave little time to become skilled, so that their loss has not been felt so much. Among the reasons for women leaving voluntarily, nearly one-third were to take other positions; one-fifth because they were dissatisfied with their work or pay; and one-sixth on account of poor health, this being a larger proportion than of men leaving because of poor health. Miscellaneous reasons accounted for the remainder.

In investigating the relation of the nationality of women to turnover, it may be noted that up to the present time a large proportion of our force has been drawn from the English-speaking races. Employes of this class, however, have shown practically the same proportion leaving as of the non-English-speaking peoples, although a somewhat larger proportion of the latter were among those discharged. It will be understood in referring to employes of the non-English-speaking races that all such women in our employ are able to speak English. Of the English-speaking races, judging from figures based on the limited data at hand, the American girls have not proved as stable as the Irish and Scotch, although more so than the English and Canadians. Among the non-English-speaking races, the Italians and Jews have shown the lowest percentage leaving. The following table gives the general comparison, and shows in the first column the relative proportion for each nationality of those leaving who have left voluntarily, and the second column the same for those discharged, while the third column shows the proportion of each nationality who left of the total number hired.

NATIONALITY IN RELATION TO TURNOVER

Women Hired in 1917 and Leaving During Same Year

Nationality	Per Cent Leaving Voluntarily	Per Cent Discharged	Per Cent of Total Leaving
American	71	29	38
English and Canadian	78	22	44
Irish	75	25	22
Scotch	80	20	25
Total English-speaking races	72	28	37.2
French and French Canadians	69	31	59
Swedes and Norwegians	62	38	47
Italians	60	40	33
Jews	67	33	21.5
Russians	100	..	38.3
Miscellaneous	50	50	50
Total non English speaking races	71	29	37.6

Some facts have also been obtained to show the relation of age to turnover, and these show that a larger percentage have left of those between twenty and forty years of age than those younger or older. The comparatively few hired who were over forty years of age (as reported) have shown the lowest turnover. The percentage discharged, however, has been about the same for all ages

There has been no bar to the employment of married women, as has been reported to be the case in some factories, and some of the most satisfactory employes are from among this class. It is believed, however, that it is too severe a strain for women to endeavor to carry full home duties with employment in the shop, and that employment should not be given in cases where this would be necessary. It has been noticed that married women sometimes seek employment for a short time only with the view, in some cases apparently, of earning a certain amount of money for a purpose they have in view, and when that is attained, to either leave or to show indifference to their work, so that their services become unsatisfactory, not because they cannot do good work, but because the incentive has been removed. Such cases, however, are not the rule.

Relative Cost of Work

Besides the points already mentioned which add to the cost of employing women, such as extra provision for their comfort, supervision, employment of matrons, etc., the fact that the girls work shorter hours allows the machines to stand idle for a greater portion of the time, and thus reduces production, as compared with employing men for the same work. Their shorter hours necessitate hiring more girls and taking more shop space for the same amount of production. These drawbacks, however, are being largely offset by the results obtained as the girls become experienced. The shorter hours worked by women employes make it possible to arrange for them to leave work before the men do, both at noon and night, a precaution which is felt to be of advantage in avoiding confusion and any tendency to annoyance which might otherwise creep in.

While, as has already been pointed out, the money question is the strong incentive with most women, it has been found that in some departments, especially where the younger girls are employed, if they earn a certain amount a week, they are satisfied, and it is difficult to make them put forth the effort necessary for increased production. This may be due in some cases to the fact that the pay envelope is taken home and turned over to the parents, and it makes no direct difference to the girl whether she earns more or less.

It will be understood that the foregoing is based on a limited experience only in the employment of women, and that many of the views here expressed and statistics given may change in the light of further experience and show quite different results from those here pointed out. The matter is presented at this time because it is felt that there is now an urgent need, and one which will grow more pressing, of maintaining and increasing the working forces in the industries essential to the winning of the war, and that there is no time to be lost in putting into operation such measures as will be of direct help in attaining that end. It is believed that there is no present source of labor supply so promising or so important to develop as the employment of women, and whatever can be given to the public that will be in any way helpful in either starting or extending the employment of such help and making it fully successful will be of especial service at this time.

* * *

In his inaugural address as president of the British Institute of Bankers, Sir Richard V. Vassar-Smith, chairman of Lloyd's Bank, Ltd., said that means would be found for a better remuneration of labor sufficient to provide a higher standard of living, with shorter hours of work and better housing, and, in addition, a share of the profit after providing a proper return on the capital employed, with reserves for depreciation and betterment. He said it was wrong to believe that low-paid labor is necessarily economical or that a high rate of wages is a handicap in competing for the markets of the world.

USING AUTOMOBILES FOR DRIVING MACHINERY

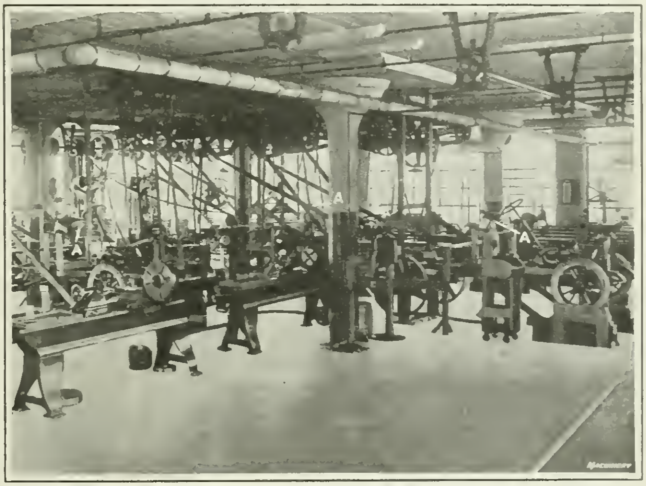
The accompanying illustration shows a machine shop in which three automobile chassis *A* drive the lineshaftings that run the machinery, because the electric power company had to shut down on account of lack of coal. The automobile chassis were mounted on blocks and the rear wheels replaced with pulleys, which were belted up to the lineshaft. Not only was all the machinery run very satisfactorily by this method, for several weeks, but power was furnished the air compressor and elevators.

C. C. S.

* * *

LOADING AND GLAZING OF A GRINDING WHEEL

The difference between glazing and loading of a grinding wheel is not always clearly understood. A loaded wheel, as defined by *Grits and Grinds*, is one to the face of which particles of the metal being ground adheres; that is, one in which the openings or pores of the wheel face have been filled with metal, leaving no room for clearance. The presence of a number of these pieces of metal on the face of a wheel prevents the wheel from cutting into the work, and the loaded places create heat. On a glazed wheel, the cutting particles have become dull or worn down even with the bond, the bond being so hard that it does not wear away fast enough to allow spaces between the cutting particles nor to allow the cutting particles to escape when dulled. In a glazed wheel, the cutting particles and the bond at the extreme surface of the wheel are of the same radius. A wheel will not load unless the bond is too hard or unless it is run very much too slow. Glazing may indicate that the wheel is too hard for the work or that it is running too fast. One remedy for loading is to increase the speed; a remedy for glazing is to decrease the speed. If the speeds are right, a softer wheel should be used in either case. Loading and glazing make excessive dressing necessary, and excessive dressing wears wheels faster than grinding. In rough-grinding, were it possible to obtain an ideal wheel for the work, dressing would not be necessary, theoretically, as the face of the wheel would automatically sharpen itself.



Unusual Method of driving Machines in Machine Shop

* * *

TESTING MANILA ROPE

A method for testing manila rope has been developed by C. E. Swett, of the Arthur D. Little, Inc., Laboratories, Cambridge, Mass. This test has been adopted by the United States Bureau of Standards. Briefly, it consists in freeing the rope from oil, soaking it for twenty seconds in a solution of bleaching powder acidulated with acetic acid, rinsing in water and then in alcohol, and finally exposing the fibers of the rope for a minute to the fumes of ammonia. Manila fiber turns russet brown, while all other rope fibers turn a cherry red

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

THE PROBLEM OF TRANSPORTATION

Most manufacturers used to consider transportation none of their business. Its problems, they argued, were problems for railroad officials. Now, however, we know that transportation is everybody's business. Every manufacturing industry is fundamentally dependent upon transportation. The last few months have taught us that. Yet how many manufacturers have done anything toward proper cooperation with the transportation systems? Railroad cars are kept idle on sidings for days. They are used for the storage of manufactured articles and raw materials. They are held, loaded with coal, on sidings and in yards for days, instead of being immediately unloaded and made available for further service.

Payment of demurrage charges absolves nobody from responsibility for holding up railroad cars. They are the most vital necessity of our whole industrial system. It is every manufacturer's business to plan in such a way that he will never cause railroad cars to remain idle. He must cooperate to the limit of his power with the railroads. Thus will the problem of transportation congestion be half solved.

* * *

WOMEN WORKERS IN MACHINE SHOPS

Is the increased employment of women in machine shops a desirable development? To give a definite answer now would be premature. What can be said, however, is this: Such employment of women seems to be necessary on account of the abnormal conditions created by the war. Much has been written about the success achieved by women workers in British machine shops. Women are now employed in Great Britain on all classes of machine work, and the working force on such high-class work as the making of fuses is almost entirely composed of women. In some kinds of work, it is maintained, they have proved superior to the men formerly employed.

The fact that huge numbers of men are now serving the nation in the war, coupled with the expansion of those industries in which men workers are essential, has induced many American manufacturers to employ women where only men were employed in the past. This is being done quite extensively in munition plants, and in some of the large machine tool building plants it has also proved successful. In arriving at judgment as to the desirability of so employing women, one must bear in mind that things must be done in time of war that would have occurred to nobody in time of peace. What has been established so far is that the women have proved satisfactory in the work to which they have been assigned and that they can, by doing such work, assist actively in making the materials which will win the war.

* * *

WATER POWER INSTEAD OF COAL

The stationary power plants of the United States, according to one authority, generate 49,000,000 horsepower and use 30 per cent of all the coal mined in the country. Secretary of the Interior Lane has estimated that 35,000,000 horsepower may be obtained from the nation's wasted water power; only 6,000,000 horsepower is now being generated hydraulically. In other words, should the country's wealth of water power be fully developed, more than two-thirds of the fuel now used to generate power—a total of 139,000,000 tons—would be saved. Not only that—380,000 men now required for mining, transporting, and firing this coal would be released for other work, only 40,000 men being required for the hydraulic plants. Nearly 200,000 railroad cars and 5000 locomotives would be set free.

The thing to do with water power is to develop it. Whatever retards or restricts its use on terms fair to the public is contrary to public policy, hostile to the nation's best interests. The Administration's Water Power Bill, which is before the present Congress, not only safeguards the people's interest in a most valuable natural asset, but provides for its proper development. Granting to private interests the right to develop national water power upon terms that are fair to all concerned is one of the most important among the industrial problems that now demand solution, since it affects materially the question of saving of coal. The present coal shortage, it must be borne in mind, instead of being merely incident to the war, is a condition that will affect to some extent the development of the country's industries for some time in the future.

* * *

SAVING CAST IRON VS. SAVING TIME IN MACHINING

Machine designers generally seek to reduce to the minimum the amount of material used in a machine or device, without, of course, impairing the strength or spoiling the appearance. This makes for cheaper production, as it eliminates unnecessary metal, every ounce of which means waste; and if there is one thing that should be impressed before others upon Americans today it is to avoid waste. But there is another side of this question: If saving a few ounces or pounds of material means more costly machining equipment, more hours in the machining of parts, then it is not true economy. Sometimes such false economy reduces the metal in castings to such an extent that the surfaces spring away from the tool during machining, necessitating special methods to prevent distortion. In other cases the effort to save a small amount of cast iron means the introduction of difficult foundry work. The whole thing comes down, after all, to a matter of judgment on the part of the designer, who must have experience enough to determine just how far he can go in saving metal without increasing expenses in the foundry and machine shop.

Generally those designs are best in which the machine designer, the tool designer, and the practical shop man have worked together, so modifying the design that the production cost is kept low without sacrificing any of the essential features of the design. If the designer is more of a shop man than an engineer he is likely to think of production only and sacrifice some of the engineering features of the machine in order to facilitate production. His error is more serious than that of a designer who, though he produces a good machine, neglects to consider the methods of molding and machining, because excellence in the product is the prime requisite. The machining processes are merely a means to an end.

The ideal designer is a man with good practical judgment, able to balance the different problems against each other, capable of producing a machine which can be manufactured cheaply and yet retain all the qualities desirable from an engineering point of view.

How Much are American Institutions Worth to You?

HOW much are American institutions worth to *you?* That is the question that every American will be asked in the next few days, and he must answer it, not in flowery words and high-sounding phrases, but in dollars and cents. He must answer it by the figures above his signature on his Liberty Bond subscription blank. It will be an answer that will ring around the world—an answer that will give Kaiserism, militarism, and autocracy something to think about.

How much are American institutions worth to *you?* That is the question that you must answer, whatever your station or condition in life; whether employer or employe, whether skilled or unskilled, whether native born or of foreign extraction, whether man or woman. How much is it worth to you to live under the institutions that have developed in this Republic? How many of your present pleasures, luxuries, or comforts are you willing to sacrifice for the safeguarding of American liberties? How large is your subscription for Liberty Bonds going to be?

You, Mr. Manufacturer, how much are American institutions worth to *you?* Will you respond not only with the surplus of present prosperity, but also with capital that you could more profitably invest elsewhere? Is it a sacrifice or is it a privilege to you to be among those who are able to respond to the call of your country in a greater measure than the great mass of citizens? Are American institutions to you worth the sacrifice of present profits in order that these liberties may remain forever secure in the future? To that question there can be but one answer. But, as an employer, a double duty and a double privilege are yours. It is for you to fire the enthusiasm of the hundreds or the thousands of men and women engaged on your work. In doing so you can meet them on common ground, for, in safeguarding American institutions, you and they are partners. You can encourage, you can stimulate, you can develop a spirit that will completely answer the question of how much American institutions are worth to every man and woman in your works in an unmistakable manner.

And you, Mr. Employe, how much are American institutions worth to *you?* When the cost of living is high and the present mode of living absorbs nearly all that you can earn, are you willing, for the sake of American institutions for yourself, your family, and your children, to change that mode of living for the time being? Are you willing to sacrifice most of the small luxuries and comforts that you have enjoyed, in order that you may help to safeguard the institutions that have grown up under the Stars and Stripes? Remember, these are days of sacrifice. The man who thinks that he can walk along in the usual way in this world upheaval will find that he is mistaken. Whether you earn little or much, there is something that you can spare, something that can go into a Liberty Bond.

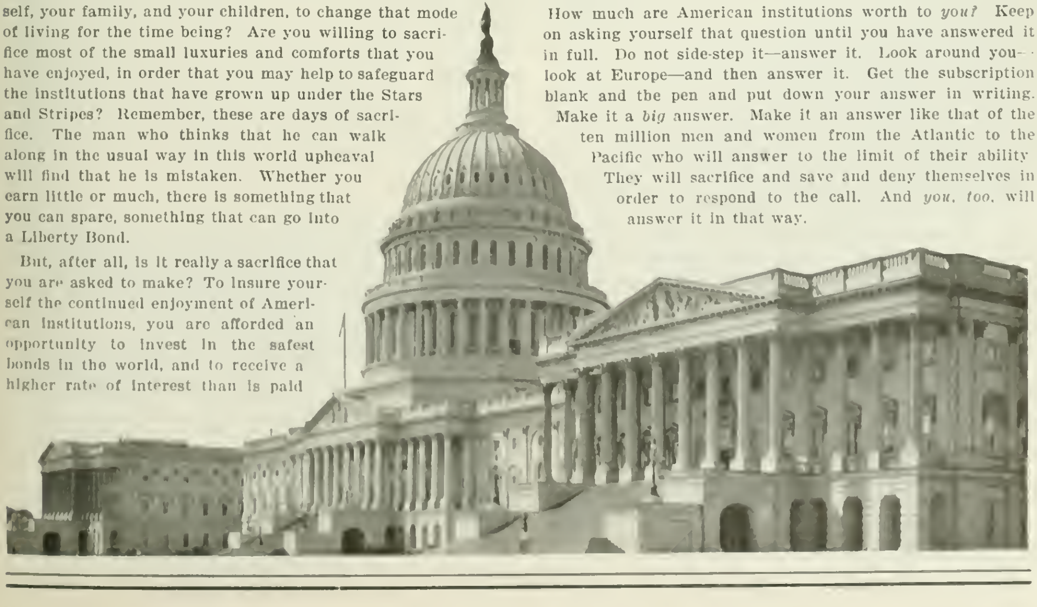
But, after all, is it really a sacrifice that you are asked to make? To insure yourself the continued enjoyment of American institutions, you are afforded an opportunity to invest in the safest bonds in the world, and to receive a higher rate of interest than is paid by any other institution offering absolute safety for your money. You lose nothing—for some day you will have your money with interest to enjoy and to spend, at a time when the cost of living will be less and when you will receive a great deal more for your money. Purely as a business proposition, is not that worth while?

What if Germany should win this war? If that happens, you will not be asked how much American institutions are worth to you; but you will help pay the indemnity, and there will be no repayment of the principal, nor will there be any interest. Even if Germany does not win and there is a peace by negotiation, what then? The world will remain an armed camp ready for the day when militarism and autocracy will again attempt to conquer. American institutions as we have known them will be a thing of the past; we, too, must be armed to the teeth, the burden of armaments will rest upon us, universal military service will become a fixed national policy, and militarism, with all that it implies, must be accepted. The choice is yours.

Some day, when the war is a thing of the past, when the horrors of the hour have faded away and the sun again shines over a peaceful world, you will think back upon the day when you were asked: "How much are American institutions worth to you?" Would you not then like to be able to say, "When the call came, I responded to the limit of my ability"; or will you say, "Others fought and sacrificed, but I shirked it all"?

Over there, hundreds and thousands of our countrymen are answering the question of how much American institutions are worth to them. They have placed the supreme value on these institutions; they are willing to defend them by making the supreme sacrifice. And here are we, safe behind the double lines of navies and armies, debating how much these institutions are worth to us. This is the answer: They are worth all the material things we have; they are worth all the luxuries and the comforts, the automobiles and the diamonds, the fancy clothes and expensive foods—everything above the very necessities. If we are not willing to answer the question in that manner, we are cowards hiding behind our soldiers, willing to reap the benefit, but not willing to make what is only a slight sacrifice compared with that which they are making, for they venture all.

How much are American institutions worth to *you?* Keep on asking yourself that question until you have answered it in full. Do not side-step it—answer it. Look around you—look at Europe—and then answer it. Get the subscription blank and the pen and put down your answer in writing. Make it a *big* answer. Make it an answer like that of the ten million men and women from the Atlantic to the Pacific who will answer to the limit of their ability. They will sacrifice and save and deny themselves in order to respond to the call. And *you, too,* will answer it in that way.



THREAD ROLLING[1]

FIRST INSTALLMENT OF A SERIES ON DIFFERENT METHODS OF FORMING SCREW THREADS BY ROLLING, VARIOUS TYPES OF THREAD ROLLING MACHINES, ADVANTAGES OF ROLLING PROCESS AND GENERAL APPLICATION

BY FRANKLIN D. JONES[2]

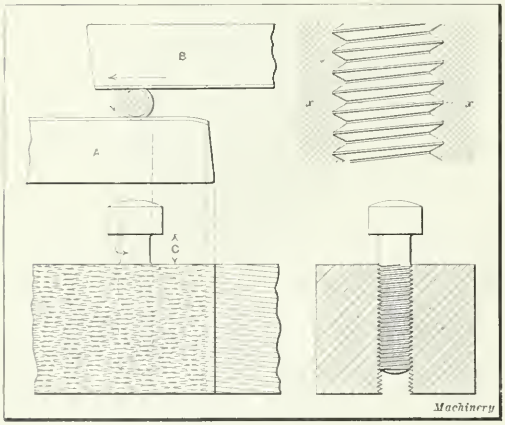


Fig. 1. Diagram illustrating how Screw Thread is rolled between Flat Dies

THE rolling process of forming screw threads may be defined as an impression or displacement method, since the thread grooves are not cut by an edged tool, but are formed by means of a die or roll having threads or ridges which are forced into the metal and, by displacing it, produce a thread corresponding to the required shape and pitch. The plain blanks upon which threads are to be rolled are somewhat smaller in diameter than the finished thread, because when a thread is rolled a certain amount of metal is displaced and is forced up above the original surface of the blank, thus producing a screw thread which is larger in diameter than the original blank. The increase in diameter is approximately equal to the depth of one thread. No material whatever is removed by the rolling process, the metal from the depression formed by the die simply being forced up on each side.

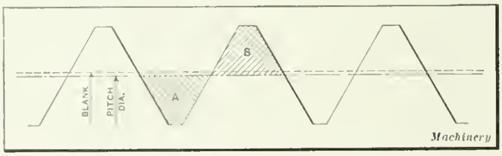


Fig. 2. Diagram showing Relation between Diameter of Blank and Pitch Diameter of Rolled Screw Thread

Screw threads may be rolled (1) by using a circular disk or roll having a threaded periphery, or (2) by rolling the blank between dies which may be either flat or circular in form. The circular roll is employed when screw threads are rolled on automatic screw machines or turret lathes, and the dies referred to are used when thread rolling is done by means of machines designed exclusively for this work. Thread rolling is done in automatic screw machines when a thread is required behind a shoulder or other intervening part, which makes it impossible to cut it by using a regular thread-cutting die. The advantage of rolling the thread in such cases is that a second operation is avoided. The important commercial application of the thread rolling process is found in the shops and factories using machines designed especially for this work. These machines are extensively employed in certain lines of manufacture for threading such parts as bolts, screws, studs, rods, etc., especially where such threaded parts are required in large quantities. Screw threads that are within the range of the rolling process may be produced more rapidly by this method than in any other way, which accounts for the use of thread rolling machines in connection with bolt and screw manufacture and wherever thousands of duplicate threaded parts are required. After describing the method of forming a thread by rolling a cylindrical blank between flat dies, some of the different designs of thread-rolling machines and their method of operation will be considered.

Thread Rolling between Flat Dies

Most of the machines designed exclusively for rolling screw threads are equipped with flat dies. There are two of these flat dies on a machine, as shown by the diagram Fig. 1, which illustrates the general principle of this method of rolling threads. One die *A* is stationary and the other die *B* has a reciprocating movement. The faces of the dies have parallel grooves and ridges of practically the same cross-sectional shape as the thread to be rolled, and are spaced to correspond with the required pitch. These ridges, which represent a development of the thread the dies are intended to roll, incline at an angle equal to the helix angle of the thread, so that as the screw blank rolls between the two dies, a screw thread of the same pitch and helix angle is reproduced on it. The thread is formed in one passage of the bolt, rod, or other part to be threaded, the work being inserted at one end so that it simply rolls between the die faces until it is ejected at the other end. The ridges on both dies incline in the same direction when viewed from the rolling sides or faces, but when the dies are in the thread-rolling machine, the ridges incline in the opposite direction, and are, therefore, in alignment with the thread groove on the work at the two lines of contact. The face of a die for rolling a right-hand thread is shown at *A* in Fig. 3. The die shown at *B* is intended for a left-hand thread, and for that reason the ridges incline in the opposite direction. So far as the inclination of the ridges is concerned, each of these dies is a duplicate of its mate, as seen from the face side.

Relative Positions of Dies and Work

The relation between the position of the dies and a screw thread being rolled is such that the top of the thread-shaped ridge of one die, at the point of contact with the screw thread, is directly opposite the bottom of the thread groove in the other die, at the point of contact, as indicated by the line x-x of the enlarged sectional view, Fig. 1. This relation between the dies and the screw thread must be maintained throughout the thread-rolling operation, and it is essential to start the work between the dies when the movable die is in the right position. If the blank to be threaded is

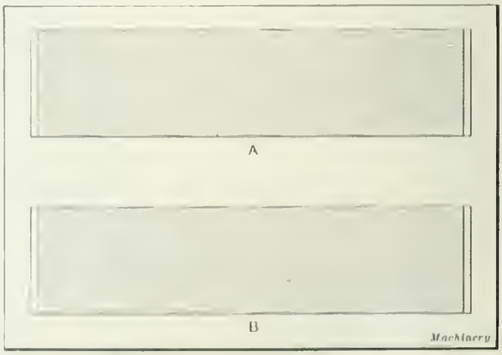


Fig. 3. (A) Die for rolling Right-hand Threads. (B) Die for rolling Left-hand Threads

started at exactly the right time, the groove rolled into it by one die will engage or match with the ridges on the other when the blank has turned a half revolution; therefore, since the two dies engage the screw thread on opposite sides and as one-half turn of the screw corresponds to one-half the pitch, the ridges on one die must be one-half the pitch above or below corresponding ridges on the other in a plane intersecting the axis of the threw thread being rolled.

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[1] For other articles on the production of screw threads, see "General Thread Cutting Practice," March, 1918, and articles there referred to.

[2] Associate Editor of MACHINERY

In order to form the thread gradually, the two dies may not be set exactly parallel, but a little farther apart at the end where the rolling operation begins, so that, as the screw blank moves from the starting end through the dies, the thread is formed by a progressive rolling action. This method of setting is sometimes reversed, the dies being set a little closer together at the starting end. A full thread is then formed more rapidly at the beginning of the rolling operation. The object is to form the thread as quickly as possible so that there will be comparatively little pressure between the work and the die during the remainder of the stroke in order to obtain a planishing effect and a smooth finish. There is a difference of opinion among the users and manufacturers of thread-rolling machines regarding the relative merits of these two methods of adjusting the dies. In any case, the adjustment from a parallel position is very slight.

Thread-rolling machines are equipped with some form of mechanism which insures starting the screw blank at the right time and also square with the sides of the dies. These machines differ in regard to the position of the dies and the arrangement of the mechanisms which operate the moving die, the blank starting device, and other parts. Machines of this general class also vary in that some have automatic blank feeding mechanisms, whereas others of simpler construction require the constant attention of an operator for feeding each blank between the dies by hand.

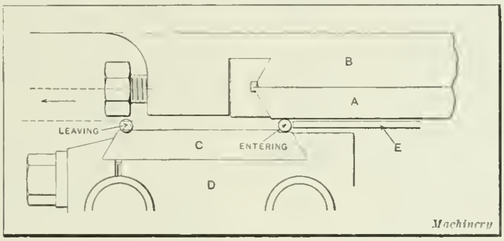

Fig. 6. Plan View of Thread-rolling Dies

Diameter of Screw Blank before Thread is Rolled

The diameter of the blank or cylindrical part upon which a thread is to be rolled should be less than the required screw diameter by an amount that will just compensate for the metal that is displaced and raised above the original surface by the rolling process. If the screw blank is too large before rolling, there will be an excessive amount of metal and the screw will be larger than the standard size. On the other hand, if the blank is too small, either an incomplete thread will be formed or, if the dies are adjusted to roll a full thread, the diameter will be smaller than standard. While the blank diameter can be determined mathematically, it may be necessary to make slight changes in the calculated size in order to secure a well-formed thread. If the diameter is first calculated by using a rule or formula which is known to be at least approximately correct, the results should be verified by actual trial if possible. The importance of determining accurately what blank diameter is required to form a full or complete thread depends somewhat upon the class or quality of the threaded work. For instance, in some plants where screw threads are rolled on ordinary bolts, etc., it is the practice to use blanks that are slightly smaller than the pitch diameter of the screw thread, and in many cases the threaded ends of the screws or bolts are a little smaller than the standard diameter, so that nuts tapped with standard taps will screw on easily. A full thread may be formed when using a blank that is less than the pitch diameter, but if this is done, the screw will be slightly under size. When completely formed screw threads of standard diameter are required, the blanks must be a little larger than those used on the less accurate classes of work.

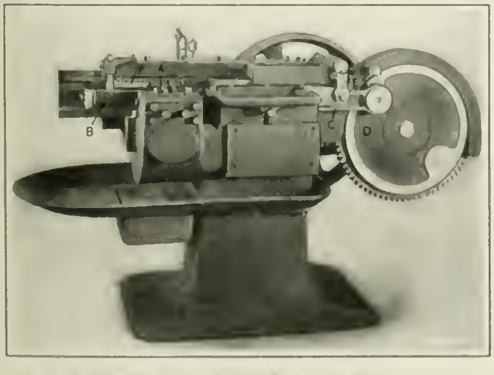

Fig. 4. Reciprocating Type of Screw-thread Rolling Machine arranged for feeding Blanks to Dies by Hand

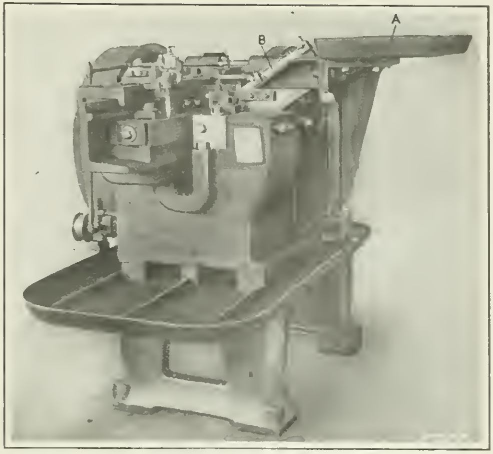

Fig. 5. Reciprocating Screw-thread Rolling Machine equipped with Semi-automatic Feeding Mechanism

Aside from the question of accuracy, the blank diameter is affected to some extent by the nature of the material of which the screw blanks are made; that is, whether it is hard and offers considerable resistance to displacement, or is soft and easily formed by the threading roll. For instance, threads may be rolled in either brass or steel, but the action of brass is different from that of steel. The condition of the surface of a steel blank may also affect the diameter. When a thread is rolled on drawn stock, there is little, if any, compression of the metal as it is displaced to form a thread, because the surface is already quite dense as the result of the cold-drawing operation. If this dense outer surface, however, is removed by a cutting tool, the metal will be subject to slight compression as it is displaced; consequently a larger blank diameter is required for a turned piece than for one which was drawn to size. Brass blanks for screws of a given size should be a little larger than those made of steel for the same reason; that is, because there is a slight compressive effect and need for a little more stock to offset this action. The variations in blank diameters due to this cause are very slight, but should not be disregarded if accurate thread rolling is to be done.

The blank diameter may be determined quite easily by actually rolling threads on blanks the sizes of which are changed as may be required to produce a well-formed thread. While this is the most reliable method, it cannot always be applied, as the stock from which the blanks are to be made sometimes is not at hand; in fact, it may be necessary to order the stock from the mill long before it is needed, and then the blank diameter is either determined by calculation or by reference to blank sizes previously tabulated for different screw thread diameters. There are several different rules and formulas for calculating blank diameters, but inasmuch as this diameter is affected by the accuracy required for the rolled thread, the kind of material to be rolled, its composition, and by any decided variation in the physical condition of the surface metal (as, for example, when the skin of cold-drawn stock is removed by turning), the impracticability of deducing a rule or formula that may be generally applied is apparent.

According to the practice in different plants where thread rolling is done, there are three general classes of blank sizes, including (1) those that are a little larger than the pitch diameter; (2) those that are approximately equal to the pitch diameter; and (3) those that are slightly less than the pitch diameter. The sizes in the first class are intended for screws that are to be rolled as accurately as possible. The difference between the blank diameter and the corresponding pitch diameter varies somewhat for screw threads of different sizes, but according to average practice, as near as this can be determined, the relationship is about as follows: The blank diameters for screws varying from 1/4 to 1/2 inch are from 0.002 to 0.0025 inch larger than the pitch diameter, and for screws varying from 1/2 to 1 inch or larger, the blank diameters are from 0.0025 to 0.003 inch larger than the pitch diameter. Threads of the second class mentioned, or those rolled from blanks which are equal to the pitch diameter, are sufficiently accurate for many purposes. Blanks of the third class or those that are slightly less than the pitch diameter are intended for bolts, screws, etc., which are made to fit rather loosely, a comparatively free fit being desirable in many cases. Blanks for this grade of work, according to common practice, are from 0.002 to 0.003 inch less than the pitch diameters for screw threads varying from 1/4 to 1/2 inch, whereas for screw thread sizes larger than 1/2 inch the blank diameters are frequently from 0.003 to 0.005 inch less than the pitch diameter. The blanks for screw threads smaller than 1/4 inch are usually from 0.001 to 0.0015 inch less than the pitch diameter for ordinary grades of work, and about the same amount larger than the pitch diameter for more accurate screw threads.

The reason why the blank diameter should be somewhat larger than the pitch diameter when a full thread of standard size is to be formed is that the volume of the thread groove extending inside the pitch line or surface as at *A*, Fig. 2, is less than the volume of the section *B* of the thread extending outside the pitch surface, the mean radius of section *B* being larger than the radius of *A*. If the blank is made somewhat larger than the pitch diameter, as indicated by the dotted line marked "blank," this will offset the difference between the volumes of sections *A* and *B*.

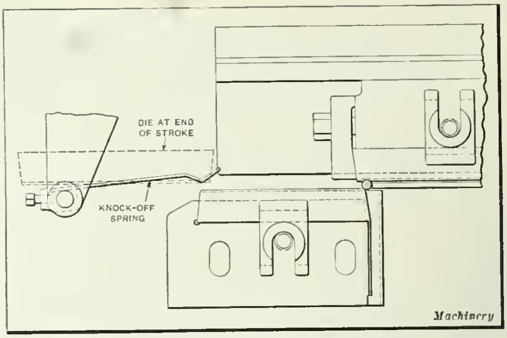

Fig. 8. Plan View showing Relation between Thread-rolling Dies and Knock-off Spring which ejects Threaded Blank at End of Stroke

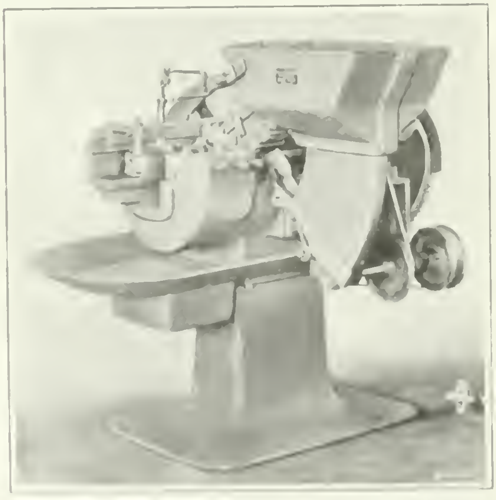

Fig. 7. Thread-rolling Machine provided with Automatic Feeding Mechanism

Reciprocating Thread-rolling Machines of Horizontal Design

The thread-rolling machine illustrated in Fig. 4 is a horizontal type which operates on the general principle illustrated by the diagram Fig. 1. This machine is one of the designs and sizes manufactured by the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. The stationary die is securely held at *A* and the movable die *B* is attached to a slide connecting with pitman *C*. This pitman is operated by a large crank gear *D*, which is driven from a pinion mounted on the driving pulley shaft. This particular machine is arranged for feeding the blanks by hand, so that it is comparatively simple in design. The blanks to be threaded are placed, one at a time, in the feeding position, the lower end resting against a stop, which may be adjusted vertically and insures rolling threads of equal length on the different blanks. Each blank is placed in position, while the slide is returning, and when the moving die has advanced to the right position relative to the stationary die a push-finger starts the blank between the dies. As soon as the blank is caught, it is rolled along between the die faces until it has passed entirely across the stationary die; the thread-rolling operation is then completed and the bolt or screw falls into a receptacle. The push-finger is operated by a cam located on the opposite side of the machine from that shown in the illustration. This cam transmits motion through a shaft and lever *E* to the slide carrying the push-finger or "starter," as it is sometimes called.

When exceptionally long blanks are being threaded, a special holder or clip is applied to machines arranged for hand feeding to insure locating the blanks square with the dies. In rolling threads on shorter blanks, such an auxiliary device is not necessary, because the vertical face of the push-finger tends to start a blank square, even though it may be slightly inclined when the push-finger moves forward. On some of these machines, the movable die has a vertical concave groove or pocket cut across the teeth or ridges near the starting end. This groove, which has a depth approximately equal to one-half the thread depth, is opposite the end of the fixed die just before the rolling operation begins, and the blank enters it as the push-finger advances. The purpose of this vertical groove or pocket is to insure starting each blank square with the dies.

Another screw thread rolling machine of the horizontal reciprocating type is shown in Fig. 5. This is one of the designs made by the E. J Manville Machine Co, Waterbury, Conn. The driving mechanism of this machine is quite similar in its general arrangement to that previously described in connection with the machine shown in Fig. 4. The reciprocating slide which carries the movable die receives its motion from a large crank gear, as in the former case, which meshes with a pinion on the flywheel shaft The crank gear is connected to the reciprocating slide by a pitman This machine is known as the direct drive type to distinguish it from earlier designs having a crank gear revolving about a vertical axis and driven

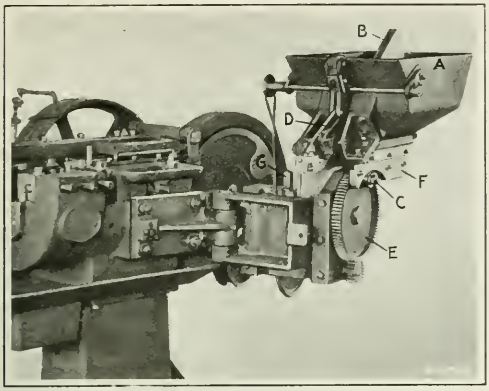

Fig. 9. Feeding Mechanism of Machine shown in Fig. 7 swung out of the Way to permit Hand Feeding

through bevel gearing from a horizontal shaft connecting with the belt pulley. The arrangement of the stationary and moving dies and the method of starting each screw blank between the dies at exactly the right time is shown by the diagram Fig. 6, which represents a plan view. The moving die *A* is carried by the reciprocating slide *B*, and the stationary or short die *C* is clamped into an adjustable holder *D*. This holder may be adjusted toward or away from die *A*, as may be required by the diameter of screw thread to be rolled. The moving die is shown at one end of its stroke. As die *A* moves toward the left, the blank to be threaded is pushed between the two dies by the starter *E*. This starter or push-finger ordinarily is operated by an adjustable cam, which transmits motion to it through a mechanism so arranged that either a positive or yielding pressure may be given to the blank as it enters between the dies.

At the starting end of die *C* there is a short blank space which is cut down level with the bottom of the grooves in the rest of the die face. This provides room for inserting a blank and enables another blank to be placed in position as soon as starter *E* has withdrawn far enough, without danger of the second blank being dragged in by the moving die before the latter is in position to receive it. It is, of course, essential to have the dies properly located relative to each other, and the action of the starter must also be timed so that the blank is pushed forward at the right instant.

Adjustment or Timing of Starter

The starter on the Manville machines is set by first placing the moving slide at the extreme end of its stroke toward the right and then moving it forward about one-eighth inch. The starting cam is then set on its highest point and the starter is adjusted endwise until its end is in line with the ends of the threads on the stationary die. After these approximate adjustments have been made, a blank is inserted in front of the starter and the machine is turned far enough to revolve the blank forward about half a revolution. The machine is then turned backward and the blank removed to see if the thread rolled by one die coincides with those rolled by the other die. If the thread grooves do not match properly, the position of the starting cam is changed so that it acts either earlier or later, thus forcing the blank between the dies when the latter are in the correct position relative to each other. Another method of remedying this trouble is by raising or lowering one of the dies slightly.

Ejector or Knock-off of Thread-rolling Machine

Bolts or screws sometimes stick to the movable die after the thread is rolled. In order to prevent a screw from being caught between the dies on the return stroke, the simple form of knock-off or ejector shown in Fig. 8 is used. A flat spring having a bent end is attached to the frame of the machine in such a position that the screw forces the spring back while it is still between both dies and is firmly held. When the spring returns to its normal position it pushes the blank forward and away from the movable die so that it cannot be caught between the dies at the beginning of the return stroke. This knock-off is located at *F* on the machine shown in Fig. 4. The same general type is also used on the machine illustrated in Fig. 5.

Semi-automatic Feeding Mechanisms

Most thread-rolling machines are either arranged for feeding blanks to the dies by hand or are equipped with an automatic feeding mechanism. In some cases, however, a semi-automatic feed is employed, and this type will be referred to before describing the kind which is entirely automatic in its operation. Fig. 5 illustrates how this semi-automatic feeding arrangement is applied to some of the Manville thread-rolling machines.

As explained previously, when blanks are fed to the dies entirely by hand, each blank must be placed in the feeding position. This method has proved very satisfactory, because the operator soon becomes so expert that the feeding is done almost as regularly as when some form of mechanical feeding device is employed. The hand-feeding method, however, requires the constant attention of the operator, which is not the case with the semi-automatic type. When the latter is applied to a machine, the operator, instead of inserting a blank between the dies for each stroke, simply transfers a number of blanks from the shallow pan *A*, Fig. 5, to the inclined tracks *B* which convey the blanks down to the dies. The blanks are fed down these tracks by gravity to a mechanism which automatically presents each successive one to the thread-rolling dies for every stroke of the machine, the same as when an automatic feed mechanism is used; therefore, when the machine has a semi-automatic feed it is simply necessary for the operator to keep the chute or tracks loaded with blanks. This type of feed mechanism is especially adapted for certain classes of blanks which are not readily lifted and caught by a slotted swinging plate such as is used with the automatic feed mechanism. When the heads of the blanks are comparatively large and the shanks short, or if the shanks are unusually long, difficulty may be experienced with a feed mechanism which is entirely automatic.

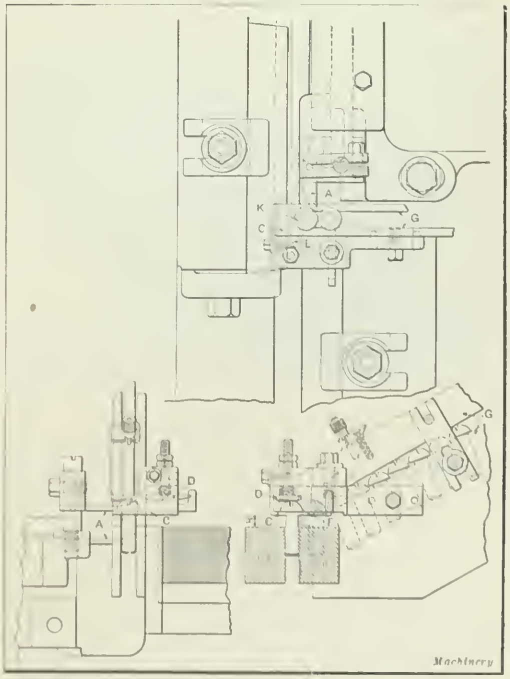

Fig. 10. Escapement or Cut-off Mechanism at Lower End of Feed Chute for feeding Blanks One at a Time to Dies

Automatic Feeding Mechanism for Thread-rolling Machine

Many of the thread-rolling machines now in use are equipped with an automatic feeding mechanism which is so arranged that the blanks to be threaded are transferred from a hopper to the dies entirely by mechanical means. A machine made by the Waterbury Farrel Foundry & Machine Co., equipped with an automatic feeding mechanism, is illustrated in Fig. 7. The entire automatic feed mechanism is mounted upon a hinged or pivoted member, so that it can be swung to one side, as illustrated in Fig. 9, in case it is desirable to feed the machine by hand. For instance, if only a few thousand screws or bolts of given size were required, the hand feed would doubtless be preferred to the automatic feed, because the latter requires more or less adjustment for adapting it to work of a different size.

A number of the blanks to be threaded are placed in the hopper *A*, and extending vertically through this hopper there is a blade *B*. This blade is pivoted at the inner end and it swings up and down through the mass of blanks when the machine is in operation, the swinging movement being derived from a roller *C* attached to the gear *E*. A vertical slot or opening extends along the upper edge of the blade, and this slot is a little wider than the diameter of the screw blank bodies; consequently, as the blade moves up through the mass of blanks in the hopper, some of them fall into the slot and are caught by the heads. When the blade reaches the top of its stroke, it remains stationary for a short time, and as the upper edge is inclined considerably, the blanks which were caught slide down to the lower end of the blade and then pass into the chute *D* which leads down to the dies when the mechanism is in the feeding position. The plate *F* attached to the oscillating blade or center-board of the hopper has a circular section which is concentric with the path of roller *C* and provides the dwell of the blade at the top of the stroke. The blade remains stationary long enough for all the blanks to slide down into the chute. Near the point where the blanks leave the blade, there is a rapidly revolving toothed wheel, so located and formed that any blanks which are not suspended by the heads and in the proper position are dislodged and thrown back into the hopper. In this way, the entrance to the chute is kept clear and clogging is prevented.

One of the interesting features of this mechanism is the escapement at the lower end of the chute which automatically feeds one blank at a time to the dies. At the lower end of the chute there is a V-shaped cut-off finger *A*, Fig. 10, which moves in at the proper time and separates the lowest blank *K* from the others in the chute. This cut-off finger derives its movement from a cam surface on the main slide. The blank which is separated from the others by the cut-off finger is placed in front of the push finger *B*, which at the proper time advances it to a point where it is caught between the dies. The action of the cut-off finger is so timed that it remains in the inner position and prevents the column of blanks from descending until the push finger is in position to serve as a stop; the cut-off finger then withdraws and the blanks descend far enough to allow the lowest one to be separated from the others as the cut-off finger again advances on the next succeeding stroke. The blank passes around a corner after leaving the cut-off finger, so that its movement is then parallel to the thread-rolling dies. While the blank passes through this parallel section of the guide plate *C*, the head is held downward upon the guide by a spring plate *D* above. This feed mechanism is so arranged that the blanks are suspended by their heads from the time they are caught by the swinging hopper blade until they are gripped between the threading dies, unless it is necessary to roll a thread close up to the head. In that case, the guide plate which holds the blank after it leaves the cut-off finger is changed. The surface of guide plate *C* is beveled and plate *F* on the opposite side is reversed, so that the blank is lowered to a point where the under side of the head is level with the upper edges of the dies. When the thread does not need to be rolled close up to the head, each blank is suspended from the head until it is pushed forward and is caught between the dies; consequently the length of the threaded part depends upon the vertical distance *x* between the guide plate and the dies. This distance (which is very small for threading close to the head) may be varied for rolling threads of different length by adjusting the entire feed mechanism vertically. The screw for making this adjustment is located at *G*, Fig. 9.

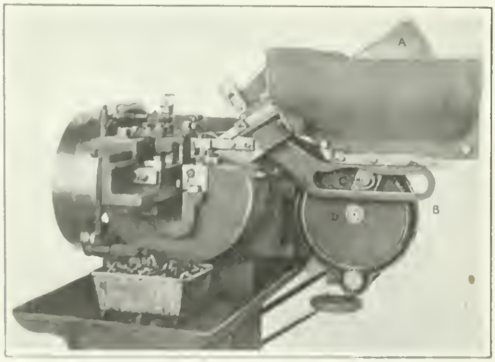

Fig. 11. Side View of Automatic Feeding Mechanism applied to Thread-rolling Machine

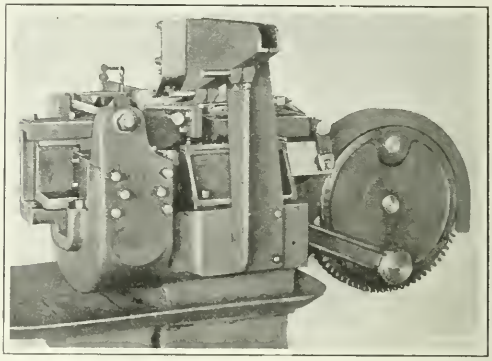

Fig. 12. Machine provided with Magazine Feeding Attachment designed for handling Studs or Headless Blanks

In adapting this mechanism for different sizes and shapes of blanks a certain amount of adjustment is necessary, as previously mentioned. In some cases it may also be necessary to alter the end of cut-off finger *A*, Fig. 10, as, for example, when the blanks have countersunk or oval heads. For instance, in the case of a countersunk head, the edge of finger *A* would be provided with a groove for engaging the blank heads, in order to prevent any tilting action. The chute *G* leading from the hopper to the dies is adjusted in accordance with the diameter of the work, and the pick-up blade in the hopper has a removable top, which can be replaced if necessary. A given width of slot can be used for a limited range of blank diameters without change. The automatic feed mechanism of a machine intended for comparatively light blanks is equipped with what is known as a vibrator. This consists of a rotating shaft carrying pins inserted in a flange and arranged to strike fixed pins and thus cause a rapid succession of light blows. The purpose of the vibrator is to prevent the blanks from sticking in the feed chute, as they sometimes tend to do when very light, and especially if covered with oil.

The automatic feeding mechanism of a thread-rolling machine made by the E. J. Manville Machine Co. is shown in Fig. 11. The slotted blade which oscillates through the center of the hopper and its operating mechanism are clearly shown in this illustration. The lower edge of this blade *A* is bolted to the swinging arm *B*, which derives its motion from the crankpin roller *C* attached to gear *D*. This blade has a positive upward and downward motion, the roller engaging a slot formed in the arm. The blade is shown at the upper end of its stroke, the roller being in contact with the circular concentric surface of the swinging arm. This mechanism, like the one previously described, is so arranged that the descending row of blanks is held back by a cut-off device until, at the proper instant, the lowest blank is separated from the others and forced outward in front of the pusher slide, which then starts it between the stationary and moving dies. In conjunction with this feeding mechanism, there is also a simple mechanical device which automatically throws back into the hopper all blanks that are not hanging in the right position as they pass into the inclined tracks leading to the dies.

Magazine Feeding Mechanism for Headless Blanks

The thread-rolling machine illustrated in Fig. 12 has a magazine feeding attachment which is designed for feeding automatically headless blanks that may require a screw thread on one end, both ends, or a thread extending the entire length. The blanks are placed horizontally in the magazine or hopper by the operator. At the lower end of the incline in the magazine hopper there is an agitator arranged to prevent the blanks from becoming clogged. The lower blank at the end of the incline is transferred to the dies or starting position by an oscillating segment, which, as each successive blank is transferred, changes it from a horizontal to a vertical position.

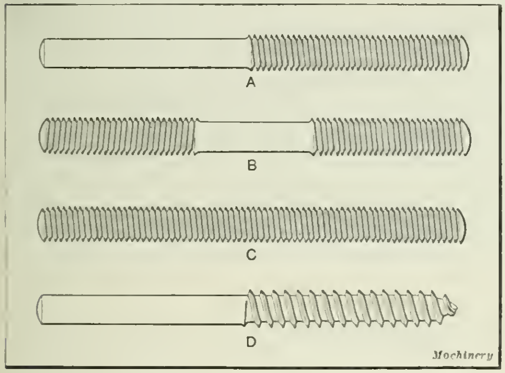

Fig. 13. Examples of Work threaded by Machine shown in Fig. 12

This segment has a notch that receives the lower blank, which is in a horizontal position when it leaves the magazine. The blank is then placed in a vertical position, after which it drops by gravity from the segment and in front of the starting slide plate. The position of the blank relative to the dies is controlled by an adjustable depth gage, and at the proper time it is pushed forward and gripped by the moving die and is then rolled through the die in the usual manner. The turning of the segment for changing the position of the blank from horizontal to vertical is effected by a spring, and the return movement is positive, being derived from a cam. This arrangement is to avoid any damage to the machine in case a blank should become lodged partly in the segment and partly in the magazine. The notch in the segment which receives the blank has a spring finger so arranged that when the segment swings the blank to a vertical position, if it should fail to drop out of the segment or drop only part way, no damage could occur to the machine or the feeding mechanism.

This design of magazine feed is adapted especially for threading parts such as are found in harvester machinery, various forms of special bolts, turnbuckle screws, skate screws, etc. One end of a piece may have a right-hand thread and the other end a left-hand thread, but whenever threads are rolled simultaneously on both ends of the blanks the diameter and pitch must be the same. A few examples showing in a general way the kind of work for which this thread-rolling machine may be used are illustrated in Fig. 13. The part shown at *A* has a thread rolled on one end only. The rod *B* has a right hand thread on one end and a left-hand thread on the other end. The piece shown at *C* is an example of work requiring a thread the entire length of the blank, and *D* shows a lag screw thread and a gimlet type of point. When threads are to be rolled simultaneously on each end of the part and an unthreaded portion is to remain between the threaded sections, as illustrated at *B*, the dies are separated by one or more fillers, according to the length of the unthreaded part. The special thread-rolling machine illustrated in Fig. 12, equipped with the magazine just described and extra deep dies, is made by the Waterbury Farrel Foundry & Machine Co.

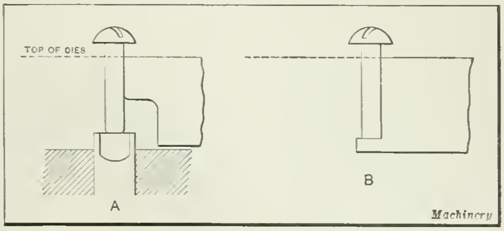

Fig. 14. Two Forms of Stops for regulating Length of Rolled Thread

Length of Rolled Thread and Methods of Regulating

The maximum length of thread that can be rolled in any one machine depends, of course, upon the size and design of the machine. In general, the maximum length of thread is nearly equal to the full face width of the deepest die the machine is capable of using. It is not practicable to roll a thread the entire depth of the dies, as an allowance of about 1/8 inch should be made. The thread-rolling machines made by the Waterbury Farrel Foundry & Machine Co. for rolling exceptionally long threads have one or two tie-rods extending across the frame above the dies to take part of the strain when threads are being rolled. The machine illustrated in Fig. 12 is provided with one of these tie-rods. This reinforcement prevents the dies from springing apart when rolling exceptionally long threads, and insures accurate work. A tie-rod does not interfere with the operation of an automatic magazine feeding mechanism nor with feeding the machine by hand, although the work must not project above the dies far enough to strike the tie-rod.

The length of the rolled thread within the range of any one machine may be regulated in three general ways: First, by placing the end of the blank against some form of stop which is located below the top of the dies a distance equal to the length of thread to be rolled; second, by suspending the blanks for screws, bolts, etc., from the heads; and, third, by cutting away the ridges or threads on the dies down to a point from the top equal to the length of the unthreaded section. When a thread-rolling machine is fed by hand, the lower end of each blank, ordinarily, is placed against some form of stop, except when a thread is required close up to the head, in which case the under side of the head serves as a stop and drops down to the level of the dies. A stop may be in the form of an adjustable depth gage, as indicated at *A*, Fig. 14, or the vertical position of the blank relative to the dies may be controlled by a projecting end or shoulder on the starter or push-finger, as illustrated at *B*. The latter has the disadvantage of not being adjustable.

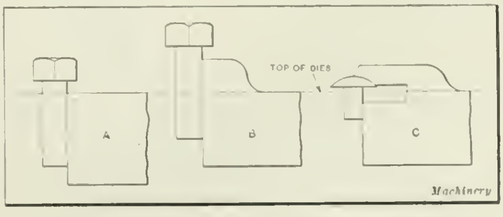

Fig. 15. Push-fingers or Starters for Thread-rolling Machines

With a machine of the design shown in Fig. 7, which has an automatic feed, the length of the thread is adjusted, as previously mentioned, by simply raising or lowering the entire feed mechanism by means of a single screw. This method of regulating the length is possible because the blanks are suspended by the heads until caught between the dies, except when the lower end of the mechanism is changed for rolling a thread close up to the head, in which case the blank is, of course, pushed down to the level of the dies.

Shape and Location of Push-fingers or Starters

The push-finger or starter of a thread-rolling machine is usually made in the form of a rectangular plate having a vertical edge which comes into contact with the body of the blank and pushes it squarely between the dies at the proper time. A simple form is illustrated at *A*, Fig. 15. The width of this push-finger should be a little less than the space between the dies. It is essential to use a push-finger which tends to hold the blanks square or perpendicular to the line of travel of the movable die. One that is not properly formed or located relative to the blank may, by acting against one end, tilt the blank from a vertical position. If a comparatively short thread is to be rolled and the blank extends considerably above the dies, an offset push-finger may be required (see sketch *B*) to secure greater contact along the blank body.

In some cases, a plain vertical edge on the push-finger is not sufficient, and it is necessary to make a special form. An example is illustrated at *C*. In this case, the blank is very short, and, as a space is required to clear the guide plate of the automatic feed mechanism, the push-finger is made with an upper section or extension which bears against the oval head of the blank as the illustration indicates. By supporting the blank at both ends, it can be pushed forward without tilting it. The exact shape and position of these special push-fingers depends, of course, upon the length of the blank and the shape of the head.

* * *

DESIGN OF FRICTION WHEELS

BY LUDWIG EISENKRAMER[1]

Some time ago, the writer was asked to design a concrete mixer on which friction wheels would be used to transmit motion from the driving to the driven, or drum, shaft. The requirements were as follows: The driven shaft *B*, Fig. 1, was to make 90 revolutions per minute while the driving shaft *A* made 200; the shafts were to be 17¾ inches apart; five horsepower was to be transmitted, and the wheels were to be engaged, and then disengaged, thirty times an hour working together for one minute and then disengaging for one minute.

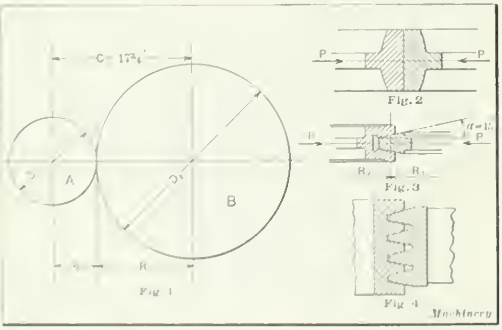

Fig. 1. Friction Wheels of a Concrete Mixer. Fig. 2. Friction Wheels with Plain Surfaces. Fig. 3. Friction Wheels with Cone Surfaces. Fig. 4. Multi-cone Friction Wheels

The first step in designing was to determine the normal pressure *P* in pounds, by which the wheels *A* and *B* are pressed together at the line of contact. The radius R_1 of the driving wheel *A* was found to be:

$$R_1 = \frac{C}{N_1 + N_2} \times N_2 = \frac{17\frac{3}{4}}{200 + 90} \times 90 = 5\frac{1}{2} \text{ inches, approx.}$$

in which C = center distance of shafts;

N_1 = speed of driving wheel *A*;

N_2 = speed of driven wheel *B*.

The diameter D_1 of the driving wheel is, therefore, 11 inches. The radius R_2 of the driven wheel was found to be:

$$R_2 = \frac{C}{N_1 + N_2} \times N_1 = \frac{17\frac{3}{4}}{200 + 90} \times 200 = 12\frac{1}{4} \text{ inches.}$$

The diameter D_2 of the driven wheel is, therefore, 24½ inches, approximately. As the circumferential velocity V of the driven wheel *B* is:

$$V = \frac{\pi \times D_2 \times N_2}{60} = \frac{\pi \times 24\frac{1}{2} \times 90}{60} = 115.4 \text{ inches per second,}$$

or 577 feet per minute; the tangential force P_1 is:

$$P_1 = \frac{\text{H.P.} \times 33{,}000}{577} = 286 \text{ pounds, approximately}$$

As both wheels are cast iron, the coefficient of friction μ may be taken as 0.125; therefore the normal pressure of the wheels *A* and *B*, when they have a straight surface, as shown in Fig. 2, is:

$$P = \frac{P_1}{\mu} = \frac{286}{0.125} = 2288 \text{ pounds}$$

But with a wheel with a cone surface, having an angle α of 15 degrees, as shown in Fig. 3, the normal pressure P is:

$$P = P_1 \times \left(\frac{\sin\alpha + \mu\cos\alpha}{\mu}\right)$$

$$= 286 \times \left(\frac{0.2588 + 0.125 \times 0.9659}{0.125}\right) = 868 \text{ pounds}$$

This pressure, even, is so high that it would injure the bearings; so the wheel periphery was made in the form of four cones, thus reducing pressure P and the pressure against the bearings to one-fourth this amount, or 868 ÷ 4 = 217 pounds. Although friction wheels with a multi-cone surface cost more to manufacture than wheels with straight surfaces, the rest of the machine does not have to be as strong. While the use of friction wheels on a concrete mixer was an experiment, this design proved very satisfactory. Thirty engagements of the wheels in an hour are possible only when the machine is very rigidly constructed.

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CADMIUM FOR RUSTPROOFING

BY A. SCHLEIMER[1]

In the article entitled "Cadmium for Rustproofing" on page 633 of the March number of MACHINERY, if the word "adding" is substituted for "dissolving" in the instructions for forming the double-salt solution, the article will be strictly correct. Both cadmium hydroxide and copper oxide are insoluble in water, but they will dissolve upon the addition of cyanide of potash, in which process of solution they are changed to cadmium and copper cyanide, respectively. So that while they are themselves insoluble in water, it may be said that they are dissolved by the addition of cyanide. What is really done is to change them to cyanides, which are soluble.

The process of solution is one of changing a substance from a solid to a liquid state by means of a liquid, solid, or heat, which change is purely mechanical or physical. If sugar is added to water, it dissolves and assumes a liquid condition, from which it can be readily recovered, in its original state, by the evaporation of the water. If a piece of metallic zinc is added to water, it will not dissolve and no action takes place. But if some muriatic acid is added to the water, the zinc immediately begins to dissolve and if sufficient acid is added the zinc will entirely disappear. However, the fluid cannot be called a solution of zinc, because this would infer that it was a solution of zinc as a metal. If the fluid is evaporated, as was the sugar solution, instead of the metal zinc, a white crystalline powder will be found; this is chloride of zinc, formed by the chemical union of the metal and the acid. In other words, the zinc was changed from the metallic form to the form of chloride before it was dissolved.

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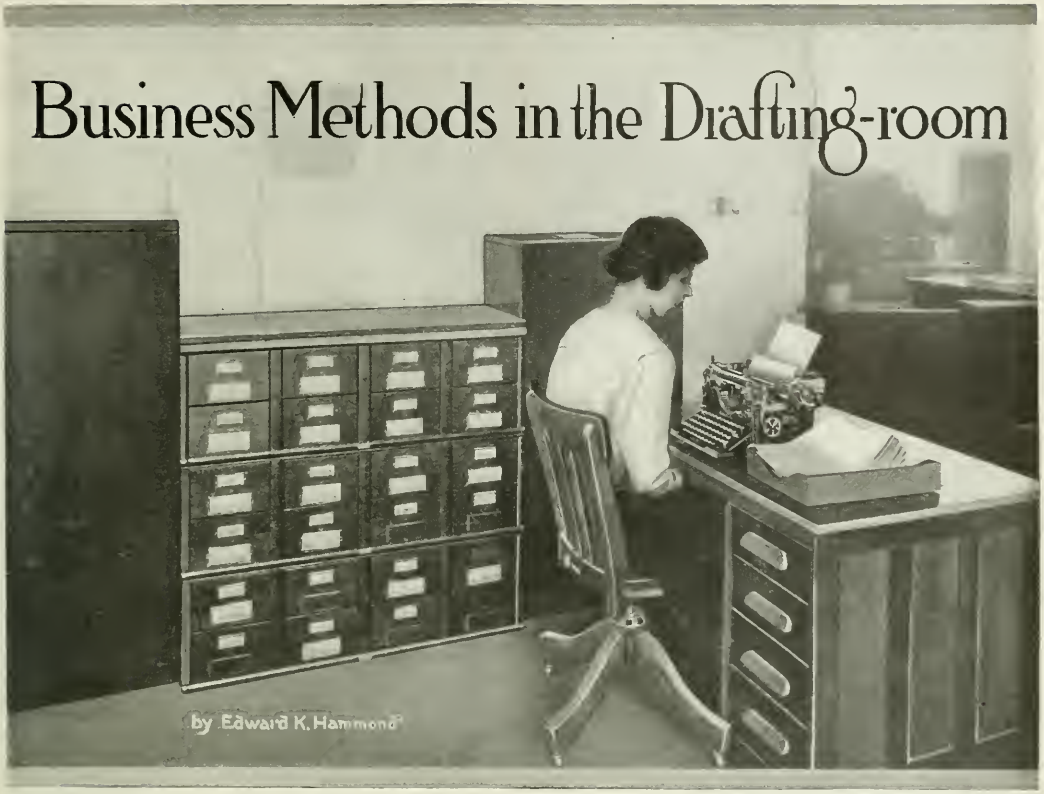
Business Methods in the Drafting-room



by Edward K. Hammond[1]

STATIONERY for business correspondence and the maintenance of office records is made to a standard size of 8½ by 11 inches. Sheets of this size are adapted for use in standard typewriters, and they fold up to fit properly into standard-sized envelopes. In businesses engaged in building machinery or other engineering work, the usual office stationery is employed, but until recently we have not heard of the extension of this standard size for office stationery to cover tracings and blueprints made in the drafting-room. With the view of economizing in tracing cloth and paper, many drafting-rooms have been in the habit of using what is known as a "multiple system" of sheet sizes. For instance, in one case the largest sized tracings and blueprints which are required are 36 by 24 inches, and these large sheets form the basis of all smaller sized tracings and blueprints by a direct method of subdivision, smaller size sheets being 24 by 18, 18 by 12, and 12 by 9 inches. So far as the complete using up of tracing cloth and blueprint paper is concerned, such a method of cutting up large sheets is admirable; but in filing tracings and blueprints, confusion is likely to be experienced through the necessity of handling sheets of different sizes; and when mailing blueprints in connection with engineering specifications, etc., there is almost sure to be trouble because of the lack of conformity of size between the office stationery and the sheets on which blueprints are made.

In the plant of S. F. Bowser & Co., Fort Wayne, Ind., the inconvenience resulting from this lack of uniformity in the size of blueprints and office stationery led Sherwood Hinds, factory engineer of the Bowser plant, to make a study of the subject, and he finally reached the conclusion that there was no good reason why the 8½- by 11-inch standard size for sheets of business stationery could not be extended to cover requirements of the drafting-room. Blueprints of working drawings for use in machine shops are generally made on sheets of about the standard business letter paper size; for instance, in the case referred to, where a practice is made of subdividing large sheets, a size of 9 by 12 inches is frequently employed for shop drawings. On the other hand, there are a great many assembly drawings where the amount of detail is so great that the scale to which the drawing is made requires the use of a much larger sheet. After giving the matter some thought, however, it was seen that this need not represent an unsurmountable obstacle to the use of the 8½- by 11-inch business standard. For small shop drawings, blueprints 8½ by 11 inches in size are ample to meet all requirements, but in cases where larger sheets are necessary, these are made in multiples of the basic size, so that they may be folded up and mailed with letters and specifications, making a neat package which will fit into an ordinary envelope with the letter unfolded. To facilitate folding blueprints to the standard 8½- by 11-inch size, the tracings are made with index marks on them to indicate the points at which the prints should be folded.

Fig. 1 shows the lay-out for different sizes of tracings that are used and the way in which "folding lines" are provided to show how to fold the blueprint made from the tracing. It will be seen that the sheet size numbers run 1, 2, 3, etc., for sheets measuring 11 inches from top to bottom, and 12, 13, 14, etc., for sheets measuring 21¾ inches from top to bottom. For sizes designated by numbers higher than 10, the 2, 3, 4, etc., indicates the width of the drawing, while the 10's digit indicates that the height is 21¾ inches. For a drawing still larger than any of those shown in Fig. 1, the same system of numbering is used; for example, a drawing 44⅜ inches wide by 32¼ inches long would be called size No. 26, the 6 denoting the number of folds right to left and the 2 indicating that there are three folds from top to bottom.

In folding up a blueprint, the bottom is first folded under, and then, starting at the right-hand side, the print is folded inward continuously until the last fold has been made. The tracings are ruled with a slight taper at the top edge of the sheet, starting from the left-hand edge; this taper is 1/16 inch per fold, although 1/4 inch is the maximum taper which is allowed for the entire length of a sheet. The top edge was tapered in this way so that, when the sheet is folded up, the corners will not project. After a sheet is folded, the corner will be located from 1/16 to 1/4 inch below the top of the outside sheet, thus allowing the folded blueprint to be turned over more easily when looking for a print in a binder.

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[1] Associate Editor of MACHINERY.

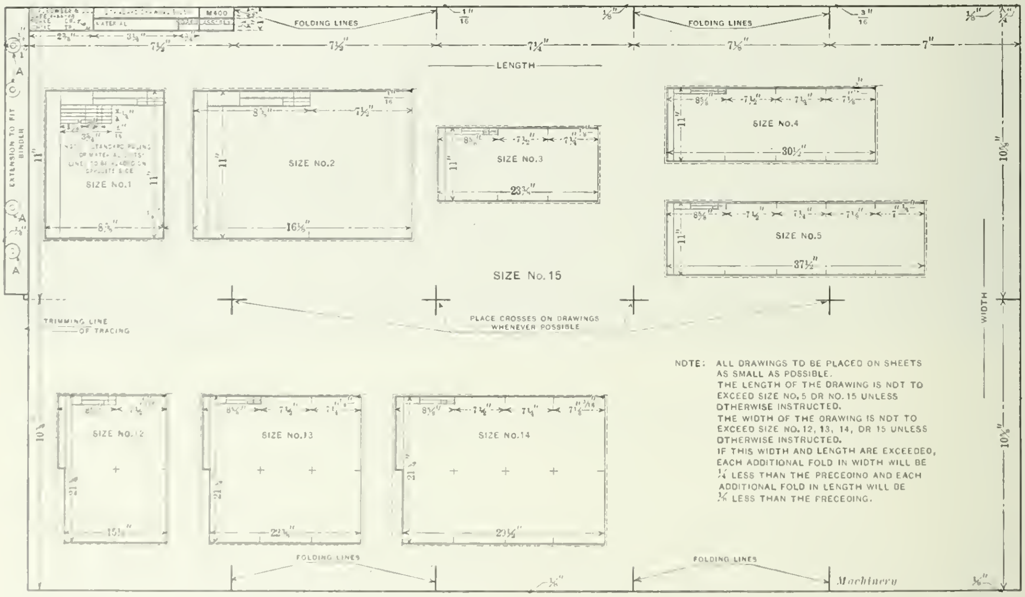
The spacing of the folding lines for different sizes of blueprints is clearly indicated in Fig. 1, and in the case of the No. 14 size of sheet, it will be seen, reading from right to left, that these lines are spaced 8⅝, 7½, 7¼, and 7⅛ inches, respectively, while from top to bottom the spacing is 11 and 10¾ inches. The reason for having the distance between folding lines decrease by regular intervals from left to right and from top to bottom is that in folding up a blueprint the bottom of the sheet is first folded in, and then, starting at the right-hand side, the sheet is folded inward until it has been reduced to the unit size of 8½ by 11 inches. Decreasing the distances between folding lines as indicated makes the sheet fold flat, while it would be bulky if the folding lines were uniformly spaced. The reason for making the reduction between the second and third folding lines 1/4 inch and then making subsequent reductions by intervals of only 1/8 inch is to make the last fold a clean-cut, sharp fold, so that the folded-up print may be conveniently turned over like the leaf of a book.

Advantages of Standardization in Maintaining Blueprint Files

So far we have dwelt upon the extension of business stationery sizes to the drafting room, as regards the mailing of blueprints with specifications, etc., but this does not by any means represent the only advantage resulting from the application of this system. Another important advantage is in the maintaining of blueprint files in the drafting room, in the offices of the company's engineers, and in any other places where a complete set of blueprints is required. An explanation has already been presented of the way in which prints are folded up for mailing, but folded up in this way the prints are also made ready for binding in the standard loose-leaf binders used for maintaining various files of data written on the regular business paper. The way in which binding is effected will be most readily understood by referring to Fig. 1, which shows a complete blueprint provided with an extension to fit into the binder. Referring to this illustration, it will be seen that at the left-hand side of the upper section of the print there is an extension one inch in width, which is punched with four holes to fit the type EA-3-R loose-leaf binders made by the John S. Moore Corporation, of Rochester, N. Y. This binding edge is punched with four holes, and as a general proposition trouble is not experienced through the blueprints tearing out of the binder. Should it happen that a print is punched badly and has to be repunched, or if the blueprint is accidentally torn at the points where the binder pins pass through the holes, the blueprint does not have to be discarded. In such cases, use is made of Dennison's No. 2 gummed rings, which are pasted around the holes, thus making the blueprint even stronger than when it was new. The arrangement of these guard rings is shown at *A*.

Attention has already been called to the practice of starting at the right-hand side of the sheet and folding inward continuously. The real object of adopting this method of folding is to obtain a folded print which acts like a single leaf when mounted in one of the loose-leaf binders. Evidently by following the practice of folding inward continuously, the outer edge of the folded print is a closed fold, so that the entire print turns over in the same way that a single leaf would. Perhaps this idea will be more clearly understood after referring to Fig. 2, which shows two binders with the blueprints folded up ready for the binder to be closed, and a third binder with one large blueprint unfolded ready for use. Business office methods have been highly standardized, and there appeared to be no reason why the same standardization could not be followed in developing methods for use in the Bowser drafting-room. Consequently, when it had been decided upon as to the different sizes in which tracings were to be made in order to produce blueprints which could be folded into the standard 8½- by 11-inch size, orders were issued for sheets of tracing paper to be printed with the border line, "folding lines," and with a space ruled for insertion of the title, drawing number, etc.; in other words, these sheets were printed so that draftsmen would not spend their time in doing work by hand which could be much more economically done in the printing office.

In this connection, the arrangement of the border lines for the tracing and the provision made for cutting away the surplus paper around the edge of the blueprint are of interest. It will be seen that each side of the blueprint is ruled with a border line which is located closer to the margin than is the ordinary practice in drafting-rooms. It is the idea to have



FOLDING LINES
FOLDING LINES
M400
1/16"
3/16"
⅛"
7½"
7½"
7¼"
7⅛"
7"
LENGTH
EXTENSION TO FIT BINDER
A
A
A
SIZE NO.1
SIZE NO.2
SIZE NO.3
SIZE NO.4
SIZE NO.5
SIZE No.15
SIZE NO.12
SIZE NO.13
SIZE NO.14
11"
8½"
16½"
23¾"
30½"
37½"
15½"
22⅝"
29½"
10¾"
10⅝"
WIDTH
TRIMMING LINE OF TRACING
PLACE CROSSES ON DRAWINGS WHENEVER POSSIBLE
NOTE: ALL DRAWINGS TO BE PLACED ON SHEETS AS SMALL AS POSSIBLE.
THE LENGTH OF THE DRAWING IS NOT TO EXCEED SIZE NO. 5 OR NO. 15 UNLESS OTHERWISE INSTRUCTED.
THE WIDTH OF THE DRAWING IS NOT TO EXCEED SIZE NO. 12, 13, 14, OR 15 UNLESS OTHERWISE INSTRUCTED.
IF THIS WIDTH AND LENGTH ARE EXCEEDED, EACH ADDITIONAL FOLD IN WIDTH WILL BE ¼ LESS THAN THE PRECEDING AND EACH ADDITIONAL FOLD IN LENGTH WILL BE ⅛ LESS THAN THE PRECEDING.
Machinery

Fig. 1. Reproduction of Blueprint showing Location of Title, Provision of Extension to fit Binder, Folding Lines which indicate Points at which Sheets should be folded up, and Linen Guard Rings A used for repairing Prints when torn out of Binder

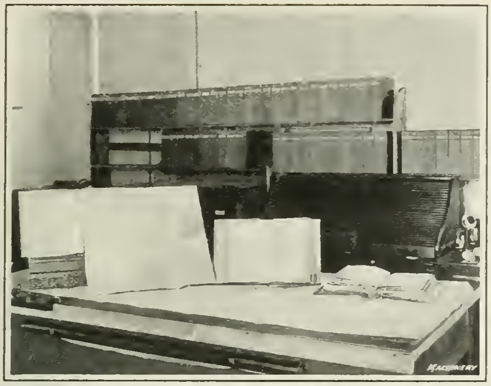


Fig. 2. Blueprint Binder with One Sheet opened out for Reference and Two Binders with Prints folded up

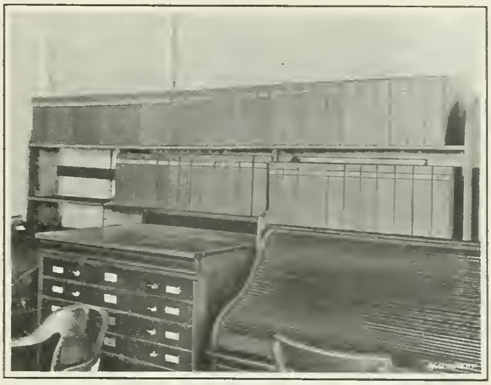


Fig. 3. Complete File of Blueprints arranged in Binders to which Reference may conveniently be made

this border line extended right around the extreme edge of the blueprint, and to provide for obtaining this result, each tracing is ruled off with a double border line extending around. The lines of this double border are placed 1/16 inch apart, and the reason for using a double border instead of a single line is that experience in trimming blueprints has shown it to be more simple for a man using shears to cut between two lines than it is for him to follow a single line. Hence, by cutting between these two lines, a margin line is left which extends around the edge of the blueprint, giving it a neatly finished appearance. The arrangement of the double lines between which the cut is made in trimming the edges of blueprints is indicated in Fig. 1, and the boys employed to do this work are carefully watched to see that the inside line is clearly visible all the way around the blueprint, while all of the outside line must be cut away. The dotted line shown around the outside of the double border lines in Fig. 1 indicates the manner in which the tracings are trimmed to within 1/8 inch of the outside margin line.

Particular attention is called to the position of the frame for the title, drawing number, etc., which will be seen in the upper left-hand corner of the blueprint in Fig. 1. This position, as compared with the usual practice of placing the title in the lower right-hand corner of the drawing, will seem strange until its position is compared with that of the first folding line; then it will be seen that, when the sheet is completely folded up in a binder, this title and drawing number appear on each folded sheet as successive sheets are turned over in the binder, without requiring time to be spent in unfolding the sheets, when it is required to locate a given blueprint by its drawing number. Two files of blueprints in binders are maintained in the drafting-room, one of these being arranged numerically according to the drawing numbers, while the other has the blueprints classified according to the parts which are shown. In the latter file, prints from all drawings of stuffing-boxes, valves, pump plungers, etc., are arranged together according to this classification, so that, if it is required to locate a drawing of a given part without knowing the drawing number, the task is greatly simplified by referring to this file. Figs. 3 and 7 show these two files.

Blueprints of Standard Commercial Parts

In making out bills of material for assembly drawings, difficulty was sometimes experienced through failure of draftsmen to use the proper commercial names in specifying parts which it was their intention should be used in assembling. To correct this undesirable condition, each piece of standard commercial hardware used in assembling any Bowser product was given a drawing number. In handling this work, the catalogues of all manufacturers from whom such parts as bolts, nuts, washers, set-screws, etc., were purchased were gone over by the drafting department and lists of the proper commercial names of these parts were made with a drawing number assigned to each.

These lists were copied on the typewriter on 8½- by 11-inch sheets of tracing paper with a reversed carbon paper on the back, and these made good clear blueprints for the use of the draftsmen in making up bills of material, so that any given part could be specified by its drawing number, thus practically avoiding any chance of mistakes being made. These blue-

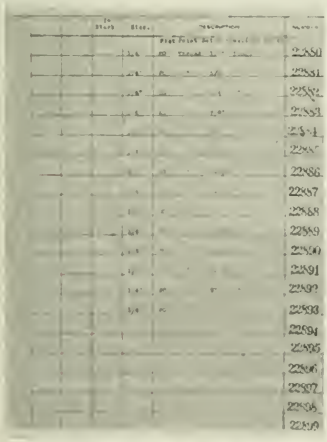

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Fig. 4. Arrangement of Drawing Numbers assigned to Commercial Hardware used by Assembling Department

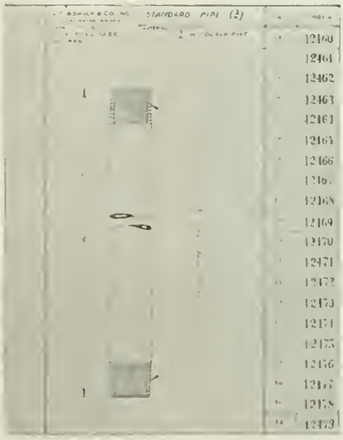

Fig. 5. Drawing Numbers assigned to Parts of Standard Design where One Dimension is Variable

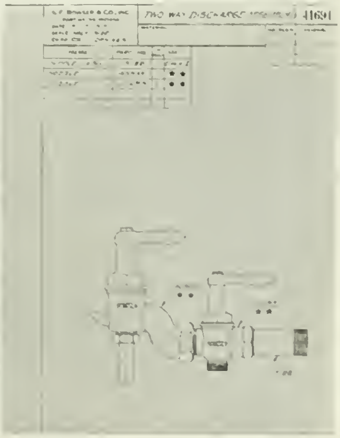

Fig. 6. Method of indicating "Partial Assemblies" in Bills of Material on Assembly Drawings

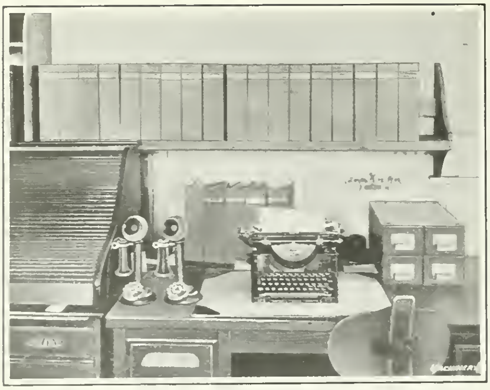

Fig. 7. File of Blueprints classified according to Parts which are shown

prints giving numbers of commercial parts are bound in binders and placed in the file of blueprints, which is arranged numerically, although there is a slight difference in the arrangement of these prints. It will be recalled from the preceding discussion that each part is given a drawing number, and attention is called to the fact that this drawing number is the same as the part number, which is believed to be a much simpler method than having different numbers for the drawing and the part. Ordinarily, there is an individual blueprint for each number, but in the case of commercial parts, blueprints are arranged with twenty numbers on each, as shown in Fig. 4, in order to economize space.

There are many parts used in the products made by S. F. Bowser & Co. which are of the same design and general dimensions, although one individual dimension may vary for different cases. For instance, use is frequently made of pieces of 3/4-inch wrought-iron pipe which are threaded at both ends and all dimensions of such pieces are the same, except the total length. In all such cases, a blueprint of the part is made with the variable dimension indicated by a letter, and pieces of each different length used are assigned different drawing numbers. These blueprints are made up with more than one drawing number to a page, with the variable dimension tabulated beside the drawing number under a letter which indicates this dimension. This practice of putting anywhere from one to twenty numbers on a sheet is not at variance with the idea that the drawing and part numbers are the same, because in such cases it is assumed that a single drawing has as many drawing numbers as the number of parts shown. For instance, Fig. 5 shows a case where there are twenty numbers, and so it is considered that this drawing has twenty drawing numbers and twenty part numbers. In cases of this kind, the numbers are always consecutive in order to adhere to this idea. There are not always twenty drawing numbers on a sheet; the number may run anywhere from two up to twenty, although it is the usual practice to have either five, ten, fifteen, or twenty. Here, again, a considerable economy of space is made possible.

Fig. 8. Arrangement of Tracing Files in Fireproof Storage Vault

Concerning Use of Partial Assemblies

Many pieces are used which are termed "partial assemblies" in turning out completed Bowser products. These partial assemblies comprise two or more pieces which are made in the factory, assembled, and placed in stock ready to be drawn out upon the requisition of the assembling department. Each of these so-called "partial assemblies" is assigned a drawing number, just as if it were an individual part, and in making up bills of material on assembly drawings of complete products, the drawing number of the partial assembly is used as if it were a single piece; then, to avoid the possibility of confusion, a double star is placed in the column devoted to the specification of the material from which parts are made. In this way, the assembling department sees at once that drawing numbers with these stars placed beside them are partial assemblies, and so there is no danger of confusion. The idea of using these partial assemblies will be clearly understood by referring to Fig. 6.

Practice Followed in Filing Tracings

For filing tracings where the system of cutting large sheets into halves, quarters, etc., is employed for making various sizes of tracings, a number of cabinets of different dimensions are required for filing sheets of various sizes, if the tracing files are to be kept in orderly fashion. The same is, of course, true of the different sized tracings required for making blueprints according to the 8½- by 11-inch system of sizes which we are now discussing, but a very satisfactory solution of the filing problem has been worked out. Attention has already been called to the fact that a majority of the tracings and blueprints used in the Bowser shops for instruction of workmen in the performance of machining operations are of the 8½- by 11-inch size, and all of these tracings are filed numerically by their drawing numbers in standard business letter filing cabinets. Cabinets with other sized drawers are provided to take the larger tracings, but, in order that their location may be readily ascertained, the file of 8½- by 11-inch tracings is made complete through the insertion of the upper left-hand section cut out from blueprints of all other sized tracings, which gives the title of the drawing and is filed numerically by the tracing's drawing number. On this section of the blueprint there is written with a red pencil the size of the tracing and its location in other sizes of cabinets required for the preservation of the larger tracings. Consequently reference to a single file at once shows the exact location of any tracing that is required. This method enables the required tracing to be located in less time than it would take if it were necessary to refer first to a card file to ascertain the location of the required tracing, and it also makes it

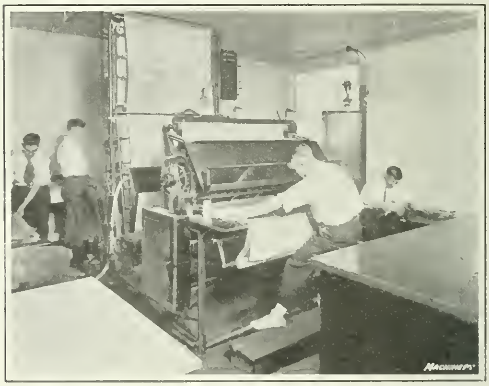

Fig. 9. Method of grouping Large and Small Tracings to secure Complete Utilization of Blueprint Paper

unnecessary to maintain such a card file. Fig. 8 shows a view in the vault where tracings are filed; the letter file for 8½- by 11-inch sheets will be seen in the foreground.

Concerning Replacement of Obsolete Prints

In every plant engaged in building machinery or in any other line of engineering work, it frequently happens that certain minor details of an existing design are required to be changed, but quite as often as not the changes are of such a character that they may be made on the original tracings without requiring entirely new tracings to be made. In working out the new drafting-room system for the Bowser shops, provision has been made for keeping a record of all changes of this kind made on old tracings, and also of cases where entirely new tracings were found necessary. There are certain departments in the factory to which new blueprints of changed tracings must be sent to replace obsolete prints in the files in these departments; and it is the duty of the drafting-room to see that such prints are sent out just as soon as they are ready, together with a written notification of the change which has been made in the design.

At the time the new print is delivered, the obsolete print must be taken up by the messenger and returned to the drafting-room. Each department to which a new blueprint is sent receives the written notification concerning the change in the machine detail shown by the print, and as there are a considerable number of departments to receive such notifications and also because there are a number of these changes in design constantly being made, it will be obvious that the handling of this work takes considerable time. As the drafting-room system developed by Mr. Hinds for use in the plant of S. F. Bowser & Co. was worked out with the idea of securing increased efficiency through the use of modern business methods, it was fairly obvious that this work of preparing notifications for the different departments to which blueprints are sent should be handled by a stenographer in order to enable the work to be done as expeditiously as possible.

A card file is kept on 5- by 8-inch cards, which constitutes a complete record of all blueprints that are sent out to the shop, and of all changes in design that are made on tracings. This card file refers not only to prints of parts which go into the latest Bowser products, but also the parts that have been declared obsolete as a result of certain changes in design. There is a separate card in the file for each drawing, and on the reverse side of the card shown in Fig. 10 spaces are provided for recording the sending out of blueprints and the return of obsolete prints from each department to which new prints are sent. This guards against any department keeping obsolete prints in its files and making parts from such prints through mistake. When the print represented by a given card in the file is declared obsolete, a small star is stamped in the upper right-hand corner of this card and a new card is made out for the print in question. Each card is marked in its upper right-hand corner with the drawing number of the part shown by the blueprint, and it will be apparent that there may be several cards of the same number, each having the star stamped in the corner with the exception of the last card of the given blueprint number, which represents the blueprint that shows the part in its latest form.

On these cards there is a ruled space on which is typewritten a statement of the changes made in the design shown by the print; and each time a change is made on a design, requiring a new card to be made out to record this change, the card is marked with the number of changes that have been made in the design of the part shown by that blueprint. These cards are blocked up in sets of one card for the drafting-room record file and one paper sheet for each department which must receive a new blueprint and notification of the changes in design of the part shown by the print. There is also one sheet of paper for the stenographer's use in taking dictation from the chief draftsman concerning the changes made in the design, and this sheet of paper is ruled with lines like the ordinary stenographer's notebook, so that the usual positions above and below the line may be used in writing the notations in shorthand. After taking dictation concerning the changes in design in each blueprint, the stenographer tears off from the pad the top sheet on which the stenographic notes were made and all sheets on which notifications to department heads will be typewritten, together with the drafting-room record card on which a typewritten statement of the change in the blueprint will be recorded. Tearing off the complete set of sheets is an easy matter, because the girl simply runs her thumb over the edge of the pad and catches the card, which is torn off with the paper sheets that are above the card. Fig. 7 shows the record card file and a set of new blueprints for which the stenographer has made out notification slips and clipped them onto the prints ready for delivery to the factory department.

Carbon paper is placed between each of the lower sheets so that all of the notification sheets and the drafting-room record card may be slipped into the typewriter and written at one time. At the bottom of each of the notification sheets sent out to the factory with new blueprints, there is a slip separated from the main sheet by a perforated line. When the new print is delivered to the department, the old print is taken out of the file in that department, and a receipt signed for the new print on the slip at the bottom of the notification sheet. This receipt is then torn off the main sheet and clipped

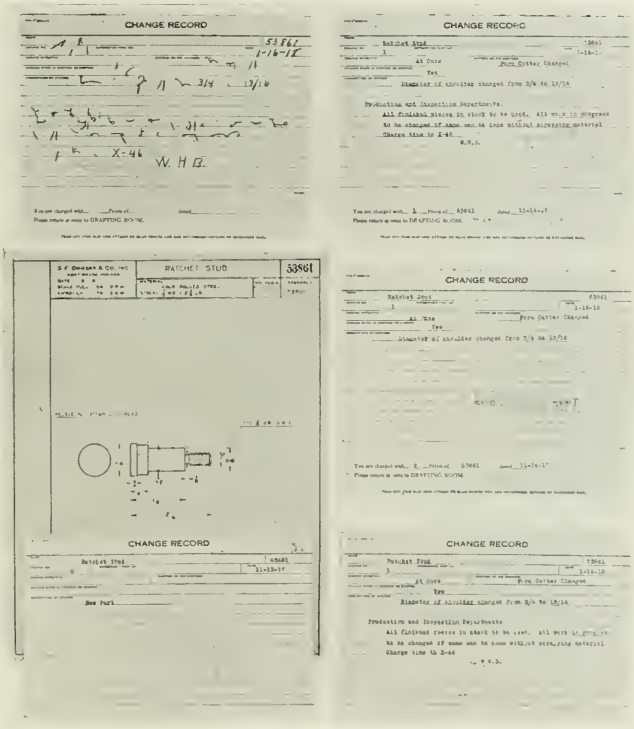
CHANGE RECORD
W. H. B.
CHANGE RECORD
RATCHET STUD
53861
CHANGE RECORD
CHANGE RECORD
CHANGE RECORD

Fig. 10. Group of Change Record Cards showing Stenographer's Notes, Notifications sent to Production and Engineering Departments, Change Record Cards of Original and Corrected Blueprints and Blueprint No. 53861

onto the obsolete print, so that both may be returned to the drafting-room office. A record of the delivery of the new print and return of the old one is then made on cards in the drafting-room file, and the old print and receipt are destroyed. The double entry on the back of a drafting-room record card serves to indicate that the card refers to an obsolete print, thus serving as a check on the small star stamped in the upper right-hand corner to indicate the same thing.

Points Observed in Making Blueprints

Blueprinting is done on one of the continuous blueprinting and drying machines built by the Pease Mfg. Co., of Chicago, Ill., and in making blueprints, care is taken to select tracings of such sizes that the blueprint paper will be used up as completely as possible. In connection with Fig. 1, an explanation was given of the different combinations of the 8½- by 11-inch units to form larger blueprints and tracings of the required sizes. This arrangement provides for the use of tracing paper, tracing cloth, and blueprint paper in rolls, either 36, 42, or 48 inches in width, with practically no waste. This economy is due to the fact that there is always a preponderance of 8½- by 11-inch tracings, making it possible to use these small-size tracings to fill in the space on the blueprint paper at the side of larger tracings. The way in which different sizes of tracings are matched up on the blueprinting paper in order to avoid waste will be appreciated after referring to Fig. 9, where it will be seen that the printed area going over the drying section of the machine covers practically the entire surface of the blueprint paper. Both tracing paper and tracing cloth are used in the drafting-room, and by a careful selection of grades of paper and cloth which are equally transparent, practically no difference can be seen between blueprints made from tracings on cloth and those made from paper when they are run through the machine together and so receive the same exposure.

* * *

METRIC SYSTEM IN WATCH INDUSTRY

BY F. A. HALSEY[1]

Referring to the article "Metric System in Watch Industry" by W. H. Dunbrack published in MACHINERY for March, I quote as follows: "But adopting the metric system as it is used in the watch industry in Waltham, Elgin, Lancaster," etc. I have before me a letter from the superintendent of the Elgin National Watch Co. from which I quote as follows:

> So far as I know, all watch manufacturers in this country with the exception of the Waltham and the Ingersoll companies use the English system of measures.
>
> Watch case making is very highly developed as a separate industry. It uses neither the English nor metric system, but the old French system.

The use of the metric system at the Ingersoll works is due to the fact that those works were originally fitted out by men from the Waltham works who carried the metric system with them, but beyond this, the influence of the Waltham works has not gone.

A recent extended investigation from this office has disclosed five industries in which the metric system was really adopted—not merely introduced—at their original foundation. These industries are watches (the Waltham Works), card indexing and filing systems (Library Bureau), magnetos (the Ericsson Mfg. Co.), chemical manufacturing (the Solvay Process Co.), and steam boiler injectors (William Sellers & Co.). Of these five industries, the system, after trial, has been abandoned for mechanical purposes in three cases. In the two remaining cases, the example of the pioneers has not been followed by their competitors, and in one of them (William Sellers & Co.) the system is unreservedly condemned, although its use is continued as a lesser evil than the effort and cost of getting rid of it. They have had a longer experience with it than any other American manufacturer, this experience dating from about 1860.

It will be recognized that the most favorable conditions possible for the adoption of the metric system are those existing at the foundation of an industry; since then no change is involved. The cost due to scrapping tools, jigs, gages, etc., of which we have heard so much, is then absent, the chief difficulty to be confronted being the psychological one of learning to think in the system. Nevertheless, we find the above history of these five real and serious attempts to adopt the system under these favorable conditions. It seems to me entirely clear that if the metric system possessed the advantages claimed for it, or, indeed, any advantage, the above condition of things could not be. The favorite slogan of the metric party at the present time is: "It is better, and we want the best," and it is now for them to explain why, on trial, these advantages did not appear.

A comical element is injected into the subject by the fact that twenty years ago the Library Bureau was considered the star example of the progress of the metric system. I have in my office a transcript of a statement made by the then president of the Library Bureau before the House of Representatives Committee on Coinage, Weights and Measures a dozen years ago in which the system is extolled to the skies, and especially the workmen are represented as taking to it like ducks to water. The Library Bureau now write:

> Our draftsmen and mechanics failed to make any attempt to familiarize themselves with the metric system, but simply translated the metric dimensions into English inches or fractions thereof, and worked accordingly. I do recall, however, having known one man connected with the Library Bureau in former days who was inclined to brag that he had mastered the metric system sufficiently so that he could actually think in it as well as he could in feet and inches, but I take it that his was a very rare case.

The Library Bureau abandoned the system after giving it a trial of more than thirty years' duration.

* * *

WARNING—DANGEROUS ETCHING FLUID

The etching fluid formed by mixing four ounces of pyroligneous acid, one ounce of alcohol, and one ounce of nitric acid, which formula was contributed to and published in MACHINERY some years ago and republished in MACHINERY's book of "Shop Kinks," though an active etching agent, is dangerous to mix, and therefore should not be used. Nitric acid is one of the most easily decomposed acids. It is also one of the most powerful oxidizing agents known; in fact, it is so powerful that should it come into contact with organic matter, such as paper, straw, wood, turpentine, oil, etc., it will invariably cause combustion. Alcohol is an organic body, and, at ordinary temperatures, the addition of nitric acid will produce a violent reaction; if the heat is above normal, this reaction will tend toward an explosion. Combining alcohol and nitric acid produces nitrous ether, which is a very light, volatile, and highly inflammable vapor. Pyroligneous acid is a product of the destructive distillation of wood—the source of acetic acid, wood alcohol, acetone, etc. Even if the pyroligneous acid is mixed with the alcohol and the mixture is cooled before the nitric acid is added, the etching fluid will retain its dangerous properties. The dilution will retard the speed of the reaction, but will not prevent it. The gas will form just the same, though slowly, and when the pressure exceeds the strength of the retainer, an explosion will result, together with fire if it is near a flame or spark. Besides, fire may be caused spontaneously. Hence, the mixture should not be used. The formula was contributed to MACHINERY's columns by a contributor who apparently had not made use of the etching fluid.

* * *

As alloys of iron with boron are so hard that they can scarcely be ground with an emery wheel, it has been suggested that boron be used for casehardening. Such alloys will be especially valuable for machine parts subject to great wear. A further advantage of these alloys is that they do not need special heat treatment, such as the annealing process required by articles casehardened by carbon. The cementation proceeds more quickly and easily with powdered ferro-boron than with amorphous boron, and a microscopic examination will show that the casehardened part of the specimen consists of compact boric pearlite with a twin crystal structure.

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[1] [illegible] American Institute of Weights and Measures, 20 Vesey St., New York City.

INVENTIONS AND INVENTORS

BY COLE NEWMAN

The writer has spent his life among mechanics, designers, and scientific men and owns a few patents; he therefore knows whereof he speaks when he says that the way of the inventor is thorny. On the one side, the hand of the law is against him, on the other, the hand of finance. Whenever clever ideas and inventions have been incidentally mentioned by mechanics, the writer has usually asked: "Why don't you use this in your business?" "Why don't you interview your employers about it?" or, "Why don't you patent it and try to do something with it?" But the average reply has been: "What's the use? It would only benefit somebody else, who would not share the returns with me."

When a human being conceives an idea, his greatest pleasure is to put this idea into material form. It is his pet; employers, however, generally take the stand that they are entitled to the inventions of their employes, and that, even if the employe has developed the invention in his own home, it should be turned over to the employer. One manufacturer of cash registers told the writer that he encouraged inventions in his factory and amply rewarded every creator of a useful idea. A few questions developed the fact that this reward ran from $5 to $150, although some of the inventions had netted the manufacturer hundreds of thousands of dollars. During a conversation outside of the plant, one of the employes revealed a certain brilliant idea; but when told that the employers would be very glad to hear of this, the employe replied: "Nothing doing! I have sold this invention for $5000 and am leaving the company next week; the company would probably give me $25 for it."

Attitude of Large Corporations

When the average corporation learns that a patent has been granted for something which may be of use to it, the first step is to learn how much money the inventor has back of him and what is his ability to fight. The next step is to approach the inventor with a "take it or leave it" air and offer him a few hundred dollars. If the man refuses and the corporation really desires the patent, the patent may be infringed and the man drawn into litigation. Inventors are considered by business men to be fools as far as commercial matters are concerned; they are not, as a rule, men of business experience, but rather specialists in some particular line. For this reason their imagination is likely to be highly developed along one line of thought. They are often enthusiastic dreamers, very imaginative, sensitive, suspicious, and reclusive.

A few business men have given their support to an inventor or a man able to conduct research, with great profit to themselves as well as to the inventor. A manufacturer of insulators in the United States built his entire fortune around the genius of a man who was able to conduct scientific research, but who was temperamentally unable to take care of himself in matters of common sense and finance. One large electrical corporation is dominated by the inventive genius of its chief engineer to whom money means so little that he has declined further increases of salary.

Every industry in the United States is founded on the work of an inventor; but the writer challenges the majority of firms in this country to prove that the original inventor of the product they are marketing was properly and adequately rewarded. Generally, a valuable patent is synonymous to a lawsuit. An article can hardly be considered as properly patented until its merits have been passed upon by the United States Supreme Court, which shows that a patent is potentially a lawsuit.

Valuable Inventions that are Unavailable

The writer knows of inventions that will probably die with their owners, because of the impossibility of the original inventor making any money out of his idea. One invention is a sight for large guns to be used on battleships. This sight is so arranged that the officer keeps a light telescope pointed at the target and it is impossible for the gun to be fired unless it is absolutely parallel with the telescope, with corrections, of course, for windage, etc. When tried out in connection with a small rifle at distances of even 1000 yards, 100 per cent of hits was recorded. This inventor's business troubles were so great that he destroyed the entire apparatus.

Another invention is a periscope that shows the entire horizon, and not only a small section of it. This periscope depends on a device similar to a moving picture whereby a little motor reflects successively all points of the landscape in such rapid succession that it appears to be one continuous picture. This inventor, also, has taken apart his apparatus because of attempts made to make use of his idea without compensating him.

A third invention was an apparatus that measured the depth of water underneath a ship by the principle of reflected sound or echo. The writer saw this apparatus in action and was amazed at the results. A ship's officer, by pressing a button, could see the depth of the ocean at any time on a differential scale, in the form of a spot of light. The details of this instrument were explained to the writer, and they are quite simple when once understood, but it is doubtful if they could be duplicated by anyone but a mathematical expert in physics. There had been so many attempts to steal this idea and the people approached had tried so hard to keep the lion's share for themselves, that the inventor abandoned the whole proposition.

Need of Greater Protection to Inventors

None of these inventors patented their inventions, because the patent gives absolutely no protection (unless there is capital behind it), while the patent laws require that the inventors must reveal their invention to the public. The inventor is thrown entirely upon the mercy of the business man. Royalties on inventions are largely a myth of dollar-and-a-half novels. Such royalties as are actually received by inventors are hardly worth mentioning, and those who receive large royalties are very few in number. A large number of inventors lose the fruits of their work, and many ideas are appropriated without compensation. The manufacturer wants new ideas, improvements, increased production, etc., but he does little to encourage the creative type of mind. He ignores the fact that the inventor *must* be a type of man entirely different from him. Ideas for improvements must come from men with broad mechanical and scientific vision, who are encouraged to do the necessary research work, and this encouragement must come from the manufacturer.

* * *

GERMANY WANTS TO KEEP ORE FIELDS

At a recent meeting of the Union of German Iron and Steel Industries, a resolution was passed, according to *Engineering*, to the effect that it was necessary for Germany to retain possession of the iron ore deposits in northern France and to secure a sufficient supply of Russian manganese and iron ores. Before the war, 50 per cent of the iron ore necessary for German industries had to be imported, and, furthermore, in the course of forty or fifty years Germany's present known iron ore deposits would be about exhausted. Hence, it was thought quite proper that France should give up to Germany such parts of that country as contain the quantities of iron ore required for Germany. It was also stated at the meeting that Russia was in a similar position. Polish deposits could supply iron ore to the upper Silesian iron works and Swedish iron ore would also be of importance in the future. It was also mentioned that it would be necessary for the German iron works to secure their share of the extensive and valuable ore deposits in Brazil. It was emphasized that the supply of iron ore and manganese ore should be kept in the foreground at the peace negotiations, for on this, it was said, hung the continued existence of the German industry, the German state, and the German people. Probably it matters little whether other nations have any ore supplies so long as the German requirements are filled.

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In England, where illuminating gas is used as motive power for motor busses, it has been demonstrated that 250 cubic feet of gas is equivalent to one gallon of gasoline.

SENSITIVE DRILLING MACHINE SPINDLE CONSTRUCTION

DEVELOPMENT OF HIGH-SPEED DRILLING MACHINE SPINDLES AND IMPORTANT FEATURES OF THEIR DESIGN

BY CHARLES E. BERNITT[1]

During the period of introduction of high-speed steel when the majority of machine tools were redesigned and developed to increase the production, ease of operation, and the speeds and feeds, little attention seems to have been given to one of the most important machine tools in the shop—the sensitive drilling machine. It is safe to say that nine out of ten machine shops have one or more sensitive drilling machines in operation, and in numerous manufacturing plants the high-speed spindles may be numbered in the hundreds. Yet for a score or more of years the possibilities of the sensitive drilling machine were not realized, the design of the machine was virtually unchanged, and each new machine brought out was practically a duplicate of its predecessor. Today the sensitive drilling machine is built in fifteen different types and sizes by one maker alone, with from one to eight spindles. The spindle speeds recommended range from 150 to 12,000 revolutions per minute, and no matter what the requirements are—whether for drilling 0.0135-inch holes (No. 80 drill size) in brass or aluminum, or 1-inch holes in mild steel—there is a sensitive drilling machine adapted for the work. This development was brought about in a comparatively few years, and is the result of a natural demand for a machine of greater efficiency to keep pace with increased quantity production, and the need for correct speeds when drilling small holes in interchangeable parts such as are found in typewriters, adding machines, automobiles, rifles, and similar products, where a fraction of a second per drilled hole is an item of no small importance. The paramount necessity of meeting these and other requirements has brought the sensitive drilling machine to a point where it must be seriously considered when estimating drilled hole output.

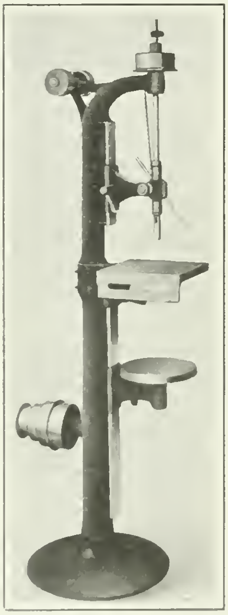

Fig. 1. Sensitive Drilling Machine with Old Type of Spindle

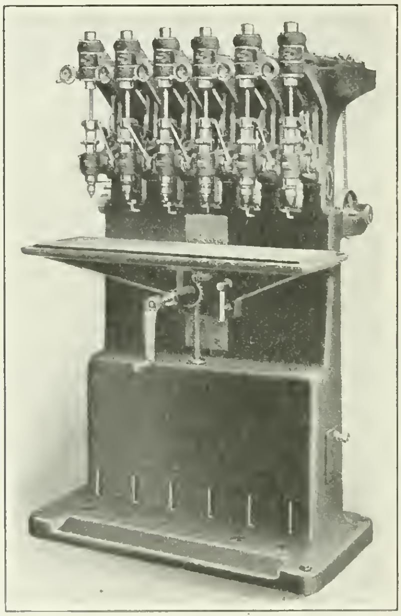

Fig. 2. Modern Type of High-speed Ball-bearing Sensitive Drilling Machine having Spindle Construction illustrated at B, Fig. 6

While different manufacturers encountered the same problems, they naturally followed different courses in seeking their solution. Countless forms of columns or housings, various methods of driving from the countershaft to the spindle, different types of tables and elevating devices, and sundry ways of varying the belt tension and of obtaining speed changes, were adopted, redesigned, and perfected. But it is the spindle and its construction to which this article is confined, because the spindle, its bearings and their mounting, and the design of the spindle pulley required the most attention in developing the modern sensitive drilling machine. Possibly a stronger reinforcing of the column against vibration and a careful selection of driving belts were contributing factors to its ultimate success. It may be well to note here that it is not the purpose of this article to describe all the existing forms of spindle design, but rather to relate the experiences of one manufacturer in improving and developing the construction to its present degree of efficiency. However, the spindle arrangements illustrated and described may serve very well as an index to general practice.

Old Design of Sensitive Drilling Machine Spindle

Fig. 1 is an illustration of what is commonly known as a sensitive drilling machine. Without doubt this is a sensitive drilling machine; there is still a wide field of usefulness for a machine of this type and at the present time a dozen or more manufacturers are building a machine that is similar to, or that varies only slightly from, the original design. But, as the machine shown in Fig. 1 was designed sometime in the eighties, it furnishes an excellent example of the old type of spindle construction. A cross-section of the spindle, the spindle quill or sleeve, the head, and the pulley mounted on the top of the column is shown at *A*, Fig. 4. The entire machine, including the spindle, has plain bearings, with a resultant loss of power due to friction. Additional power is consumed at the point where the thrust of the drill is taken by a fiber washer. High speeds, of course, are impracticable, and a machine with this design of spindle is seldom recommended for drill speeds exceeding 500 or 600 revolutions per minute.

The drive is transmitted to the spindle by means of screw-key *c* through the pulley and bushing *d*. This sort of key is obviously a poor design, as it affords very little driving surface on the spindle keyway. It has a tendency to open out the keyway, especially when drilling a great many holes with the table and head in one position, so that the key bears continually on a short length of the sliding spindle. Some makers of the more recent models of this machine use a longer square key in place of the screw. The bushing *d* is inserted for machining purposes, to give the pulley a straight bore. In some cases the pulley is bored to the size of the spindle and then counterbored to fit the pulley sleeve. Very little can be said in favor of the stop-collar *e* on the upper part of the spindle except that it is the simplest design possible and is most easily attached. It is located too high up to be conveniently adjusted, and the operator has difficulty in setting it in conjunction with the graduations on the spindle quill below. The revolving screw head is objectionable, besides necessitating the use of a wrench or screwdriver for tightening. A sensitive drilling machine should require no tools except those incorporated directly in the machine. This statement, of course, excludes the drift key, which is indispensable and is usually attached to the column or table by means of a chain. An examination of the repair list of this machine for some years back reveals the fact that, of the details shown at *A*, the spindle sleeve *f* required the most frequent replacement due to wear on the feed rack, which was cut directly in the cast-iron sleeve.

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Preliminary Design of Spindle for High Speeds

One of the first attempts to evolve a spindle construction for high speeds is shown at *B*, Fig. 4. The natural tendency was to use ball bearings. Exhaustive tests conducted with sensitive drilling machines of both plain and ball bearing types have proved conclusively that the loss of power in friction on the latter type of machine is only one-fourth to one-fifth that of the former, with a resultant increase in efficiency of about 200 per cent. The bearings shown are of the four-point contact design and are known in shop parlance as the "home-made" type, which means, of course, that they are made in the shop where the machine itself was built. There are several other improvements to be noted in this design. One of them is the steel feed rack, which is inserted in the sleeve between shoulders *h* and further secured by screws *j*. The stop-collar *e* is placed on the spindle sleeve closer to the operator than the previous type. It can be set directly to the graduations on the sleeve for the desired depth of hole, and is quickly clamped in position by means of lever *k*. A ball thrust bearing at the bottom of the sleeve and a fiber washer at the top are noteworthy additions. It is needless to say that most of the repairs were occasioned by the wearing of the balls and ball races in the pulley.

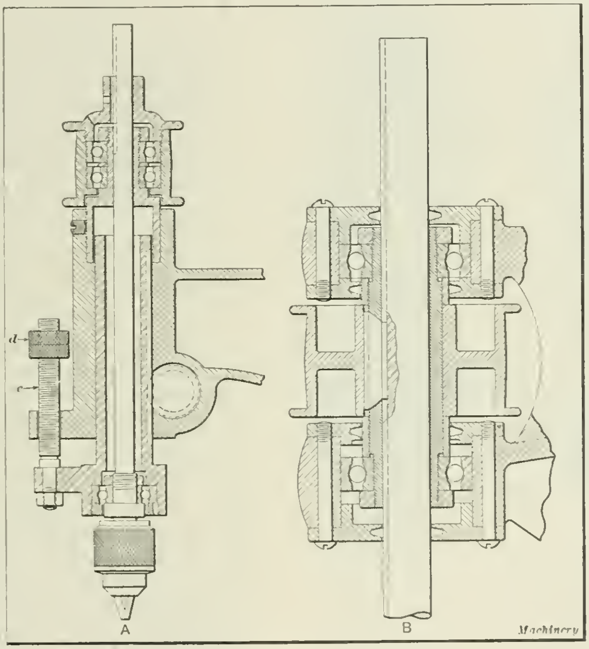

Fig. 3. (A) Spindle which proved Successful at Speeds up to 5000 R.P.M. (B) Pulley located between Bearings

Although the type of ball bearing previously referred to is now being used extensively on some sensitive drilling machines, nevertheless on many high-speed machines this bearing was discarded after a few years and the commercial type of radial bearing was adopted in its stead. Manufacturers advance many reasons why this was done. In the first place the commercial grooved radial bearing has a capacity for much higher speeds than the other type. It comes to the user completely assembled, adapts itself readily to mounting and requires no adjustments. No matter how thoroughly a machine tool builder may "rig up" in the beginning for the manufacture of his own bearings, it is not probable that he can achieve the same accurate results as those who devote their entire time and attention to the making of ball bearings alone. The manufacture of bearings is conceded to be an industry in itself, as attested by the fact that automobile builders—probably the largest users of ball bearings—almost without exception have adopted the commercial types of thrust and radial bearings. So many elements enter into the making of this product that it is admittedly beyond the scope of the machine builder to turn out a bearing of the necessary degree of precision and also make it at a profit without seriously interfering with his regular line of work.

Spindle for Speeds up to 2000 Revolutions per Minute

A relatively modern spindle construction is shown at *A*, Fig. 5, and while this design is gradually giving way to a still more recent one, it is an excellent arrangement for a general manufacturing machine. The design permits of efficient drilling speeds up to 2000 revolutions per minute, which affords a sufficiently wide range to meet ordinary requirements. A good film of oil in the sleeve bearing and the ball thrust at the top and bottom assure a cool-running spindle.

Thus far we have seen developments in the production of a dependable machine for general shop use, with ample range to satisfy modern demands but the problem of really high speeds requires greater refinements of construction. In drilling brass as it should be drilled with high-speed drills, at 300 feet per minute, the smallest hole that can be drilled at 2000 revolutions per minute is 9/16 inch; and even in mild steel, with a surface speed of 120 feet per minute, the smallest hole is about ¼ inch. These cutting speeds are maintained by many production managers, and under favorable circumstances are often exceeded. It is not difficult to recall numerous industries, such as the manufacture of adding machines, electrical appliances, timing fuses, etc., where the majority of drilled holes are below ¼ inch in diameter and where a large number may be found among the eighty different drill gage sizes. In work of this kind, where parts are made in large quantities, a slight saving of time in drilling each hole augments the output considerably and is productive of enormous results in the aggregate. So it is evident that the ultimate aim of the designer must necessarily be a machine that is capable of running at speeds heretofore unheard of in a manufacturing drilling machine; and that these speeds must be maintained without undue heating of the bearings; without constant belt wear or slippage due to high speeds; and, finally, without serious vibration or noise, and with the simplest construction possible.

Spindle Supported by Ball Bearing and without a Plain Bearing in Sleeve

The first step toward the construction of a machine for extremely high speeds is shown at *B*, Fig. 5. This design is intended to eliminate the sliding friction in the spindle sleeve bearing. As this was the only plain bearing in an otherwise ball bearing design, it naturally limited the speed capacity of the remainder of the construction. The pulley arrangement is the same as shown at *A*. A double-row annular bearing has its inner race clamped to the spindle and its outer race *l* held securely in the bottom of the sleeve. The spindle does not touch the sleeve at any point. The collar *k* is provided as a dust-cap and revolves with the spindle. This design was very short-lived, both because it failed to fulfill its promise of extremely high speeds and because for slower speeds and heavier drilling the sleeve construction shown at *A* is vastly superior. The distance between the bearing *l* at the bottom of the sleeve and the point *m* where the spindle enters the pulley bushing, was great enough to cause a "whipping" of the spindle midway between these two points. This whipping action, in turn, as the speeds increased, culminated in a vibration of the whole machine. However, the design served the purpose of emphasizing the need of strengthening the entire machine from base to pulley.

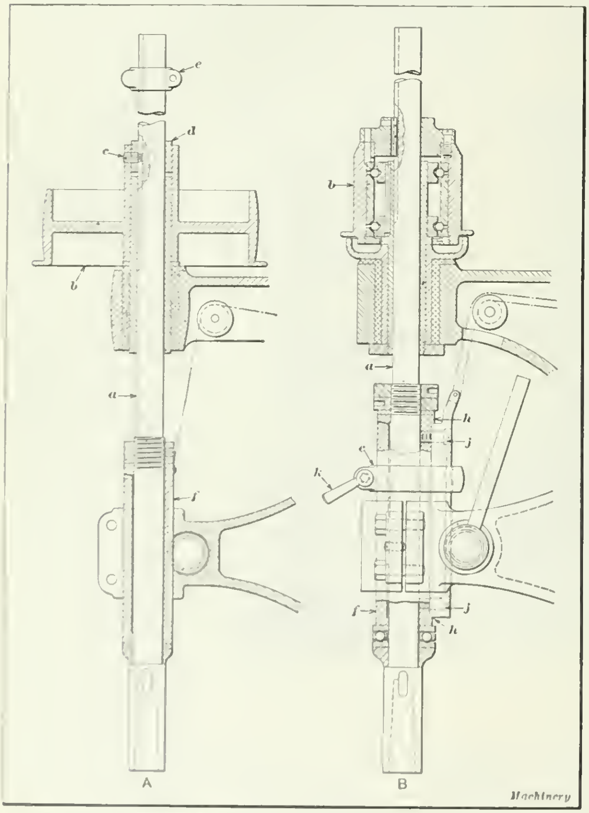

Fig. 4 (A) Spindle of Machine shown in Fig. 1. (B) A Design intended for High Speeds

The general idea incorporated in the design shown at *B*, Fig. 5, is applied to the spindle illustrated at *A*, Fig. 3, which is for a small bench type of drilling machine. This machine has no sliding head, adjustments for different heights of work being obtained by raising or lowering the table. As the spindle has a comparatively short sleeve travel, it has proved a complete success at speeds as high as 5000 revolutions per minute, notwithstanding that on the larger machine (of the type having an adjustable head and longer spindle feed) this design was a pronounced failure. The depth gage or stop-screw c with lock-nuts *d*, that may be adjusted to any predetermined depth of hole, is a radical departure from those shown previously, although, perhaps not an altogether wise one. That the gage can be conveniently reached by the operator, and can be set to a very accurate depth is true, and there is no apparent objection to its application to a spindle with a short rack travel; nevertheless, on a long-travel sleeve it has frequently been found to pull the lower end of the sleeve forward, and, consequently, throw the spindle out of alignment, under ordinary pressure on the feed lever at the end of the stroke. What this means to the life and alignment of the machine is apparent.

End Thrust Taken by Radial Type of Ball Bearing

The spindle shown at *A*, Fig. 3, has an annular bearing to take the drill thrust. Engineers for a long time were—and some still are—at variance as to the advisability of applying a thrust load on a radial type of ball bearing. Some makers of sensitive drilling machines and even a number of bearing manufacturers decry the use of the radial bearing in this capacity. While this contention may be justified theoretically, thorough experimenting, backed by subsequent daily observation in long running tests, has shown that a thrust load may be applied to an annular bearing, provided that the thrust load is from one-tenth to one-fourth of the rated radial capacity. It is even claimed, with good reason, that at speeds above 1500 revolutions per minute a radial thrust bearing is superior to the regular collar type bearing. This would be especially true in a sensitive drilling machine where high speeds go hand in hand with smaller sizes of drills and proportionately smaller thrusts. It is rather unfortunate that this function of the radial bearing has not been more fully comprehended by the average designer. This type not only absorbs less power in friction than the ordinary ball thrust but it lends itself to a much simpler and less expensive mounting. Its substitution for the thrust bearing on high-speed machinery is often the deciding factor in the success of the design.

Method of Mounting Spindle Pulley

It is perhaps relevant at this point to describe an improvement in the spindle pulley design made simultaneously with the construction just described, but applied to a different type of drilling machine. This improvement, which is in the method of mounting the pulley, has some bearing on the question of high speed, although the change was made for an altogether different purpose. The view *B*, Fig. 3, illustrates a method of mounting the pulley with a bearing above and below and the belt pull in between. Heretofore, the drive key was located at the top of the pulley, and the distance between the drive and the drill caused the entire length of the spindle to be subjected to considerable torque when doing heavy drilling. This causes an intermittent jarring and vibration, to the detriment of the bearings and the accuracy of the machine in general. With the pulley mounting illustrated at *B*, the key is placed farther down and has more driving surface on the spindle keyway. This form of drive is ideal for low speeds and heavy work, and may be classed as the "heavy pattern"; the "light pattern" is shown at *A*, Fig. 5.

Design that Proved a Failure Due to Method of Lubricating Ball Bearings

To return to the question of high speeds, the substantial design of pulley mounting shown at *B*, Fig. 3, combined with the spindle quill design that employed the annular type bearing for radial and thrust loads, was used as a basis for the construction illustrated at *A* in Fig. 6. With the addition of bearing *n* in the top of the quill, the problem was thought to resolve itself into the simple one of maintaining ample lubrication on the balls. This pulley design and others resembling it, are being used at present on different types of machines, sensitive drilling machines included, but all of these run at more or less moderate speeds. Any claims for this design at extremely high speeds are unfounded. It is well known that the most satisfactory lubricant for ball bearings operating at speeds below 2000 revolutions per minute is vaseline, thinned out to a certain extent with some light, acid-free mineral oil. As the speeds are increased and the temperatures rise accordingly, grease of any kind naturally loses its consistency, and for this reason a thin oil is substituted where high speed is essential. Some bearing manufacturers insist that grease is preferable even at the highest speeds, but even if this were true, the process of removing the dust-caps, clamping nuts and such parts for renewing the lubricant at intervals makes its use on the sensitive drilling machine undesirable. The task of lubricating the bearings on a machine usually devolves on the operator, and a renewal of this sort is often neglected, whereas an injection now and then with the oil-can is deemed a matter of routine.

The pulley mounting shown at *A*, Fig. 6, is designed to insure ample lubrication. The bushings *d* answer the purpose of reservoirs to keep the lubricant on a level with the ball bearings. The chief argument against this design is the great number of details necessary and the attendant cost of construction. This point would be well taken in regard to a slow-speed machine, but it would have been no detriment to the adoption of the design had the latter turned out to be suitable for the purpose for which it was made. The first test, however, established the fact that a bearing may be given too much lubrication, and that a ball bearing made to run at high speed in an oil bath is a predestined failure. The churning action of the balls, at the test speeds, caused the oil to become heated and finally to smoke. After a comparatively short period of running, the bearings and adjacent parts were found to be so hot that the design was pronounced a failure.

Spindle which Operates Successfully at Speeds as High as 18,000 Revolutions per Minute

Up to this point, many things had been learned and unlearned in regard to spindle construction, but, as is apparent, no definite design was evolved that proved satisfactory at extremely high speeds. About this time the demand for a machine of this kind became insistent, whereupon was begun a thorough, scientific study of the numerous problems involved and a painstaking search for the solutions. Strange to say, the design shown at *A*, Fig. 6, formed the basis on which the successful construction was built. By a system of addition, elimination and substitution, and a strenuous testing of the machine after each alteration, the design shown at *B* was developed. This type of spindle arrangement is now in operation on hundreds of machines and many of them run constantly at speeds as high as 18,000 revolutions per minute without heating or excessive vibration. It has undergone rigid tests at 22,000 revolutions per minute and is recommended for a regular maximum speed of 12,000 revolutions per minute. There were so many vaguely defined stages in the development of this type, and its final achievement effected such important strides in sensitive drilling, that it may be well to relate in detail the difficulties that were encountered by manufacturers in their attempts to secure excessive speeds, and to summarize the methods employed in overcoming these obstacles and developing this final construction to its present stage of perfection.

The first question, and a very important one, is that of balancing. It is essential, of course, that all revolving parts have a perfect running balance both before and after assembling. The designer who adopts aluminum as the material for those pieces of largest diameters, has dispensed with seventy-five per cent of the trouble from vibration due to centrifugal force. The spindle is ground for its entire length and an additional keyway to balance the driving one is absolutely necessary. The long projecting spindle nose that provides for the use of taper shank drills is discarded and the chuck shank is ground directly on the spindle close up to the lower bearing, as shown. This means that the chuck must be furnished with the machine and must be of a type that is guaranteed to be in running balance. Nut *w* is provided to facilitate the removal of the chuck.

The problem of bearings has already been discussed. The annular bearing is used throughout the design and solves the problem of absorbing the thrust of the drill. For the reason that most drilling is performed with the head and table in the highest position, bearing *n* in the upper part of the sleeve is clamped some distance down in the sleeve to distribute the four bearings as evenly as possible over the entire length of the spindle. This is done also to avoid a binding action of the spindle between drive-key nut *o* and the bearing. A discrepancy of a fraction of a thousandth in the entire length from the top of the column bore to the bottom of the sliding head dovetail causes a retarding action of the spindle and a consequent slipping of the belt. This lowering of the bearing tends to equalize the error and allows the spindle to turn freely at all times. The pulley is mounted on a sleeve that gives a greater part of the spindle a sliding bearing. The spindle never projects beyond this sleeve enough to cause it to "whip", and is never visible above the top of the machine, the hood cap *p* covering it even in its highest position. The length of pulley sleeve *r* allows the bearings to be set far apart. The upper bearing *m* is held securely in the column and the lower one is held only on the sleeve, making the entire construction easily assembled. Every bearing is completely guarded against dust or grit; guard *s* covers the belt and pulley and the lower hood *t* covers the key bushing. The only exposed revolving part, aside from the drill chuck, is a section of the spindle between the spindle quill and the lower hood.

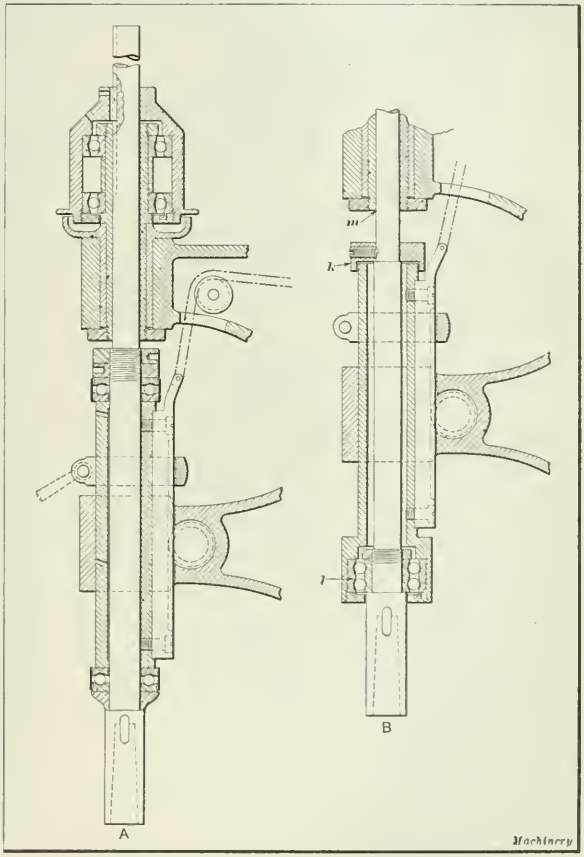

Fig. 5. (A) Another Step in Development of High-speed Spindle Construction. (B) Design intended to eliminate Sliding Friction in Sleeve Bearing

Next in importance to the type of bearings and their mounting is the method of lubrication. Many high-speed machines have ball bearing arrangements that permit the oil or grease to run off when it becomes heated, necessitating frequent renewal. The ideal way of oiling the bearing would be to station someone with an oil-can in close proximity to it to administer a drop or two of lubricant at frequent intervals. This method, everyone will agree, is entirely out of the question. However, the design illustrated is a close approximation to this condition. The oil is put in at c and settles in the cup formations in lower caps *c*. Attached to and revolving with the pulley sleeve are "flingers" *d* usually of spun copper. Bushings *k* have two oil-holes *l* that enter counterbores in the top leading to the bore of the bushing. The centrifugal action of these flingers impels the oil outward, and it is forced slowly upward in the oil-holes and thence onto and through the bearing. This practically amounts to a continuous circulation and, though the bearings receive ample lubrication, there is no opportunity for the oil to become heated. Air holes *b* are provided so that there will not be a vacuum and a resultant escape of the oil beneath the fingers. This hole and the clearance between the finger and the lower cap, are just large enough to allow a carefully calculated amount of lubricant to find its way to the bearings in the quill below. An occasional application of oil to the keyway above the spindle quill while the machine is not running further provides for lubricating these bearings.

The next consideration is the spindle itself. This is made as small in diameter as possible—consistent with the capacity of the machine—to keep the size of the bearings and the relative velocity of the balls down to a minimum. That it must be made from a good grade of steel is obvious. The equal distribution of the bearings, the location of the drive key as far down as possible and the compactness secured by chucking the drills directly below the lowest sleeve bearing combine to lessen the torsional strain on the spindle and correspondingly reduce the vibration of the machine.

The problem of driving belts is one that is solved only by the cooperation of sensitive drilling machine manufacturers and belt makers. After many tests with numberless round and flat belts of different materials and texture, a closely woven flat cotton belt, with a positive belt-tension arrangement, was found to be the type with the smallest amount of slippage at high speed. With the spindle shown at *B* running at a calculated speed of 20,000 revolutions per minute, the indicated speed was 18,050 revolutions per minute—an actual loss of about 10 per cent. Many sensitive drilling machines are sold at the speeds calculated from the driving and driven pulleys, and no thought is given to natural loss of speed due to the air cushion between the belt and the pulley, the small arc of contact on the spindle pulley, and the "jumping" of the belt on the idlers of belt tension devices that are self-adjusting and not positive.

A modern type of high speed, ball bearing sensitive drilling machine with six spindles is shown in Fig. 2. This machine is equipped with the spindle construction shown at *B*, Fig. 6. A few years ago a six- or eight-spindle machine, with each spindle running from 3000 to 18,000 revolutions per minute, was considered an impossibility. A comparison of this machine with that shown in Fig. 1 illustrates the great progress made in a short time in the design of this hitherto neglected machine tool.

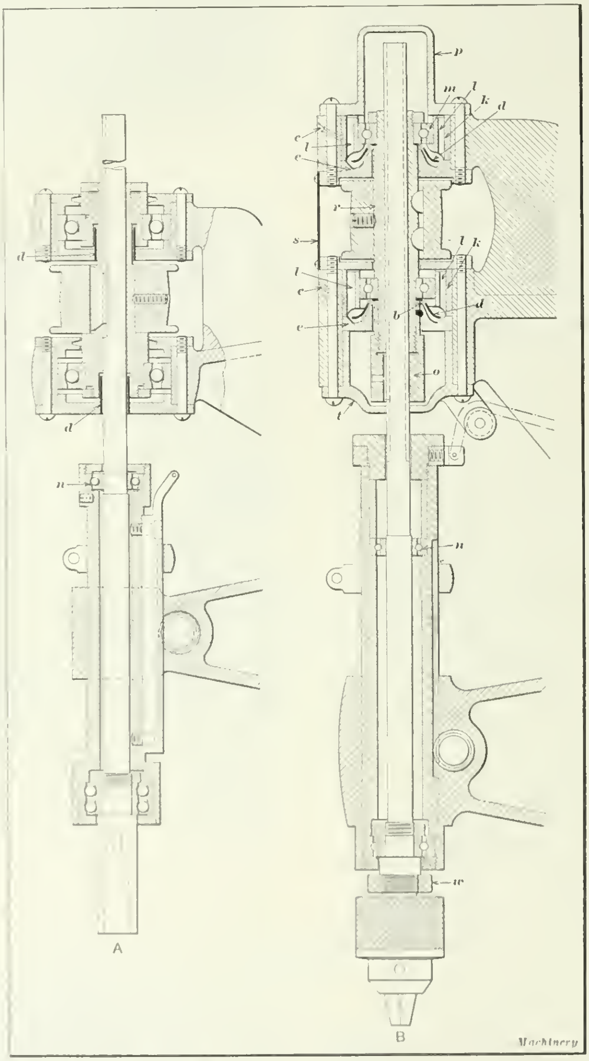

Fig. 6. (A) Design which proved a Failure owing to Method of Lubrication. (B) Spindle Construction capable of High Speeds

ALCOHOL AS A FUEL FOR INTERNAL COMBUSTION ENGINES

A report has been published by the Commonwealth Advisory Council of Science and Industry of Australia dealing with alcohol as a fuel for internal combustion engines. The committee states that alcohol has been used with success for a number of years in Germany in specially designed engines. Any ordinary gasoline engine can be run on alcohol, except that it will not start on this fuel. The consumption of alcohol in ordinary gasoline engines is about 50 per cent greater than that of gasoline for equal power development. Engines specially designed for using alcohol, however, will not consume any more alcohol, by volume, per horsepower than the gasoline consumed in the operation of gasoline engines.

The main changes required in the design of an engine that is to use alcohol are increasing the compression to about 180 pounds per square inch, preheating the fuel and air, or the mixture of the two, and enlarging the fuel supply pipes. In starting, the carburetor should be preheated, or an arrangement must be made for using gasoline to start the engine. After once having started, the exhaust gases are used for preheating. It is easier to apply these changes in design and to use alcohol for stationary engines than for automobile engines, especially on account of the advantages of slow speeds and long piston strokes in engines using alcohol. The successful alcohol engines in Germany are almost wholly of the stationary type, and the records available indicate that comparatively little work has been done with a view to using alcohol as a fuel for automobile engines. It is possible that something may be done along these lines in the future.

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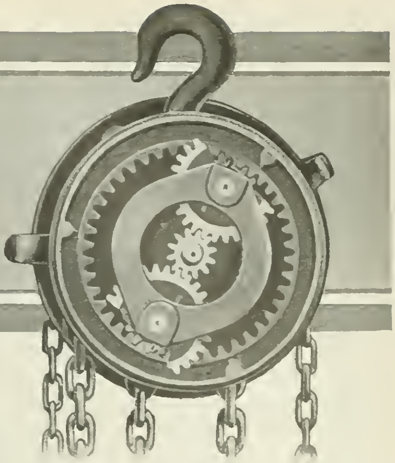
Cylindrical grinding of all shafts in machines is becoming common practice because of the economy of this method of machining and the superior quality of the work. A ground shaft is the last word in fine machine work, except the journals. A ground shaft journal is much improved by lapping in order to remove the microscopic ridges left by the grinding wheel and to impart a high polish. Lathe spindle journals may be lapped advantageously with ruby dust, especially if fitted in babbitt bearings. A lapped journal fitted to a well proportioned babbitt bearing is a long-lived affair that will give no trouble if kept free from grit and supplied with oil.

Differential Motions and Planetary Gear Combinations

By Franklin D. Jones[1]



Second Installment of a Treatise on Mechanisms that Require Differential Motion and Methods of Determining Relative Velocities of Planetary or Differential Gears[2]

IN the first installment of this article, published in the March number of MACHINERY, a number of mechanisms having differential motions were described, including differential screw and hoist, differential planetary gearing, differential governors for water turbines, and differential gearing for automobiles. In this installment, which concludes the treatise, such subjects as speed regulation through differential gearing, differential hoisting mechanisms, reversal of motion, application of floating or differential levers, control mechanisms with differential motions, velocity ratio of planetary gears, and compound trains of planetary gearing will be taken up.

Speed Regulation through Planetary or Differential Gearing

When the speed of a driven part is governed by drives from two different sources, differential gearing may be used to combine these drives and allow any variations in speed that may be required. An application of this kind is found on the fly frames used in cotton spinning for drawing out or attenuating the untwisted fiber or roving, by passing it between different pairs of rolls which move, successively, at increased speeds. After the fiber is attenuated, it is wound on bobbins and at the same time given a slight twist. The diagram Fig. 10 represents a mechanism for controlling the speed of the bobbins, one of which is indicated at *B*. This bobbin receives its motion through a train of gearing connecting with the main shaft of the machine and through another combination of gearing which is driven by a pair of cone pulleys for decreasing the speed of the bobbin, in revolutions per minute, in order to maintain a uniform peripheral speed as the roving is wound upon the bobbin and the diameter becomes greater.

The main shaft is driven by pulley *A*, and motion is transmitted through shaft *S* and the gearing shown to the cone *C* and the rolls, one of which is indicated at the upper part of the diagram. The cone *C* and the rolls move at a constant speed, and the roving is delivered by the rolls at a uniform rate of speed. On the shaft *S* there is a bevel gear *E*, which is one of the gears of a planetary train that is commonly known as the "differential motion." The large gear *D* corresponds to the arm of the gear train, since it carries the two intermediate bevel pinions *J* and *K*. Gear *D* is driven from the lower cone C_1, which is connected by belt with the upper cone. Bevel gear *F*, which meshes with the pinions carried by gear *D*, is loose on shaft *S* and is connected through gearing with the bobbin *B*. With this arrangement, the speed of the bobbin depends first upon the speed of bevel gear *E*, which is constant, and also upon the speed of gear *D*, which may be varied by shifting the position of the belt on the cones. Any variations in the relative speeds of gears *D* and *E* will produce twice the variations in the speed of the bobbin.

The roving is wound on the bobbin in successive helical layers by means of the flyer *H*, which is driven at constant speed by gear *M* on shaft *S*. The roving passes from the rolls to the flyer, and entering the top of its hollow spindle, is threaded down through one arm of the flyer and then wound on the bobbin. The flyer and bobbin revolve in the same direction, but the bobbin has a higher velocity and, for that reason, draws the roving from the flyer and winds it in successive layers as the bobbin travels up and down, so as to cover its entire surface. As each successive layer is added, the bobbin increases in diameter, and its rotative speed relative to that of the flyer must be decreased in order to prevent breaking the roving. This change of speed is transmitted to the bobbin through the differential gearing referred to by gradually shifting the belt on the cone pulleys.

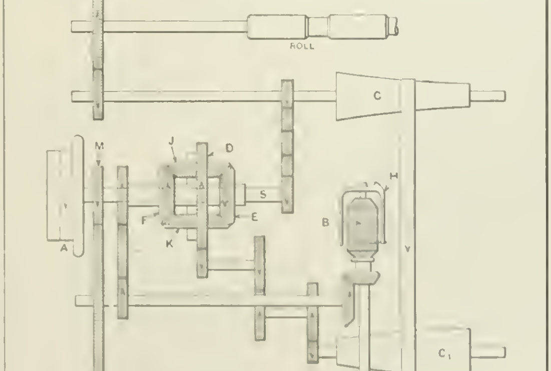


Fig. 10. Diagram of Mechanism having Differential Gearing through which Speed Changes are transmitted

Differential Gear and Cam Combination

The differential gear and cam combination to be described is used on fly-frames in conjunction with the same general class of mechanism illustrated by the diagram Fig. 10. This mechanism differs from the differential ordinarily used in that it has no planetary train of gearing. As previously explained, a differential motion is employed in connection with a shifting belt and cone

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[1] Associate Editor of MACHINERY

[2] A chapter that will be included in the author's book "Mechanisms and Mechanical Movements," to be published in the near future

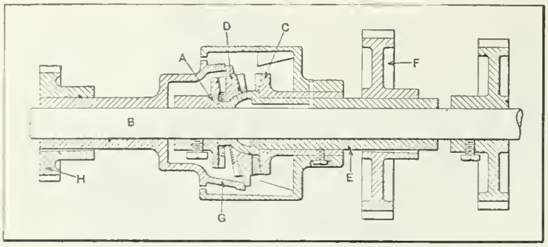


Fig. 11. Differential Gear and Cam Combination

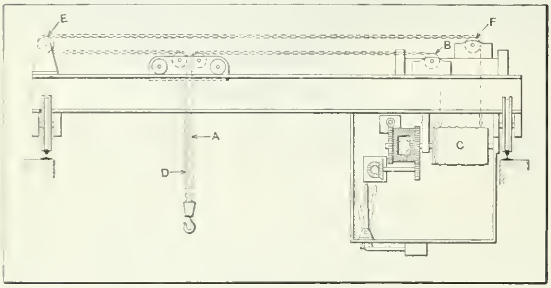


Fig. 12. Crane equipped with Differential Hoisting Mechanism shown diagrammatically in Fig. 13

pulleys for changing the speed of the bobbins. The differential action is obtained, in this case, by means of the crown gear *A*, Fig. 11, which is attached to the main driving shaft *B*; the crown gear *C* secured to sleeve *E*, which carries the bobbin-driving gear *F*; and the double crown gear *D*, which is mounted on a spherical seat and engages gears *A* and *C* at points diametrically opposite. This double crown gear operates in an oblique position, so that a small part of the gear meshes with gear *A* on one side and a small part on the other side meshes with gear *C*. The spherical bearing allows the intermediate crown gear *D* to swivel in any direction, and it is held in position by a cam surface on the edge of sleeve *G*. Gear *C* has the same number of teeth as intermediate gear *D*, but gear *A* has a somewhat smaller number of teeth.

The differential action is obtained by the relative motions between gear *A* and cam *G*. This cam is driven from the lower belt cone of the machine, which is connected with gear *H*. If cam *G* were revolving at the same speed as gear *A*, the same teeth on gears *A* and *D* would remain in contact and the entire gear combination would act practically the same as a clutch. As soon as the speed of the cam differs from that of gear *A*, the position of intermediate gear *D* is changed so that different teeth are successively engaged. As the result of the differential action, the speed transmitted to gear *C* is either increased or decreased. The extent of the differential motion depends upon the difference between the speeds of gear *A* and cam *G*. As this difference diminishes, the speed of gears *D* and *C* increases; when the speed of cam *G* is reduced, the speed of gear *C* is also reduced, since the motion from gear *A* is lost as the result of differential action. The advantages claimed for this mechanism are quiet operation and reduction of friction.

Differential Hoisting Mechanism

An ingenious method of utilizing differential action to vary the speed of a hoisting mechanism is illustrated by the diagram Fig. 12, which is not shown as an example of modern crane design but merely to illustrate one of the many possible applications of planetary gearing. There are two chains attached to the crane hook. One of these chains *A* passes over a pulley on the trolley and over pulley *B* to the winding drum *C*. The other chain *D* passes upward over its trolley pulley to the left, and over pulley *E* to pulley *F*, and then down to a drum located back of drum *C*. These chains may be wound upon their respective drums either in opposite directions or in the same direction, and at varying rates of speed. If both drums are rotated in opposite directions at the same speed, the effect will be to raise or lower the hoisting hook, whereas, if the drums rotate in the same direction and at equal speed, the chain will be taken in by one and given off by the other, thus causing the hook and its load to be carried horizontally without raising or lowering it. Any difference in the speed of the two drums when moving either in the same or opposite directions will evidently cause the hook to move both vertically and horizontally at the same time.

The mechanism for operating the two hoisting drums is illustrated diagrammatically in Fig. 13. There are two electric motors *J* and *K*. Motor *J* drives the worm-wheels *L* in opposite directions and also the attached bevel gears. The other motor *K* drives the spur gears *M* and the upper bevel gears. The intermediate pinions *N* between the bevel gears revolve on arms *Q* which are keyed to the shafts of their respective drums. The bevel gears with which the pinions mesh are loose on their shafts. With this arrangement, if motor *K* is stationary, motor *J* will drive the drums in opposite directions and raise or lower the hook as previously explained. On the other hand, with motor *J* stationary, motor *K* will operate the drums in the same direction and move the crane hook horizontally. As these motors may be reversed or operated together at varying speeds, any desired combination of movements and speeds for the hook and its load may be obtained.

Reversal of Motion through Planetary Gearing

A train of planetary gearing may be designed to give a reversal of motion. This form of transmission has been applied to some automobiles of the smaller sizes. The principle governing the operation of one of the earlier designs is shown by the diagram Fig. 14. Two sets of differential gears, indicated at *A* and *B*, are mounted inside drums. These drums may be revolved independently for obtaining the slow forward speed and a reverse motion, or they may be locked together

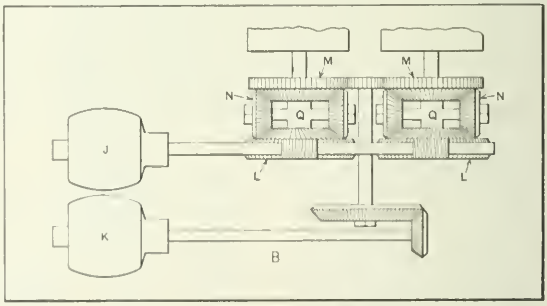


Fig. 13. Differential Hoisting Mechanism

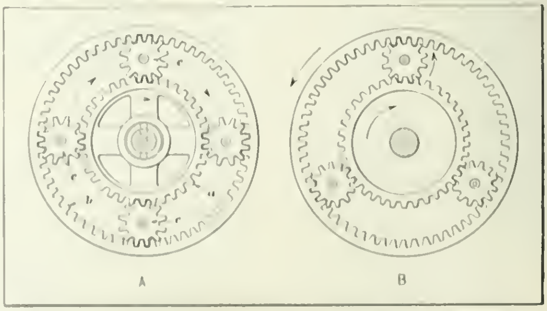


Fig. 14 Diagram showing Arrangement of Planetary Gearing for obtaining Forward and Reverse Motions

so as to revolve as a unit with the crankshaft for obtaining the direct high-speed drive. The central gear *a* is the driver in each case, and is keyed to the crankshaft. The slow forward speed is obtained with the combination illustrated at *A*. To obtain a reduction of speed, the internal gear *b* is held stationary by the application of a brake-band to its periphery; the pinions *c* carried by the driven member are then forced by the driving gear *a* to roll around inside the internal gear, thus transmitting a slow rotary motion to the driven member attached to the pinions. In order to obtain a reversal of motion through the combination of gearing illustrated at *B*, the disk carrying the pinions is prevented from rotating by the gripping action of another brake-band, so that the pinions merely revolve on their studs and rotate the internal gear in a reverse direction. In this case, the internal gear is the driven member, transmitting motion to the driving sprocket.

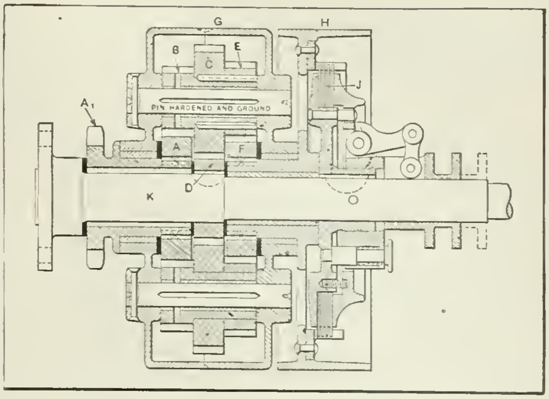


Fig. 16. Another Arrangement of Planetary Gearing which gives Forward and Reverse Motions

A reversal of motion may also be obtained with the train of planetary gearing shown in Fig. 16. In this case, there is no internal gear. Gear *A* is mounted on the sleeve of sprocket A_1, gear *D* is keyed to shaft *K*, and gear *F* is attached to the extended hub of drum *H*. The three gears *B*, *C*, and *E* are locked together and revolve upon a pin carried by drum *G*. A duplicate set is also located on the opposite side of the drum, as the illustration shows. When this drum is held stationary by a brake-band, gear *A* and sprocket A_1 are driven at a slow forward speed through gears *D*, *C*, and *B*, gears *D* and *A* revolving in the same direction. The direct high-speed drive is obtained when clutch *J* is engaged, the whole mechanism then revolving as a unit with shaft *K*. When drum *H* is held stationary by a brake-band, gear *D* causes gear *E* to revolve about the stationary gear *F* in a direction opposite to the rotation of *D*; consequently, gear *A* is forced to follow in the same direction in which drum *G* and the planetary gears *B*, *C*, and *E* are moving, thus reversing the motion of gear *A* and the sprocket.

Application of Floating or Differential Levers

What are known as "floating" or "differential" levers are utilized in some forms of mechanisms to control, by the application of a small amount of power or force, a much greater force, such as would be required for moving or shifting heavy parts. Floating levers are commonly applied to mechanisms controlling the action of parts that require adjustment or changes of position at intervals varying according to the function of the apparatus subject to control. The initial movement or force may be derived from a hand-operated lever or wheel, and the purpose of the floating lever is to so control the source of power that whatever part is to be shifted or adjusted will follow the hand-controlled movements practically the same as though there were a direct mechanical connection. A floating lever is so termed because it is not attached to fixed pivots and does not have a stationary fulcrum, but is free to move bodily, or to "float" within certain limits and in accordance with the relative forces acting upon the different connections.

Fig. 15 illustrates one application of the floating lever. The diagram at the left represents an auxiliary braking apparatus for a large hoist. The brake-shoe *A* is applied to the brake-drum *B* whenever the dead weight *C* rests upon the lever *D*. This lever is connected by rod *E* with a cross-head attached to the upper end of a piston-rod extending through the oil cylinder *F* and into the steam cylinder *G*. When steam is admitted beneath the piston in cylinder *G* by opening a valve at *H*, the weight is raised and the brake released, and, if, for any reason, the steam pressure should be suddenly reduced, weight *C* would fall and the brake be applied automatically. The movements of the piston in cylinder *G* and, consequently, of weight *C* are controlled by hand-lever *L* through floating lever *J*, in such a manner that the weight rises and falls, as the lever is shifted, practically the same as though the force for moving the weight were derived directly from the lever by means of a rigid mechanical connection. The action of the mechanism is as follows: If the weight is down and the brake applied, and lever *L* is moved from its central position to the right, the left-hand end of lever *J* will be raised (as shown on an exaggerated scale by diagram *X*), thus lifting rod *K* and opening valve *H*; this valve has no lap, so that any movement of the lever admits steam to the cylinder. As soon as the piston begins to rise, the right-hand end of lever *J* also rises (see diagram *Y*) and, turning about pivot *O*, immediately begins to close the steam valve. If lever *L* is moved through a small arc, the valve is closed quickly and the weight only rises a short distance; on the contrary, if the lever is thrown over to the extreme position, the piston and weight must move upward a proportionately greater distance before the valve is closed. If the lever, after being thrown to the right, is moved toward the left, valve *H* opens the exhaust port and the weight descends; as soon as it begins to move downward, the left-hand end of the floating lever is raised, which tends to close the exhaust port and prevent further downward motion.

An apparatus of this kind responds so quickly to adjustment that the weight follows the motion of the hand-lever almost instantaneously and the end of the floating lever connected to rod *K* has little actual movement. The oil cylinder *F* is used to stabilize the action of the weight and prevent over-travel which would occur if there were only the cushioning effect of

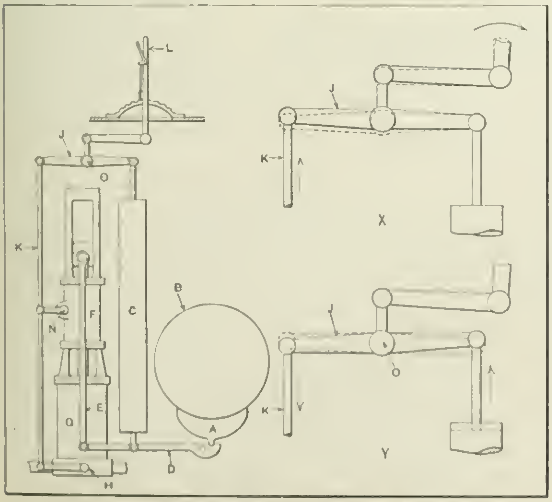


Fig. 15. Diagrams Illustrating Application and Action of Floating Lever

steam. The by-pass valve *N* controls the flow of oil from one end of the cylinder to the other as the piston moves up or down, so that the motion of the weight ceases as soon as the steam and oil valves are closed.

Differential Controlling Mechanism of Steering Gear

The practical effect of the floating lever previously described for controlling the movements of power-driven apparatus may be obtained by other mechanical devices, examples of which are found on steamships for controlling the action of the steering engines. Engines used for this purpose are commonly equipped with a control valve which distributes steam to the engine valves. The latter are generally of the hollow piston type and are arranged to receive steam either at the ends or in the center, the exhaust varying accordingly. The admission of steam either to the ends or in the center is governed by the position of the control valve. For instance, if the control valve is moved in one direction, steam may be admitted to the ends of the engine valves and be exhausted in the center. If the control valve is moved in the opposite direction, this order is reversed and also the direction in which the engine rotates; therefore, each engine valve requires but one eccentric, the control valve acting as a reversing gear. The mechanism which operates this control valve is so designed that, when the engine is set in motion to move the rudder either to port or starboard, this same motion is utilized to shift the control valve in such a way that the movement of the rudder coincides with the motion of the steering wheel. While the floating lever has been used in connection with this controlling mechanism, the common form of control depends upon the action (which is often differential) either of gearing or of a screw and nut.

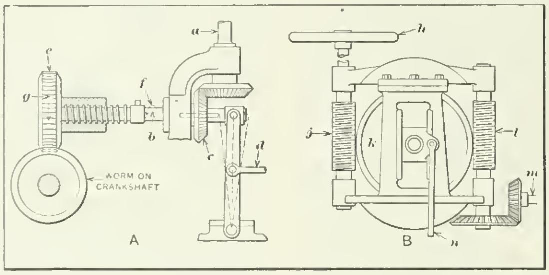


Fig. 17. (A) Controlling Device for Steering Gear. (B) Mechanism used as Substitute for a Floating Lever

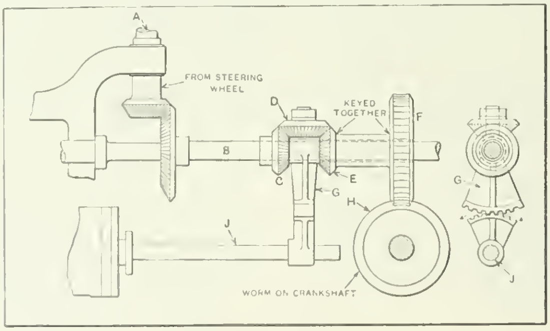


Fig. 18. Steering Gear Control Mechanism having Differential Bevel Gearing

With the arrangement illustrated at *A*, Fig. 17, the control valve of a steering engine is governed by the action of a screw that is operated by the steering wheel, and a nut that is revolved by the engine. The shaft *a* is connected with the steering wheel and transmits rotary motion to screw *b* which is splined to, and free to slide through, gear *c*. The rod *d* serves to operate the control valve of the steering engine. Any rotary motion of shaft *a* moves screw *b* in a lengthwise direction in or out of the nut on worm wheel *e*, unless this nut is revolving at the same speed as the screw. The action of the mechanism is as follows: If worm-wheel *e*, which meshes with a worm on the steering engine crankshaft, is stationary, the rotation of shaft *a* will turn screw *b* in or out of the nut and shift the control valve, thus starting the engine in one direction or the other, depending upon which way the control valve is moved. As soon as the engine starts, worm wheel *e* and the nut begin to revolve, which tends to move the screw and control lever in the opposite direction. Suppose screw *b* were revolved in the direction shown by the arrow *f*, thus moving the screw and control lever to the right; then, as the engine starts, worm wheel *e* and the nut revolve as shown by the arrow *g*. Now as soon as the rotation of shaft *a* and screw *b* is stopped or is reduced until the speed of rotation is less than that of worm-wheel *e*, the screw is drawn back into the nut and the control valve is closed. If the steering wheel and screw *b* were turned slightly and then stopped entirely, the rudder would be moved only a corresponding amount, because the control valve would soon be shifted, by the action of worm-wheel *e*, to the closed position. Steering engines, in general, are equipped with some form of stopping device which automatically limits the movement of the rudder and prevents over-travel and damaging the mechanism.

Steering Gear Control Mechanism having Planetary Bevel Gearing

The steering-gear controlling mechanism illustrated in Fig. 18 operates on the same general principle as the design previously described, although the construction is quite different. The control valve, in this case, operates with a rotary motion, instead of moving in a lengthwise direction. Shaft *A* is revolved by the steering wheel and transmits rotary motion to shaft *B* through the gearing shown. The differential action for regulating the position of the control valve is obtained by means of three gears *C*, *D*, and *E*. Gear *C* is keyed to shaft *B*, and gear *E* on the extended hub of worm-wheel *F* is free to revolve about shaft *B*. Gear *D* interposed between gears *C* and *E* is mounted upon a segment gear *G* which engages another segment gear on the control valve spindle *J*. If shaft *B* is revolved while gear *E* and the worm-wheel are stationary, gear *D* rolls around between the gears and, through the segment gear, turns the control valve, thus starting the steering engine and with it the worm *H* on the crankshaft which drives worm-wheel *F* and gear *E*. As soon as the rotation of shaft *B* is stopped, gear *E* which has been revolving in the opposite direction to that of *C* rolls gear *D* back to the top position, thus closing the control valve and stopping the engine. If gears *C* and *E* are revolved at the same speed, gear *D* simply rotates between them and the control valve remains open. If the speed of gear *E* exceeds that of *C*, the valve begins to close, and if *C* revolves faster than *E*, the valve is opened wider and the engine continues to operate.

Rolling Worm-wheel Type of Controlling Mechanism

The ingenious substitute for the floating lever, illustrated at *B* in Fig. 17, depends for its action upon a worm wheel which is interposed between two worms. The handwheel *h* controls the rotation of worm *j*, which meshes with the worm-wheel *k*. The worm *l* on the opposite side of the worm wheel is rotated by whatever apparatus is to be controlled. The shaft of the worm wheel is journaled in boxes which are free to slide up and down the vertical slides in the framework shown. Any vertical displacement of the worm wheel is transmitted to rod *n* which operates the valve, clutch, or other mechanical device used for starting, stopping, and reversing the driving machinery. Assume that the mechanism is at rest with the worm-wheel midway between its upper and lower positions in the vertical slides of the housing. When the handwheel h is revolved in a direction corresponding to the motion desired, worm j revolves, and worm l is stationary, since the mechanism is not yet in motion; therefore, the rotation of the handwheel has the effect of rolling the worm-wheel k between the two worms either up or down, depending upon the direction in which the handwheel is rotated. Any vertical displacement of the worm-wheel will, through the medium of controlling rod n, start the power-driven machinery. This motion is immediately transmitted to shaft m and worm l which acts to move worm-wheel k in the opposite direction vertically, provided worm j is stationary or is revolving slower than l. The result is that the power-driven member is moved or adjusted proportionately to the rotation of the handwheel h. The handwheel, for instance, might be turned to a position corresponding to a certain required adjustment, which would then be made automatically. The operation of this controlling device is based on the same general principle as the steering-gear controlling mechanisms previously described.

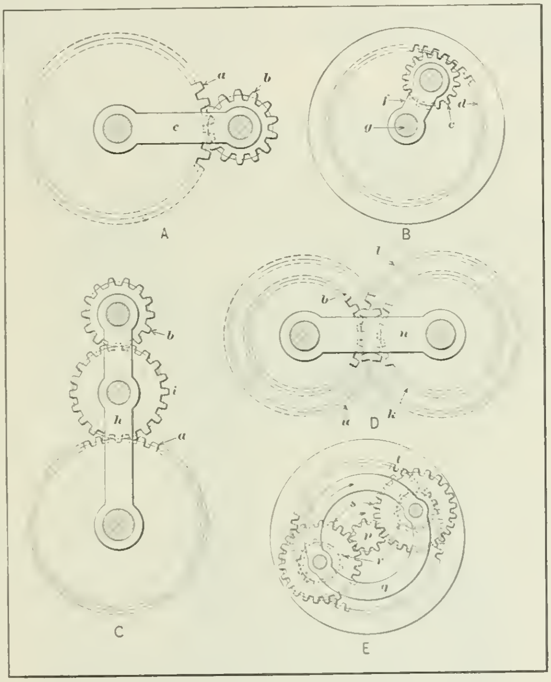


Fig. 19. Differential Combinations of Planetary or Epicyclic Gearing

Velocity Ratios of Planetary Gears

Determining the relative speeds of planetary gears is often complicated somewhat because of confusion as to the relative motions and the distinction between the rotation of a planetary gear about its own axis and its rotation relative to a fixed plane or stationary part of the mechanism. To begin with, the relative speeds of a pinion and gear arranged as shown at A, Fig. 19, will be considered. These two gears are held in mesh by a link c. If this link remains stationary and gear a makes one revolution, the number of revolutions made by gear b will equal the number of teeth in a divided by the number of teeth in b, or the pitch diameter of a divided by the pitch diameter of b. If a and b represent either the pitch diameters of the gears or the numbers of teeth, the revolutions of b to one turn of a equal $\frac{a}{b}$. If gear a is held stationary and link c is given one turn about the axis of a, then the revolutions of gear b, relative to arm c, will also equal $\frac{a}{b}$, the same as when gear a was revolved once with the arm held stationary. Since a rotation of arm c will cause a rotation of gear b in the same direction about its axis the total number of revolutions of gear b, relative to a fixed plane for one turn of c, will equal 1 (the turn of c) plus the revolutions of b relative to c, or $1 + \frac{a}{b}$. For example, if gear a has 60 teeth and gear b, 20 teeth, one turn of arm c would cause b to rotate $\frac{60}{20}$, or 3 times about its own axis; gear b, however, also makes one turn about the axis of gear a, so that the total number of revolutions relative to a fixed plane equals

$$1 + \frac{60}{20} = 4 \text{ revolutions.}$$

In order to illustrate the distinction between the rotation of b around its own axis and its rotation relative to a fixed plane, assume that b is in mesh with a fixed gear a and also with an outer internal gear that is free to revolve. If the speed of the internal gear is required, it will be necessary, in calculating this speed, to consider not only the rotation of b about its own axis, but also its motion around a, because the effect of this latter motion on the internal gear, for each turn of link c, is equivalent to an additional revolution of b.

Diagram B represents an internal gear d in mesh with gear e on arm f. If arm f is held stationary, the revolutions of e for one turn of d equal $\frac{d}{e}$, d and e representing the numbers of teeth or pitch diameters of the respective gears. If the internal gear is held stationary and arm f is turned about axis g, the rotation of e about its axis will be clockwise when f is turned counter-clockwise, and *vice versa*; hence, the revolutions of gear e, relative to a fixed plane, for one turn of f about g, will equal the difference between 1 (representing the turn of f) and the revolutions equal to $\frac{d}{e}$.

Analysis of Planetary Gear Trains

A simple method of analyzing planetary or epicyclic gearing, which has been applied extensively by designers, etc., is to consider the actions separately. For instance, with the gearing shown at A, Fig. 19, the results obtained when link c is fixed and the gear a (which normally would be fixed) is revolved are noted; if gear a is revolved in a clockwise direction, then, in order to reproduce the action of the gearing, the entire mechanism, locked together as a unit, is assumed to be given one turn counter-clockwise. The results are then tabulated, using plus and minus signs to indicate directions of rotation. Assume that gear a has 60 teeth and gear b, 20 teeth, and that + signs represent counter-clockwise movements and — signs, clockwise movements. If link c is held stationary and gear a is turned clockwise (—) one revolution, gear b will revolve counter-clockwise (+) 60/20 revolution. Next consider all the gears locked together so that the entire combination is revolved one turn in a counter-clockwise (+) direction, thus returning gear a to its original position. The practical effect of these separate motions is the same as though link c were revolved once about the axis of a fixed gear a which is the way in which the gearing operates normally. By tabulating these results as follows, the motion of each part of the mechanism may readily be determined.

	Gear a	Link c	Gear b
Link stationary......	— 1 turn	0 turn	+ 60 20 turn
Gears locked........	+ 1 turn	+ 1 turn	+ 1 turn
Number of turns....	0	+ 1	+ 4

The algebraic sums in the line headed "Number of Turns" indicate that, when gear a is held stationary and link c is given one turn about the axis of a, gear b will make 4 revolutions relative to a fixed plane in a counter-clockwise or + direction, when link c is turned in the same direction.

The application of this method to the arrangement of gearing shown at B will now be considered. Assume that gear d

has 60 teeth and gear *e*, 20 teeth. Then, if gear *d* is turned clockwise with link *f* stationary, and the entire mechanism with the gears locked is turned counter-clockwise, an analysis of the separate motions previously referred to will give the following results:

	Gear d	Link f	Gear e
Link stationary......	— 1 turn	0 turn	— 60/20 turn
Gears locked........	+ 1 turn	+ 1 turn	+ 1 turn
Number of turns.....	0	+ 1	— 2

Effect of Idler in Planetary Gear Train

If an idler gear *i* is placed between gears *a* and *b* (diagram *C*, Fig. 19), the latter will rotate about its axis in a direction opposite to that of the link (the same as with the arrangement shown at *B*), and the revolutions of gear *b*, relative to a fixed plane, for one turn of link *h* about the axis of *a*, will equal the difference between 1 (representing the turn of *h*) and the revolutions equal to $\frac{a}{b}$. Assume that gear *a* has 60 teeth, idler gear *i*, 30 teeth, and gear *b*, 20 teeth. Then the turns of *b*, relative to a fixed member for one turn of *h* about the axis of *a*, are shown by the following analysis:

	Gear a	Idler i	Link h	Gear b
Link stationary.	— 1 turn	+ 60/30 turn	0 turn	— 60/20 turn
Gears locked....	+ 1 turn	+ 1 turn	+ 1 turn	+ 1 turn
Number of turns.	0	+ 3	+ 1	— 2

The direction of rotation of *b*, relative to a fixed member, may or may not be in the same direction as that of link *h*, depending upon the velocity ratio between gears *a* and *b*. If gears *a* and *b* are of the same size, one turn of link *h* will cause *b* to revolve once about its own axis, but, as this rotation is in a direction opposite to that of *h*, one motion neutralizes the other, so that *b* has a simple motion of circular translation relative to a fixed member. If gear *b* were twice as large as *a*, it would then revolve, for each complete turn of link *h*, one-half revolution about its own axis, in a direction opposite to the motion of *h*; this half turn subtracted from the complete turn of link *h* gives a half turn in the same direction as *h*, relative to a fixed member.

Compound Train of Planetary Gearing

Diagram *D*, Fig. 19, illustrates a compound train of planetary gearing. This arrangement modified to suit different conditions is commonly employed. Gear *a* represents the fixed member and meshes with gear *k*, which is attached to the same shaft as gear *l*. Gear *l* meshes with gear *b* the axis of which coincides with that of fixed gear *a*. Assume that gear *a* has 36 teeth, gear *k*, 34 teeth, gear *l*, 35 teeth, and gear *b*, 35 teeth. Then one turn of link *n* about the axis of gear *a* would give the following results:

	Gear a	Link n	Gears k and l	Gear b
Link stationary.	— 1 turn	0 turn	+ $\frac{36}{34}$ turn	— ($\frac{36}{34} \times \frac{35}{35}$) turn
Gears locked...	+ 1 turn	+ 1 turn	+ 1 turn	+ 1 turn
Number of turns	0	+ 1	+ 2 1/17	— 1/17

From this analysis, it will be seen that, for each counter-clockwise turn of link *n*, the rotation of gear *b* equals $1 - \frac{a}{k} \times \frac{l}{b}$, in which the letters correspond either to the pitch diameters or numbers of teeth in the respective gears shown at *D*. If the value of $\frac{a}{k} \times \frac{l}{b}$ is less than 1, gear *b* will revolve in the same direction as link *n*, whereas, if this value is greater than 1, gear *b* will revolve in the opposite direction.

Compound planetary gearing may be used for obtaining a very great reduction in velocity between the link *n* and the last gear *b* in the train. As an extreme example, suppose gear *a* has 99 teeth, gear *k*, 100 teeth, gear *l*, 101 teeth, and gear *b*, 100 teeth.

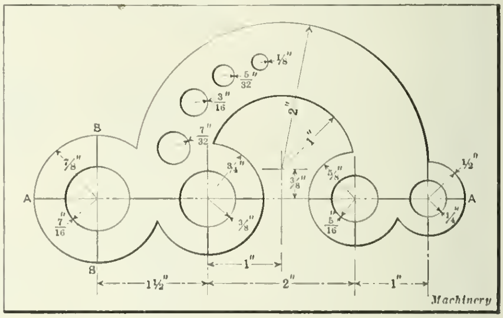
The speed of gear *b* will equal $1 - \frac{99 \times 101}{100 \times 100} = \frac{1}{10,000}$ revolution, hence link *n* would have to make 10,000 revolutions for each revolution of gear *b*. The arrangement of planetary gearing shown at *D* is known as a "reverted train."

Diagram *E* shows another arrangement of a reverted train. An internal gear *t* forms part of the mechanism, and either this gear, frame *q*, or pinion *p* may be the stationary member, depending upon the application of the mechanism. In this case, instead of a single set of gears between *p* and *t*, there is a double set located diametrically opposite and connected by a suitable frame *q*. This arrangement is similar to the mechanism of a certain type of geared hoist. The central pinion *p* is the driving member, internal gear *t* is stationary, and the frame *q* is the driven member and imparts motion to the hoisting sheave.

* * *

RADIUS JIG FOR DRAFTSMEN

The radius jig (see illustration) is so named because it is intended for use whenever an arc is to be drawn tangent to two straight lines. Drawing fillets on casting details and round corners are examples of work for which the radius jig is adapted. When the arc is to be tangent to two lines at right angles, the center lines *AA* and *BB* may be used to determine the points of tangency. This jig saves the time usually required for finding the center of the arc when using a compass. It may be made of celluloid 0.020 to 0.030 inch thick. This celluloid may be obtained from the scrap bag of an upholstery shop. When laying out the jig, the radii given on the drawing should be 1/64 inch short for an external radius and 1/64 inch long for an internal radius to allow for the width of the pencil point. When cutting out the circular edges, a pair of draftsman's dividers will be found to work very well, one point of the dividers being used as a cutting edge. Care should be taken not to exert too much pressure on the cutting point, as the dividers will spread and spoil the edge. The external arcs should be cut first, thus leaving centers for cutting the inner circles. A piece of fine emery cloth should be used to smooth the edges after cutting. Numbers may be scratched or cut upon the surface to designate the radii of the different arcs and curves, but after this jig has been used a short time, the draftsman will remember the location of the different sizes and the figures will no longer be needed. The scrap material, when cut to the proper size, makes excellent washers for bow instruments and ruling pens, two washers being used on each screw, so that one will slide upon the other when making adjustments. C. A. C.



Radius Jig for drawing Arcs Tangent to Straight Lines

* * *

The importance of securing greater uniformity than now exists in mathematical and other symbols in the various engineering fields has long been recognized. A committee of the American Association for the Advancement of Science took the matter in hand some time ago and made efforts to secure international cooperation. It is now advocated that American scientists and engineers should not wait for international agreement, but should standardize symbols for their own use. In normal times, this would be considered a most unfortunate suggestion, but it is obviously the only method feasible at present.

SPEEDS AND FEEDS FOR DRILLING[1]

METHODS OF DETERMINING PROPER CONDITIONS OF OPERATION — EFFECT OF HIGH-SPEED UPON EFFICIENCY OF TWIST DRILLS

BY EDWARD K. HAMMOND[2]

THERE are so many variables which enter into the performance of a drilling operation that it is extremely difficult to establish anything in the nature of hard and fast rules for the speed and feed that are correct for drilling a hole of specified size in a given class of material. It is quite general practice for an experienced mechanic to determine what appears to him to be the proper speed and feed for a given job by the use of "cut and try" methods. Experience will enable him to tell very closely what are the proper conditions of operation, and with this as a basis he will observe the operation of the drill and from that judge whether he is working under conditions that yield the maximum production. The successful use of high-speed steel drills often depends more upon the conditions under which they are operated than upon the tools themselves, provided they are properly made from a suitable grade of steel.

Concerning Desirability of Drilling at High Speed

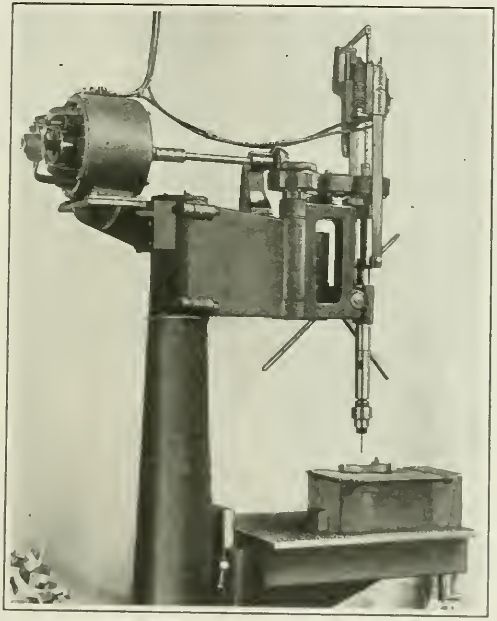


Fig. 1. Radial Drilling Machine equipped with "Magic" Quick-change Chuck and Automatic Control for Variable-speed Motor Drive to assure Proper Cutting Speed for All Tools

Recent years have witnessed great increases in the speed at which drilling operations are performed in many shops, and the advocates of high-speed drilling—both among builders of drilling machines and users of such equipment—claim that numerous advantages are secured by drilling at these high speeds. There is another body of mechanical men who scout the idea of benefits resulting from high-speed drilling, and state that this is a fad which has been carried to great excess. In any case, the proper speed at which a drilling operation should be performed is that speed at which the most desirable balance is obtained between cutting down of production through lowering the drilling speed and loss of time through the necessity of more frequently stopping the drilling machine to grind drills, where higher drilling speeds are employed. Owing to this diversity of opinion in regard to the most efficient speed at which drilling operations can be performed, the following recommendations made by different authorities should prove of interest and practical value.

H. M. Norris, chief engineer of the Cincinnati-Bickford Tool Co., has made a careful study of the question of drilling speeds, and the results of his investigations have led him to the conclusion that occasionally a drill is found which is capable of standing up satisfactorily at a cutting speed of 150 feet per minute in either cast iron or steel, but it is seldom desirable to drive anything but very small drills at speeds in excess of 100 feet per minute. Under average conditions of operation, the best results will be obtained with a cutting speed of 80 feet per minute in cast iron, while for steel, a speed of $\frac{12}{d} + 76$ feet per minute will give satisfactory results. Where this rule is used, the cutting speed will be decreased from 100 feet per minute for a 1/2-inch drill to 80 feet per minute for a 3-inch drill. In explaining the rule, attention is called to the fact that, while cast iron is cut dry, a lubricant is required for drilling steel and a volume of lubricant sufficient to keep a 1/2-inch drill cool at 100 feet per minute will only be sufficient to cool a 3-inch drill at 80 feet per minute.

Selection of the proper speed and feed for a given drilling operation is governed by the diameter of the drill and the kind of material being drilled. Exhaustive tests and close observation of the Cleveland Twist Drill Co. have led to the conclusion that in establishing the best conditions of operation for a given job, it is well to start carbon steel twist drills under the following conditions of speed and feed until more definite data are available as to the maximum speed and feed which can properly be employed for the operation under consideration. When drilling machine steel use a peripheral speed of 30 feet per minute; for cast iron use a speed of 35 feet per minute; and for brass use a speed of 60 feet per minute. In each case a feed of 0.004 to 0.007 inch per revolution should be employed for drills up to 1/2-inch in diameter, while for larger sizes the feed should be from 0.005 to 0.015 inch per revolution. In the case of high-speed steel drills the preceding rates of speed should be increased from 100 to 125 per cent, while the same rates of feed are employed. The Standard Tool Co. recommends starting high-speed steel drills at a peripheral speed of from 50 to 70 feet per minute for wrought iron or steel, and from 60 to 80 feet per minute for cast iron, or at 140 feet per minute for brass. The feeds recommended are 0.004 inch per revolution for a 1/16-inch drill in wrought iron or steel, 0.005 inch per revolution for a 1/4-inch drill, 0.008 inch per revolution for a 1/2-inch drill, 0.010 inch per revolution for a 1-inch drill, and 0.015 inch per revolution for a 1½-inch drill.

The Detroit Twist Drill Co. states that high-speed steel drills can often be run efficiently at over 100 feet per minute in cast iron, but that better results will usually be obtained at 60 to 70 feet per minute. In establishing the proper conditions for a given drilling operation, a freshly ground drill of a given size should be tested at each of the two speeds provided by the machine above and below that which is necessary to give a cutting speed of 70 feet per minute, and then each successive feed provided on the machine should be tried until one is found at which the drill will run without slowing down the machine or injuring the drill during a period of one hour's operation, which is the standard shop interval during which a drill should operate without requiring grinding. This sounds as if it would require considerable time, but, as a matter of fact, establishment of speeds and feeds by this method can be quickly accomplished and the saving will more than compensate for the time spent in determining the most efficient conditions of operation where there are a large number of parts to be drilled. For drilling wrought iron or steel, the drill should be started at a peripheral speed of from 50 to 70 feet per minute, for cast iron the speed should be from 60 to 80 feet per minute, and for brass, from 100 to 150 feet per minute. Under favorable conditions, the feed should be 0.004 inch per revolution for a 1/16-inch drill in wrought iron or steel, 0.005 in per revolution for a 1/4-inch drill, 0.008 inch for a 1/2-inch drill, 0.010 inch for a 1-inch drill, and 0.015 inch for a 2-inch drill. If the drill breaks or chips on the cutting edges, the rate of feed should be reduced.

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[1] For previous articles on drilling practice, see "Modern Drilling Practice," in the January, February, and March numbers of MACHINERY

[2] Associate Editor of MACHINERY

TABLE 1. CUTTING SPEEDS

	FEET PER MINUTE														
Diam., Inches	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
	Revolutions per Minute														
1/16	917.	1223.	1528.	1834.	2140.	2445.	2751.	3057.	3363	3668	3974	4280	4586	4891	5197
1/8	459.	611.	764.	917.	1070.	1222.	1375.	1528.	1681	1834	1986	2139	2292	2445	2598
3/16	306.	408.	509.	611.	713.	815.	917.	1019.	1121	1222	1325	1426	1529	1630	1732
1/4	229.	306.	382.	458.	535.	611.	688.	764.	851	917	994	1070	1147	1222	1300
5/16	183.	245.	306.	367.	428.	489.	550.	611.	672	733	794	856	917	978	1039
3/8	153.	204.	255.	306.	357.	408.	458.	509.	560	611	662	713	764	815	865
7/16	131.	175.	218.	262.	306.	349.	393.	437.	481	524	568	611	656	699	743
1/2	115.	153.	191.	229.	268.	306.	344.	382.	420	459	497	535	573	611	649
9/16	102.	136.	170.	204.	238.	272.	306.	340.	373	407	441	475	509	543	577
5/8	91.8	123.	153.	184.	214.	245.	276.	306.	337	367	398	428	459	489	520
11/16	83.3	111.	138.	167.	194.	222.	249.	273.	300	333	360	389	416	444	472
3/4	76.3	102.	127.	153.	178.	203.	229.	254.	279	306	330	357	381	408	432
13/16	71.1	94.8	119.	142.	166.	190.	213.	237.	261	284	308	332	356	379	403
7/8	65.5	87.3	109.	131.	153.	175.	196.	219.	241	262	285	306	329	349	372
15/16	61.0	81.4	101.	122.	142.	163.	183.	204.	224	244	265	285	305	326	346
1	57.3	76.4	95.5	115.	134.	153.	172.	191.	210	229	258	267	287	306	325
1 1/16	53.9	71.8	89.8	108.	126.	144.	162.	180.	197	215	233	251	269	287	305
1 1/8	51.0	68.0	85.0	102.	119.	136.	153.	170.	187	204	221	238	255	272	289
1 3/16	48.3	64.4	80.5	96.6	113.	129.	145.	161.	177	193	209	225	242	258	274
1 1/4	45.8	61.2	76.3	91.8	107.	123.	137.	153.	168	183	199	214	230	245	260
1 5/16	43.6	58.2	72.8	87.3	102.	116.	131.	146.	160	175	189	204	218	233	247
1 3/8	41.7	55.6	69.5	83.3	97.2	111.	125.	139.	153	167	180	195	208	222	236
1 7/16	39.8	53.0	66.3	79.5	92.8	106.	119.	133.	146	159	172	186	199	212	225
1 1/2	38.2	50.8	63.7	76.3	89.2	102.	115.	127.	140	153	165	178	191	204	216
1 9/16	36.6	48.8	61.0	73.2	85.4	97.6	110.	122.	134	146	159	171	183	195	207
1 5/8	35.0	47.0	58.8	70.5	82.2	93.9	106.	117.	129	141	152	165	176	188	199
1 11/16	33.9	45.2	56.5	67.8	79.1	90.4	102.	113.	124	136	147	158	170	181	192
1 3/4	32.7	43.6	54.5	65.5	76.4	87.3	98.2	109.	120	131	142	153	164	175	185
1 13/16	31.7	42.2	52.8	63.3	73.9	84.4	95.0	106.	116	127	137	148	158	169	179
1 7/8	30.6	40.7	50.9	61.1	71.3	81.5	91.9	102.	112	122	133	143	153	163	173
1 15/16	29.6	39.4	49.3	59.1	69.0	78.8	88.7	98.5	108	118	128	138	148	158	167
2	28.7	38.2	47.8	57.3	66.9	76.4	86.0	95.5	105	115	124	134	143	153	162

	FEET PER MINUTE														
Diam., Inches	90	95	100	110	120	125	130	140	150	160	170	175	180	190	200
	Revolutions per Minute														
1/16	5502	5808	6114	6725	7337	7643	7948	8560	9171	9782	....	....	....	....	....
1/8	2750	2903	3056	3362	3667	3820	3973	4278	4584	4890	5195	5348	5501	5806	6112
3/16	1834	1936	2038	2242	2446	2548	2649	2853	2157	3261	3465	5367	3668	3872	4076
1/4	1376	1453	1528	1681	1734	1910	1986	2139	2292	2445	2598	2674	2750	2903	3056
5/16	1100	1161	1222	1344	1466	1527	1589	1711	1833	1955	2077	2139	2200	2322	2444
3/8	916	967	1018	1121	1222	1273	1323	1425	1527	1629	1731	1782	1832	1934	2036
7/16	786	830	874	961	1049	1093	1136	1224	1311	1398	1486	1530	1573	1661	1748
1/2	688	726	764	840	917	955	993	1070	1146	1222	1299	1337	1375	1452	1528
9/16	611	645	679	747	813	869	883	951	1019	1086	1154	1188	1222	1290	1358
5/8	552	581	612	673	736	765	796	857	918	979	1040	1071	1102	1163	1224
11/16	500	527	555	611	666	692	722	770	833	888	944	971	999	1054	1110
3/4	458	483	508	559	610	635	661	711	762	813	864	889	914	965	1016
13/16	427	450	474	521	569	593	616	664	711	758	806	830	853	901	948
7/8	392	416	438	482	526	548	569	613	657	701	745	767	788	832	876
15/16	366	387	407	448	488	509	529	570	611	651	692	712	733	773	814
1	344	363	382	420	458	478	497	535	573	611	649	669	688	726	764
1 1/16	323	341	359	395	431	449	467	503	539	579	610	628	646	682	718
1 1/8	306	324	340	374	408	425	442	476	510	544	578	595	612	646	680
1 3/16	290	306	322	354	386	403	419	451	483	515	547	564	580	612	644
1 1/4	274	291	306	337	367	383	398	428	459	490	520	536	551	581	612
1 5/16	262	276	291	320	349	351	378	407	437	466	495	509	524	553	582
1 3/8	250	264	278	306	334	348	361	389	417	445	472	487	500	528	556
1 7/16	239	272	265	292	318	331	345	371	398	424	451	464	477	504	530
1 1/2	230	241	254	279	305	318	330	356	381	406	432	445	457	483	508
1 9/16	220	232	244	268	293	305	317	342	366	390	415	427	439	464	488
1 5/8	212	222	234	257	281	293	304	328	351	374	398	410	421	445	468
1 11/16	203	215	226	249	271	283	294	316	339	362	384	396	407	429	452
1 3/4	196	207	218	240	262	273	283	305	327	349	371	382	392	414	436
1 13/16	190	200	211	232	253	264	274	295	317	338	359	369	380	401	422
1 7/8	184	194	204	224	244	255	265	286	306	326	347	357	367	388	408
1 15/16	177	187	197	217	236	246	256	276	296	315	335	345	355	374	394
2	172	181	191	210	229	239	248	267	287	306	325	334	344	363	382

Machinery

Starting with any of the preceding speeds and feeds which have been recommended by different authorities, the operator carefully notes the condition of the drill after it has been working for some time. If the drill shows a tendency to wear away on the outside, it is running too fast, while if it breaks or chips on the cutting edges, the feed is probably too heavy for the job. A little careful experimenting in this way, making changes gradually according to indications which are shown after working for some time, will usually result in hitting upon a combination of speed and feed which will be the means of securing something approaching the maximum possible production. It will, of course, be obvious that to obtain a given peripheral cutting speed, the number of revolutions per minute must differ according to the size of the drill which is being used. This is the reason for running very small drills at extremely high speeds in order to have them working under conditions which approximate the required cutting speed for the material that is being machined. For the convenience of users of twist drills and other rotary cutting tools, tables are available which show the number of revolutions per minute at which a given size of drill should be run in order to obtain the required cutting speed. In Table 1 it will be seen that the diameters of drills are given in the left-hand column, while peripheral cutting speeds in feet per minute are noted at the top of the table. By finding the intersection of horizontal and vertical lines through the given drill diameter and the required cutting speed, we find the number of revolutions per minute at which the drill must be run in order to obtain this speed. Table 2 gives the decimal equivalents of nominal sizes of drills, and will be found useful when calculating the peripheral cutting speed of drills of various sizes; this table also shows the relation of the different sizes of drills, which are designated by letters and numbers, as compared to the fractional sized drills.

TABLE 2. DECIMAL EQUIVALENTS OF NOMINAL SIZES OF DRILLS

Inch	Wire Gage	Decimals of an Inch	Inch	Wire Gage	Decimals of an Inch	Inch	Wire Gage	Decimals of an Inch	Inch	Letter Sizes	Decimals of an Inch	Inch	Decimals of an Inch	Inch	Decimals of an Inch
	80	0.0135		44	0.0860		10	0.1935		T	0.3580	7/8	0.8750	1 33/64	1.5156
	79	0.0145		43	0.0890		9	0.1960	23/64		0.3594	57/64	0.8906	1 17/32	1.5313
1/64		0.0156		42	0.0935		8	0.1990		U	0.3680	29/32	0.9063	1 35/64	1.5469
	78	0.0160	3/32		0.0938		7	0.2010	3/8		0.3750	59/64	0.9219	1 9/16	1.5625
	77	0.0180		41	0.0960	13/64		0.2031		V	0.3770	15/16	0.9375	1 37/64	1.5781
	76	0.0200		40	0.0980		6	0.2040			0.3819	61/64	0.9531	1 19/32	1.5938
	75	0.0210		39	0.0995		5	0.2055		W	0.3860	31/32	0.9688	1 39/64	1.6094
	74	0.0225		38	0.1015		4	0.2090	25/64		0.3906	63/64	0.9844	1 5/8	1.6250
	73	0.0240		37	0.1040		3	0.2130		X	0.3970	1	1.0000	1 41/64	1.6406
	72	0.0250		36	0.1065	7/32		0.2188		Y	0.4040	1 1/64	1.0156	1 21/32	1.6563
	71	0.0260	7/64		0.1094		2	0.2210	13/32		0.4063	1 1/32	1.0313	1 43/64	1.6719
	70	0.0280		35	0.1100		1	0.2280		Z	0.4130	1 3/64	1.0469	1 11/16	1.6875
	69	0.0293		34	0.1110				27/64		0.4219	1 1/16	1.0625	1 45/64	1.7031
	68	0.0310		33	0.1130		Letter Sizes		7/16		0.4375	1 5/64	1.0781	1 23/32	1.7188
1/32		0.0313		32	0.1160				29/64		0.4531	1 3/32	1.0938	1 47/64	1.7344
	67	0.0320		31	0.1200		A	0.2340	15/32		0.4688	1 7/64	1.1094	1 3/4	1.7500
	66	0.0330	1/8		0.1250	15/64		0.2344	31/64		0.4844	1 1/8	1.1250	1 49/64	1.7656
	65	0.0350		30	0.1285		B	0.2380	1/2		0.5000	1 9/64	1.1406	1 25/32	1.7813
	64	0.0360		29	0.1360		C	0.2420	33/64		0.5156	1 5/32	1.1563	1 51/64	1.7969
	63	0.0370		28	0.1405		D	0.2460	17/32		0.5313	1 11/64	1.1719	1 13/16	1.8125
	62	0.0380	9/64		0.1406	1/4	E	0.2500	35/64		0.5469	1 3/16	1.1875	1 53/64	1.8281
	61	0.0390		27	0.1440		F	0.2570	9/16		0.5625	1 13/64	1.2031	1 27/32	1.8438
	60	0.0400		26	0.1470		G	0.2610	37/64		0.5781	1 7/32	1.2188	1 55/64	1.8594
	59	0.0410		25	0.1495	17/64		0.2656	19/32		0.5938	1 15/64	1.2344	1 7/8	1.8750
	58	0.0420		24	0.1520		H	0.2660	39/64		0.6094	1 1/4	1.2500	1 57/64	1.8906
	57	0.0430		23	0.1540		I	0.2720	5/8		0.6250	1 17/64	1.2656	1 29/32	1.9063
	56	0.0465	5/32		0.1563		J	0.2770	41/64		0.6406	1 9/32	1.2813	1 59/64	1.9219
3/64		0.0469		22	0.1570		K	0.2810	21/32		0.6563	1 19/64	1.2969	1 15/16	1.9375
	55	0.0520		21	0.1590	9/32		0.2813	43/64		0.6719	1 5/16	1.3125	1 61/64	1.9531
	54	0.0550		20	0.1610		L	0.2900	11/16		0.6875	1 21/64	1.3281	1 31/32	1.9688
	53	0.0595		19	0.1660		M	0.2950	45/64		0.7031	1 11/32	1.3438	1 63/64	1.9844
1/16		0.0625		18	0.1695	19/64		0.2969	23/32		0.7188	1 23/64	1.3594	2	2.0000
	52	0.0635	11/64		0.1719		N	0.3020	47/64		0.7344	1 3/8	1.3750	2 1/64	2.0156
	51	0.0670		17	0.1730	5/16		0.3125	3/4		0.7500	1 25/64	1.3906	2 1/32	2.0313
	50	0.0700		16	0.1770		O	0.3160	49/64		0.7656	1 13/32	1.4063	2 3/64	2.0469
	49	0.0730		15	0.1800		P	0.3230	25/32		0.7813	1 27/64	1.4219	2 1/16	2.0625
	48	0.0760		14	0.1820	21/64		0.3281	51/64		0.7969	1 7/16	1.4375	2 5/64	2.0781
5/64		0.0781		13	0.1850		Q	0.3320	13/16		0.8125	1 29/64	1.4531	2 3/32	2.0938
	47	0.0785	3/16		0.1875		R	0.3390	53/64		0.8281	1 15/32	1.4688		
	46	0.0810		12	0.1890	11/32		0.3438	27/32		0.8438	1 31/64	1.4844		
	45	0.0820		11	0.1910		S	0.3480	55/64		0.8594	1 1/2	1.5000		

Machinery

Variable-speed Drive for Drilling Machine

Where quick-change chucks are used to facilitate changing tools for the performance of a sequence of operations on a piece of work, it is apparent that provision must be made for changing the spindle speed of the drilling machine for different sizes of tools, or else some of these tools will have to be driven below the most efficient speeds for such sizes of drills, counterbores, etc. In Fig. 1 is shown a radial drilling machine equipped with variable-speed motor drive and means of automatically changing the speed so that approximately the proper speed may be obtained for each size of tool that is used. The machine is shown at work in the shops of the Universal Motor Co., and the automatic speed-changing device was designed by L. J. Monahan, president of the firm, who has applied for a patent on this idea. Referring to Fig. 2, it will be seen that the drilling machine is equipped with one of the "Magic" chucks *A* made by the Modern Tool Co., and the collets *B* which enter this chuck are each provided with a pin *C* which extends up through the chuck body and engages the bottom of pin *D*. These pins *C* are made of different lengths and automatically adjust a speed-controlling rheostat *E* to provide for regulating the speed of motor *F* to give the proper spindle speed for the particular size of drill or other tool being used. In this way there is assurance of each tool being driven at its most efficient speed. By making the speed change automatically, no demand is made upon the operator, and so there is no loss of time in speed changing; also the "Magic" chuck enables tools to be changed without stopping the rotation of the drilling machine spindle.

Critical Drilling Speeds

In experimenting to determine the number of revolutions per minute at which a drill will have the greatest productive capacity, some interesting results are secured. Researches which were made at the plant of Baker Bros., with the view of securing data required in connection with the design of their drilling machines, showed that there are certain critical speeds at which a twist drill will have a satisfactory rate of production, while there are other speeds—often lying between two rates of speed where the production is satisfactory—at which the drill will fail to give anything approaching satisfactory results. This condition is clearly shown by Fig. 3, which is plotted with data taken from the original tests in the Baker Bros. plant; in this connection the reader's attention is called to the fact that these investigations were made several years ago, so that, while the condition shown by this set of curves is an established fact, the rates of speed and feed are lower than would be used in conducting similar tests at the present time. The point brought out by this diagram is the remarkable increase in production which can be secured by increasing the speed. The curves are plotted for the maxi-

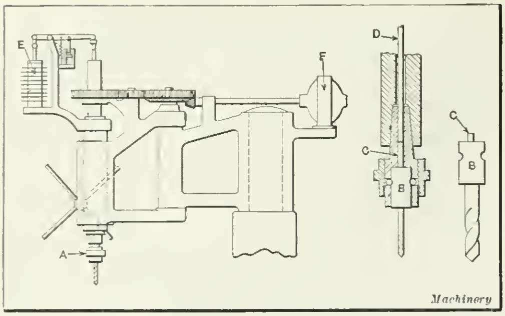

Fig. 2. Method of obtaining Automatic Control of Variable-speed Motor Drive

mum feed at which the stock was successfully drilled without destroying the drill; at the next higher feed the drill would be destroyed. Curve No. 2 shows that the drill would give a far greater production without failing at 200 R.P.M. than it would at 250 R.P.M., and also that it would give a much greater production if the speed were still further increased to 400 R.P.M.

This is of particular interest in connection with the suggestions made for experimenting to determine the speed at which a given drilling operation may be performed to secure the greatest possible output. Should it happen that the drilling machine operator has reason to believe that the speed he is using is too low, but finds that a moderate increase in speed results in an even less satisfactory rate of production, he is justified in believing that if the speed rate of penetration were plotted in the form of a curve shown in Fig. 3, the "speed-penetration" curve has taken one of those peculiar dips exhibited in this illustration, and that at a still further increase in speed will probably result in determining a rate at which the desired production will be attained. If such is the case, it is obvious that correction of the original cause for the unsatisfactory rate of production will be made by a considerable increase in speed and not by making a reduction in speed, as might be inferred from the fact that advancing a little from the original speed at which production was unsatisfactory showed that even less desirable results were being obtained.

Recently a well-known manufacturing establishment had an investigating committee working for over two years on the development of a table of speeds and feeds for use in connection with different sizes of drills working in various materials. The result of this investigation is presented in Tables 3 and 4, and although it is not claimed that the data presented can be followed without modification, it is claimed that the thousands of tests which were made during the period over which these data were secured have led to results which may safely be regarded as an average maximum of the rate of speed and feed under which a drilling machine may be operated. These tables are copyrighted by the Henry & Wright Mfg. Co., and the tests were made on a special drilling machine built by this company.

In starting to work on a new job the operator of the drilling machine will use the speed and feed shown in this table, but should he find that the drill shows a tendency to wear around its periphery or that there is a considerable amount of chipping along the cutting edges of the drill, it indicates that the speed or feed is too heavy, and so the required adjustment of operating conditions must be made. In the plant where these data were obtained, the investigating committee reported that the installation of machines capable of operating under these conditions of speed and feed would represent a saving of $30,000 a year. The speeds recommended are rather high, and if twist drills are unable to stand them, the drill manufacturers should be notified, as it is claimed that any responsible maker can furnish suitable drills for use under these conditions, if he is required to do so. The speeds are also too high for machines equipped with plain bearings, but properly constructed machines with ball bearings will easily stand up under such conditions of operations.

After reading the preceding suggestions concerning the most efficient speeds and feeds at which drilling operations can be performed, the reader will naturally be impressed by the difference in these recommendations, and noting that they are made by men who have equal opportunities of determining the required information, he will ask himself which conditions are likely to produce the best results in his own shop. The difference in these recommendations is probably due to the fact that there are so many variables which enter into the performance of drilling operations that different combinations of variable conditions enable the most satisfactory results to be obtained when using speeds and feeds which differ substantially. Regardless of the reason, it is a matter of fact that different men have found that the most satisfactory results are obtained when running their drilling machines under conditions of speed and feed which differ substantially when drilling a given size of hole in the same material. Such being the case, the best advice which can be given to the man who is trying to improve conditions in his drilling department is to adopt the method of experimenting with trial speeds and feeds—adopting those trial speeds and feeds recommended in the preceding discussion—until he has found the conditions of speed and feed which give the most satisfactory results on his work.

Advantages of Drilling at High Speed

Machine tool builders are now making drilling machines fully equipped with ball bearings so that they are adapted for operation at speeds which would have been utterly impossible of attainment a few years ago. For instance, the Leland-Gifford Co. builds a machine which is adapted for operation at speeds of from 11,000 to 15,000 revolutions per minute, and the same speeds are recommended for use on a bench drilling machine recently brought out by the Fenn Mfg. Co. Other machinery builders are making high-speed drilling machines. Driving twist drills at such speeds means that the drilling operation is practically instantaneous; in fact, the speed at which holes may be drilled is often equal, if not in excess, of the speed at which the same work could be done on a power press. It is this constant increase in the speed of drilling, with the constant reduction of the ratio between "drilling time" and "setting-up time," which has emphasized the fact that, in order to approach the maximum rate of production,

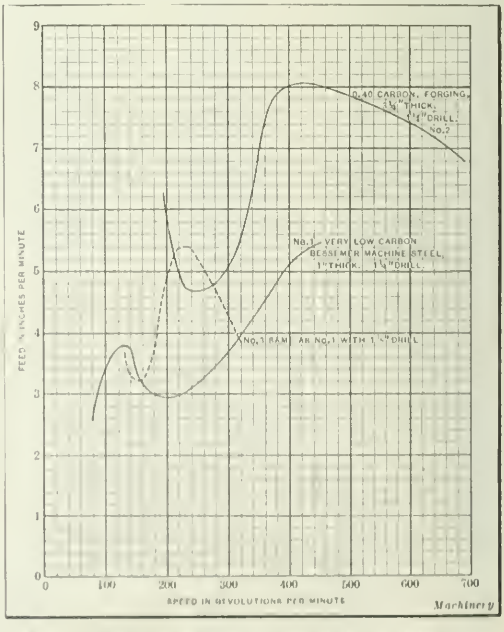

Fig. 3. Diagram showing Effect of Critical Speeds on Penetration-speed Curves

TABLE 3. SPEEDS AND FEEDS FOR HIGH-SPEED DRILLS WORKING IN VARIOUS METALS

Size of Drill, Inch	Feed per Rev., Inch	Bronze, Brass, 300 Feet, R.P.M.	Cast Iron, Annealed, 170 Feet, R.P.M.	Hard Cast Iron, 80 Feet R.P.M.	Mild Steel, 120 Feet, R.P.M.	Drop-forging 60 Feet, R.P.M.	Malleable Iron, 90 Feet, R.P.M.	Tool Steel, 60 Feet, R.P.M.	Cast Steel, 40 Feet, R.P.M.
1/16	0.003	....	....	4880	....	3660	....	3660	2440
1/8	0.004	....	5185	2440	3660	1830	2745	1830	1220
3/16	0:005	....	3456	1626	2440	1210	1830	1220	807
1/4	0.006	4575	2593	1220	1830	915	1375	915	610
5/16	0.007	3660	2074	976	1464	732	1138	732	490
3/8	0.008	3050	1728	813	1220	610	915	610	407
7/16	0.009	2614	1482	698	1046	522	784	522	348
1/2	0.010	2287	1296	610	915	458	636	458	305
5/8	0.011	1830	1037	488	732	366	569	366	245
3/4	0.012	1525	864	407	610	305	458	305	203
7/8	0.013	1307	741	349	523	261	392	261	174
1	0.014	1143	648	305	458	229	349	229	153
1 1/4	0.016	915	519	244	366	183	275	183	122
1 1/2	0.016	762	432	204	305	153	212	153	102
1 3/4	0.016	654	371	175	262	131	196	131	87
2	0.016	571	323	153	229	115	172	115	77

Machinery

the user of high-speed drilling machines must design his work-holding fixtures in such a way that work may either be set up in indexing fixtures while the drilling operation is being performed, or, if this is not feasible, the clamping devices on fixtures must be so constructed that a minimum amount of time is consumed in securing the work in place ready to be drilled.

Several important advantages are secured through drilling at high speed, and this is particularly the case with small sized drills, which are likely to break, and also with high-speed steel drills. The reasons for this are as follows: In the case of small drills operated in sensitive drilling machines equipped with hand feed, running the drill at high speed makes it improbable that the operator will impose an excessive feed on the drill, because, in the case of a drill which is running at from 10,000 to 15,000 revolutions per minute, it would be necessary to pull the feed lever down extremely fast in order that the feed for any one revolution of the drill would be sufficient to impose a stress in the steel which would be in excess of the maximum that the strength of the drill is capable of withstanding. A further explanation for the increased strength of a drill when running at high speed is that where an excessive amount of feed pressure tends to bend the drill slightly when running at high speed, the length of time that any set of fibers in the drill is subjected to stress is so short that the danger of breaking may be less than if the load remains on such fibers for a greater length of time. This is, of course, a moot question and is advanced in the form of a hypothesis rather than a statement of fact; in any case, the question is an interesting one.

TABLE 4. SPEEDS AND FEEDS FOR CARBON STEEL DRILLS WORKING IN VARIOUS METALS

Size of Drill, Inch	Feed per Rev., Inch	Bronze, Brass, 300 Feet, R.P.M.	Cast Iron, Annealed 85 Feet, R.P.M.	Hard Cast Iron, 40 Feet, R.P.M.	Mild Steel, 60 Feet, R.P.M.	Drop-forging 30 Feet, R.P.M.	Malleable Iron, 45 Feet, R.P.M.	Tool Steel, 30 Feet, R.P.M.	Cast Steel, 20 Feet, R.P.M.
1/16	0.003	....	5185	2440	3660	1830	2745	1830	1220
1/8	0.004	4575	2593	1220	1830	915	1375	915	610
3/16	0.005	3050	1728	813	1220	610	915	610	407
1/4	0.006	2287	1296	610	915	458	636	458	305
5/16	0.007	1830	1037	488	732	366	569	366	245
3/8	0.008	1525	864	407	610	305	458	305	203
7/16	0.009	1307	741	349	523	261	392	261	174
1/2	0.010	1143	648	305	458	229	343	229	153
5/8	0.011	915	519	244	366	183	275	183	122
3/4	0.012	762	432	204	305	153	212	153	102
7/8	0.013	654	371	175	262	131	196	131	87
1	0.014	571	323	153	229	115	172	115	77
1 1/4	0.016	458	260	122	183	92	138	92	61
1 1/2	0.016	381	216	102	153	77	106	77	51
1 3/4	0.016	327	186	88	131	66	98	66	44
2	0.016	286	162	87	115	58	86	58	39

Machinery

With high-speed steel drills, there is an increase in strength and durability when running at high speed which can be explained in a more definite way. At a speed of, say, 10,000 R.P.M., the frictional resistance and tendency for the drill to become heated is far more pronounced than where the drill is being operated at, say, 350 R.P.M. It is a well-known fact that many classes of high-speed steel are tough and hard even at temperatures corresponding to a dull red heat; conversely, such steels are inclined to be quite brittle at low temperatures. As a result, the increase in frictional resistance resulting from the operation of a high-speed steel drill at the higher speed results in increasing its temperature, with a corresponding improvement in the toughness and hardness of the steel. Consequently it is obvious that a high-speed steel drill should give better results when working at speeds which cause it to become heated slightly while in operation.

This naturally leads to two points which should be observed in caring for high-speed steel drills in order to enable them to give the best possible results. In cold weather it will be found advantageous to warm the drills slightly before they are placed in service. Such an increase in temperature will be the means of taking much of the brittleness out of the metal, thus avoiding danger of the drill breaking before it has had time to become warmed up through frictional resistance between the tool and work which is being drilled. Another point which is sufficiently important to merit careful consideration is that some makes of high-speed steel are likely to be damaged if suddenly quenched in cold water. In grinding a drill, some operators will plunge the point into water, and when this is done there is danger of introducing cracks in the cutting edge; these may not be of sufficient magnitude to show to the naked eye, but when the drill is put to work trouble is likely to be experienced at once through the chipping away of steel along the lips of the drill.

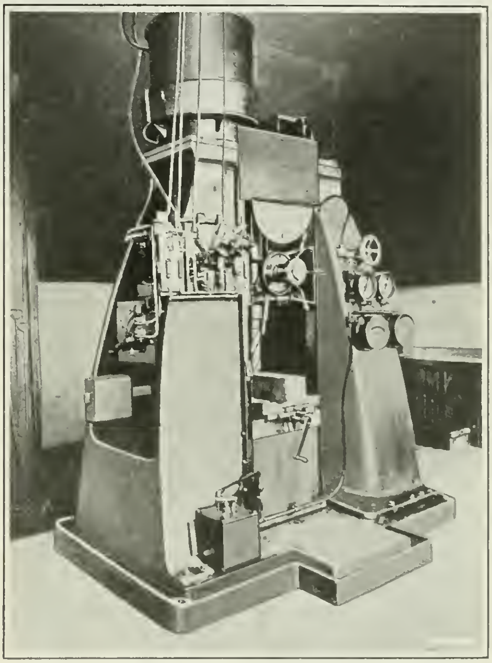

Fig. 4. Special Drilling Machine used in Laberatory of Standard Tool Co.

Investigation of Feed Pressure Required for Drilling

In Fig. 4 there is shown a special drilling machine which was built for use in the laboratory of the Standard Tool Co. for conducting experimental work on twist drills. It will be seen that this machine is symmetrically designed on both sides of an axis corresponding to the axis of the twist drill which is being tested, this arrangement tending to equalize all stresses that are set up in the frame of the machine and to cause the thrust of the drill to be vertically downward. In the case of an ordinary drilling machine with the overhanging type of frame, there is a cantilever action which causes the thrust of the drill to be separated into two components. On this special drilling machine shown in Fig. 4, the bedplate which supports the work rests on a 12-inch piston, which is ground to a sliding fit in a cylinder filled with oil. Arms and counterweights attached to each side of the piston compensate for the total weight of the piston and bedplate, so that gages connected to the oil cylinder indicate the pressure actually applied by the drill, the gages being calibrated to indicate the total pressure on the 12-inch ram. Two gages are used, one of which reads up to 3000 pounds, while the other reads up to 15 tons.

The spindle and feed mechanisms are driven by two independent electric motors. For driving the spindle, the motor is mounted at the top of the machine with the armature shaft in a vertical position, so that it may be direct-connected to the spindle of the drilling machine. The feed mechanism is driven by a motor located at the right-hand side of the machine, and this motor is connected to the feed through a system of worm-gears and a rack and pinion. An indicating wattmeter in each circuit shows the power consumption, and each motor is furnished with an independent rheostat by which variations in speed are effected. The speeds of the motors that drive the spindle and feed mechanism are indicated by two Warner tachometers, and a chart has been developed to give the rate of feed for different speeds of the motor that drives the feed mechanism.

A series of tests was conducted on this machine by Paul Bedell Starr and John Millard Marsh to secure data for a thesis presented at the time these men took the degree of Bachelor of Science in mechanical engineering at the Case School of Applied Science. The object of this investigation was principally to determine the feed pressure required to drive different sizes of drills under various conditions of speed and feed. That very little reliable data were available on this subject was shown by the fact that, when the special drilling machine was first built by a firm of wide experience in the design and construction of equipment of this type, a pressure gage reading up to 3000 pounds was provided. At the first test, using a 1-inch drill at a normal rate of feed, the range of this gage was shown to be entirely inadequate, and so a gage reading up to 15 tons was substituted, which proved suitable for the service required of it, this difference in gages showing conclusively that the knowledge concerning the magnitude of feed pressures was not at all definite.

Five series of tests were conducted under the following conditions: On the first series, the clearance angle of the drills used was less than the standard 12-degree clearance adopted by the Standard Tool Co., which furnished the twist drills used in making this investigation. On the second series, the clearance angle was greater than the standard 12 degrees. On the third series, the drills used were standard in every respect. On the fourth series, the web thickness of the drills was 10 per cent under standard, and thinned in accordance with the practice of the Standard Tool Co. On the fifth series, the web thickness was 10 per cent above standard. The first series of tests, with the clearance angle less than the standard of 12 degrees, showed that an excessive amount of feed pressure was required to operate a drill ground in this way, such a result being entirely expected, because the cutting edges are not given free play. In the second and third series of tests, where the clearance angle was greater than the standard of 12 degrees, and where all dimensions of the drills were standard, practically the same results were obtained as regards feed pressure, which indicated that no particular advantage was obtained by increasing the clearance angle beyond 12 degrees. It will also be recalled that such an increase results in weakening the cutting edges of the drill and introducing a tendency for them to be damaged by chipping.

In the fourth series of tests, where the web thickness was reduced 10 per cent, there was a noticeable decrease in feed pressure, which indicates that advantages are to be secured through thinning the point of the drill, provided this work is carefully done, so that there is no danger of weakening the drill sufficiently to cause it to split up the center. For the fifth series of tests, where the web thickness was greater than standard, the results obtained were not entirely satisfactory, but, under these conditions of operation, it is fairly safe to assume that an increase in feed pressure would be the result. The data secured from these tests must be regarded more in the light of indications of probable results from varying conditions of operation than as statements of fact concerning results actually discovered, because lack of time made it impossible for Mr. Starr and Mr. Marsh to carry their investigations far enough to secure average results; and average results are particularly important in the case of drilling tests, because of the numerous variations which may affect results.

Power Required to Drive Drilling Machines

The Detroit Twist Drill Co. states that the efficiency of most drilling machines is from 10 to 20 per cent, *i.e.*, there is seldom over one-fifth of the power used to drive a drilling machine which is transmitted to the drill point. It frequently happens that very little care is taken to see that drilling machine bearings are properly aligned and lubricated, and this is especially true in the case of ball thrust bearings, which must be kept in good working condition in order to be effective in helping the machine to give the maximum possible service. Attention to the upkeep of machine bearings is exceptionally important in the case of drilling machines operated at excessively high speed.

Coolants and Lubricants Used for Drilling

For drilling operations, satisfactory results can usually be obtained through the use of one of the soluble oil coolants, for all classes of work where the length of chips produced is not very great; but in cases where long chips are formed, there is a rubbing action produced by the chips sliding over the lips of the drill, which produces a condition analogous to that of a machine bearing, thus making it necessary to apply a fluid which serves the combined purpose of lubricant and coolant. The following is an outline of lubricants and coolants recommended for drilling operations in various classes of material, and the lubricants used are recommended in the order in which they are named. In this list "cutting compound" refers to any satisfactory brand of soluble oil mixed with water, in accordance with the manufacturer's instructions; and "mineral lard oil" is a mixture of lard oil and light petroleum oil. The proportions of this mixture vary according to the work, but one part of lard oil to two parts of petroleum gives a mixture that is well suited to the requirements of many average drilling operations. For drilling high-carbon or alloy steel, use mineral lard oil or turpentine; low-carbon steel, mineral lard oil or cutting compound; cast iron, dry or compressed air; wrought iron, cutting compound or mineral lard oil; malleable iron, cutting compound; brass, dry; bronze, cutting compound or dry; copper, mineral lard oil; aluminum, kerosene, beeswax, or tallow; monel metal, cutting compound; and glass, solution of camphor in turpentine.

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QUENCHING LIQUIDS

The quenching of a piece of steel is most important. The quenching liquid should cool the piece readily without being so harsh as to cause a rupture of the fibers. When hot steel is continually dumped into a tank of oil, the lighter and volatile oils are evaporated and finally only the heavier oils will be left. When the oil becomes thick, it will not take the heat away from the steel rapidly; consequently the steel will be soft and will not show the maximum physical properties. To obtain such results, the quenching liquid should be of a constant specific gravity and maintained at a temperature of 70 to 90 degrees, but the exact temperature at which the bath is maintained does not matter so much if it is always the same. To insure the best results in manufacturing, the bath should always be maintained at a certain specific gravity and at some certain temperature.—*Proceedings of Steel Treating Research Society of Detroit*

Pneumatic Riveting Practice

by A. Mason MacFarland[1]

SHIP RIVETING — DIFFERENT TYPES OF PNEUMATIC RIVETING TOOLS AND MACHINES, THEIR USE, ABUSE, MAINTENANCE AND REPAIR

THE pressing importance to the country, at the present time, of the machines classed as "pneumatic tools," and the necessity for developing to the greatest degree their efficient use, may be realized from a consideration of these facts: Authorities agree that the greatest immediate need of the war is more ships. A ship may require a million or more rivets to fasten together the plates and frames. In some shipyards it is the practice to ream each hole after the work is assembled, both to remove the material stressed by the punching operation and to align the holes, avoiding later troubles in inserting the hot rivets. Thousands of these holes are so located that it is found more convenient to drill them after the work is assembled than to lay them out for punching previous to assembling. The edges of all of the thousands of plates comprising the shell, bulkheads and tanks of the ship—all the water-tight joints—must be cut to a smooth edge and calked to make a water-tight joint. Under our present conditions, almost all of this work in all the thousands of ships planned and under construction will be done with pneumatic tools.

One of the new yards fitting up to employ 34,000 men is reported to have placed a single order for 6000 pneumatic machines, including riveting and chipping hammers, drilling machines, etc. Several great yards, employing thousands of men on ship repair work, also make extensive use of these tools. For instance, one of the eastern yards employing 1500 men has an equipment of 200 air machines of various kinds, about 50 per cent of which are in more or less constant use. About all the men skilled in the use of these machines which the country can supply are employed, and many who in less busy times would rank as helpers are now drawing pay as skilled men. The additional thousands required to man the new yards and the proposed extensions to the old ones must be made out of raw material. Just how raw this material may be can be realized only by one who has had some experience in the "making" process. It is much easier, however, to teach a man to do this kind of work with a machine than to teach him to do it by the old hand methods.

The numerous riveted joints necessary in ship-work add hundreds of tons to the weight of the ship, due to the overlapping plates, liners, fillers, butt-straps, etc. The way in which the riveting process impresses the uninformed observer was voiced by a fair Vassar graduate who visited the shipyard. After seeing the rivet driving, she was asked what she thought of it: "It seems so foolish," she said, "to make all those little holes and then fill them up again."

Considerable attention has been given to possible ways and means of avoiding this extra labor, but not much progress has been made. The plates have been made larger, thus reducing the number of joints. A system of "jogging" or offsetting the ends of the plates so that a joint may be made without filling pieces is quite extensively used, but no general substitute for rivets on ship-work is yet in sight.

Spot-welding and continuous welding of joints has been developed to a degree where it is practical for light work, and even under some conditions for heavy work, but up to date it has not been considered practical to apply any of these welding processes to the extensive joining of heavy plates.

Riveting Requirements and General Methods of Driving Rivets

The requirements necessary to produce good tight rivets are as follows: The holes must be practically in line; the plates must be well bolted together; the rivet heads must be up against the plate; the rivet necks must fill the hole; the rivets must be hot enough to expand and fill the hole the entire length when driven; the holding-on device must hold the rivet firmly in place; the riveting machine must have sufficient power to form the rivet before it gets too cold to fill the hole. A rivet which is loose in the hole may be calked up so that it will pass the inspectors' testing hammer, but such a rivet will not hold its estimated load under a breaking strain, and any large percentage of such rivets would lower the efficiency of the joint to the danger point.

Referring especially to ship-work, there are two different ways of driving rivets: one is the one-man machine method, and the other is the two-man "hand-gang" method using hand-hammers. Driving rivets by hand is a business that requires some natural aptitude and training, extending over considerable time and demanding much experience. A hand-gang is, therefore, likely to have had more experience and be more skilled in the business than the machine man. This is partly the reason why hand-driven rivets have in the past had a better reputation than machine-driven rivets. Given a husky machine man who knows the business, in combination with a good machine, proper air-pressure, a heater who will "get 'em hot," and a holder-on who will "get the

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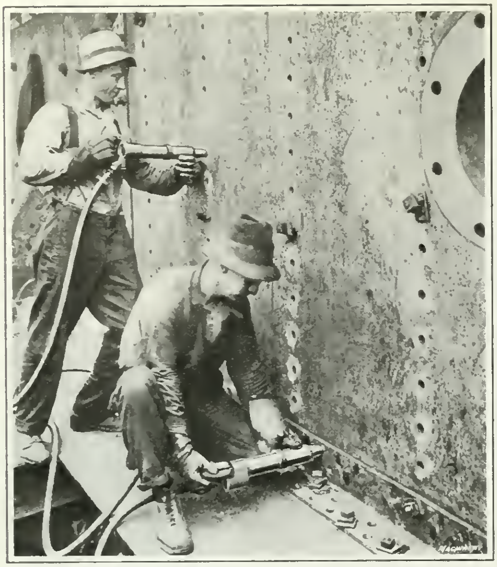

Fig. 1. Long-stroke Riveting Hammers made by Independent Pneumatic Tool Co. driving 7/8-inch "Flush" Rivets in Engine-room Bulkheads

heads up," and the machine man will do more work than the hand-gang and it will be equally good. There are many places where it is not convenient to pipe the air to the job, or to rig up for a few rivets. In these places hand work is more economical.

In our present emergency, hand work is out of the question, for the supply of skilled workers is very limited; therefore, broadly speaking, all of our new ships are likely to be machine riveted. The "long-stroke" air hammer is the type adapted to the general run of riveting. Driving rivets with one of these hammers is a strenuous occupation and calls for a strong man hardened by experience. The hammer weighs about 25 pounds and contains a solid steel plunger 1 1/16 inch by 2 1/2 inches, which makes 600 or 800 strokes per minute. The length of the stroke varies for different hammers, and may be 6, 8, 9 or 11 inches. The vibration added to the weight increases the difficulty of holding and controlling the machine. In driving cone-head or button-head rivets, the head of the rivet helps to hold the machine in place while the rivet is being headed. In the "flush riveting" such as is required on the outside shell of a ship, the machine must be guided and controlled without this assistance from the rivet head, which is flattened until it is either flush with the surface of the plate or slightly convex.

Appliances of various kinds have been made to hold the machine in position and to relieve the operator of the weight and vibration. Generally speaking, they are not much used, as the men will not take the trouble to rig them up. Under present conditions, where many inexperienced men must be taught to drive shell rivets (the rivets in the outer shell which require a flush head), it is probable that interest in these devices will be revived and improvements made.

Wherever cone-head or button-head rivets are to be driven and a convenient backing is available, the so-called "jam-hammers" may be used to advantage. These consist of a riveting hammer telescoping in an air cylinder in such a way that the hammer is thrust out against the rivet, the backing taking all the weight and vibration. Many records for fast work have been established with these machines. The work is likely to be uniformly good, as they strike a harder blow than the pneumatic hammers which are held by hand. These machines may be opposed by the regular holding-on machines, or one jam-hammer may be used to work against another. If this is done, an extra heavy die should be used in the holding-on machine. The foreman should keep in mind that wherever the weight and vibration of the machine can be taken by some mechanical device, the operator is relieved of the hardest part of the work, and, other things being equal, more work should be done.

Under the system being adopted for the construction of our new ships, certain assembled units are being fabricated in inland shops and assembled in the shipyards. This makes it possible for some of the riveting to be done by the shop machines, the use of which has heretofore been confined principally to boiler and structural work.

Pressure Riveting Machines

Where a sufficiently strong backing may be obtained behind the rivet, the best possible kind of work may be secured by steady pressure. Generally speaking, there are two kinds of machines used for this purpose; one comprises a yoke and a single cylinder and piston operated by direct hydraulic pressure, and the other is a pneumatic machine, consisting of a yoke and a cylinder containing a piston operated by air pressure. The pressure necessary for riveting is obtained by a system of toggles or levers.

To form a good rivet of the ordinary sizes (3/4 to 1 inch), about 60 tons pressure is required, but the full pressure of the machine, which may amount to 100 tons or more, is usually applied to all the larger sizes indiscriminately. The yoke which carries the holding-on die must be sufficiently strong to withstand this pressure. If the depth of the yoke is sufficient to take in wide plates, the weight becomes so great that the machine is made stationary and the work is carried to the machine. Up to a 20-inch or 30-inch gap, it is within limits to carry the machine to the work.

Very fast and satisfactory work can be done with these machines, but their use is limited to such work as can be spanned by the yoke, or such work as can be economically lifted and moved to position by the crane. A light yoke riveter of comparatively deep gap may be equipped with a heavy "jam-hammer" on one end and a holding die on the other, and drive the rivet by a great number of rapid blows rather than a single application of heavy pressure. This type has the advantage of lightness as compared with the pressure riveters, but is not quite as rapid and does not insure that the work will be pressed solidly together as does the pressure system. The ultimate strength of a joint riveted by heavy pressure is no greater than that of one riveted by hand or by an air hammer, but the pressure-riveted joint will stand a much greater strain before visible "slip" or yield occurs. Some of the pressure riveters are also arranged to be used for punching holes in plates. The rivet-forming dies are simply replaced with a punch and die.

For doing speedy work with these machines, it must be remembered that the time actually required to drive the rivets is small, and that the delays occur in getting the rivets in the holes or shifting the machine; therefore, care should be taken to have every convenience provided to facilitate these operations.

Importance of Care in Laying Out Rivet Holes

Each shop has its own system of laying out the holes. While the general method is about the same, some concerns have adopted and developed refinements not used by the others. As a result, the work turned out by some shops can be erected with the minimum amount of trouble, while others have a good deal of unnecessary reaming and pinning to do to bring the holes of adjacent parts into alignment. A little careless work in laying out or punching the holes or in making the templets is paid for ten times over in erecting. Under the system of ship construction now being adopted, of fabricating small units in various widely scattered shops, endless trouble would be experienced by the erecting yards if the greatest care were not observed in laying out the holes.

Suitable Rivets

It should be the duty of the foreman to see that rivets of the right length for the plates, laps, and frames are available and convenient for the heaters, so that no time will be lost in hunting them after the work is started. "Swell-necked" rivets are sometimes used where trouble is experienced in filling the holes on the head side. When these are used, care must be taken to get the heads up against the plate before riveting. Usually they are driven home with a heavy hammer before "holding-on."

Heating Rivets

Various methods of heating the rivets are employed, depending on the conditions. The foreman should make it a point to be certain that the rivets are being heated as fast as they can be used; if they are not, he should revise his method of heating. The common hand-forge serves the purpose where the speed of the work is limited for some reason, or if there are frequent delays. A "fire-pot" using hard coal or coke and furnished with an air blast from the compressed air hose is quite a satisfactory device for heating rivets rapidly, but the rivets may be burned if there are frequent delays and care is not used in regulating the fire. The gas or oil furnace is adapted to conditions where a great many rivets are used. The heating furnace should be set up where it will be convenient to the job. If ventilation or other conditions make this impossible, convenient arrangements to pass the rivets should be provided. Oftentimes a length of 2-inch pipe makes a good tube through which the rivets may be dropped by the heater and guided to the holder-on, lower down in the ship. A foreman who is interested in the work will see that such conveniences are supplied.

Bolting Up Plates before Riveting

The work should not be turned over to the riveters until it has passed a careful inspection to insure that it is properly bolted up. The plates must be in absolute contact; otherwise the rivets will not be tight. The bolts should be so arranged that the riveter can remove them with the minimum amount of trouble and delay. The time of a bolting-up gang is worth less per hour than that of a riveting gang, and it is, therefore, economy to have them do as large a share of this work as possible. If the bolts are too long, or put in without washers, the riveter is delayed while he unscrews the nut a dozen unnecessary turns.

If the yard economizes by using old bolts with bad threads, the riveter may have to use a wrench to unscrew the nut the entire length of the bolt. Where the thread is right, the nut, once loosened, can easily be taken off with the fingers. Sometimes, in drawing up the work, the plates shift and bind the bolts in the holes. In such cases, the bolting-up gang should remove the bolt and shift it to an adjacent hole, either reaming or pinning the bad hole until a rivet will enter. Otherwise the job will have to be done by the riveter.

Where soft packing is used between plates, the greatest care must be taken to have the work tightly bolted together. Extra bolts should be used and they should all be gone over several times, drawing down one after another until all the yield is taken out of the packing. Otherwise the heat and drawing effect of the rivets will loosen the whole joint. The bolting-up gang should make free use of the heavy sledge hammer and test the joints with a thin blade to make sure there is no open space between the plates. When the bolting-up is properly done, the riveter should be able to take out the bolts without delay and get the rivets through the holes without trouble. Also the driving of one rivet should not loosen any of the rivets previously driven. All liners and fillers should be in place before the riveting is started. Going back to drive a half dozen rivets in a liner which was not ready means an extra shipping of both the riveting and holding-on equipment, and will probably cost as much as 100 rivets driven in the ordinary way.

Advantages of Reaming Holes before Riveting

When holes are punched in heavy steel plates, the metal surrounding the hole is stressed and cracked until its condition somewhat resembles a bullet hole in a pane of glass. Under heavy strain, these minute cracks will widen and the plate will break. The loss of strength from using punched holes without reaming is estimated at 26 per cent for 1/2-inch plate and 33 per cent for 3/4-inch plate. The full strength of the plate is restored if the hole is reamed to remove the stressed material. About 1/8 inch on the diameter is allowed for reaming 7/8-inch holes. While the increase in strength due to reaming is generally known, in many places—especially on repair work—it is not given consideration and the holes are punched to full clearance size.

In all plate work there is bound to be a certain percentage of holes which will show faulty alignment. If the holes are very bad, they should be reamed to the next size larger and a larger rivet used, as otherwise the conditions shown at *A* in Fig. 5 will obtain. If care is taken to use extra long rivets and to have them well heated the entire length, such holes can be filled up, but often empty pockets are left, as indicated by the illustration, and the joint loses in strength.

The reaming of holes is such an extensive operation, and at best requires so much time and expense, that it deserves especial consideration. In shipyard work, a large percentage of this reaming is done after the work is assembled, and, therefore, it is usually most convenient to do it by means of the pneumatic machines.

Machines for Reaming Rivet Holes and their Use

The machines used for reaming rivet holes are made in a wide range of sizes from the small high-speed machines weighing about 8 pounds to the large slow-geared machines weighing up to 100 pounds. The machines used for the average all-around drilling and reaming weigh about 30 pounds, and develop about 3/4 horsepower under ordinary working conditions. They are used for drilling, reaming, flue rolling and cutting, and for driving various small portable machines, such as port-light cutters, boring-bars, etc. Fig. 2 illustrates how rivet holes are reamed, the machine being handled by two men.

The electric machines compete with them to some extent, but the great advantage of the air machine lies in its light weight as compared with the power developed. For the light work—say drilling up to half-inch holes—the extra weight of the electric machine is not of much consequence, but even for this class of work an air machine may be selected as heavy as can be handled conveniently, and its surplus power used to give a higher drilling speed.

The mechanic trained in the tool-room of a high-class plant, who has learned that a reamer is an article to be treated with respect, that its edge must be guarded carefully against injury and its lubrication given constant attention, requires some little time to readjust his views to the accepted practice of the ship-workers reaming rough holes with an air machine. He is right in believing that they abuse the machine; they also abuse the reamer, they fail to lubricate it properly, and they seldom have the reamer properly sharpened. These facts

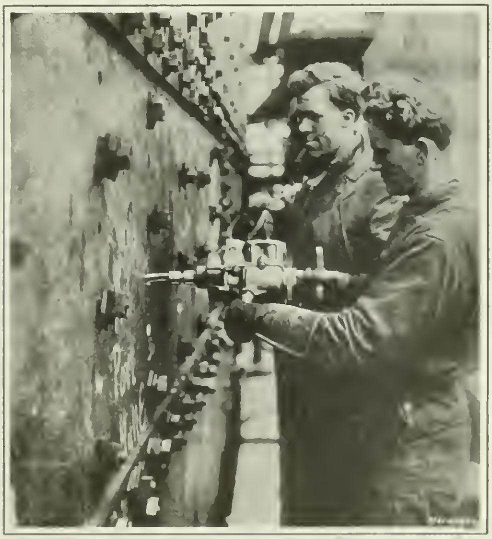

Fig. 2. Reaming Holes in Shell Plates of Ship, using Machine made by Ingersoll-Rand Co.

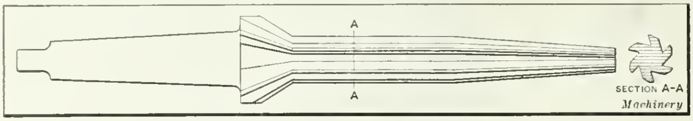

Fig. 3. Combined Reamer and Countersink used to insure that Conical and Straight Sections of Rivet Hole are Concentric

he notes at once, but after a time he also learns that it is not possible to get a full crew of men who will take care of the tools; that the extra work obtained from the rough-and-ready method of jabbing the tool in the hole as fast as possible, and proceeding to the next more than pays for the tools destroyed; that dwelling too much on the injurious effects of scanty lubrication and burned reamers makes the men overcareful and slows down the work; that if the tool is kept hard at work, it will, in the course of a day, earn enough money to buy several new reamers. The skill of the tool-room man should be employed to put the reamer in the best possible cutting condition. If this is done, it will cut itself clear and not be nearly so liable to injury, besides doing more work. The efficiency of the operator may vary several hundred per cent under different management. It is a common sight in a shipyard to see two men struggling with a machine, reaming, say, 7/8-inch holes. They are certainly working hard, and, on the face of it, there seems nothing to criticize. A closer observation may show that the machine lacks power to turn the reamer in the hole; that the reamer often sticks in the hole and pulls out of the machine; that the reamer is dull and worn out or badly sharpened, or blunt on the point; and that, while the men are working hard, they are not accomplishing results comparable with their efforts.

One of the New England yards maintaining this "economical" type of equipment decided to reform. Each gang was given two new reamers and a pot of tallow for lubricating the reamer, and only machines which passed a standard power test were sent out. The men were given an incentive to do as much work as possible. They had been doing an average of twelve holes per hour counting delays. The average output immediately jumped to fifty holes per hour and there were no delays. In this case a little intelligent supervision plus a small increase in cost of equipment increased the output 40 per cent on the same "overhead."

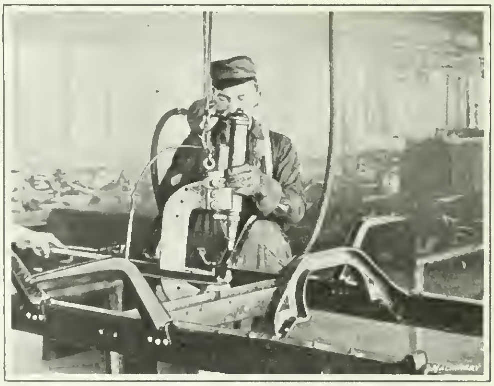

Fig. 4. Riveting Automobile Frame with Yoke Riveter made by Chicago Pneumatic Tool Co.

The following combination of troubles is very commonly met with. A department superintendent saves money by skimping on drills, reamers, or countersinks. A cheap or overworked repair man has neither time, equipment nor ability to maintain the machines to full power and efficiency. An overtaxed air compressor is unable to deliver full pressure to the mains. Undersized mains are unable to convey a full supply to distant parts of the yard, and perhaps, as a final touch, a machine which requires a full 1/2-inch pipe is taking air through a 1/4-inch nipple, or 3/8-inch hose "leader." Ice in the hose may further reduce the power or cut it off completely. In a plant of any size, these conditions can only be prevented by having one man give his entire time to supervising the general conditions of the air plant and equipment and operation, and be responsible for them directly to the main office, independent of foremen and superintendents. Experience has shown that yard foremen and even officials higher up are blind to these conditions and are slow to move in the direction of reform. Also, each department is likely to advance its own ends at the expense of other departments where this can be done.

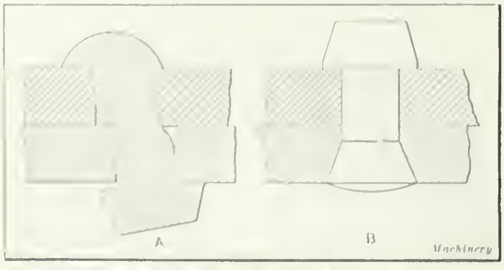

Fig. 5. (A) Rivet driven into Offset Rivet Hole. (B) "Flush" Rivet having Crowned or Slightly Rounded Head to avoid chipping off Excess Material

Countersinking Rivet Holes

When countersinking rivet holes for flush work, etc., care should be taken to insure that the countersink is concentric with the hole. Some yards use a combined reamer and countersink of the form shown in Fig. 3, which insures a concentric countersink under all conditions. It is very common to see the holes countersunk all on one side, especially where the holes are crooked or near an angle. Of course, a rivet cannot be expected to show 100 per cent holding power under these conditions. Where conditions demand that the rivets must be finished absolutely flat with the plate, as in deck work, the only way of insuring this is to use rivets a trifle too long, and chip off the surplus material while hot. Oftentimes where "flush" rivets are specified, it is not important that they be finished absolutely flat, and the work of chipping may be avoided by using a die having a very flat cup and finishing the heads with a slight crown, as shown at *B* in Fig. 5. This does away with chipping and at the same time insures a full head.

The equipment for countersinking must include sharp countersinks; otherwise much time will be lost in forcing them to cut. It is important that the shanks of both reamers and countersinks should fit well in the socket, as there is no constant pressure to hold them in place, as in drilling. If they keep pulling out, the workman will probably "rough" the shank with a chisel and drive it in. If he avoids splitting the socket driving it in, he is likely to do some damage in getting it out.

Under present conditions, where the work is standardized and units are fabricated in the shops, it should be possible to do a considerable portion of the reaming by the shop machines operated by one man. Under the best conditions, there will remain millions of holes to be reamed in the yard.

Hammer Signals of Riveting Gang

The riveter generally arranges a code of signals with his holder-on whereby he may communicate his next move through the side of the ship or bulkhead which usually separates them. For instance, continued blows of the hammer means "Hurry up—come on with the rivets." Two short blows means "Go back and hold on the last rivet driven to finish up the head." Three short blows means "Take out the rivet"; if followed by continuous blows, the signal means "Come on with the rivets and get them hot." The most common reason for taking out a rivet without driving it is because it is not hot enough. A riveter and holder-on who are accustomed to working together soon learn each other habits or methods and are able to cooperate without frequent delays for conference.

Because of the noise and difficulty of talking through the side of the ship, these hammer signals should be sufficiently well understood to enable the riveter to signal all his more common wants. Such items as "rivets too long," "too short," "not hot enough," "get on the last rivet," "wait awhile," "come on with the rivets," "in the wrong hole," etc., should be well understood. Because of this understanding that is established between the members of the riveting gang, it is customary for a foreman to keep the gang intact, and always assign the same men to work together where possible.

Driving Rivets

The importance of having the machine used for rivet driving in first-class order is not usually given the consideration which it deserves. When, for instance, a riveting hammer gets out of order, it means that one man makes a trip to the tool-shop with the machine while the other two or three men comprising the gang are glad of the excuse to await his return, doing nothing in the meantime. When he returns, very likely the gang is scattered and the fire low, often making a total delay of an hour or more for the three or four men. Then if the machine sticks or "kicks" or lacks power, the riveter may put up with it rather than risk a "call-down" for further delay, and, as a result, work is done which will later require to be calked or cut out.

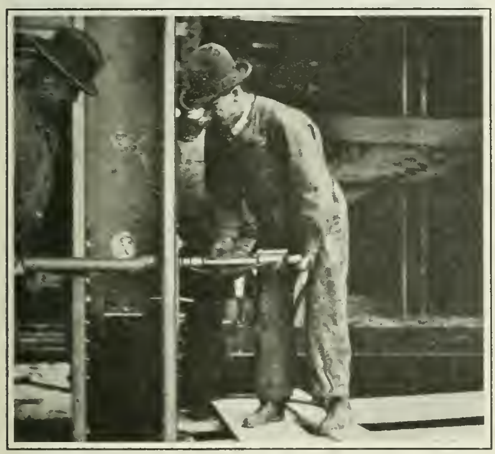

Fig. 6. Holding-on with Offset Dolly-bar

In the actual driving of rivets, the result depends largely upon the skill of the man operating the machine. If all the preliminaries referred to have been properly taken care of, almost any man of reasonable intelligence can quickly learn to drive rivets. More than average strength and endurance are required, however, but not more than may be found in thousands of men adapted to this work.

In driving cone-head or button-head rivets, they should be "plugged" squarely into the hole, care being taken not to bend over the point of the rivet, but to upset it, filling the hole its entire length. The machine should be strong enough to form a perfect head without rocking to work down the edges. The machine should be started off lightly until the rivet has settled into the hole somewhat, to prevent bending to one side. In driving any kind of rivets held or backed up by a dolly-bar or hand-hammer, the riveter must learn to run his machine slowly until enough head is formed to hold the rivet in the hole, as otherwise the holder-on will have difficulty in keeping the hammer or dolly-bar on the rivet.

The necessary equipment for driving flush rivets includes a pneumatic clipping hammer and several "hot-flat" chisels for chipping off the surplus material. The extra difficulty of driving flush rivets lies in the necessity of getting the rivet headed to a point where the surplus metal may be chipped off while it is still hot and soft, and the difficulty of holding and guiding a flat die on a flat surface. The rivet must be plugged in the hole and the surplus metal worked over to one side and chipped off as quickly as possible. The rivet may then be finished down to a flat surface or, on shell work, left slightly rounding.

In driving flush rivets, it is customary to go back to the last one driven and give it an extra finishing after it has cooled somewhat. A blow must never be struck on a rivet point until the holder-on has his hammer or dolly-bar firmly on the head, because the rivet is likely to be loosened. When there is a large amount of deck work to be riveted, it pays to rig up a "deck machine," which is a riveter carried by some kind of support. A common rig is a kind of wheelbarrow which holds the riveting machine in a vertical position and has two handles whereby it may be wheeled about and guided on the rivet. Sometimes it pays to provide an extra man to chip the rivet when using this type of machine.

Holding-on

Getting the rivets into the holes hot and "getting the heads up" is a necessary preliminary to obtaining tight work, and it is up to the holder-on to see that this is done. The device used to hold the rivet in position while it is being driven should be adapted to the work. In any case, mere pressure will not suffice. There must be sufficient weight behind the rivet to form a solid anvil against which it may be headed. For general use in connection with air hammers, the pneumatic "holder-on" is best adapted. These are made by several companies, but are all of practically similar construction. A solid piston of steel of about 3 inches in diameter works in a cylinder and is forced out by air pressure. One end carries a die adapted to fit the head of the rivet. The other end of the machine is extended by screwing in a piece of pipe of convenient length to reach some solid backing.

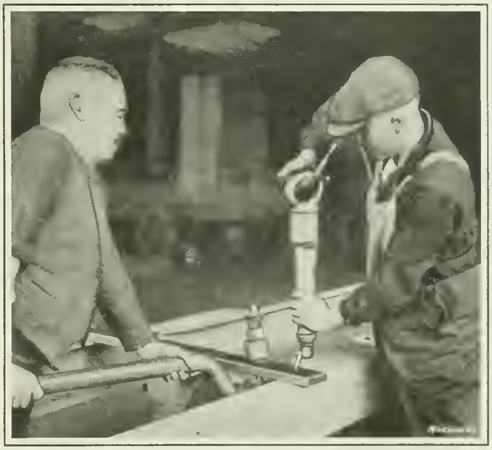

Fig. 7. Dolly-bar used as Lever for holding-on

A foreman or tool-man may save considerable time by arranging convenient backing for these machines. Often a long plank is rigged up with bolts at each end extending through rivet holes in the ship, or hooks may be attached to the machine to hook over channels or I-beams. When working under decks from a staging, the extension of the machine usually rests on the staging. As the thrust of the air cylinder may easily amount to 500 or 600 pounds, care must be taken to have the staging strong enough to withstand this extra strain. The pneumatic "holder-on" is usually tapped out to receive ¾-inch pipe for the extension. Up to a length of about 3 feet, ¾-inch pipe is sufficiently strong for the purpose, but when, as sometimes happens, it is necessary to have this extension tall 5 or 6 feet long, larger pipe should be used to avoid dangerous accidents. It is a good plan to use a short piece of solid iron rod threaded into a 1¼- by ¾-inch malleable iron pipe coupling and use 1¼-inch pipe for the longer extensions. If the connection is a ¾-inch pipe-nipple, it is likely to break.

The piston of the holding machine should be in good order and work freely in the cylinder, so that it will fall back of its own weight. The valve should be tight, as otherwise the plunger will push out and bother the holder-on while he is trying to adjust the rivet. If the holes are reasonably good, these machines will hold the rivet heads up against the plate satisfactorily, but when the hole is tight or crooked, the head should be driven up with a heavy hammer before applying the "holder-on" to it. A husky man can hold-on rivets for the air hammers with a dolly-bar or hand holding-on hammer and do good work, but it is much harder than using the pneumatic holding machine. (See Figs. 6 to 9, inclusive). Where there are only a few holes in a compartment, or convenient backing is not available, it does not pay to run an air hose and rig up a pneumatic holding machine.

Under normal conditions, these machines will save much time and labor, and they require less skill and experience than the hand method. When the rivets are to be driven by hand, the hand-holding hammer or dolly-bar is the most satisfactory, as it rebounds under the impact of the heavy blow of the hand-hammer and "gets the head up." The pneumatic holding machine is likely to yield somewhat to the heavy blow and fail to come back strong enough to get the head up in every instance when used in connection with hand work. Crooked-neck dies may be used in the holding machines to extend around angles, but they must be rigid, because any elasticity in the neck will result in a yielding action and the rivet will not be held solidly enough to insure good work.

Where the rivets fit easily in the holes, and the holes are clean-cut and sound on the head side, perfectly good work is obtained by the use of the simple pneumatic holding-on machine. Under conditions which sometimes obtain in repair work, especially where old rivets have been cut out and the holes reamed again, many of the holes will be bad on the head side, and the rivet head cannot be put against the plate or held there by pressure alone. Under these conditions, the holding-on machines will not do satisfactory work if used alone. The rivets may be driven up with a heavy hammer before putting the machine on, or one of the hammer-holding machines may be used. These machines consist of a plain holding-on machine having the thrust cylinder, and also a light pneumatic riveting hammer inside of the cylinder which may be operated to drive up the head of the rivet and then be shut off without releasing the thrust.

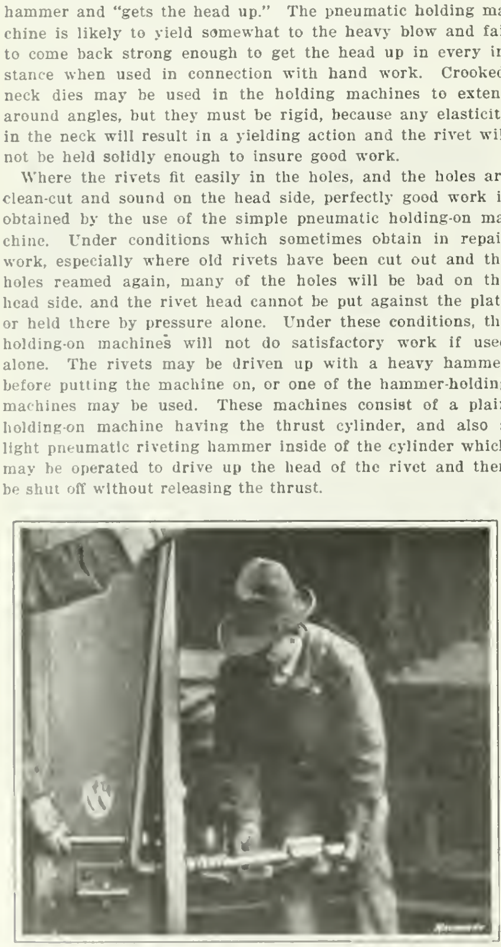

Fig. 8. Dolly-bar having Extension to serve as Fulcrum

When the rivet heads need hammering, some yards permit the use of a regular pneumatic riveting hammer as a dolly-bar to hold-on the rivet. The air is turned on long enough to drive the head up, after which the machine is used dead and acts the same as any solid dolly-bar. In theory, this is not good for the hammer, although in practice it is not often that any damage results, except the damage to the dies caused by the extra heating.

Fig. 10 illustrates the use of the self-supporting pneumatic hammer (made by the Independent Pneumatic Tool Co.) for holding on while driving 7/8-inch rivets with a riveting hammer. These self-supporting hammers are usually used in pairs. When applied in this way, the cut-off valve admitting air to the cylinder of the "holder-on" end is opened on both machines. The throttle valves of the riveting hammer ends are then opened and both machines are started at the same time. They also should be stopped simultaneously after completing the riveting operation.

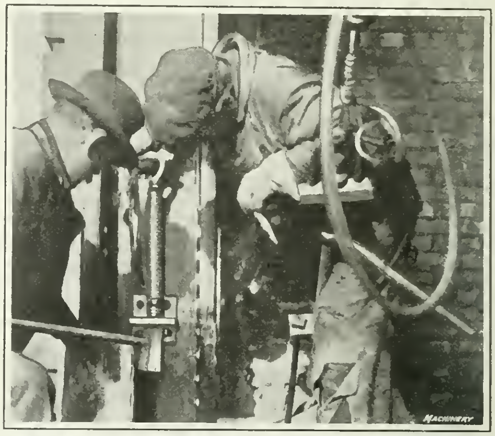

Fig. 9. One Method of using Hand Holding-on Hammer

Cutting Out Defective Rivets

Oftentimes it is necessary to cut out one or more bad rivets. Formerly it was the custom to do this work with a pneumatic chipping hammer. A slot was cut through the head, making it like a slotted screw-head, after which the backing-out punch and sledge hammer would do the rest. It is a convenience to have backing-out punches made to fit the pneumatic riveting hammer, which enables the riveter to back out the rivets without the assistance of a helper to swing the sledge. Many shipyards now burn off the heads of defective rivets with the oxy-acetylene flame. The burning torches are connected by long sections of hose, and it only requires about a half minute to burn off a rivet head. Either countersunk or button-head rivets can be melted or burned off clean without damaging the plate. The chipping process requires a much longer time. Sometimes when the burning equipment is at hand, the riveter will use it to reheat a bad rivet and will thus be enabled to finish it off without cutting it out. Or if a single rivet is too long, he will use the torch to burn the end off, thus making it the right length.

Where a lot of old work is to be cut out, a gang of burners is assembled to burn off the heads in wholesale fashion. Sometimes in oil-ship work this cannot be done on account of the fire risk. In such cases, flush rivets are usually drilled and punched out, and where possible the pneumatic "rivet busters" are used on the button-head rivets. If properly rigged up, these "busters" will knock off heads about four or five times faster than they can be burned, four or five 7/8-inch rivets to a minute not being uncommon.

Selection of Equipment

While a part of the shop work on our new ship parts will undoubtedly come within the range of the pressure riveters, the assembler's work in the yards will have to be riveted by the air hammers as usual. The selection, operation, maintenance, repair, and equipment of these air hammers is a subject which demands the careful consideration of all construction superintendents having this department in hand.

The hammer selected should be powerful in its action, operate with a minimum of vibration, be well balanced in its design, and convenient to hold and guide. The efficient operation of these riveting hammers or "machines" should be facilitated by insuring a good supply of air and convenient hose connections, means for keeping the line free from ice, and provision for oiling the machines as required. The tool-room should be supplied with spare parts and be able to supply promptly such accessories and conveniences as experience has shown will promote the work. As nearly all disorders to which these machines are subject operate either to reduce the power of the machine or to increase the vibration, the repair man should be competent to remedy such disorders with the minimum delay. Efficient and economical service demands that the riveting hammer shall deliver sufficient power to drive the rivet while it is still hot; that it shall not "kick" or vibrate to an extent which makes it difficult to hold or guide; and that it shall respond to the throttle promptly, giving light or heavy blows, as desired, under the full control of the operator.

For supplying air to the average riveting hammer, 50 feet of 3/4-inch hose, with 10 feet of 1/2-inch "leader" hose attached is the usual equipment. No connection should be smaller than a 1/2-inch pipe-nipple, if the full power of the hammer is required. When the air pressure is low, an increase in power may often be obtained by discarding the "leader" and connecting the 3/4-inch hose directly to the hammer. Of course, it is less convenient to manipulate a hammer connected to a large hose, but this inconvenience may be endured better than the lack of power.

The shop should furnish "clips" or springs which have not been bent out of shape. The "clip" should be capable of holding the riveting die or "set" in place when the hammer is quickly picked up by the handle. Otherwise the "economy" in 25-cent clips is likely to result in the loss of a $1.25 set and a $1.50 plunger.

Many riveters place leather cuffs around the neck of the set for convenience in holding the hot set when the work is coming fast, but this is generally regarded as an individual convenience, and is done by the riveter to suit himself. The shop may save time by contributing a piece of old belting, a belt lacing, and some tacks, or keeping these materials on hand for this purpose. The set or die should be adapted to the work, and be kept sharp and clean. The recent advance in the price of tool steel has resulted in the use of a cheap steel for dies, the surface being hardened by the pack-hardening process. When these dies become soft and a burr is formed on the edges, they may be annealed and reshaped with an old countersink, and rehardened by heating them nearly to the burning point and, after treating the ends with cyanide, plunging them into cold salt water; some of them will crack, but not a large percentage. If the dies are badly out of shape, they may be turned up in a lathe before hardening.

Recent improvements in riveting hammers has made the 6-inch size so strong and fast that it is quite generally used for the average run of work, only a few of the heavy machines being carried for special work. While this practice is not universal, it is becoming quite general. Considering the hammer itself, the 6-inch machine may weigh about 25 pounds. Practically all the hammers have a 1 1/16-inch bore. The size, whether 6-, 8-, 9-inch, etc., indicates the stroke of the plunger, which is a piece of hardened steel carefully ground to fit the cylinder. The plungers vary in length from 2 1/8 to 4 inches. The length of the plunger has an important effect on the operation of the machine.

For many years the manufacturers of riveting machines have consistently opposed the use of short plungers. In spite of the opposition, the workmen have persisted in reducing the standard length of plunger, and the idea was gradually forced on the manufacturers until they now realize that advantages are gained from the use of a plunger shorter than their original standard. Machines which were formerly equipped with 3-inch plungers are now operated with 2½-inch plungers. Machines with shorter plungers run faster, with less vibration, apparently do as much work and are easier to control. What is lost in weight of plunger is gained by length of travel. The companies opposed this practice largely because the workmen in cutting down the plungers left the ends rough or soft, so that they would either chip off pieces or expand and stick in the machine. The modern riveting machines are perfectly adapted to the use of the 2½-inch plunger and it has now become standard equipment.

Riveting Hammer Troubles and Repairs

The cylinder of a pneumatic hammer is open at one end to receive the shank of the die which forms the head of the rivet. The plunger in the cylinder makes from 600 to 800 strokes per minute, striking the shank of the die at one end and an air cushion at the other end. It is apparent that the admission and exhaust of air must be correct or there will be trouble. There are two principal causes of defective operation, lack of power and excessive vibration. The valve which controls admission of air to the cylinder is operated by the air pressure acting on its various shoulders, the admission of air being controlled by the plunger. When the plunger is at the limit of its stroke, it uncovers a drilled port which admits air to reverse the valve. If this port is plugged up or the valve leaks around the shoulder, or some of the air escapes through leaky joints, or the valve sticks, the plunger will not reverse quickly and the machine will either develop excessive vibration or lack power, or both; probably it will also run slowly. Owing to this intangible connection between the piston and the valve, these machines require especial study on the part of the repair man. The design and location of the valves in different styles of machines varies, but all depend on air pressure working through drilled ports to operate the valve.

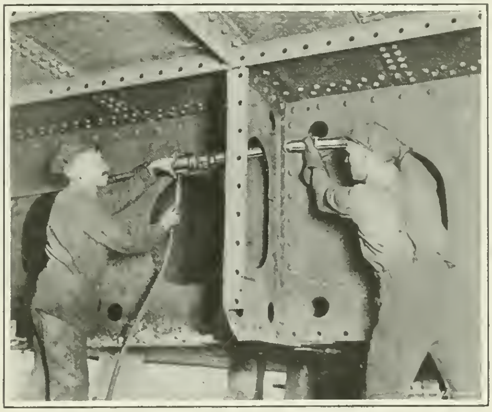

Fig. 10. Self-supporting Hammer holding-on while driving 7/8-inch Rivets

Only a small percentage of the repair men ever learn exactly why or how these machines operate, but if they will remember that they worked properly when they left the factory and learn to keep them in their original condition, it is all that is necessary. Even this is not so simple as it sounds, but it may be accomplished by a little care and observation. When a repair man inherits machines which have been handled by some predecessor, he may safely assume that some damage has been done to the inside by careless handling. As the machines come in for cleaning or repairs, he should examine carefully the surfaces which are supposed to fit together with an air-tight joint, and remove any burrs with a very fine flat file, countersinking the dowel-pin holes slightly to provide clearance for the ring which usually surrounds the dowel-pin on the corresponding part.

The repair man should frequently try out on a heavy block of wood, arranged for this purpose, one of the riveting hammers which is known to have sufficient power and to run smoothly. With the operating characteristics of this machine as a standard, he will soon learn how fast a machine ought to run, how much vibration is to be expected under normal conditions, and how rapidly the die ought to cut into the wooden block when the machine is developing normal power. With these standards in mind, he can test doubtful machines and know by the comparison whether or not they are right. All of the hammers should be numbered and a record should be kept of each time they come in for repairs. For instance, if

No. 6 comes in a dozen times during the week for lack of power or excessive "kick," he will know that there is something radically wrong and go after it.

Often the men complain without cause, or the fault may be in low air pressure or plugged hose. The repair man should know his machines well enough to be able to state positively whether the machine is right or not. When the machine has plenty of power, but is slow or "kicks," or refuses to start off promptly, it generally means that either the plunger is sticking in the cylinder or that the valve is sticking at one end of its stroke. The plunger should fall freely the entire length of the cylinder by its own weight. If it fails to do this, examine it carefully and it will most likely be found to have particles of hard material sticking to the polished surface. These should be removed with an oil-stone or by other means which will not scratch the surface. Generally by forcing the hard plunger through the well-oiled cylinder several times, any rough spots in the cylinder will be smoothed down. If not, the cylinder may be made smooth by using crocus cloth on a wooden mandrel.

After the plunger is known to be running smoothly, the valve should be examined to see if it travels freely. Before taking the valve apart, move it with the fingers the entire length of its travel, being sure that it is making full-stroke. It should not have the slightest tendency to stick at the end of the stroke, and if it is of a type which has tension springs, it should not move so freely as to fall of its own weight in either direction. If the valve sticks, find the rough spot and carefully smooth it either with a half-round very fine file, crocus cloth or scraper, being careful not to cut away any of the metal except the edges of the scratch. Oftentimes washing it with kerosene is sufficient. If the hammer refuses to start promptly, but has no other trouble, it is likely that the valve is too tight. Its action should be compared with the standard previously referred to. When springs or other means are provided to adjust the tension of the valve, these springs should be examined carefully for sharp corners, or any projecting ends which may be responsible for the irregular action. If the valve starts too easily, it will open and close the ports and reverse the air admission before the piston has had time to follow its action. It is assumed that the repair man will always clean out all of the drilled parts and pin-holes, being careful not to overlook any of the smaller ones. If the valves or any removable parts of the machine are aligned or positioned by dowel-pins, care should be exercised to see that the dowel-pins are in the right holes before force is applied. Frequently the surfaces of such parts are badly defaced from careless work of this kind. A mysterious loss of power may sometimes be traced to the leakage occurring between such defaced surfaces. When such damage is sufficiently serious to affect the operation of the machine, refacing in a lathe is generally required before the defect can be overcome. If adjustable or renewable tension springs are provided to overcome the loose action resulting from wear to the valve, and if the repair-man does not unnecessarily cut away the important surfaces of the valve in connection with cleaning or smoothing operations, it will be a long time before the valve will require complete renewal. If the tension spring is kept at the proper tension, and all the joints are kept smooth and air-tight, as may easily be done, the hammer will give several years of hard service without requiring extensive renewals for wear.

When the hammer makes a loud purring noise, but refuses to start, it indicates that the valve is only traveling part stroke, not going far enough to admit air under the piston, or reversing before the piston has time to move. It may also indicate excessive leakage around the shank of the die. This condition can generally be overcome by making the valve tighter and making sure that all joints are tight. It often indicates a broken tension spring. In the type of valve which has no tension spring it may indicate that the valve is worn. In the hammers which have no springs or means of adjustment, the troubles may generally be traced to scratches, particles of sand, scale or rust, or excessive wear.

One of the indispensable requirements of the repair shop is a tank of kerosene or gasoline for washing out the hammers. The tank should be large enough to submerge several hammers at the same time. A galvanized iron box about 12 by 24 inches and 12 inches deep, with a cover, is about what is required. Many times, simply soaking in this tank for ten minutes will cure the trouble and prevent the necessity of taking the hammer apart. Gasoline is the most satisfactory for cleaning purposes, but its use is sometimes prohibited by the fire risk.

* * *

AIR-TIGHT CASTINGS

The greatest care must be exercised from the designing of a piece to the pouring of the metal, in order to obtain a solid, air-tight casting, and even then failures are likely to occur. Brass and bronze are the metals best adapted for use in the manufacture of air-tight castings. Strength may be produced by proper design, but the desirable quality of density is not easily obtained, due no doubt, to the many variable and uncertain elements which enter into the process of manufacture.

The design of the casting has an important bearing upon the ultimate success of the casting. The designer should guard against draws by having all cross-sections of approximately equal thickness, or by providing access to all large sections to allow the use of chills. When large cores are used, they will act as chills. The use of large fillets should be avoided, so that excessive masses of metal will not be concentrated at one point. The patternmaker must know what chills are to be used so that large chilled surfaces may be placed in a vertical position and thus prevent the metal from "kicking off" these surfaces. An exceptionally clean casting may be obtained by gating it to another casting in which all the dirt will be accumulated. A clean mold is absolutely essential in air-tight castings. It is necessary that the unimportant parts be placed high in the cope, so that the loose sand in the mold may flow to them. In general, chills should be used on all enlarged sections which are in close proximity to smaller ones and connected to them. Use a sinking-head placed at the heavy part of the castings of exceptionally large sections. Gate the castings at a light section, using a heavy upright pouring gate as near the pattern as possible. To safeguard against draws in the casting at the gate, the gate leading from the pouring gate to the pattern should be large at the pouring gate and reduced sharply into the pattern.

The following alloys have been tried and found satisfactory for making air-tight castings:

COMPOSITION OF METAL FOR AIR-TIGHT CASTINGS

Alloy No.	Copper, Per Cent	Tin, Per Cent	Zinc, Per Cent	Lead, Per Cent
1	72.50	1.75	19.25	6.50
2	82.00	7.50	4.75	5.75
3	83.00	11.50	4.00	1.50

Machinery

Alloy No. 1 is used for ordinary castings and is easily machined, while alloys Nos. 2 and 3 are used on high pressures and are proportionally harder to machine. The treatment of the metal in the furnace is of vital importance. Proper allowance for oxidation of zinc must be made, otherwise a satisfactory alloy will not be produced. If the metal is not taken from the furnace when it reaches the proper heat, but is allowed to soak in the furnace, it will assimilate gases and the castings may be porous. Many castings are no doubt spoiled, because of carelessness in pouring. If the temperature is too cold it is almost impossible to obtain solid castings; if poured too hot, the castings may be porous throughout. Aluminum is a dangerous metal in the brass foundry; therefore great care must be exercised that none may get into the mixture. A very small percentage of aluminum will cause the castings to leak, although they may appear to be solid. Antimony and iron have a similar effect in a smaller degree.

* * *

No employer in Great Britain can have in his employ an enemy alien except under license. Except for Belgian refugees, there are very few alien workmen in England.

PASS LIMITATION IN ROLLING MILL PRACTICE

BY ALFRED MUSSO [1]

The principal aim of the rolling process, undoubtedly, is to attain the greatest reduction of the cross-sectional area of the part being rolled that is consistent with the quality of the finished product. The reduction of the piece depends upon several elements, which can be grouped into two classes. To the first class belong all elements concerning the piece itself, and this includes all data referring to its size, the nature of the metal it is made of and also its condition while being rolled. To the second class belong all elements concerning the rolling mill, such as its dimensions and power. The scope of this article is to show some of the mechanical relations existing between the different elements mentioned and how they control the reduction of the piece.

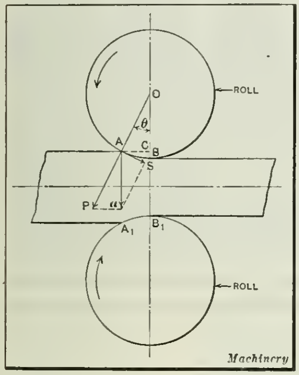

Diagram showing Relation between Rolls and Stock being rolled

Let us consider a vertical cross-section through the rolls of a rolling mill as represented in the accompanying illustration. The thickness of the piece while passing through the rolls is reduced from its original value AA_1 to the new value BB_1. We will call BB_1 the "pass." Evidently, $AA_1 = BB_1 + 2CB$, but $CB = OB - OC$, and $OC = AO \cos AOC$; then the first equation becomes:

$$AA_1 = BB_1 + 2(OB - AO \cos AOC)$$

Assume that:

$AO = OB = R$, radius of roll;
$AA_1 = T$, original thickness of piece;
$BB_1 = p$, pass; and
$\theta =$ angle AOC.

The last of the preceding equations may now be expressed as follows:

$$T = p + 2R(1 - \cos \theta) \qquad (1)$$

This is the fundamental equation of the mechanics of rolling mills. Now, by assuming the width of the piece to be unity, the values of T and p, for all practical purposes, will represent the sectional areas before the piece has entered and after it has left the rolls. This is in harmony with actual rolling mill practice. Equation (1) arranged in the form:

$$T - p = 2R(1 - \cos \theta)$$

shows that the reduction of the piece is a function of the angle θ. This angle, called the "approach of the piece to the rolls," or, more simply, the "approach," is the controlling element in the relations between the dimensions of the piece and those of the rolling mill.

An inspection of the illustration, as well as proper transformations of Equation (1), show that for a given value of T the value of p will decrease, while that of θ increases, and *vice versa;* also, if the value of p is given, the value of T will increase with that of θ. These facts may be embodied in the following statement: For a known size of rolls, the approach is directly proportional to the original thickness of the piece and inversely proportional to the pass. Considerations beyond the limits of this article show that the value of θ should not exceed 30 degrees, and in actual practice such a value is never reached. We will now establish the relations between the properties of the piece and its approach, which will enable us to find the proper value of the pass, consistent with the economy of the rolling mill output. Let us assume the following notations:

$a =$ normal pressure on piece;
$f_s =$ allowable unit shearing stress for piece;
$p =$ pass;
$P =$ radial pressure of roll;
$R =$ radius of roll;
$S =$ tangential shearing force;
$T =$ original thickness of piece;
$\theta =$ approach.

Evidently,

$$S = a \sin \theta$$

But

$$a = P \cos \theta$$

Then,

$$S = P \sin \theta \cos \theta = 1/2 P \sin 2\theta$$

The last equation shows that S is also a function of θ, and because P is constant, and depends upon the dimensions and power of the rolling mill, it is evident that the ratio of S and θ is also a constant. This enables us to regard the above equation as suitable for any value of θ. Introducing the properties of the piece, we must have $\frac{S}{T} \leqq f_s$; then, selecting the highest safe value, *viz.*, $\frac{S}{T} = f_s$, which is consistent with good practice, the last equation becomes:

$$S = f_s T = 1/2 P \sin 2\theta, \text{ and, consequently,}$$

$$\frac{2 f_s T}{P} = \sin 2\theta \qquad (2)$$

With the help of a table of sines, we will be able to find the value of 2θ, and, of course, of θ. The latter value substituted in Equation (1) will determine the value of p as follows:

$$p = T - 2R(1 - \cos \theta)$$

The value of p thus found is the minimum safe pass which can be set in the rolls, and indicates the maximum safe reduction of the piece. As a practical application of the preceding formulas, assume that a band of 0.20 per cent carbon steel, having a thickness of No. 16 Birmingham wire gage (B. W. G.), is put through a cold-rolling process in a 10-inch strip rolling mill, driven by a 70-horsepower motor at 50 revolutions per minute. The efficiency of the mill is 40 per cent. The problem is to determine the pass. From the data given, the radial pressure at the rolls is first determined.

$$P = \frac{0.40 \times 70 \times 12 \times 33{,}000}{10 \times 3.14 \times 50} = 7061 \text{ pounds}$$

The value of f_s for a 0.20 per cent carbon steel can be assumed at 6000 pounds per square inch. Then arrange the data as follows:

$f_s = 6000$ pounds per square inch;
$P = 7061$ pounds;
$R = 5$ inches;
$T = 0.065$ inch.

Substituting these values in Equation (2), we find:

$$\text{Sin } 2\theta = \frac{2 \times 6000 \times 0.065}{7061} = 0.11046$$

By referring to a table of sines, we find that $2\theta = 6$ degrees — 20 minutes; therefore, $\theta = 3$ degrees — 10 minutes, and $\cos \theta = 0.99847$. By substituting these values in Equation (1):

$$p = 0.065 - 10\ (1 - 0.99847) = 0.0497 \text{ inch,}$$
$$\text{or approximately } 0.050 \text{ inch}$$

This shows the maximum reduction consistent with safety to be $T - p = 0.015$ inch, or 23 per cent of the original thickness of the piece. This result is corroborated by actual results in everyday practice.

* * *

During 1917, the total cost in the state of New York of "workmen's compensation," including the expense of administration, was $35,000,000, or $117,000 a day. Seven out of every ten applicants for compensation could not speak English. In Pennsylvania last year, $7,161,094 was awarded in compensations, an increase of $2,936,219 over the year before. In Massachusetts, there was paid as compensation about $5,000,000, against $1,667,000 in 1913. Part of this increase is attributed to the increase of the maximum award from 50 to 66 2/3 per cent of the wage.

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Manufacture of the U.S. 75-Millimeter Shell

Second of a Series of Articles Describing Approved Methods Employed by the American Shell Co. in the Making of U. S. Ammunition — By Erik Oberg[1]

IN the article in the March number of MACHINERY, the general lay-out of the plant of the American Shell Co., Paterson, N. J., was described; the order of the operations embodied in the company's practice was given, together with illustrations showing the shell after each operation, and the methods used in machining the work were reviewed up to and including the nosing or bottling of the shell. In the present article, the heat-treatment and the operations that follow the hardening and tempering operation will be dealt with.

Heat-treatment

The heat-treatment consists of hardening and tempering the shells. Two hardening and two tempering furnaces are used. The hardening furnaces, shown in Fig. 1, are each provided with eleven tubes passing entirely through the furnace, these tubes consisting of 3½-inch pipe. The shells are fed into the tubes from one end, and in passing through the furnace are actuated by an automatic timing device which permits each shell to remain within the heating zone for sixty minutes. The inclined roller conveyors in the front carry the shells down to the opening of the furnace tubes. Above these are seen the hydraulic cylinders from which the mechanism for pushing the shells through the tubes is actuated, this mechanism, in turn, being controlled by a timing device which consists of the mechanism shown in Fig. 2. Pulley *A* makes 300 revolutions per minute, and planetary gearing is provided at *B*, the reduction of this being as 1 to 1000; hence, the slow-speed hollow shaft *C* makes 0.3 revolution per minute. A camshaft is driven from this slow-speed shaft by means of a silent chain from sprocket *D*. On the camshaft are eleven pairs of cams, which, in turn, operate eleven double-action pneumatic valves which control the hydraulic cylinders, the pistons of which push the shells through the furnace. A diagrammatical view of the mechanism for pushing the shells into the furnace tubes is shown in Fig. 3. The shell, resting on the rollers, is pushed forward by the pawl *A* acting against the edge of the shell, as indicated, whenever pressure is admitted back of the piston *B* through the action of the timing mechanism.

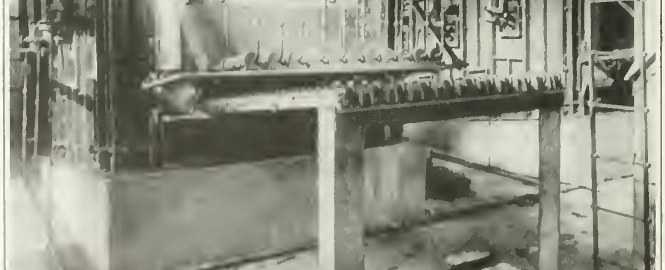

Fig. 1. Hardening Furnaces provided with Automatic Pusher Feed, regulating Time Shells are in Furnace

At the back end of the furnace (at the end of each pipe) is a door opening into a kind of an ante-chamber. The door opens only as the shells are pushed through the furnace, and closes after them. The shells then move forward by gravity and open a second door between the ante-chamber and the oil tank into which they drop. The ante-chamber makes it possible to retain the heat in the tubes and prevents the outside air from striking the shells. The furnaces are oil-fired, the temperature in the furnaces being 1600 degrees F., and that of the shells, about 1500 degrees F.

When the shells drop into the oil tank, they fall onto

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[1] Editor of MACHINERY

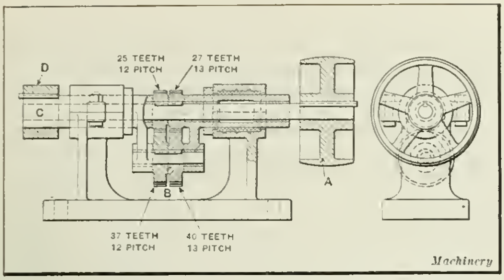

Fig. 2. Timing Mechanism which controls Pusher Feed for Shells

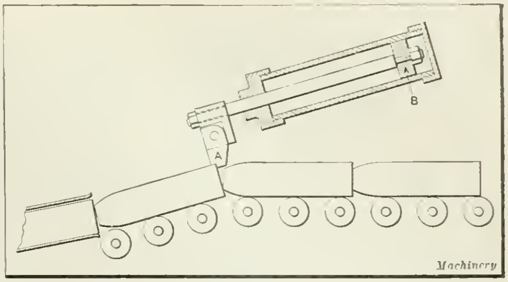

Fig. 3. Diagrammatical View of Hydraulic Pusher Feed

a link-belt conveyor, which moves them up an incline, where they drain, and then deposits them in a draining tank for further draining of the oil. The quenching oil is cooled off by passing through a series of coils in a water tank, shown in Fig. 4, located behind the nosing-in presses.

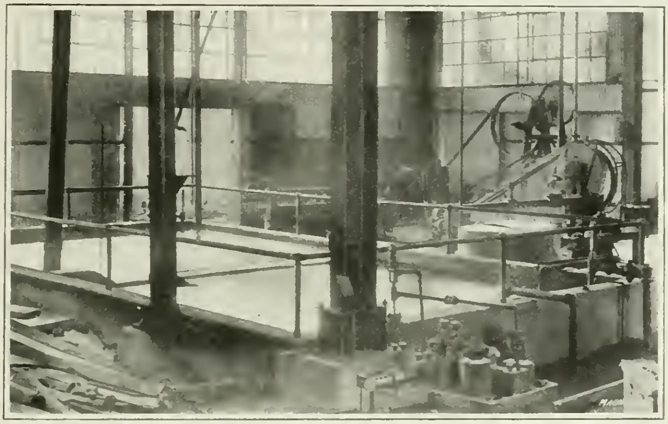

Fig. 4. Cooling Tank for Quenching Oil used in hardening Shells—Oil passes through Pipe Coils in Water Tank

From the draining tank, the shells are taken by a gravity conveyor to the tempering furnace, which is similar to the hardening furnace, the only difference being that, instead of passing through tubes, the shells in this furnace are conveyed in chutes, so that the flame from the oil burners heats the shells directly. The temperature in the tempering furnace varies from 1100 to 1300 degrees F., according to the quality of the steel. The higher the carbon content of the steel, the higher the tempering temperature. Each shell remains twenty-five minutes in this furnace. At the back of the tempering furnace, two automatic conveyors, running toward each other, discharge the shells onto a third conveyor, which carries them into the cooling space. The conveyors at the back of the tempering furnaces are so timed that two shells are never placed upon the third common conveyor at the same time. At the end of the conveyor in the cooling space, there is a swinging chute, which makes it possible to discharge separate heats in separate piles.

After the cooling, tests are made in order to determine whether the shells are of the proper physical characteristics and whether the proper heat-treatment has been given to the steel. Test pieces are prepared from two shells out of each lot of 1000, for making tensile tests. Scrap shells are passed along with the others for this purpose. Brinell tests are also made on 10 per cent of the shells. The details of these tests will be given in a subsequent article.

Machining Operations after Heat-treatment

The first machining operation after heat-treatment is to finish the base and under-cut the boss for the center. This under-cutting serves the purpose of making it possible to shear off the center in a later operation. The work is done on a Gisholt lathe, and a regular round-nosed tool is used both for the facing and under-cutting.

The hole for the fuse is now bored, recessed, faced, and beveled at the end. This work is done on a Potter & Johnston semi-automatic machine. Special tools are used only for the recessing operation, the tool used being shown in Fig. 5, where the recessing tool proper is shown at *A* mounted in a slide *B*. A stop or straight cam surface on the cross-slide acts against the roller *C*, thus moving the recessing tool in a transverse direction against the pressure of spring *D*. The tool then cuts a recess in the bore at the under side of the thread, which serves the purpose of clearing the milling cutter when the thread is cut. Screw *E* acts as a stop.

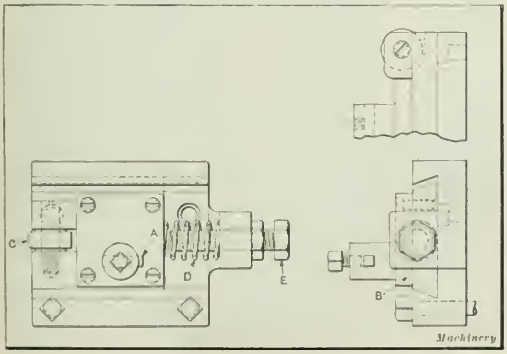

Fig. 5. Recessing Tool that is used for cutting Clearance for Thread Milling Cutter

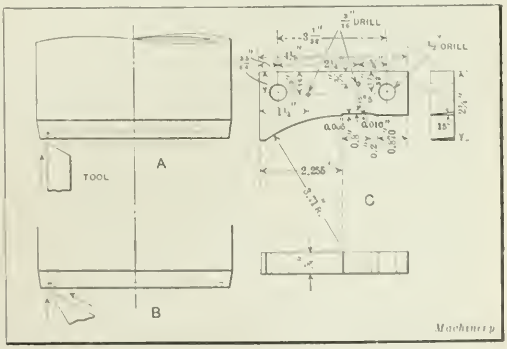

Fig. 6. Method of cutting Groove for Brass Plate, and Detail of Forming Tool used for finishing Nose

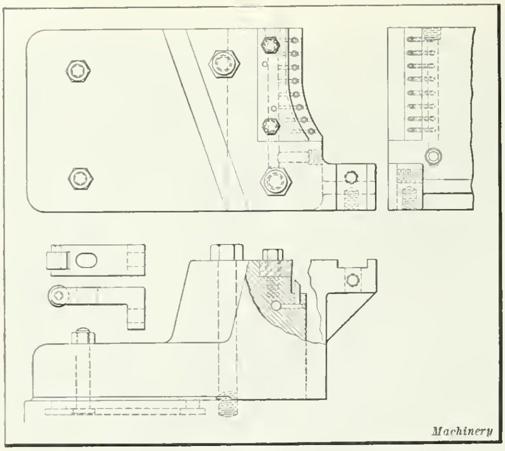

Fig. 7. Holder for Forming Tool which finishes Shell Nose

The rough-grooving for the copper band is done in a Wood turret lathe, a plain straight tool with a flat end being used. The groove is finished in the same type of machine, but a circular forming tool is used in this case, which produces the thread in the bottom of the groove. By presenting a knurl with straight teeth to the bottom of the groove which contains this thread, a very coarse, prominent knurling is provided to bind the copper band. The knurling is done in the same type of machine as is used for the cutting of the groove. The knurl, shown in Fig. 8, is made from high-speed steel on account of the heat developed in the knurling operation, it having been found that carbon steel will not meet the requirements. The knurls are cut in the shop on a Bilton automatic gear-cutter.

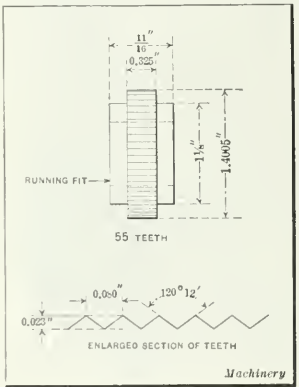

Fig. 8. Knurl used for knurling Copper Band Groove

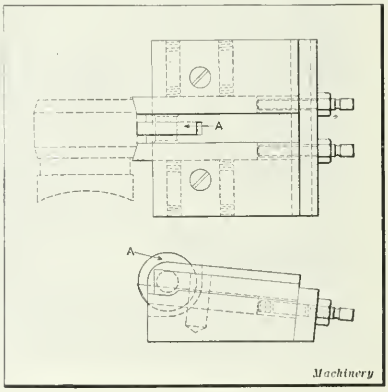

Fig. 9. Tools and Holder used for beveling Shell Body below Copper Band

The rough-turning of the nose is performed in a Gisholt machine with a regular four-tool forming head. The finish-turning of the nose is done on the same type of machine, but, in this case, a finishing profiling tool, 4 inches wide, held in a holder, as shown in Fig. 7, is employed, this tool giving the nose the correct shape. Eight oil-tubes located at the edge of the forming tool, as indicated, supply lubricant to the tool. The forming tool is shown in detail at *C* in Fig. 6. The body is now finish-turned above and below the groove for the copper band, an expanding mandrel holding the work by that part of the bore which is later to be threaded. The machine used is provided with a special air-operated centering cup, which is used for holding the work at one end, while a regular center is used on the other end.

A slight bevel is next cut at each end of that part of the body which comes below the copper band. The bevel next to the base is provided in order that the shell may be inserted easily into the cartridge case, while the bevel next to the copper band is for the purpose of crimping the case onto the shell. This operation is performed in engine lathes provided with special tool blocks of the type shown in Fig. 9. A roller at *A* acts as a stop by coming in contact with the body of the shell. The work is held by a cup-center at one end and by an air-operated tail-center at the other

The grinding of the bourrelet is done in the grinding machines shown in Fig. 10, especially built for the purpose. The shells are fed transversely toward the wheel only, the wheels being wide enough to grind the whole surface at once. The amount of feed to obtain the correct diameter is shown by a graduated indicator on the machine, which is set each time the wheel is trued. The wheels are trued frequently in order to make sure that the wear of the wheel will not affect the accuracy of the grinding. The shells are held for this operation by a cup-center at one end and an air-operated tail-center at the other.

All of the operations that need to be performed on centers are now completed, so the center at the base is removed by shearing. A power press is used for this purpose, provided with two shear blades, very similar in operation to a sprue cutter. These blades are made from carbon steel, as high-speed steel has no advantage for this purpose; in fact, high-speed steel will not give as good service as carbon steel for this work, as not enough heat is produced in the operation to develop the qualities that make high-speed steel superior to carbon steel. After having sheared off the center, the base is faced in a Gisholt machine by an ordinary high-speed steel facing tool.

The groove in the base for the brass cover is now cut. The base cover is inserted to prevent a possible premature explosion due to ignition of the charge in the shell from the charge in the cartridge case, through a "pipe" in the center of the base of the shell. This groove is cut in two operations, two Oliver lathes being used. In the first lathe, a tool as indicated at *A*, Fig. 6, cuts a plain groove; in the second lathe, a tool as indicated at *B* is used, which is set at an angle. This tool is also fed at an angle, and thus produces the under-cut which is required to bind the brass cap securely in place.

The thread for the fuse is now cut. A Lees-Bradner thread milling machine is used, provided with an air-operated collet. The cutter shown in Fig. 13 is first fed into the hole to the correct depth, and

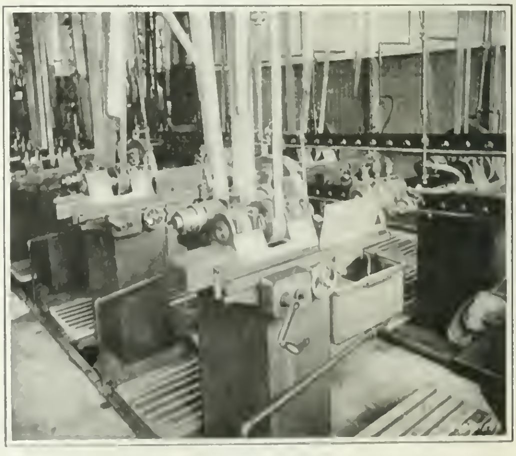

Fig. 10. Machines used for grinding Bourrelet

is then fed sidewise until the proper depth of thread has been cut, after which the shell is rotated about one and one-half times around to cut a complete thread. There are twelve threads per inch of a modified U. S. standard, the top being a sharp vee, while the bottom has the U. S. standard flat, as indicated in the enlarged view of the thread. While the operations call for sizing the threads after milling, it has been found that they are generally so perfect when leaving the milling machines that no further tapping operation is required. Once in a while, a shell that may not have a perfect thread is sized on a separate machine with a sizing tap. An ordinary drill press is used for this purpose, provided with an Errington automatic tapping chuck and a pneumatically operated vise.

From the thread milling machines, 10 per cent of the shells pass to the hydraulic testing press, where they are subjected to a test which indicates the elastic limit of the shell. Details of this test will be given in a subsequent article. The shells that have been hydraulically tested are then passed back to the drill press, where the thread is sized, as the hydraulic test slightly alters the accuracy of the thread.

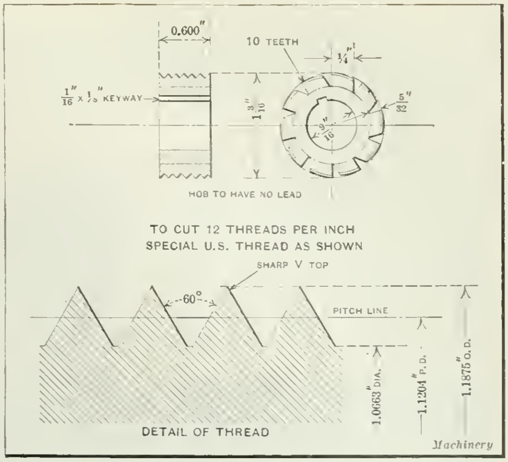

Fig. 13. Detail of Milling Cutter or Hob for milling Threads for Fuse

Automatic Notching Machine

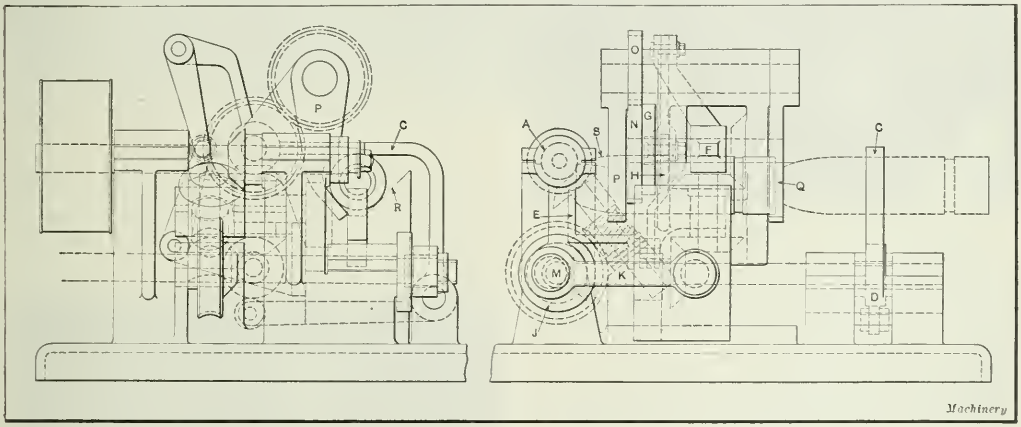

Fig. 11. Automatic Machine for notching Shells for Detonator

The shells are now provided with a small notch at the open end for the detonator. This notch is cut by a full-automatic notching machine built by the company, which takes the shells from a gravity conveyor and deposits them onto another conveyor after the notch has been cut. This machine is shown in Fig. 11. The milling cutter which cuts the notch is shown at *A* and the shell operated upon at *B*. The shells are automatically clamped and fed forward to the cutter. As the shells are fed by the gravity conveyor to the machine in one continuous flow, it is necessary to clamp not only the shell being operated upon, but also the next succeeding one which has just passed off from the conveyor, so that the shells behind the one operated upon will not press that shell forward or interfere with the proper operation of the machine. The next succeeding shell, therefore, is shown automatically clamped at *C*, while the other shells on the conveyor back up against the end of this shell. When the shell operated upon has been discharged, as will be described later, clamp *C* is released by the action of cam *D*, and is pushed forward by the weight of succeeding shells until it comes into position *B* against stop *E*. Clamp *F* then grips the shell by the action of cam *G* and toggle joint *H*. The axis of the cutter-spindle is stationary, and the shell is fed forward to it by the motion of the shell carriage, which is operated by means of a crank and pitman *J* and *K*, the crank being driven through a bevel gear, worm, and worm-wheel from the main spindle. Shaft *M* also carries a bevel gear, which, in turn, drives the transverse spindle that operates the clamping mechanism through a series of bevel gears, thereby assuring a proper sequence of operations with regard to the release of the clamps.

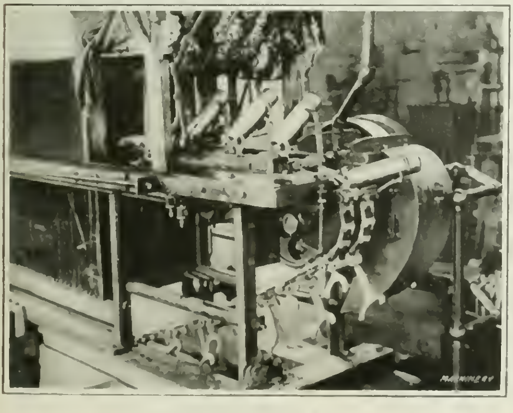

Fig. 12. Shell Washing Machine

The discharging mechanism is carried by a shaft driven by the gears *N* and *O*, which are part of the clamping mechanism. These gears continuously rotate arms *P* and *Q*, which come around once each time a shell is ready and which push it up an incline *R* and onto the conveyor. Previous to the use of this automatic machine, the shells were notched in a small standard milling machine, the shells being laid in a V-block.

Final Operations and Inspection

The shells now pass through a washing machine consisting of a long, endless chain conveyor, as indicated in Fig. 12, which carries them into a tank containing hot oakite. The shells are placed upon the conveyor by hand at the end shown, and then pass into the tank indicated to the left, from which they pass out at the other end, which is similar to the end shown, and where they are removed by hand. The shells are held in an inclined position while passing into the tank, and are simultaneously sprayed on the inside by a solution which is forced into them from nozzles placed beneath them. After washing, the whole shell is inspected at a long table, each inspector checking one dimension only, the shell being passed from inspector to inspector. This inspection is repeated in the government inspection room, after which the shell returns to the shop and the copper band is put in place in West tire setters, Fig. 14. The regular type of machine is used, except that the ordinary jaws are replaced by tool-steel jaws. The copper bands are next turned in a special American Shell Co.'s machine. A roughing tool is placed in a holder on the turning machine, and a finishing tool of the under-shot forming-tool type is used on a lever-operated cross-slide. This tool is of the form shown in Fig. 15.

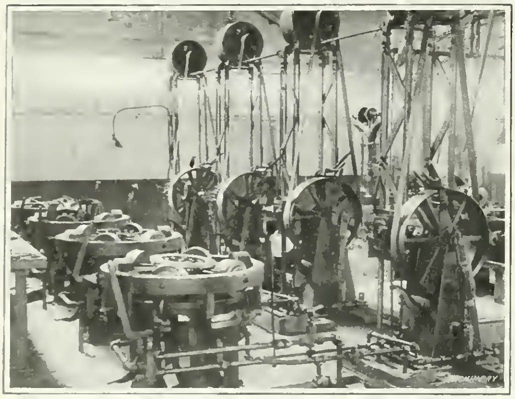

Fig. 14. Machines used for pressing Copper Band into Place

The shell is now ready for putting the brass plate onto the end. A lead plate is first attached to the base by petroleum jelly; then the brass plate is dropped in place and the shell put under a press provided with a special punch or die, which forces the brass plate into position. The punch or die is compounded, having an inner die which holds the plate in position while the outer part crimps the edge of the groove cut in the shell base over the plate. This die is shown in Fig. 16. A small 40-ton hydraulic press is used for this operation. After the final government inspection, the shells are numbered in a Dwight & Slate numbering machine, being laid in a cradle consisting of two rollers, after which the eccentric marking wheel is forced down upon them.

The lacquering on the outside of the shells is done in the machine shown in Fig. 17, especially built for the purpose. The shells are placed upside down on studs attached to a moving link belt. At a certain point in their travel, the shells strike rollers which force them to rotate. At this time, the operator directs the spraying gun onto them, thus covering them completely with lacquer. The shells then automatically move into a drying oven, from which they pass out at the other end, where they are removed. The inside is then sprayed by hand; no special drying means are provided after this spraying. This finishes the operations upon the shells before they are ready for shipping.

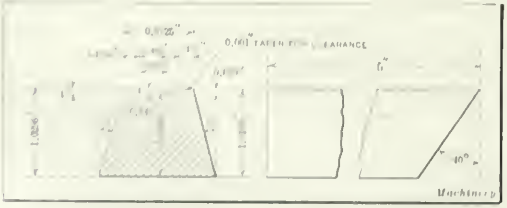

Fig. 15. Forming Tool for finishing Copper Bands

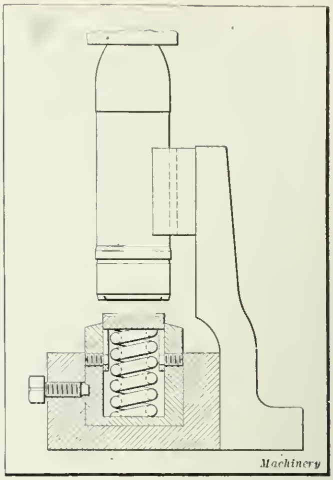

Fig. 16. Die for pressing Brass Plate onto End of Shell

Employment of Women in Shell Work

The American Shell Co. employs a large percentage of women on the manufacture of the 75-millimeter shell. Women are employed not only on inspection operations and such work as in the past was ordinarily performed by women operators, but also on a great many of the machining operations. It is stated that the work done by the women is very satisfactory. The operations performed by women in the making of the shell are as follows: second rough-turning of entire outside, together with inspection; all government inspection; Brinell test; boring, recessing, facing, and beveling of the hole for the fuse, with inspection; finish-turning of the body above and below the groove for the copper band, together with inspection; beveling the body of the cartridge case, with inspection; the grinding of the bourrelet, with inspection; the cutting of the groove in the base for the cover, with inspection; the milling and inspecting of the thread; the final shop inspection of the whole shell; the final government inspection; the inspection of the copper band; the assembling of the base cover; and the pressing of the base cover into place.

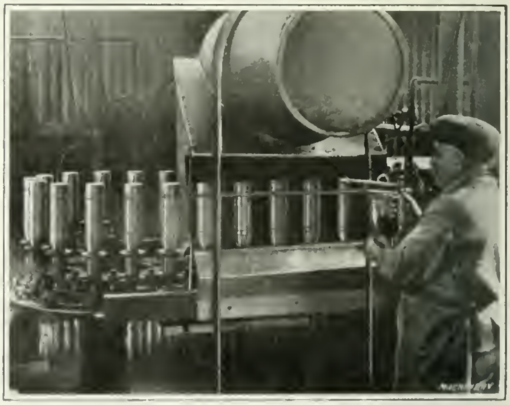

Fig. 17. Machine for varnishing Shells on Outside

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Owing to the lack of workmen's houses, the British Government has decided to erect from 150,000 to 200,000 dwellings. While these houses will be standardized, there will be slight variations in dimensions and style in different localities. Where conditions permit, the cultivation of gardens will be encouraged. A standard system of planting is advocated, the number of houses not to exceed twelve for each acre. The width of arterial roads will be 100 feet, secondary roads, 50 feet, and residential roads from 36 to 40 feet.

PROJECTION METHOD OF TESTING SCREW THREADS[1]

ARRANGEMENT AND USE OF PROJECTION APPARATUS AS APPLIED TO INSPECTION OF THREAD GAGES FOR MUNITIONS MANUFACTURE

BY FRANKLIN D. JONES[2]

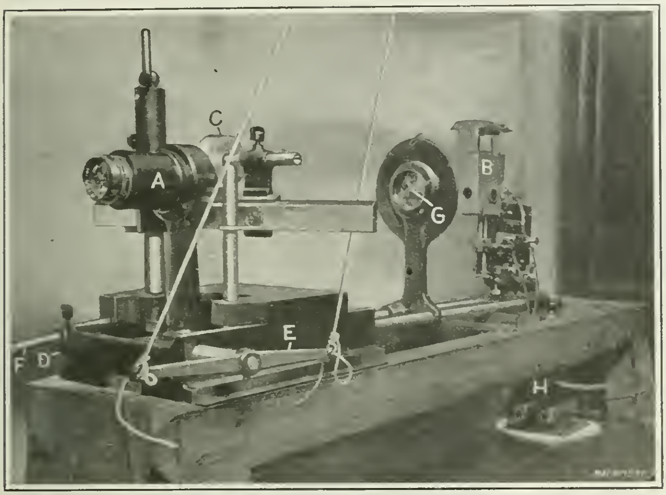

Fig. 1. Projection Apparatus for testing Screw Threads

CONSIDERABLE progress has been made in the development of apparatus for detecting inaccuracies in screw threads, especially during the past three years, because of the tremendous amount of screw cutting necessary in connection with munitions manufacture and the great importance of maintaining the screw thread dimensions within the limits prescribed. Different types of gages and precision measuring machines have been improved in design and new forms of apparatus originated. A modern and very effective method of testing screw threads is by the use of an optical projection apparatus. The principle is very simple: An image of the thread is projected upon a suitable screen and is then compared with the profile or outline of an accurate thread of standard proportions. It is necessary, of course, to determine previously the magnification or the extent to which the thread under observation is to be enlarged upon the screen, so that the profile or thread outline used as a standard in making comparisons may be drawn to a corresponding scale. This projection method shows errors in the pitch, angle, or form of the thread, and it is especially valuable for testing the shape of a Whitworth thread.

Optical Projection Apparatus

The projection apparatus to be described was developed by the National Physical Laboratory of England and is employed in conjunction with other precision measuring machines for verifying the accuracy of inspection gages. This work of gage inspection, for the plants in this country manufacturing munitions for the British Government is carried on under the direction of H. J. Bingham Powell, inspector in charge of the Department of Gages and Standards of the British Ministry of Munitions of War in the United States. The apparatus will first be described and then some examples illustrating its practical application will be referred to.

Two views of the apparatus are shown in Figs. 1 and 2. There is a projection lens at *A*, an arc light at *B*, and adjustable conical centers at the rear of the lens for holding the gage *C* to be examined. Just beneath these centers there is a clamp which may be used for holding any gage or other part that cannot readily be mounted between centers. The slide which carries the work-holding clamp and centers may be adjusted along its base, thus varying the distance between the object to be projected on the screen and the lens. The purpose of this adjustment is to obtain the proper focus. The focussing slide is attached to a rod *F* which connects with a small eccentric at *D* mounted on a shaft carrying the double-ended lever *E*. The focus is first adjusted approximately by unclamping the slide from the rod and moving it along the base, and lever *E* is then used to obtain the fine adjustment. This lever has cords attached to it so that adjustments may be made from the screen where it is possible to see more clearly just when the focus is correct.

It is very essential to provide for this apparatus a lens of good quality and one that has been corrected for distortion to secure an accurate reproduction of the thread profile on the screen. A strong source of light is also necessary, so that a clear and sharply defined outline or shadow will be projected. The carbons of the arc light used with this apparatus are located 90 degrees apart instead of being placed one above the other. With this arrangement the crater or concave depression which forms in the end of the positive carbon is pointed directly toward the lens; consequently, a maximum amount of light is reflected and shadows of the crater wall or edge are not projected upon the screen. When one carbon is placed above the other, the formation of the arc at dif-

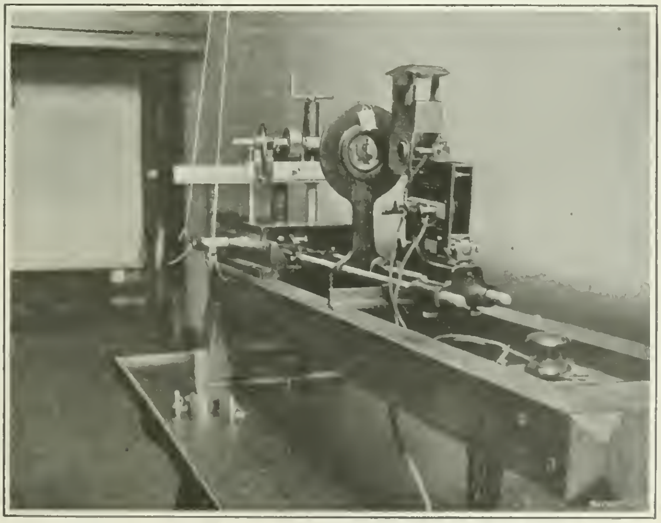

Fig. 2. Rear View of Projection Apparatus, showing Screen in Background

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[1] For other articles on thread testing, see "Precision Screw Testing Machine," February, 1918; "Inspection of Screw Gages for Munitions of War," January, 1918; "Gaging Systems for Screws and Taps," July, 1917; and "Gaging and Inspecting Threads," February and March, 1917.

[2] Associate Editor of MACHINERY.

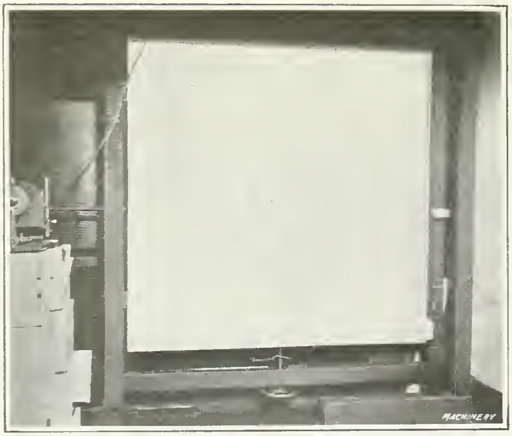

Fig. 3. Screen upon which Screw Threads are projected

ferent points around the edge of the crater sometimes results in casting a shadow of the crater wall upon the screen, thus interfering with the image of the part under observation.

The projection apparatus referred to is arranged for a magnification of 50, the thread section being enlarged that number of times, which enables even slight inaccuracies to be observed readily. The magnification may be verified before testing a screw thread by placing between the centers back of the lens a cylindrical part such as a plug gage, and then adjusting the focal distances until the shadow upon the screen is of the required size as determined by measurement. The focal distances mentioned are the distances between the screen and projection lens and the distance from the screw to the projection lens, the measurements in each case being along the line of projection.

Between the lens and the arc light there is a condenser or lens *G* which gathers the rays of light from the arc and changes their direction so that all the rays between the condenser and lens are parallel. These parallel rays are obtained by locating the condenser at the right distance from the arc. The axis of the gage or screw thread to be observed is located at right angles to the axis of the lens, so that the image projected on the screen represents an enlarged section of the thread in the plane of its axis, or in the plane in which the thread angle should be measured. As is quite apparent, if the gage were adjusted from this perpendicular position an amount equal to the helix angle of its thread, the projected image would represent a section normal or at right angles to the thread.

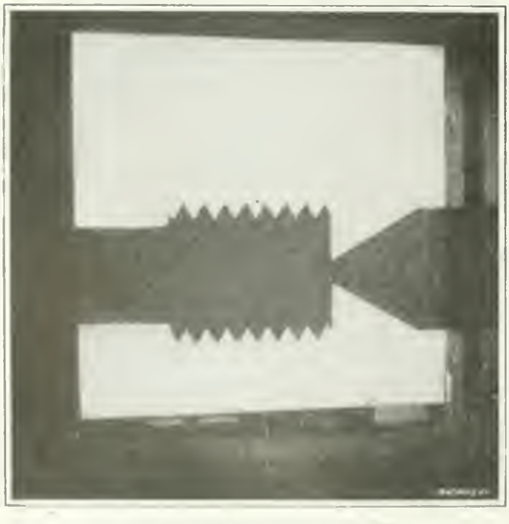

Fig. 4. Small Plug Gage projected upon Screen

In order to secure a clear, sharply defined projection on the screen, it is essential to have the light rays between the condenser and lens in line with the thread on the side that is to be observed and projected. This alignment of the light rays with the helix angle of the thread is of particular importance when the pitch is large in proportion to the diameter or when the thread inclines considerably relative to its axis. Therefore, the arc light and condenser are mounted upon a frame which is pivoted directly beneath the lens and is free to swing in a horizontal plane. When a gage is placed between the centers preparatory to projecting its image upon the screen, the frame referred to is adjusted until a well-defined projection is secured. The apparatus is connected with an ordinary 110-volt lighting circuit, but the voltage is reduced considerably by means of a rheostat *H*, Fig. 1.

Screen upon which Thread Profile is Projected

The screen upon which the shadow or image of the thread is projected is practically a large drawing-board faced or covered with heavy drawing paper or bristol board. The particular screen seen in the background of Fig. 2 and also in Fig. 3 is provided with rollers at the bottom and is mounted upon a horizontal track. The screen is also supported by a vertical screw, so that it may be adjusted either in a horizontal or a vertical direction for locating any standard thread outline which may be drawn upon the screen in coincidence with the projected image for observing any differences of form, angle, or pitch. This adjustable feature, however, is an unnecessary refinement, as it is much more convenient to have the standard thread outlines drawn on sheets of cardboard which are held against the screen in line with the projection when examining a thread.

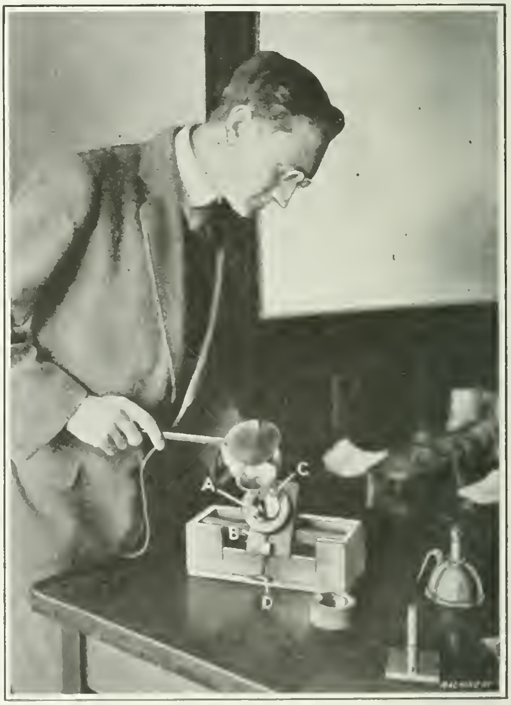

Fig. 5. Making a Cast of a Section of a Ring Gage Thread preparatory to testing by Projection Method

Incidentally, it is important to locate the screen so that it is perpendicular to the line of projection, and in order to test its position the lens and any other part that may be in the

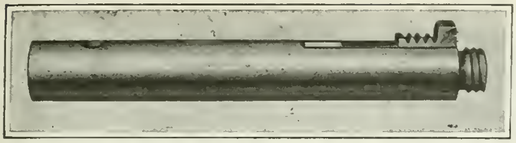

Fig. 6. Spindle containing Cast made as shown in Fig. 5

holder are removed. The parallel beam of light from the condenser then illuminates a small circle on the screen. A mirror is held against the screen in such a position that the beam of light is reflected back onto the apparatus. The screen slide is then adjusted until this reflected beam coincides with the projected beam, or until it passes back through the opening which ordinarily contains the projection lens.

Testing Ring Gages by Projection Method

When the profile of a thread gage of the plug type is to be examined, the gage is placed between the centers back of the lens and the slide carrying these centers is adjusted vertically until the thread profile on the lower side of the gage is in line with the center of the lens. This vertical adjustment is, of course, necessary for examining gages of different diameters. The pivoted frame which supports the arc light and condenser lens is then swiveled in a horizontal plane as previously described, in order to align the light rays with the thread. The observer then goes to the screen and, after carefully adjusting the focus by means of the cords connecting with the apparatus, compares the projected image with a standard thread profile. A comparison with a standard thread outline will show readily minute errors of form as well as any appreciable inaccuracy of pitch or angle. A true form at the crest and root of a Whitworth thread is very important, except when clearance spaces at these points are provided, as, for example, in the case of plug gages of the type used for checking the effective diameter only of a ring gage. The nature of the errors detected by the projection method vary, of course, considerably. For instance, the radius at the crest or at the root may be incorrect, or if it conforms to the standard radius the rounded part may be off center relative to the remainder of the thread. All errors of this kind as well as any irregularity along the slope, or decided variation either in pitch or angle, are readily detected by the projection method. The illustration Fig. 4 is an actual photographic reproduction of the image of a small plug gage projected upon the screen. This gage is one of the small sizes shown in Fig. 2 upon the table which supports the projection apparatus.

When the angle of the thread is tested, a piece of cardboard is used upon which lines are drawn to the standard included angle of 55 degrees (Whitworth thread) and to several greater and smaller angles with variations of thirty minutes. An error of ½ degree may be detected easily by simply comparing the projected image with the standard referred to. An error in the pitch will be detected by a lack of coincidence of the successive threads of the image and standard thread outline, but it is not advisable to attempt to measure such differences since the scale of magnification is insufficient to obtain the result accurate to tenths of a thousandth of an inch, an error of 0.0001 inch in the gage being indicated by 0.005 inch on the screen with the 50 magnification used, which is a quantity too small for accurate measurement.

Application of Projection Method to Ring Gages

When a plug gage is being examined, the profile of the thread is projected directly upon the screen, but obviously this method could not be employed when testing a ring gage, although the accuracy of the latter may easily be verified by the use of the projector. This is done by making a small cast of a section of the thread by using an appliance designed by H. J. Bingham Powell and patented in the United States. This cast or impression (which corresponds to a segment of a plug gage of corresponding diameter and pitch) is then mounted in the projector the same as a plug gage. The cast is made of a composition containing 93 per cent sulphur and 7 per cent graphite. This composition is poured into a mold formed by a slot in a spindle which is held against one side of the ring gage. Fig. 5 illustrates how a cast is made. The spindle *A*, which contains a slot and serves as a support for the cast, is screwed into baseplate *B* and is perpendicular to the surface of this plate. The ring gage *C*, the thread of which is to be examined, is held against the spindle by screw *D* and then the composition is poured into the mold thus formed, as the illustration indicates. A detailed view of the spindle with the cast in place is shown in Figs. 6 and 7. The latter illustration also shows the baseplate of the casting fixture and three cast segments which have been removed from the spindle to show clearly their form. The spindle and cast segment is placed between the centers of the projection apparatus, the same as though it were a plug gage. These casts taken from ring thread gages are also used in connection with the Bingham-Powell patented pitch-measuring machine, which was described in the January number of MACHINERY, page 452.

Tracings of Inaccurate Thread Forms

In order to secure a permanent record of the thread outline, the edge of the shadow projected on the screen may be traced in pencil upon a sheet which is filed for future reference. These outlines are sometimes sent to gage-makers to show them the exact nature of the error or to manufacturers when the outline is of a thread on the product instead of a gage thread. Figs. 8 to 10, inclusive, show a number of these tracings which were obtained by means of the projection apparatus. The dotted line in each case shows the standard thread form, and the full line, the actual shape of the thread. The thread illustrated at *A*, Fig. 8, is on a plug gage intended for testing the fuse holes in the ends or noses of shells. This thread is accurate as to pitch, but the crest is flat instead of being rounded, whereas the root extends considerably below the dotted arc representing the correct depth and radius. The outline shown at *B* is the thread of a ring gage and was projected from a cast. In this case the pitch is also very accurate and the principal defect is at the root which has too large a radius, so that the sides of the thread are under-cut. Another ring gage thread is shown at *C*. The radius of the crest is small and the radius of the root large, the result being a thread that is too narrow. It will be understood that these thread profiles were not selected as typical examples of gage work, but merely to illustrate the nature of some of the common defects. Tracings are only made when the errors are sufficiently pronounced to require an investigation. Most of the gages examined conform more closely to the standard outline than is indicated by the examples shown in Fig. 8, but when the gage is sufficiently accurate to pass the inspection test, the outline is not traced, since there is no need of such a tracing.

Fig. 9 shows two examples of threads on the product or work. The upper view *A* illustrates the thread on a ¼-inch bolt forming part of an airplane motor. The actual thread form in this case deviates only slightly from the standard outline and this is regarded as a very good example of work. The other extreme is illustrated at *B*, which represents the

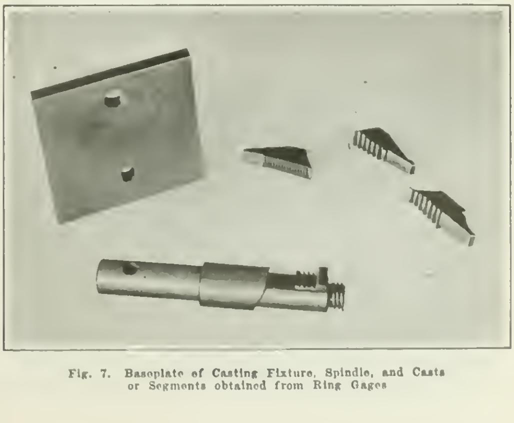

Fig. 7. Baseplate of Casting Fixture, Spindle, and Casts or Segments obtained from Ring Gages

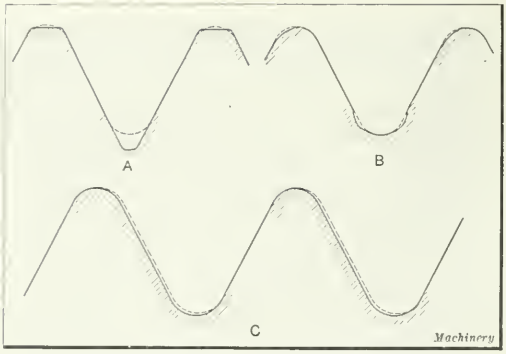

Fig. 8. Tracings made in Conjunction with Projection Apparatus which show Inaccuracies in Plug and Ring Gages

thread of a nut. This thread was supposed to conform to the British Association standard indicated by the dotted line, and it illustrates what it is possible for a tap to do when it is not in good condition or is improperly applied.

While the projection apparatus is of especial value for examining Whitworth threads, it may also be used to advantage in connection with the United States standard thread or any other form. Two tracings from United States standard threads are reproduced in Fig. 10. The outline shown at *A* was projected from a plug gage having eighteen threads per inch. The pitch of the thread is very accurate, but the top is a little too wide and the root is finished almost to a sharp vee. The thread illustrated at *B* was projected from a turnbuckle. There are thirty threads per inch in this case, and it is supposed to conform to the United States standard, although there is considerable deviation, as indicated by the full and dotted lines.

Photographing Thread Forms

A photograph of the outline of a projected thread may be obtained without much difficulty instead of tracing the contour in pencil, although the latter method is simpler, more rapid, and less expensive. One method of securing a photograph is as follows: A part similar in form to the focussing bellows of a camera is attached in front of the projector lens and is arranged to hold a plate slide. The exposure is made either on a rapid plate or directly upon bromide paper. A ground glass screen is inserted in the plate slide prior to making the exposure and is used for focussing. For comparative purposes the outline of a standard thread form may be secured in conjunction with the photograph of the thread to be examined by first making an artificial negative. This should be a duplicate of the standard thread except that the outline is enlarged in proportion to the magnification of the projected thread image. A magnification of 20 is considered about right for making photographic reproductions. The artificial negative may be made by drawing as accurately as possible the thread contour on tracing paper. This outline, which should be twenty times the actual size of the thread, is next filled in with India ink to obtain a solid black thread section. Several coats of the ink should be applied, and to prevent the paper from wrinkling and buckling, it should be moistened before applying the ink and then be smoothed out thoroughly after the ink is dry by using a hot flat iron. This artificial negative is placed in contact with the sensitized plate preparatory to making the exposure and it serves as a standard for comparing the photographic reproduction with the actual thread. The artificial negative must be set so that it will be parallel and close enough to the projected image to enable the actual and true outlines to be compared readily.

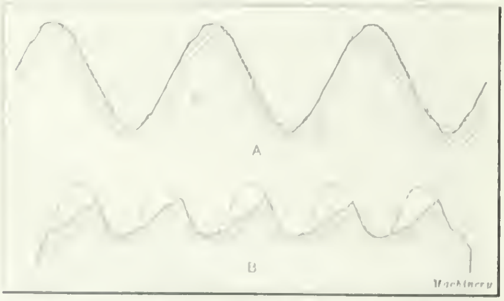

Fig. 9. (A) Tracing of Thread on Airplane Motor Bolt. (B) Thread supposed to conform to British Association Standard

The optical projection apparatus is not restricted in its use to testing screw threads, but may be employed to correct the accuracy of the profiles of gear teeth, the shapes of cams or gages of the contour type, or any other parts having an outline that may be projected and compared with a standard form.

* * *

RIGHT- AND LEFT-HAND TOOLS

BY THOMAS FISH[1]

In the December, 1917, number of MACHINERY there appeared an article signed R. L. commenting on the writer's article entitled "Right- and Left-hand Tools" in the September number. R. L. states that he does not agree with the decision that we made in reference to the use of the terms "right-" and "left-hand" and "right-" and "left-bent," etc., and he is of the opinion that if several men who knew nothing of machines or tools were shown tools of various hands and bends their definition of the tools would coincide with his. The writer might agree with this statement, but he also has to agree with the other side. There are a good many who do not endorse the conclusions of the writer as stated in the September number, but these were based on a complete investigation which showed that the majority of the leading machine tool companies and mechanical engineers in this country used the terms given with the meanings stated. Our thought was that it would be preferable for us as manufacturers of tool-holders to coincide with the majority of the mechanical engineers, rather than try to force the majority to accept terms that we might believe in, but that did not conform with the general standard of opinion. What we would like to see brought about, however, is a general understanding as to the terms that are used and universal adoption of standard terms. We believe that this was covered in the article in the September number.

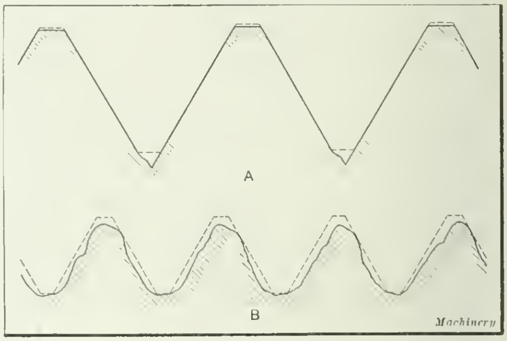

Fig. 10. Two Examples of Defective U. S. Standard Threads

* * *

On its trial trip, the *Namsenfjord*, the first reinforced concrete full-powered vessel, showed that it had excellent seagoing qualities and very little vibration. It will carry 200 tons of cargo at a speed of seven and a half knots. Although the hull is heavier than if made of wood or steel, the cost of upkeep will be practically nothing, and the cost of repairs, in case of accident, is greatly reduced. It is thought that this increased weight of hull will make possible the use of oil engines on tugs.

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[1] President Ready Tool Co., Bridgeport, Conn.

LETTERS ON PRACTICAL SUBJECTS

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BORING ATTACHMENT FOR LATHE

A boring attachment suitable for use on any size lathe in shops where there are no boring mills or other machines, and where, occasionally, large pulleys and gears must be bored, can be made by any machinist possessing ordinary skill. The attachment shown in Fig. 1 was made in a shop that was equipped with an 18-inch lathe and a small planer. The writer made the patterns and did all the machine work, and the cost was covered in the first two jobs on which the attachment was used. In boring out two large pulleys there was an error of but 0.002 inch in six inches length, due, doubtless, to the fact that the cold-rolled shafting was not trued up after the keyway had been cut. This attachment was designed by the writer to prevent a shut-down.

The parts required are two cast-iron bearing standards, one of which is shown at *A*, the other being at the tailstock end of the lathe; a faceplate *B*, 22½ inches by 13 inches, with a 2½-inch hole in its center; an angle-plate and two braces *C*; a bearing plate *D* for the lathe carriage; two pieces of cold-rolled steel shafting, and some gears. The gears can be easily procured, if nowhere else, at any garage and sometimes they may be found in the junk pile of an automobile repair shop. Those used by the writer were taken from a discarded gear-case of a Buick car. They were bored out and then shrunk over suitable bushings to receive the shafts and keys. The drive shaft *E* is made of 1 7/16-inch cold-rolled shafting and is long enough to reach from the chuck through the first bearing standard *A*. It is squared at the end that enters the chuck and a keyway is cut in the other end for the gear. The boring shaft *F* is made of 1 15/16-inch cold-rolled shafting and is about five feet long. One end has a ½-inch square hole for the boring tool; at the other end a 1-inch standard thread is cut for two inches. Then the shaft is turned to 1 3/16 inch for a distance of 3 3/4 inches, and a keyway ½ inch by ¼ inch is cut toward the center for a distance of 2 feet, 1 inch, or until it passes through the standard bearing *A*. The gears are fastened to the shaft on the headstock side of this bearing. Collars and washers are used to fasten the end of the boring shaft to the bearing plate *D* on the lathe carriage, and adjustments are made by means of a knurled nut *G*, three inches long. Two headless set-screws are used to keep the nut from working off the shaft. The nut can be set as tightly as desired, thus making a very steady shaft as regards the horizontal movement.

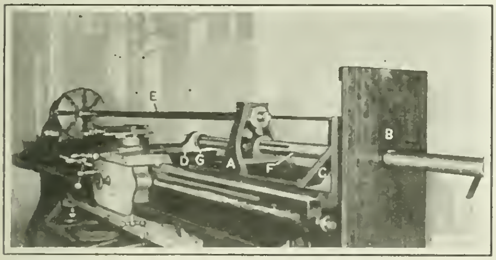


Fig. 1. Boring Attachment for a Lathe

As a knurl was not available, the adjusting nut *G* was knurled by the following method: The compound rest was set horizontal with the work and the tool set as for chasing threads, setting the lathe to turn the coarsest thread possible. Proceeding as if only one thread were to be cut, the tool entered the work about 1/32 inch, but on the second cut, instead of going in the same line, the compound rest was moved ahead about 1/16 inch and a cut was taken. This process was continued until there were thread marks the full length of the part to be knurled. Then the threads were reversed as if a left-hand thread were to be cut, and the same procedure followed. A very satisfactory knurl was produced by this method.

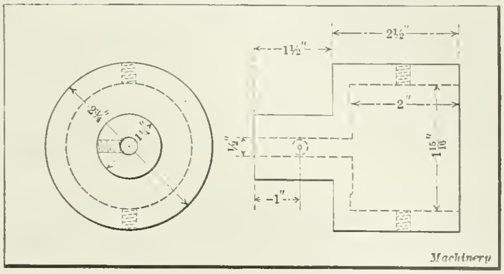


Fig. 2. Drilling Attachment for Use on Boring-bar shown in Fig. 1

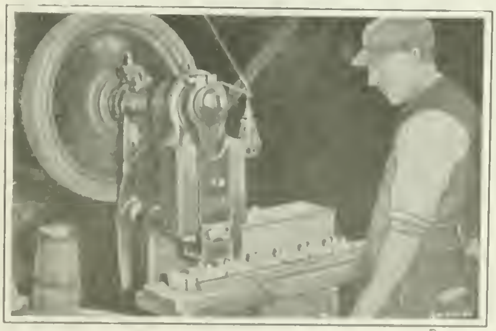
The cast-iron bearing plate *D* that goes across the lathe carriage, giving the boring-bar its horizontal movement, is fastened to the lathe with ½-inch bolts. The plate has lugs on the bottom that fit into the slots in the carriage. The hole in this bearing plate for the boring shaft is drilled and no bushings are required. The upper hole in the standard bearing *A* is drilled and not bushed, although no doubt a bushing would improve the wearing quality. The lower hole in this bearing and the hole in the bearing at the end of the bed are provided with bronze bushings. It is necessary to remove the tailstock when this boring attachment is used. When bolting the faceplate to the lathe, care must be taken to see that it is in line with the boring-bar. Once in place, there is slight possibility that it will have to be removed. The angle-plate braces are fastened so as to strengthen the faceplate; ½-inch cap-screws are sufficiently heavy to hold without vibration.

In Fig. 2 is illustrated an attachment for drilling work in the lathe. The attachment is made from a cold-rolled bar 2¾ inches in diameter and 4 inches long. While the one shown was made to receive a Morse ½-inch straight-shank, flattened-side twist drill, this attachment may easily be made to receive taper-shank drills.

Plant City, Fla. C. W. Wilkinson

INSERTING WOODEN PLUGS WITH A PUNCH PRESS

One type of clutch-shifting yoke is a bronze casting with a cored pocket in which the oil is put. As no channels are provided for carrying the oil from this pocket to the friction sur-



Inserting Wooden Plugs in Clutch-shifting Yoke face, four wooden plugs are pressed into the pocket. Capillary action then causes sufficient oil to exude from the plugs to lubricate the friction surface. The four plugs are pressed into the yoke at one stroke of a punch press.

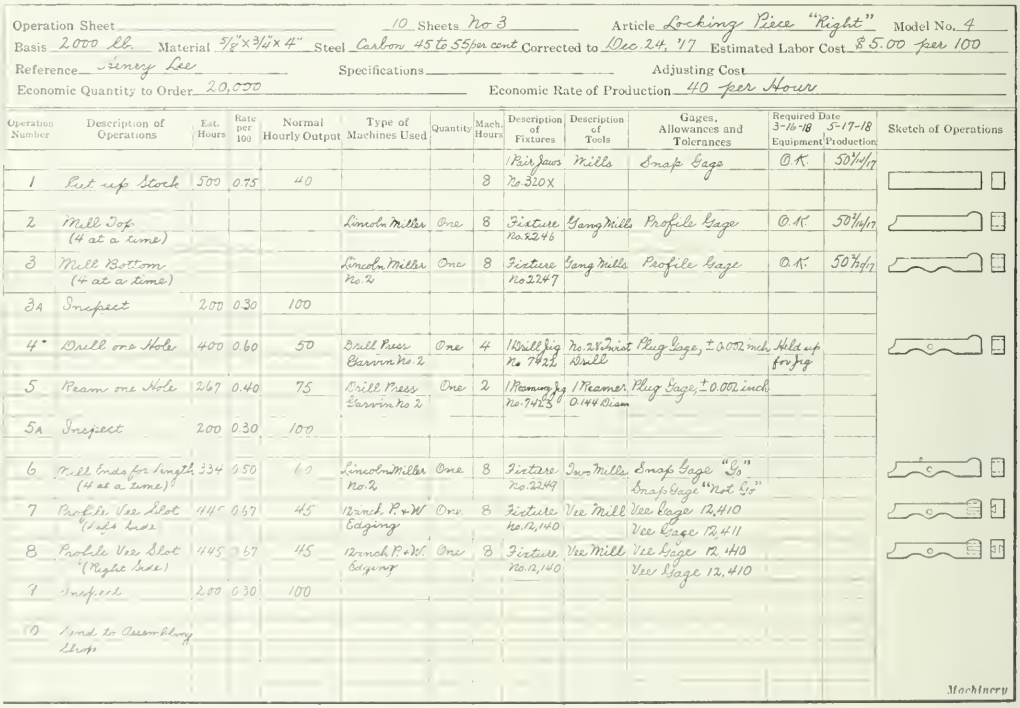
As shown in the accompanying illustration, the punch press table has bolted to it a long, narrow plate casting with guides on the top. The shifting-yoke castings, with the wooden plugs just stuck in the holes, are slid along these guides. These plugs have a short tapered end so that they may be stuck in the holes by hand and fed along on the table. As the plugs are pressed into place, each yoke is pushed along by the next one to pass under the press head and soon drops off into a barrel at the end of the press. The plugs are pressed into place before the friction surface of the yoke is machined.

Flint, Mich. C. C. SPREEN

USE OF SKETCHES ON OPERATION SHEETS

When a new article is to be manufactured in a large plant, an operation sheet, or what is sometimes called a general plan, which designates the various operations to be done from start to finish, is sent into the shops where the fixtures, gages, jigs, or tools are made. This operation sheet is valuable in showing what jigs, fixtures, tools, or gages are needed first. Thus each device follows in its regular sequence and a jig to be used on the seventieth operation will not be made before a jig used on the fifty-eighth operation. The equipment and manufacturing methods are clearly brought out before all concerned, and anything causing a fluctuation in the daily output can be easily localized and readily adjusted. The detrimental effects in the methods and costs adopted are easily discerned. In fact, operation sheets are summaries of each standard part of the product, and from them arrangements for the manufacture of other devices are often possible at a much smaller expense than would otherwise be the case.

However, the value of this sheet is increased by placing on it sketches of the article with each operation completed, as shown in the accompanying illustration. Then the jig or fixture maker sees immediately what his fixture or jig is desired to accomplish; oftentimes the man who makes the working drawings gets incorrect data or fails to put in every detail. Also, the foreman of the shop, by the aid of the sketches, can see more clearly what must be made to a nicety and what can be approximately correct and do the work just as well as if the piece or part were made to 0.001 inch, thus saving time and money. The writer knows of fixtures being made correct to 0.001 inch before they would pass inspection, but as soon as they were placed on a manufacturing job the operator would knock his piece out of its locating points in the fixture by means of a large babbitt hammer, and thus would throw off these points from 0.01 to 0.05 inch, yet the work would gage up, practically as well as when dead true. Of course, this would not do for all operations, but is permissible in some roughing cuts. The usefulness of the operation sheet is self-evident. It illustrates the article or part as it passes through the various channels of the works, so that the production overseers are acquainted with every detail in the manufacture of their product. In this case, the product has not passed the fourth operation, as it is waiting for the drill jig. It is, therefore, useless to complete the reaming jig for the fifth operation before this jig is made.



Operation Sheet 10 Sheets No 3 Article Locking Piece "Right" Model No. 4
Basis 2000 lb. Material 5/8"×3/4"×4" Steel Carbon 45 to 55 per cent Corrected to Dec. 24, '17 Estimated Labor Cost $5.00 per 100
Reference Henry Lee Specifications Adjusting Cost
Economic Quantity to Order 20,000 Economic Rate of Production 40 per Hour

Operation Number	Description of Operations	Est. Hours	Rate per 100	Normal Hourly Output	Type of Machines Used	Quantity	Mach. Hours	Description of Fixtures	Description of Tools	Gages, Allowances and Tolerances	Required Date 3-16-18 Equipment	Required Date 5-17-18 Production	Sketch of Operations
1	Cut up Stock	500	0.75	40			8	1 Pair Jaws No. 320X	Mills	Snap Gage	O.K.	50 2/14/17	
2	Mill Top (4 at a time)				Lincoln Miller	One	8	Fixture No. 2246	Gang Mills	Profile Gage	O.K.	50 2/16/17	
3	Mill Bottom (4 at a time)				Lincoln Miller No. 2	One	8	Fixture No 2247	Gang Mills	Profile Gage	O.K.	50 7/20/17	
3A	Inspect	200	0.30	100									
4*	Drill one Hole	400	0.60	50	Drill Press Garvin No. 2	One	4	1 Drill Jig No. 7422	No. 28 Twist Drill	Plug Gage, ± 0.002 inch	Held up for jig		
5	Ream one Hole	267	0.40	75	Drill Press Garvin No 2	One	2	1 Reaming Jig No. 7423	1 Reamer 0.144 Diam	Plug Gage, ± 0.002 inch			
5A	Inspect	200	0.30	100									
6	Mill Ends for length (4 at a time)	334	0.50	60	Lincoln Miller No. 2	One	8	Fixture No. 2249	Two Mills	Snap Gage "Go" Snap Gage "Not Go"			
7	Profile Vee Slot (Left Side)	445	0.67	45	12 inch P.+W. Edging	One	8	Fixture No. 12,140	Vee Mill	Vee Gage 12,410 Vee Gage 12,411			
8	Profile Vee Slot (Right Side)	445	0.67	45	12 inch P.+W. Edging	One	8	Fixture No. 12,140	Vee Mill	Vee Gage 12,410 Vee Gage 12,410			
9	Inspect	200	0.30	100									
10	Send to Assembling Shop												

Machinery

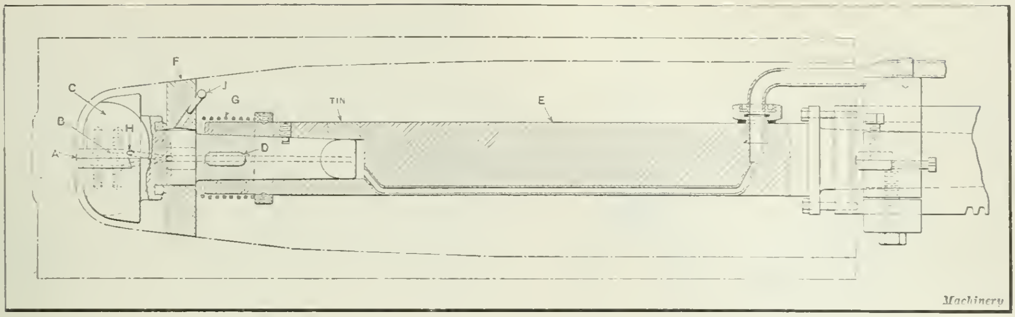
Operation Sheet showing Sketches of Different Operations

These sketches also help the manufacturer to decide what can be approximately correct and what must be exact. For instance, if a slight error is made in the manufacture of a jig or fixture, the foreman will know whether such an error is permissible. As these sketches show each successive operation, they assist greatly in demonstrating the locating points and giving such other data as is often thought unnecessary until the jig or fixture is being made.

New Haven, Conn. ERIC LEE

SHELL FACING BAR

The writer designed the facing bar that is here illustrated for use on a horizontal boring machine built by the Niles-Bement-Pond Co. in facing the inside bottom end of forged shells 13 inches in diameter and 4 feet in length. The two blades *A* are secured by screws *B* to the removable holder *C*,



Bar with Two-blade Cutting Device

which is keyed at *D* to the bar *E*. This holder *C* is centered by star *F*, which, by the pressure of spring *G*, adheres to the inside of the shell rotating with it, having a running fit on the holder *C*. By this means the blade-holder is firmly supported and all chatter and vibration is eliminated during the operation. The easy disengagement of the chips is assured through the star, and sufficient lubricant is poured upon the blades through the holes *H*. The inside bearing of the star is oiled by a drilled hole, which is closed by the wooden plug *J*. The parts at the rear end of the facing bar are not special, being an ordinary attachment that is mounted directly on the spindle of the boring machine head.

Ruelle (Charente) France C. Jouve

PREVENTING LOSS OF TOOLS

It is an advantage to have the owner's name, not merely his initials, on all tools. When they are marked with the owner's name, if a tool is misplaced, the finder will recognize the surname and return the tool to Jones or whoever the owner may be. Employes are known in shops by their surnames, not by their initials. The writer feels certain that fully 75 per cent of all tools misplaced would be returned to the owner if the finder knew his name. Of course, one can always take a found tool to the tool crib, but it is more satisfying to return a tool directly to the owner, which eliminates the thought, and the possibility, that the owner may not receive the article from the crib. This is assuming, of course, that the finder desires to return the article found. But even were the finder otherwise inclined, it would yet be important to have all tools marked, as no man will use a tool with another's name on it, and tools thus marked are not easily sold.

The best method of marking the tools is to cut in the name with nitric acid. First the surface should be cleaned with benzine, turpentine or kerosene and then given a substantial coat of paint or varnish. When the paint is two-thirds dry, the name should be inscribed and the paint allowed to harden, preferably over night. The acid is applied with a camel's hair brush, which will not scratch and on which the acid will have little effect. Ten minutes after the acid begins to sparkle is sufficient time for a good impression.

New York City E. J. Higgins

USE OF TECHNICAL TERMS

In reading technical journals, one notes considerable difference in the use of technical words, though it would seem to be one of the many duties of an editor to keep the various contributions within reasonable bounds. This supervision might be applied to advertising matter as well. Among those who misuse technical terms are the contributors of articles relating to machinery and tools for working sheet metals. When a company is formed for the manufacture of articles from sheet metal, it may be named the U. S. Stamping Co. and the machines it purchases for the production of stampings may be called punch presses. If a flat plate is used on the bed of a power press to help fill the opening, the piece may be called a bolster plate; but later the writer may use the word bolster when he means some part of his die. When the term sub-bolster is used, one naturally thinks of something under the bolster, but we learn that sub sometimes means over as well.

In the equipment necessary to produce an article cut and formed from a flat sheet, the manufacturer generally has a machine that he may call a press, a power press, a punch, a punch press, or a stamping press. When he wants to make or purchase the dies required to produce this particular article, how should he specify these tools when he writes to a tool shop for prices? Shall he send a drawing, or sample, of the article and ask for prices on a die to be used in a No. 20 X. Y. Z. press? If he does, can he be sure of getting quotations on all the necessary punches, dies, bolsters, strippers, extractors, etc., necessary for producing the article in the most approved manner?

Indianapolis, Ind. John D. Riggs

RECESSING TOOL FOR GASOLINE ENGINE CYLINDERS

In automobile and marine gasoline engines having the head cast integral with the cylinder, the cylinder bore should be slightly larger beyond the upper limit of travel of the top piston ring. As the piston moves up and down, it gradually wears away the walls of the cylinder between its limits of motion, and if the upper end were not slightly enlarged, a ridge would soon be formed there. At the same time all the piston bearings are slowly worn away so that the travel of the piston is slightly increased; as a result, if a ridge were formed at the end of the cylinder, a knock would be produced.

The boring tool shown in Figs. 1 and 2 can be used to bore the enlarged part of cylinders cast so that they can be bored only from one end; this tool may be operated in either a horizontal or a vertical boring machine. The tool has some special features, principally the method of operating the cutter. The

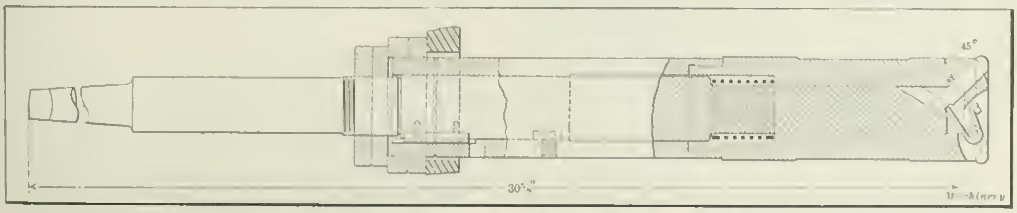


Fig. 1. Detail View of Tool for recessing End of Automobile Engine Cylinders

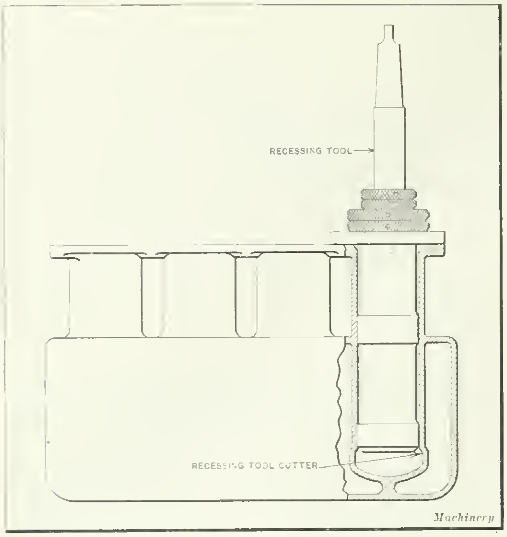


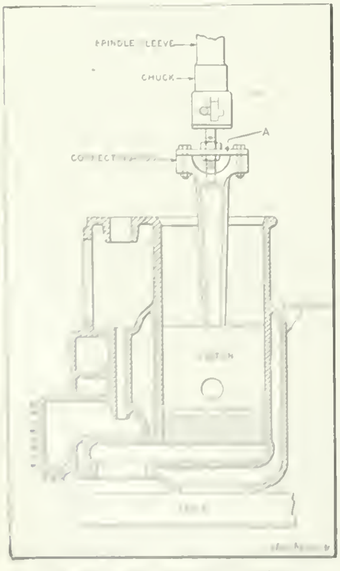
Fig. 2. Tool for recessing End of Automobile Engine Cylinders in Operation

outer sleeve is mounted on a plate, which is centered by pins placed in the cylinder flange bolt holes. The range of travel of the boring-bar is controlled by the step-pin in the outer sleeve. A spring holds the boring-bar at the upper limit of its travel. At the lower end of the bar a slot is cut on an angle in which the cutter is located; this cutter is held in place by a spring, which also holds it against the back of the slot. Therefore, as the boring-bar is pressed down, the cutter is fed out and cuts the relief in the end of the cylinder bore.

Flint, Mich. C. C. Spreen

LAPPING AUTOMOBILE CYLINDERS

In the accompanying illustration is shown a unique way of lapping a scored cylinder for an automobile engine. The cylinder block, which is for a four-cylinder engine, is laid out on the plate of a vertical, power-driven drilling machine, and the connecting-rod is clamped to the chuck, as shown, by means of a plate *A* laid across the face of the split crankshaft bearing. The cylinder wall and the piston are smeared with lapping compound or lapping powder before the piston is placed in the cylinder. Then by raising and lowering the spindle, while the piston is rotated in the drilling machine, the scored piston and cylinder are quickly lapped. It is well known that the lapping of cylinders by hand requires a good deal of time, and by doing it as described the job is finished in about one hour. Of course, it is understood that this method is used merely for repair jobs and not for the building of new engines.



Lapping Scored Automobile Cylinders

Art Sandberg

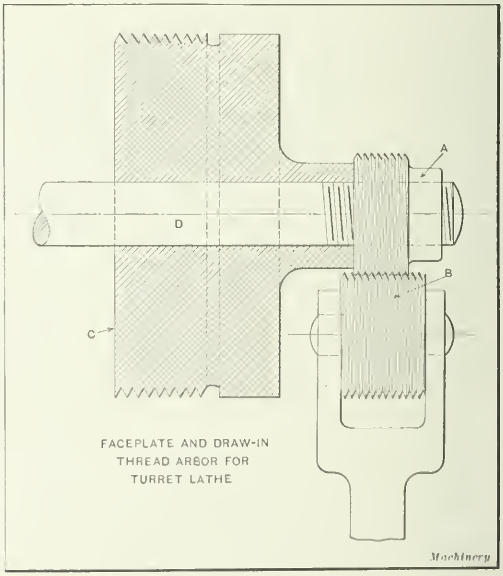
Ottawa, Ill.

HARDENING CUTTERS FOR LARGE SHEAR

A shop that used a shear for cutting all kinds of stock up to two inches square had considerable difficulty keeping the cutters in good condition. The cutters, which were made of tool steel, 1¼ by 5 by 7 inches, and hardened in water, would bend or chip in a short time. As some cutters hardened in oil lasted six months, which was much longer than any previously used, but were somewhat too soft, it was decided to make the next set just a little harder by the following method: Eight inches of water and sixteen inches of oil were placed in the oil tank. When the cutters were heated to 1500 degrees F., they were plunged into this bath and moved continuously up and down, so that they were part of the time in water and part of the time in oil. These cutters, after six months' use, were still in good condition. R. M. P.

SALVAGING HIGH-EXPLOSIVE FUSE ADAPTERS

When manufacturing high-explosive fuse adapters for shells for the Allies, quite a number came through too small to pass the gage. Rather than sacrifice the material involved and waste the time spent on them, as time was an important element in the contract, a means was sought to bring them up to size. A hardened steel roller *B* was therefore made of the proper size but with the threads cut deeper, so that when the adapter *A* and the roller *B* were brought together and revolved under pressure, the metal was forced into the deeper threads of the hardened roller and brought to the required size. To operate, the adapter *A* is screwed on the threaded draw-in arbor *D*, which is then drawn back against the faceplate *C*, and the thread roll *B* is brought against the adapter *A* by means of the cross-slide.



Method of bringing Fuse Adapters to Size

Boston, Mass. John A. Shand

USE OF AIR-OPERATED HAMMERS

A development that deserves attention in the design of machine and industrial plants is the use of compressed air for operating press hammers ordinarily employing steam as the motive power. Frequently, comparatively small plants are operated by motors driven from current purchased from outside public utility companies or gas-producer plants. In such instances the use of steam for operating the hammers necessitates the installation of a high-pressure boiler unit with its fixtures, piping and attendance. On the other hand, practically every manufacturing plant is equipped with a motor-driven air-compressing outfit for use in the various tools. In motor-operated plants the use of air will eliminate the necessity for providing high-pressure steam boilers, piping, etc.

While the cost of operating the hammers by air will probably be higher than the cost when using steam, it is a question whether this added cost will not be more than offset by the savings realized from reduced investment, reduced cost for attendance, simplification, and savings in floor space. Besides, the air-operated hammer will strike a quicker and harder blow; there is also no large quantity of condensation or drips to be taken care of, and the heat surrounding the hammer is reduced, improving the working conditions.

The use of compressed air necessitates the installation of a large air receiver on the intake line, in order to insure a plentiful supply of air ready for the demands of the hammer. This receiver will also reduce the size of the air-compressing equipment needed. With the use of air for operating hammers, it is important to watch carefully for leaks in the pipe lines and connections, which are bound to occur because of vibration and which are not as noticeable as steam leaks.

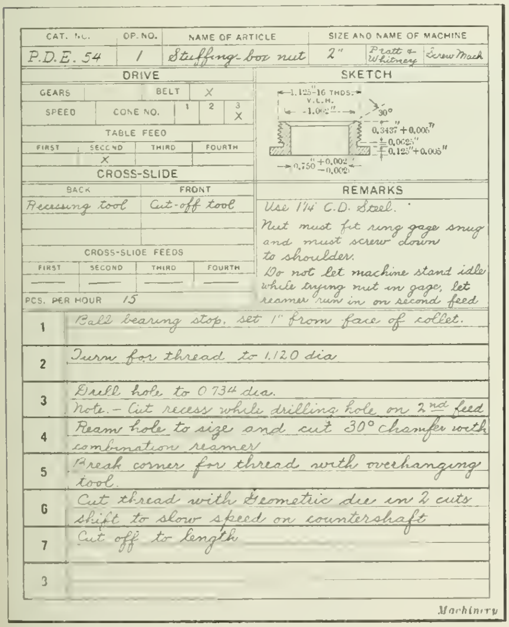
Philadelphia, Pa. **W. A. Lailer**

SCREW MACHINE SET-UP CHARTS

Some time ago, while working in the hand screw machine department, doing piece-work on pneumatic drill and hammer parts, the writer had a job on which he made from sixty to seventy-five cents an hour; but about four months later, on the same job, all he could make was forty-five cents an hour and he could not discover the reason until he was nearly through with the job. He had forgotten that he formed the piece at the same time that he drilled the hole.

About a month later the writer was appointed assistant foreman. As he had a little trouble remembering the different set-ups, he ruled up a card, like the one here shown, had a thousand printed, and then worked overtime a few evenings filling them out. Although nearly all the hands were green, with these cards they quickly learned how to set up their jobs, because the cards were fool-proof. As a result, the writer was placed in the piece-rate and lay-out department.

Aurora, Ill. **J. J. Borkenhagen**



CAT. NO.	OP. NO.	NAME OF ARTICLE	SIZE AND NAME OF MACHINE		
P.D.E. 54	1	Stuffing-box nut	2"	Pratt & Whitney	Screw Mach

DRIVE

GEARS		BELT	X

SPEED	CONE NO.	1	2	3
				X

TABLE FEED

FIRST	SECOND	THIRD	FOURTH
	X		

CROSS-SLIDE

BACK	FRONT
Recessing tool	Cut-off tool

CROSS-SLIDE FEEDS

FIRST	SECOND	THIRD	FOURTH
——	——	——	——

PCS. PER HOUR 15

SKETCH

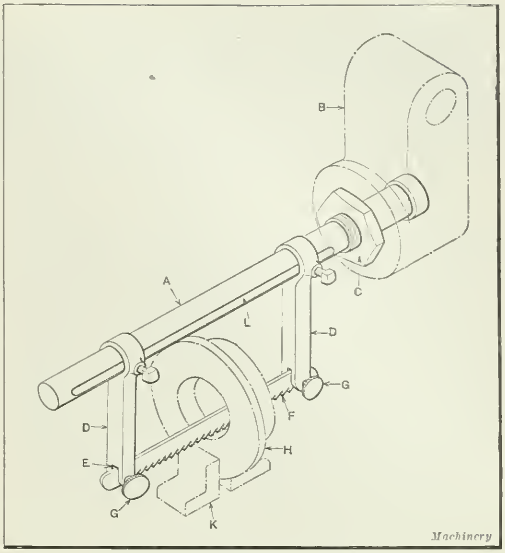
1.125"-16 THDS.
V.L.H.
1.002"
30°
0.3437"+0.005"
±0.0025"
0.125"+0.005"
0.750"+0.002 −0.002

REMARKS

Use 1¼" C.D. Steel.
Nut must fit ring gage snug and must screw down to shoulder.
Do not let machine stand idle while trying nut in gage, let reamer run in on second feed

1	Ball bearing stop, set 1" from face of collet.
2	Turn for thread to 1.120 dia
3	Drill hole to 0.734 dia. Note.—Cut recess while drilling hole on 2nd feed
4	Ream hole to size and cut 30° chamfer with combination reamer
5	Break corner for thread with overhanging tool.
6	Cut thread with Geometric die in 2 cuts shift to slow speed on countershaft
7	Cut off to length
3	

Screw Machine Set-up Chart



Attachment for cutting Keyways on the Shaper

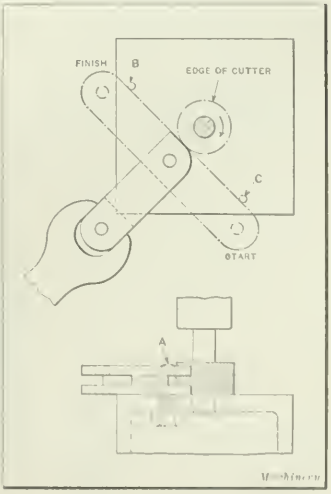
CUTTING KEYWAYS ON THE SHAPER

With the attachment shown in the accompanying illustration satisfactory keyways may be quickly cut on the shaper; the attachment is especially good for keyways in small holes. The bar *A* is held in the regular shaper swivel *B*, being clamped in position by the nut *C*. This bar supports two rods *D* at the lower end of which are slots *E* for the keyseating tool *F*, which is held in place by knurled screws *G*. The work *H* is held in the jaws *K* of the shaper. The attachment shown has a flat *L* on the bar *A* to keep the link sliding in line when adjusted, but a key and keyway are preferable to the flat. When the work is to be removed, the knurled screws *G* are loosened and the tool removed. Often larger keyways can be made with a smaller cutter, but in general the cutter should be made for the size of keyway required.

Irvington, N. J. **Charles Eisler**

MILLING ON A DRILL PRESS

Some time ago the writer had several hundred machine steel yoke or clevis ends of different sizes to be faced off round with a fairly good finish and shape. As shaping, grinding, and filing was not very satisfactory, the device illustrated was designed and used with good results. An old box jig was bolted to a drill press table, and a hole was bored to fit a short milling machine arbor. A spiral milling cutter with an outside diameter that would finish the yoke to the desired size was mounted on this arbor. The piece to be machined was placed on stud *A* in the position indicated by the dot



Device for milling Yoke Ends

and dash lines, and moved through an arc of 180 degrees by using an open-end wrench. Stop-pins *B* and *C* prevented the piece from being machined too far. The bulk of the material to be removed was first cut out on a shear or by drilling a number of small holes.

Harvey, Ill. H. S. **Zevenhouse**

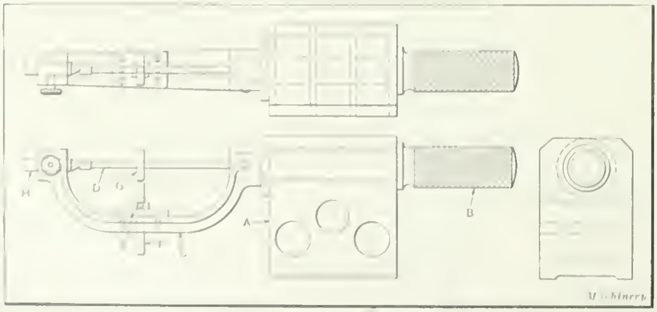
GRINDING WHEEL TRUING DEVICE

During the past three years of unusual industrial activity there has been an exceptional demand for many types of gages. It is a matter of fact that gage-making at the present time has been brought much closer to a strictly manufacturing basis than was formerly the case; but before this high degree of efficiency was reached manufacturers had to feel their way by slow and expensive steps. There are still some concerns that are producing component gage parts by hand, and where this method is followed the cost of gages is prohibitive in many cases. Consequently, any method or means of increasing the rate of production and accuracy with which gage-making can be done is of great service both to toolmakers who take contracts to supply gages to manufacturing plants, and the plants in which such gages are to be used.

The shop in which the writer is employed has been actively engaged in designing and manufacturing gages for the parts of a military rifle. From time to time my assistant and I have introduced time-saving methods for the rapid production of gage parts, the methods being such that they can be depended upon to produce work of the required accuracy. Although we make no claims concerning the originality of this method, we are fully convinced that the results obtained with it are entirely satisfactory, and so far as we know the method itself is new. The accompanying illustration shows a truing device made to dress grinding wheels to an exact radius of curvature. Gage-makers who make templets to a certain radius of curvature and then proceed cautiously to true a wheel up to fit such a templet will appreciate the value of the present method.

It will be seen that the wheel truing device consists of a base *A*, handle *B*, arm *C*, disk-holder *D*, bracket *E*, diamond-holder *F*, and setting disk *G*. Diamond-holder *F* is set so that the diamond point is off center, and in operation the diamond is swung in a circular arc over the wheel by turning handle *B* so that "radius arm" *C* is swung about its pivot in block *A*. Diamond-holder *F* is made round so that a sharp facet of the diamond may be centrally located by turning this holder in the bracket. The capacity of this truing device is for truing grinding wheels to radii from 0.010 to 1 inch.

Base *A* is ground on all surfaces, and it will be apparent that a set of hardened and ground disks *G* must be furnished with the attachment to provide for setting the diamond point for truing wheels to the desired radii. In setting the attachment for truing a convex surface on the wheel, disk *G* is placed on arbor *D* and the diamond point is brought up into contact with the disk. This locates the diamond in the desired position for truing a convex surface on a grinding wheel to a radius of curvature corresponding to the disk used in making the setting. The throat of the radius arm is of sufficient depth to accommodate grinding wheels up to 7 inches in diameter, and no difficulty is experienced in finishing the curved grinding face to an accuracy of 0.0001 inch on the radius. The holes drilled in the base of the attachment are merely to lighten it.

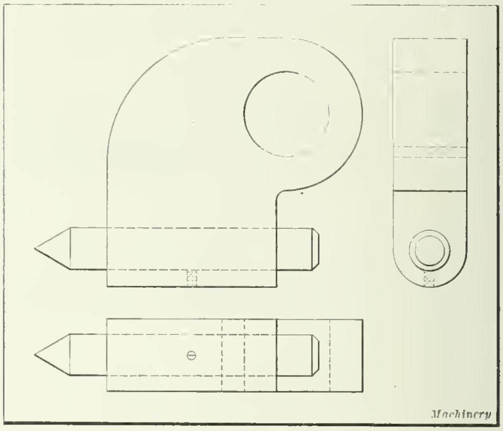


Device for truing up Grinding Wheel to a Convex Surface

Springfield, Mass. F. C. **Bolton**

LAYING-OUT FIXTURE FOR MILLING MACHINE

The practice of spacing holes in work from center-punch marks is so general that the fixture here shown may be used to excellent advantage. It is clamped on the milling arbor and the centers are accurately spaced on the work by the use of the index dial on the feed-screw. The center-punch should fit the holder snugly, so that when the punch is raised from the work, it will not fall down again. However, a small brass screw may be used to take up any slight wear.



Laying-out Fixture for Milling Machine

New York City E. J. **Higgins**

AMMONIA FOR FIRE EXTINGUISHING

The writer's attention has been called to an article in the January number of Machinery bearing the title "Ammonia for Fire Extinguishing," which advocates the use of ammonia instead of water for fire protection. It says that, as combustion depends on free oxygen, the displacement of that constituent of the air by ammonia gas will have the effect of "suffocating" combustion, so that a little ammonia gas will go a long way toward extinguishing a good sized fire. Means by which this medium might be manually or automatically liberated in a building in case of fire are also given. It is pointed out that, since ammonia is a gas and will rise in air, it should be liberated near the floor. Had the use of carbon dioxide, which is heavier than air and accordingly could be introduced through overhead piping similar to the present sprinkler pipes, been advocated, the idea might have been more feasible, especially as that gas would be more active than ammonia in putting out flame and less active in extinguishing human life.

There is little fear that an experiment of this kind would be tried a second time by the same person if the matter were brought to the attention of the proper authorities, especially at the present time, when, on account of ammonia shortage due to the urgent demand for that substance for the manufacture of explosives, food-conserving industries employing ammonia as a refrigerant are facing possible restrictions.

New York City F. E. **Matthews**

Vice-president of American Society of
Refrigerating Engineers.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

IN THIS NUMBER

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NEEDHAM DOUBLE-PURPOSE LATHE

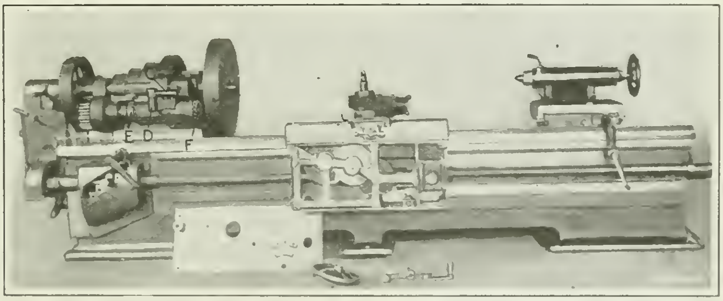


Fig. 1. Needham Double-purpose Lathe with Front Plate removed from Apron

THERE are a large number of machine shops in small towns, which handle an occasional job calling for a lathe swinging up to about 40 inches, but such a large machine would not be well adapted for machining the average run of work handled in these shops. To meet the requirements of such machine shops, A. W. Needham, 72-74 Tenth St., Long Island City, N. Y., has developed the double-purpose lathe illustrated and described herewith. The best idea of the provision made for adjusting the swing of this lathe will be gathered by reference to the end views shown in Figs. 3 and 4, where it will be seen that cross-slides are provided to support the headstock and tailstock, and that the two back V-ways on the bed of the machine are placed at a considerably lower level than the front way, so that when the headstock and tailstock are pushed back, this lower position of the back ways helps to increase the swing.

In order to adjust the transverse position of the headstock, it is merely necessary to loosen four bolts and then push the headstock to the desired position on its cross-slide. After this setting has been obtained, the four bolts are retightened to clamp the headstock in the desired position. Adjustment of the tailstock is secured in exactly the same way. With the headstock and tailstock in the back position, the lathe has a swing of 40 inches, and it is of sufficiently heavy construction so that it may be used for turning car wheels and other heavy work. With the headstock in the forward position, a small faceplate is furnished, which is shown leaning against the lathe bed in the rear view of the machine shown in Fig. 2, and equipped in this way the lathe is adapted for handling the average run of heavy work that comes to a jobbing shop.

Forty-two changes of feed are available on this lathe. In the front view of the machine it will be seen that at the left-hand end of the feed-screw there is the usual arrangement of quick-change gears, which provide seven changes of feed. Now, referring to the end view of the lathe shown in Fig. 3, it will be seen that lever *A* is furnished with a locating pin which may be pushed into any one of three holes. This lever actuates sliding gears in this case, which provide for multiplying the seven feed changes of the quick-change gear at the front of the machine, giving a total of twenty-one changes of feed. By means of two change-gears in case *B* the number of available feed changes is again multiplied, giving a total of forty-

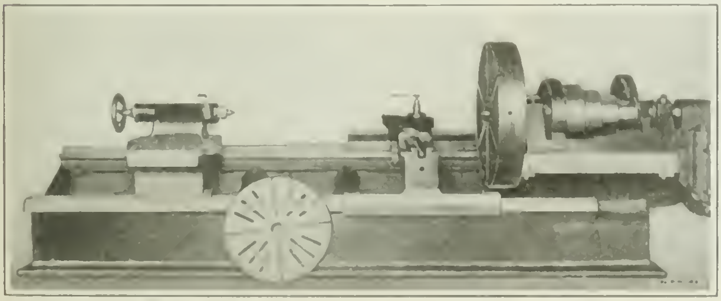


Fig. 2. Opposite Side of Needham Double-purpose Lathe shown in Fig. 1

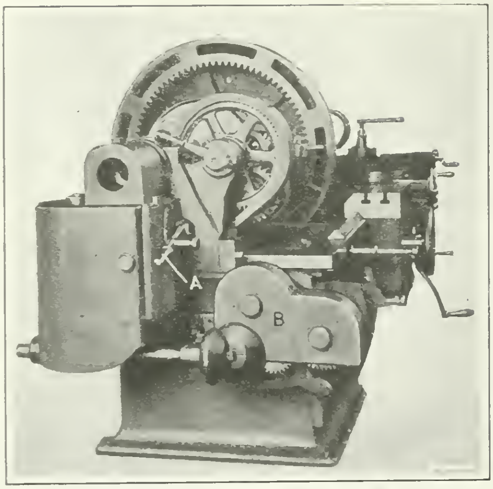


Fig. 3. End View of Lathe showing Arrangement for obtaining Feed Changes

two rates of feed. It will be apparent by referring to the illustrations that the headstock of this lathe is furnished with a four-step cone pulley and single back-gears. For handling average classes of work, the drive may be either direct or through the back-gears, which are designed in accordance with the usual practice except that they are placed at the front of the lathe spindle. For heavy-duty work where the large faceplate is used, it is naturally desirable to drive by means of the faceplate gear, which furnishes additional power. To provide for obtaining this result, a lever *C*, Fig. 1, is furnished at the front of the lathe, which is mounted at the top of a short vertical shaft which carries a pinion *D* at its lower end. It will be apparent that this pinion meshes with rack teeth cut in a horizontal sliding shaft *E* that carries a pinion *F* at its right-hand end. When it is desired to drive through the faceplate gear, lever *C* is turned to slide horizontal shaft *E* to the right and bring pinion *F* into mesh with the faceplate gear. This movement of shaft *E* results in disengaging a clutch so that the back-gears are thrown out at the same time that the faceplate gear is engaged.

Attention is called to the fact that in the front view of the lathe shown in Fig. 1, the apron has the front plate removed and shown leaning against the lathe bed. This front plate is so designed that by removing four cap-screws and knocking out the taper pins that hold the handwheels on their shafts, the front plate of the apron can be removed to give access to the mechanism. It will also be noticed that despite this provision for removing the front of the apron, each stud in the apron is furnished with a double bearing support. By removing the spider, all gears may be removed in four minutes without disturbing the apron, as the gears are all in front of the apron. The lead-screw can also be removed without disturbing the carriage or apron. Attention is called to the manner in which bearings are provided for in the apron at the front of the lathe bed. The apron is gibbed to the bed in such a way that the carriage bridge may be removed—the bridge being made separate from the carriage for this purpose—and a special brace substituted in its place, so that the lathe swings 40 inches over both the carriage and ways. When this is done, the apron will be quite firmly supported on the bed and capable of operating satisfactorily.

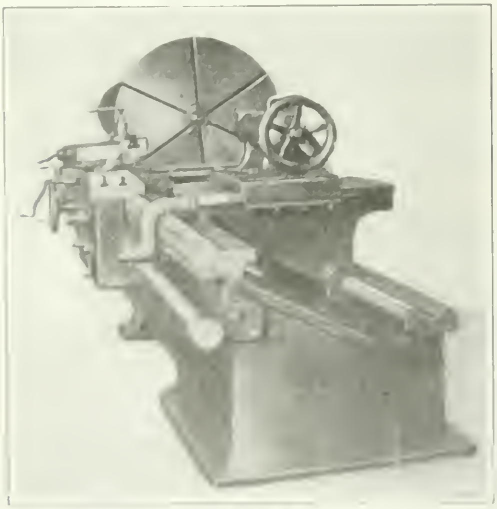
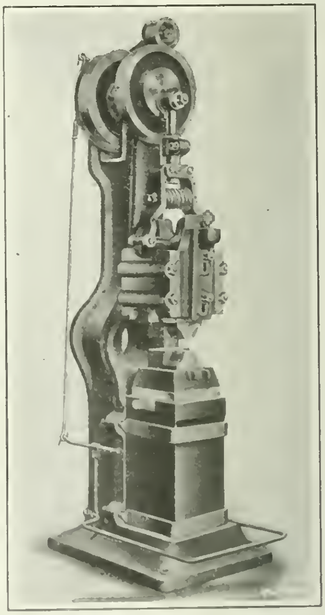


Fig. 4. Opposite End of Lathe showing how V ways are at Different Levels

FAIRBANKS POWER HAMMER WITH ADJUSTABLE GIB

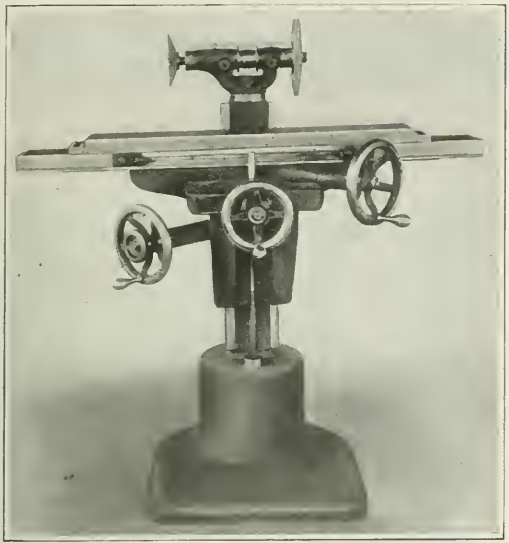
The United Hammer Co., Oliver Bldg., Boston, Mass., are now building the Fairbanks power hammers with an adjustable bronze taper gib the object of which is to provide for taking up wear in the ram guides. With this gib, which may be seen in the accompanying illustration, provision is made for rapidly and accurately making the necessary adjustment. The advantage of such an arrangement on a Fairbanks hammer is that it makes it possible to obtain much finer adjustment of the ram than was formerly the case. It should also be mentioned that these gibs and faceplates have been so designed that they may be fitted to hammers which were originally built without this improved feature.



"Fairbanks" Power Hammer made by United Hammer Co.

MANHATTAN UNIVERSAL TOOL GRINDER

In the accompanying illustration there is shown a universal tool grinding machine which is a recent product of the Manhattan Machine & Tool Works, 42-50 Market Ave. N. W., Grand Rapids, Mich. It will be apparent from the illustration that this machine is of comparatively simple design, without complicated mechanism that is likely to wear or get out of order. It is furnished with a table, 6 by 42 inches in size, which has a working surface of 6 by 22 inches. This table has a maximum longitudinal movement of 22 inches, a transverse movement of 8 inches, and a vertical movement of 12 inches. The greatest height from the center of the grinding wheel to the surface of the table is 12 inches, and work up to 9 inches in diameter by 21 inches in length can be supported on centers. The following equipment is furnished for use in connection with this tool grinding machine: one internal grinding attachment, one pair of central head- and tail-centers, one pair

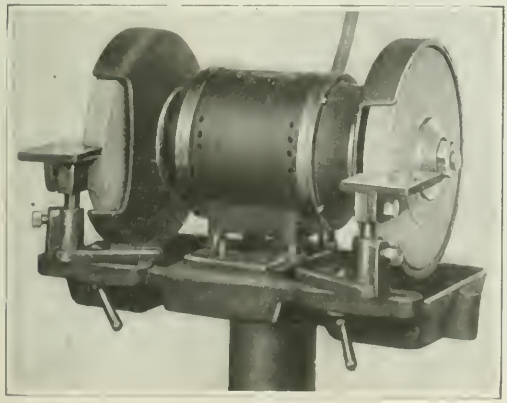


Universal Tool Grinder built by the Manhattan Machine & Tool Works

of offset head- and tail-centers, one faceplate 8 inches in diameter, one chuck for the central head, one swivel base vise, six pairs of grinding wheel flanges, six driving dogs of assorted sizes, one height gage, one tooth-rest socket, seven extension bars, three spring tooth-rest springs, six T-slot bolts, and a countershaft for driving the machine.

UNIVERSAL ELECTRIC GRINDING MACHINE

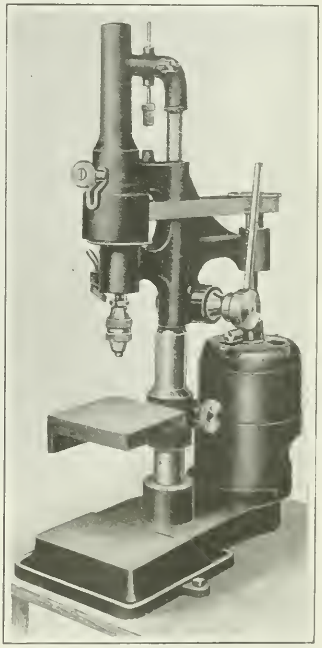
One of the recent products of the Universal Electric Co., 9 Oliver St., Newark, N. J., is a grinding machine built in bench and floor types. This machine has the spindle mounted in SKF ball bearings and is provided with grinding wheels 8 inches in dameter by 1 inch face width. Adjustable guards are provided over the grinding wheels, these guards being held by friction furnished by spring washers, which makes it possible to turn the guards to any desired position without the necessity of loosening screws. The tool-rests are adjustable in all directions and the electric motor is mounted on a baseplate that has a depression under each wheel to form a reservoir for cooling water. A two-pole push-button knife switch controls the motor and this switch is conveniently located for the operator. Motors may be furnished for operation on direct-current circuits or for two- or three-phase alternating-current circuits.



Grinding Machine built in Floor and Bench Types by the Universal Electric Co.

HIGH-SPEED BALL BEARING DRILLING MACHINE

The motor-driven sensitive drilling machine shown in the illustration which accompanies this description is a recent product of the High Speed Hammer Co., Inc., 307 St. Paul St., Rochester, N. Y. This is known as a Model E50 ball bearing machine. It weighs only 60 pounds so that it may be readily moved about the shop and the drive is by a motor especially designed for connection to electric lighting circuits where the potential is from 110 or 155 volts, either alternating or direct current. Special attention is called to the spindle lock which facilitates changing drills, it being possible to release or engage a drill with one hand, and the operator is not required to hold the pulley with the other hand. Annular ball bearings are used throughout this machine and there is also an end-thrust bearing which takes the pressure of the spindle and practically eliminates friction. An adjustable depth gage is furnished which enables stop drilling operations to be performed with a great degree of accuracy.



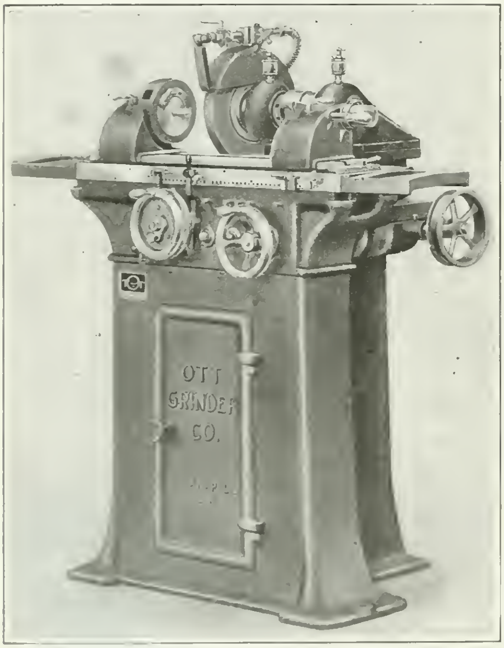
Ball Bearing Sensitive Drilling Machine built by the High Speed Hammer Co.

This machine is adapted for driving drills ranging from the smallest sizes up to 3/16 inch in diameter. The standard spindle speeds are 2100 and 6000 revolutions per minute, but the machine can be furnished with special pulleys to provide for driving the spindle at any speed up to 10,000 revolutions per minute. The spindle is made of heat-treated steel; it is ground to size and guided through a bronze quill, with the spindle supported at each end in an annular ball bearing. A quick-adjustable table provided on the machine has a working surface 5½ by 5 inches in size, and work up to 4⅜ inches high can be drilled. The surface of the table is ground to provide for accurately drilling holes in relation to finished surfaces on the work. The base of the machine is furnished with a ground working surface 4 by 6 inches high, and work up to 7½ inches high can be drilled in place on this base. Surrounding this base there is an oil-groove. An idler pulley takes up any stretch in the belt, which is of the endless woven type. It will be seen that the front pulley and upper part of the spindle are covered by a semi-tubular guard which insures safety of the operator. Either hand or foot control may be provided. The principal dimensions of the machine are as follows: over-all height, 24 inches; size of base, 7½ by 18 inches; capacity of driven motor, 1/10 horsepower; diameter of spindle, 7/16 inch; maximum spindle feed, 2¼ inches; available spindle speeds, 2100 and 6000 revolutions per minute; and capacity, for drilling to center of 6-inch circle.

OTT PLAIN GRINDING MACHINE

The 5- by 18-inch plain grinding machine which forms the subject of the following description is a recent product of the

Ott Grinder Co., Indianapolis, Ind. This machine is equipped with a grinding wheel 10 inches in diameter by 1¼ inch face width, that is carried by a wheel-stand which moves transversely on large vee and flat ways, movement of the wheel-stand being controlled by a handwheel. The wheel-spindle is made of special steel which is hardened, ground and lapped, and the bearings are bushed with bronze and furnished with means of compensating for wear. Alignment of the headstock and tailstock is secured from the front edge of the swivel table. The automatic cross-feed mechanism is of simple design and provision is made for varying the rate of feed while the machine is in operation. Both the countershaft bearings and the loose pulleys are equipped with Hyatt roller bearings.



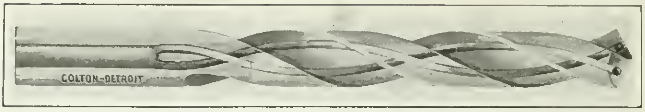
Five- by Eighteen-inch Plain Cylindrical Grinding Machine built by the Ott Grinder Co.

This machine is especially adapted for production grinding where large quantities of duplicate straight or tapered cylindrical parts have to be finished within close limits. It is claimed that the machine will handle work that is now being ground on larger machines, thus economizing in floor space and increasing the facility with which grinding operations can be performed. The automatic cross-feed operates at each reversal of the table and may be adjusted to its feed limits while in operation. When the work is ground to size the feed is automatically thrown out and a positive stop is provided for the hand-feed. Drive to the table is transmitted through a worm and worm-wheel, insuring smooth, uniform travel, which is controlled by adjustable dogs that may be quickly set in the desired positions. The table handwheel is disconnected when the power traverse is employed, and the reversing mechanism is non-centering, thus assuring accurate and positive reversal.

To provide for performing taper turning operations, the table swivels on a large central stud which is hardened and ground to size. Clamps secure the table at both ends, and the right-hand clamp is graduated for setting the table to grind tapers expressed in inches per foot. The headstock is arranged for dead-center drive, and is clamped to the swivel table by means of a T-head bolt; and the tailstock spindle is operated by a spring lever so that it can be rigidly clamped if desired; the tailstock is secured to and maintains its alignment on the swivel table in the same way as the headstock. A pump is furnished which has ample capacity to supply a copious flow of water for wet grinding operations. The equipment furnished with the machine includes one 10- by 1¼-inch grinding wheel, one universal back-rest, one wheel-truing device on the tailstock, one center-grinding attachment, one pair of adjustable work-dogs, a set of overhead works, and the necessary water guards and wrenches.

The principal dimensions of the machine are as follows: swing, 5 inches; capacity between centers, 18 inches; range for taper grinding, up to 3 inches per foot; diameter of headstock and tailstock spindles, 1½ inch; taper of work-centers, No. 6 Jarno; dimensions of front grinding wheel-spindle bearing, 1⅝ by 3¾ inches; dimensions of rear spindle bearing, 1½ by 3¾ inches, minimum rate of automatic cross-feed, 0.00025 inch; maximum automatic cross-feed, 0.005 inch; range of table feeds per minute, 20 to 65 inches; horsepower required to drive machine, five; floor space occupied, 31 by 68 inches; and net weight of machine, approximately 1700 pounds.

COLTON HIGH-SPEED OIL-HOLE DRILLS



Oil-hole Drill made by Arthur Colton Co.

The Arthur Colton Co., of Detroit, Mich., are now manufacturing a line of oil-hole drills, a phantom view of one of which is shown in the accompanying illustration. These are forged and twisted drills, the twisting operation being performed after the oil-holes have been drilled. Colton oil-hole drills are made in all standard sizes from high-speed steel.

GISHOLT SHELL BORING LATHE

In Figs. 1 and 2 there are shown two views of a special 25-inch boring lathe which has recently been developed by the Gisholt Machine Co., of Madison, Wis., for boring 6-inch shells; and Fig. 3 shows cross-sectional views of 155-millimeter shrapnel and high-explosive shells in which *A*, *B*, *C* and *D* indicate the finished surfaces which can be machined on this lathe. For performing these operations use can be made of either a

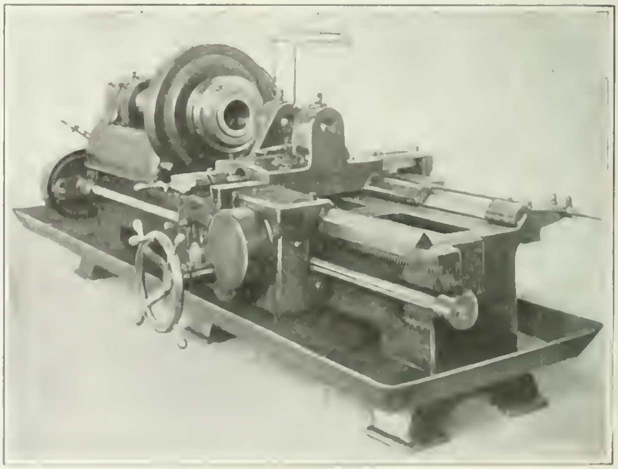


Fig. 1. Twenty-five-inch Shell Boring Lathe built by the Gisholt Machine Co. for boring 6-inch Shells

single-point cutter in the boring-bar, with a former block on the taper attachment which is shown at the back of the machine in Fig. 2, or with a boring head located on the boring-bar and with the cross-slide carriage set in a central position. In addition to its application for the performance of boring operations in shells, this lathe could be used to advantage for boring many other classes of work.

These 25-inch Gisholt lathes are made in several models, some of which are furnished with turrets and others with simple toolposts, etc., according to the particular operations for which individual machines are to be used. Also the lathes may be equipped with either a collet chuck or with a 24-inch three-jaw universal geared scroll chuck, or with a four-jaw independent chuck. This machine is one of the special type of lathes built for shell work in munition plants in England, France, and Italy. Until recently, the demand for the machines from abroad has been so great that no attempt was made to bring them to the attention of the munition manufacturers in this country. At present, however, several lots of this type of lathe are being built for use in American plants.

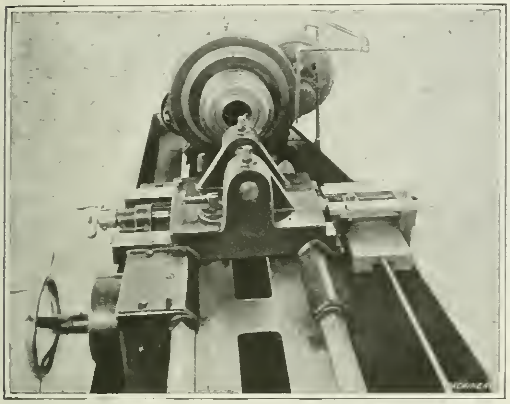


Fig. 2. Partial View of Lathe showing Arrangement of Taper Turning Attachment

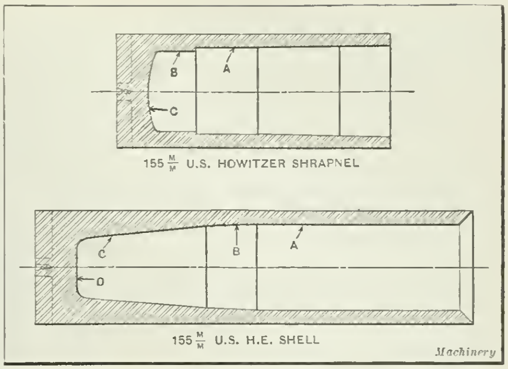
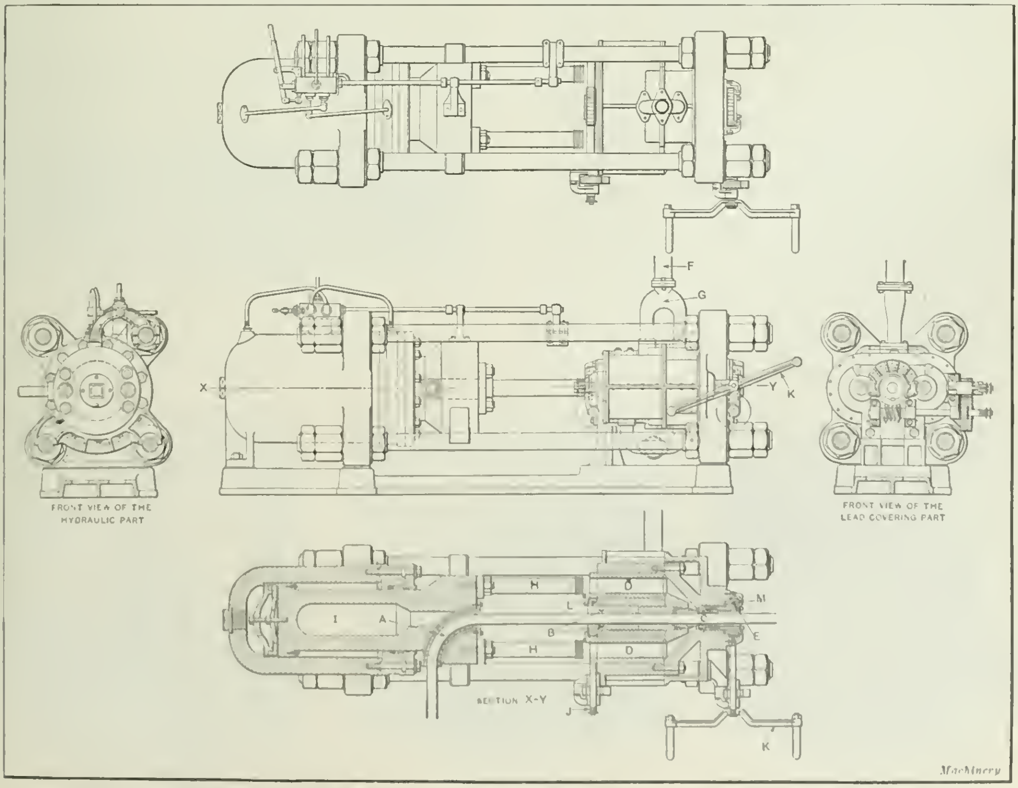


Fig. 3. Cross-sectional Views of 155-millimeter Shrapnel and High-explosive Shells showing Surfaces to be machined

SOUTHWARK LEAD CABLE COVERING PRESS

The Southwark Foundry & Machine Co., of Philadelphia, Pa., are now building a hydraulic press for applying a lead covering to cables. This press is built in accordance with designs worked out by R. Poliakoff. The cable to be covered with lead is fed into the press through the roller guides of the curved canal *A*, the radius of which is sufficiently large to prevent danger of impairing the pliability of the cable when passing through or distorting it. The cable next passes through bushing *B* and comes into contact with the molten lead, which fills


F
G
X
Y
K
FRONT VIEW OF THE HYDRAULIC PART
FRONT VIEW OF THE LEAD COVERING PART
H
D
M
I
A
L
C
E
B
H
D
SECTION X-Y
J
K
Machinery

Hydraulic Press built by Southwark Foundry & Machine Co. for applying Lead Covering to Cables the ring space between this bushing and die *C* through which the cable is drawn after being covered with lead. As a result of being drawn through the die, the surface of the lead is smoothed out and the diameter of the lead coating is reduced to exactly the required size. The end of the cable comes out of the press leaded and completely finished, so that it can be wound on a drum which serves the additional purpose of furnishing the means for drawing the cable through the machine.

The main parts of the mechanism of this hydraulic cable-covering press may be briefly described as follows: The section of the press required for applying the lead coating is composed of two cylindrical chambers *D* which are filled with molten lead, two bushings *B* and *E*, and the die *C*. The hydraulic part of the press is intended to keep the molten lead in chambers *D* under a definite pressure. Lead is melted in a pot located above the press and delivered into chambers *D* through a pipe *F*. In order to insure a uniform delivery of lead into chambers *D*, pipe *F* is connected to them by an elbow *G*. From these chambers the molten lead comes into contact with the cable through a ring-shaped space between bushing *B* and die *C;* and by moving bushing *B* backward or forward, it is possible to adjust the size of the ring opening to regulate the amount of cable surface that is in contact with the molten lead at any time.

The lead contained in chambers *D* is always under pressure applied by rods *H*, which act as pistons in chambers *D*. These rods are actuated by pressure from hydraulic cylinder *I*, and as the supply of lead in chambers *D* is reduced, rods *H* move to the right to maintain a uniform pressure. When the rods reach the extreme of their movement toward the right, drawing of the cable is stopped and rods *H* are moved back to their original position by shifting the operating valve of the hydraulic press; chambers *D* are then refilled with molten lead from the melting pot, after which the drawing of the cable can be continued.

Naturally, the parts of the press coming into contact with the molten lead will wear out faster than others, and such parts have to be adjusted or repaired from time to time. To facilitate this work, the press has been designed in such a way that these parts can be easily removed. Bushings *B* and *E* are each made of several pieces screwed one into the other, after which the entire bushing is screwed into the press. Provision is made for taking out bushings *B* and *E* by simply giving a few turns to levers *J* and *K*, respectively. Turning of either of these levers transmits motion through a train of gears to a worm-gear *L* or *M*, as the case may be, these worm-gears being set on the bushings to provide for withdrawing them from their respective positions. By this means it is a very easy matter to remove the bushings.

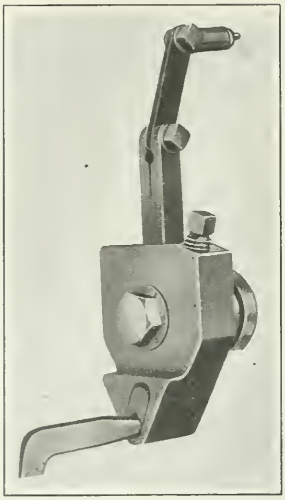


Fig. 1. Bruno Slotting Attachment for Shapers and Planers

BRUNO SLOTTING ATTACHMENT

A slotting attachment made by the Bruno Mfg. Co., 61 Terrace, Buffalo, N. Y., for use on shapers and planers is shown in Fig. 1, and Figs. 2, 3, and 4 show applications of this attachment. It will be seen that the slotting attachment is bolted to the clapper in place of the toolpost, allowing the use of a very short stiff cutting tool, as there is no projecting toolpost in the way, necessitating the use of a long, slender tool. The tool has an adjustable friction arm riding on the head slide, which prevents vibration. All dies, jigs, gages, or other work requiring internal machining of regular or irregular shaped holes may be accurately handled with this attachment. The cutting tool is made of round or square stock and can be turned in any position so that a cut may be taken on the bottom, side, or top of the opening.

In Fig. 2 the Bruno slotting attachment is shown at work on a large die, and on work of this kind the adjusting friction arm with its buffer end effectively prevents vibration of the tool regardless of the speed. Fig. 3 shows a part of a gage which is set 10 degrees out of perpendicular by means of 10-degree parallels. The slot may be quickly and accurately done on a shaper or planer equipped with the Bruno slotting attachment. Fig. 4 illustrates the way in which a keyway may be cut in a gear and it will be apparent to any experienced mechanic that this attachment constitutes a very convenient means of handling operations of this kind.

METZGER ELECTRICALLY WELDED PRODUCTS

The Metzger Welding Co., 1623 Blue Rock St., Cincinnati, Ohio, are manufacturing electrically welded tools and bolts of the types shown in the illustrations which accompany this description. The scarcity and consequent high price of high-speed steel makes economy in its use a matter of necessity, and by welding a high-speed steel inset to a carbon steel shank, making a tool of the form shown in Fig. 1, the benefits of a high-speed steel cutting tool are obtained at a small fraction of the cost of a solid tool made from the higher priced material. These welded tools can be retempered or reheated to any extent without the weld being impaired in any way, as the inset is secured to the tool shank by a permanent weld which has resulted in a complete union of the metals at the joint. The tools are made in six sizes, ranging from 1/2 by 1 by 6, to 1 by 2 by 14 inches.

The cap-screw shown in Fig. 2 is made by welding a head onto the body, thus greatly economizing in material through

Fig. 2. Bruno Slotting Attachment working on Large Die

Fig. 3. Slotting a Gage with Bruno Attachment

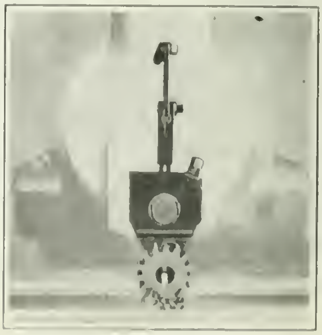


Fig. 4. How Keyways are cut in Gears with Bruno Attachment

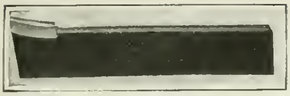


Fig. 1. Tool made by the Metzger Welding Co. by welding a High-speed Steel Inset onto a Carbon Steel Shank

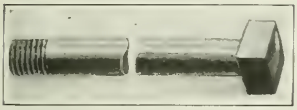


Fig. 2. Type of Cap-screw made by Metzger Welding Process

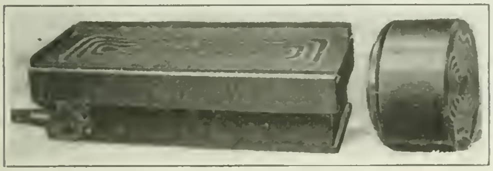
avoiding the necessity of turning away the metal from the body in order to provide for producing a head of the desired size. The heads can be made of square, hexagon, or round stock of any size, and welded to the body, which may be of any desired length or diameter. In making the weld, sufficient pressure must be applied to force the semi-molten steel together, and this expels all burnt metal and slag, leaving the structure of the metal at the joint fully as strong as that of the rest of the bolt. Bolts and cap-screws of this kind are made in a variety of sizes to meet the requirements of different users.

WEST HAVEN PUNCHES

In the May, 1916, number of MACHINERY descriptions were published of center-punches and pin driving punches which had just been placed upon the market at that time by the West Haven Mfg. Co., of New Haven, Conn. This company is now selling sets of these pin driving punches and center-punches which are furnished in a case in which each punch is held in a separate compartment, so that any desired punch may be readily picked out. The set contains an assortment of five different sized center-punches and eight different sized punches for driving out pins or rivets; one solid driving punch, used for starting a rivet or pin that "starts hard," and one prick-punch for punching holes through thin metal.

D & W MAGNETIC CHUCK

The accompanying illustration shows an improved design of the magnetic chuck which the D & W Fuse Co., of Providence, R. I., have been manufacturing for several years. The improvement of this chuck consists of providing a new form of faceplate in which the sections of opposite polarity are separated by bands of non-magnetic material which follow a winding path instead of being straight as was formerly the case. It is claimed that in this way greater holding power is provided for the chuck. In other respects, these chucks are similar in design to those previously made by this company.



Improved Type of Magnetic Chuck made by the D & W Fuse Co.

SIMPLEX FOUR-JAW CHUCK

In the May, 1917, number of MACHINERY a description was published of a four-jaw chuck which had just been placed on the market at that time by the Simplex Tool Co., of Woonsocket, R. I. The design of the chuck has now been improved, and Figs. 1 and 2 show one of the Simplex four-jaw chucks of the latest model. The original chuck was made in such a way that it was necessary to thread the chuck boss to fit the spindle of the lathe, which limited the use of the chuck to lathes with the same type of spindle nose. In the improved chuck, a back-plate can be used in connection with a spigot and bolts to secure the chuck in place. The nuts and washers that were used for keeping the jaws flat in the jaw ways of the old chuck have been replaced by a special adjusting feature which is shown in the rear view of the chuck in Fig. 2. It is claimed that this chuck cannot be strained so that the jaws will not grip for their entire length, and that ample strength and gripping power are provided for work which comes within the range of a chuck of this size.

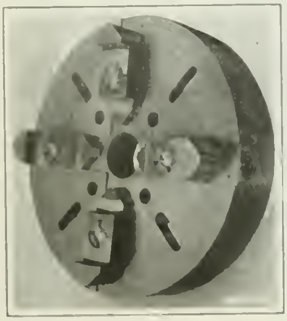


Fig. 1. Four-Jaw Chuck made by Simplex Tool Co.

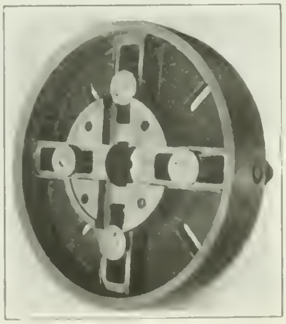
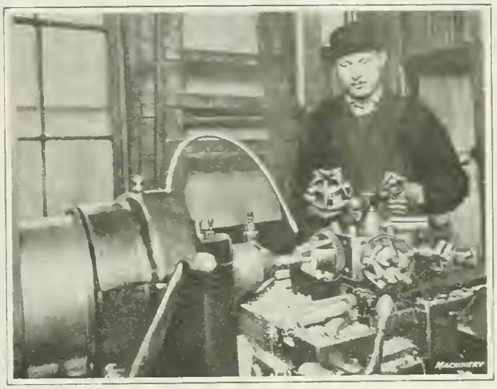


Fig. 2. Opposite Side of Simplex Four-Jaw Chuck

GENESEE ADJUSTABLE HOLLOW-MILL

The Genesee Mfg. Co., of Rochester, N. Y., are now making a line of adjustable hollow-mills of the type shown in operation in the accompanying illustration. Mills of this type are made to handle work from 1/8 inch to 2 inches, and they are made with three or more blades, according to the size of the tool. These blades are positively held by a screw acting in conjunction with a bushing which is shouldered in such a way that the bushing and screw fit into a hole on the side of each blade and pull it down into the holder. A threaded collar on the body of the holder acts as an end support for the blades, and means are provided for adjusting their position as desired. These mills are especially adapted for use on screw machines, but they may also be used on other machine tools.



Application of Genesee Adjustable Hollow-mills on Screw Machine

FLEMING COMBINATION LATHE

To provide for the performance of turning, milling, and boring operations on a single machine, the George W. Fleming Co., 16 Broadway, Springfield, Mass., are building a combination lathe which is shown in Figs. 1 and 2. It is claimed that one of these machines has all of the facilities provided on a 16-inch lathe, a horizontal boring mill, and a plain milling machine, with the additional feature that the lathe is of the sliding-bed gap type. When in use, each unit can be operated just as readily as if it were a separate machine. The base, which carries the sliding member, is ribbed to provide a stiff construction, so that the lathe bed is supported without vibration; and the milling machine table acts as a support for the sliding bed when this bed is in the "closed" position. The sliding lathe bed is strongly ribbed, and the ways are carefully scraped to

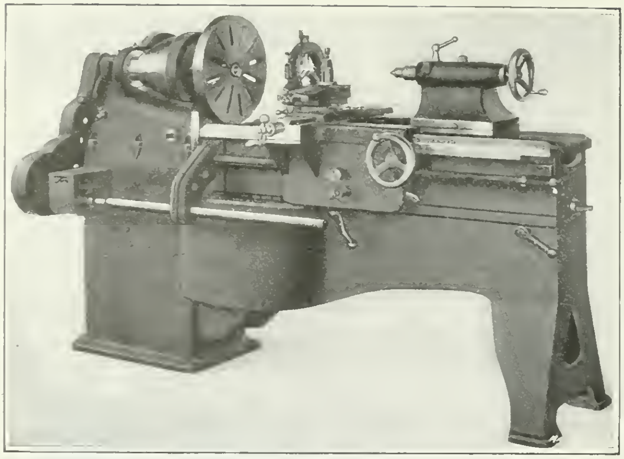


Fig. 1. Combination Lathe built by the George W. Fleming Co., arranged for Use as a 16-inch Lathe

secure accurate alignment of the spindle with both the carriage and the tailstock. The lathe carriage is made to extend out over the face of the apron to allow the compound rest to be used up to the full swing of 25 inches, when the work is of such a size that it requires the gap lathe arrangement to be used.

For driving the machine, the usual arrangement of a four-step cone pulley and single back-gears is employed, and the headstock is provided with a hollow spindle supported by carefully scraped bearings in which provision is made for taking up wear. The milling machine table, saddle, and knee are scraped to accurate fits on all sliding surfaces, and the table is elevated on the face of the column by means of helical gears and a screw. The crank for operating the table is located on the face of the column where it may be conveniently reached by the operator. On the standard machine, hand feed is provided for the milling machine table. The horizontal boring mill is of the table type, and is designed for the use of a boring-bar 1½ inch in diameter, which is furnished with power feed. The drive for the power feed is taken from the lathe change-gears. The regular equipment furnished with this combination lathe includes a countershaft, large and small faceplates, a steadyrest, a set of change-gears, one milling machine arbor, and the necessary punches for making all adjustments. The following may be furnished as extra equipment and features of design: power longitudinal feed to the milling machine table, a taper attachment, a milling machine vise, and a dividing head for the milling machine.

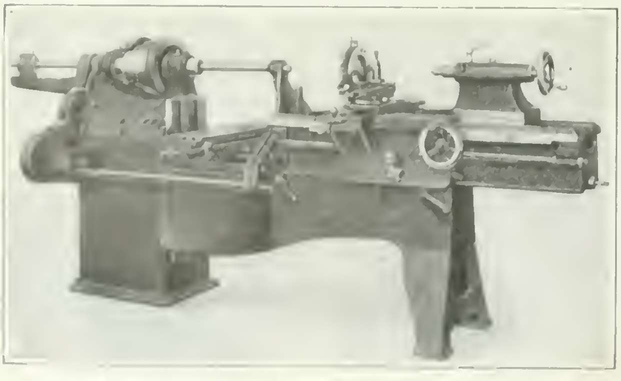
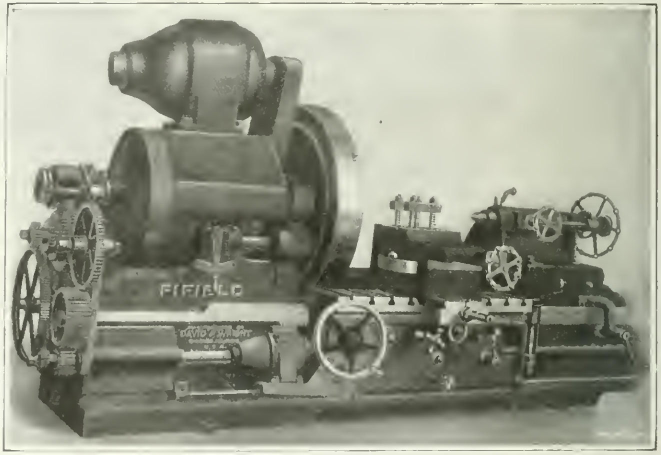


Fig. 2. Fleming Combination Lathe arranged for Use as a Horizontal Boring Mill and Milling Machine

MOTOR-DRIVEN "FIFIELD" LATHE

In the October, 1917, number of MACHINERY an announcement was made of the acquisition of manufacturing rights for the "Fifield" heavy-duty engine lathe by David A. Wright, 568 Washington Blvd., Chicago, Ill. This lathe is now being built in a motor-driven type which is illustrated and described herewith. The range of sizes in which these motor-driven lathes are available is as follows: 34-, 36-, 40-, 50-, 60-, 72-, 84-, and 96-inch swing in standard types, and 40-, 50-, and 60-inch swing in a special heavy type. Lathes of these different sizes are built with any length of bed to meet the requirements of different shops.

In working out the design of these lathes, all gears have been guarded to prevent the possibility of injury to the operator, and all main and high-speed bearings are bushed with bronze. The bushings are securely fastened to their seats and large oil-channels are provided with oil-holes conveniently located to facilitate oiling. It will be seen that the headstock is of the all-geared type and any of three mechanical changes of speed can be obtained by manipulating a single lever. The motor mounted on top of the headstock may be supplied for connection with either alternating- or direct-current circuits and may be either constant- or variable-speed. All bearings in the headstock are of the self-oiling type, and they are furnished with large oil-wells that carry an ample supply of lubricant. The shafts and spindles are ground to size, and the bearings in which they run are reamed and scraped to a close fit.

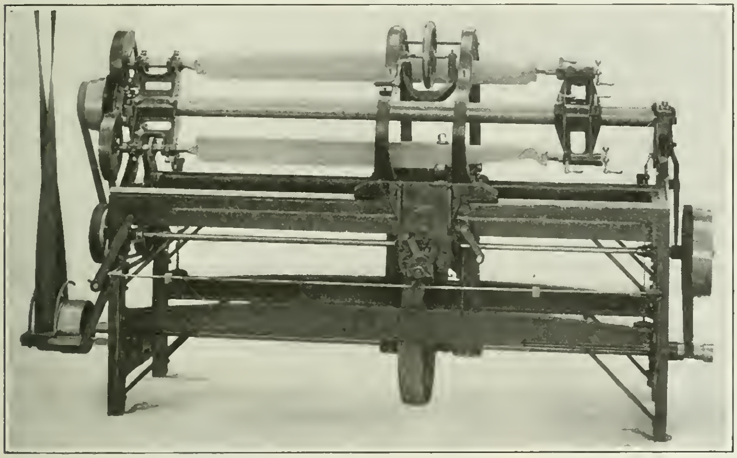


"Fifield" Motor-driven Heavy-duty Engine Lathe built by David A. Wright

The carriage is fitted to V-ways on the bed and is gibbed underneath the ways at both the front and back. A clamp provides for securing the carriage in any desired position when the cross-feed is to be employed. Power feed and hand longitudinal feed are available in either direction. The tool-slide has taper gibs furnishing means of adjustment for wear, and it is fitted with straps and bolts designed to hold large tools. When a taper attachment is used on the machine, it is secured to the carriage and bolted to T-slots on the side of the bed. The apron has a friction clutch for traverse feeding and a lead-screw nut for the performance of threading operations, with feed reverse in the apron. The feed gears are driven by a spline in the lead-screw and may be disengaged while the lathe is cutting threads. A steadyrest of box section is furnished with the lathe, and this rest has three jaws with liberal wearing surfaces. The top half of the steadyrest may be swiveled on one side and is easily removable. Cross adjustment of the upper part of the tailstock is accomplished by means of a screw, and the tailstock is operated by a crank wrench and gearing, which engage the steel feed rack for traversing the tailstock along the bed by hand. Fourteen change-gears are furnished with the machine for use in thread cutting.

AIRPLANE STRUT TURNING MACHINE

In the March, 1916, number of MACHINERY a description was published of a rifle stock turning machine which had just been placed on the market at that time by Gilman & Son, of Springfield, Vt. In the accompanying illustration there is shown a machine of similar design which has been developed for use in turning airplane struts. In both this machine and the rifle stock turning machine, a model of the desired form is made for use in the machine and this acts as a "master" for the guide on the turning machine, which controls the operation of the tools to provide for turning the work to exactly the same form. In the illustration, the master is shown in the upper position and the partially turned airplane strut is shown in the lower position. The general features of the machine are the same as that of the rifle stock turning machine. This airplane strut turning machine is built by the Fitz-Empire Double Pivot Last Co., Rochester, N. Y., of which the firm of Gilman & Son is a branch. The carriage that supports the cutter-head can be fed in either direction, which avoids the necessity of returning to the starting point. The rate of feed is 4 to 6 inches per minute. Machines of this type are built in three sizes, with capacities of 50, 72, and 100 inches between centers.



Airplane Strut Turning Machine built by Fitz-Empire Double Pivot Last Co.

KANE & ROACH ANGLE BENDING MACHINES

On the No. 14 angle bending machine built by Kane & Roach, Niagara and Shonnard Sts., Syracuse, N. Y., light angles up to 2½ by 2½ by 1/4 inch can be bent. To provide for bending larger angles, this firm has brought out a heavy-duty machine that is built in three sizes. The No. 22 machine handles angle-irons up to 3 by 3 by 3/8 inch. The No. 23 machine handles work up to 4 by 4 by 1/2 inch, and the No. 26 machine handles work up to 6 by 6 by 5/8 inch. In addition to bending angles, these machines can be employed for bending equivalent sizes of I beams, channels, T-irons, rounds, squares, tubular stock, flat stock, and other shapes by simply making "filling in" collars or rolls to suit any particular kind of work. It is also possible to bend either one angle or two angles at a time, according to the quantity of work which is being handled.

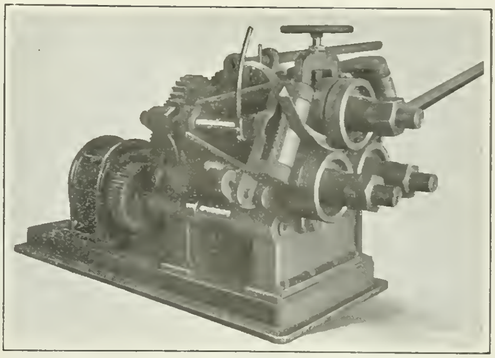


Fig. 1. Kane & Roach Angle Bending Machine equipped for Individual Motor Drive

In working out the design of these machines, the bending rolls were placed as close to the floor as possible, in order to facilitate placing heavy work in the machine. In Fig. 1 a machine is shown equipped for individual motor drive, and Fig. 2 shows the machine arranged for belt drive with reversing pulleys. In cases where belt drive is employed, the shifters are so constructed that the operator of the machine can manipulate either shifter to provide for running the machine forward or back, as required. In handling certain classes of work, it is necessary to reverse the machine several times to provide for running the work back and forth, and in such cases a conveniently located operating lever is particularly important. It will be noticed that the bending rolls are almost in contact with each other, and there are several reasons for this arrangement. In the first place, having the rolls close together practically avoids the flat or straight spot at either end of a piece that is being bent, which is an important feature, because it not only saves time in bending the ends of the work to the required curvature, but material is also saved through avoiding the necessity of crop-

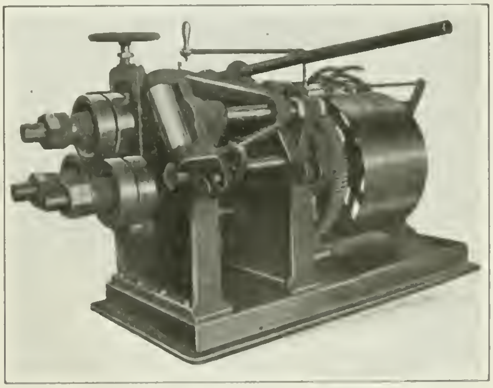


Fig. 2. Kane & Roach Angle Bending Machine equipped with Reversing Pulleys for Belt Drive

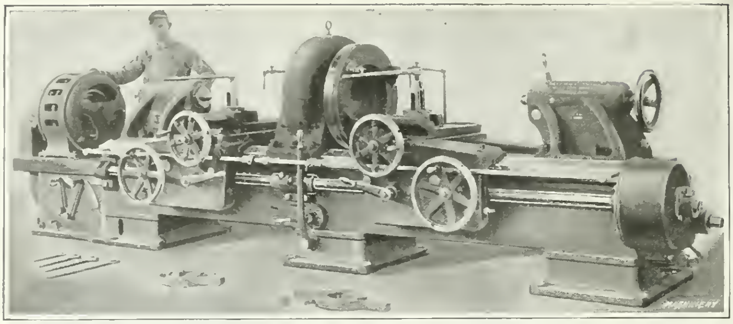


Fig. 1. Front View of Niles-Bement-Pond No. 3 Axle Lathe

ping off the extreme ends of the work which cannot be bent to the desired form. Another feature of having the rolls close together is that the material can be started into the roll to be bent without having to start the bend by hand. This is the means of making a very important reduction in the cost of bending work. A sliding gag under the adjusting screw provides for holding down the top roll, and this gag can be slid out from under the screw to enable the top roll to be raised out of the way when it is desired to put work in the machine or take it out after a bend has been completed. With this arrangement, the screw adjustment does not have to be altered. When one piece has been removed and another piece has been put into position on the lower rolls, the upper roll is dropped into place and the gag slid back under the adjusting screw, after which the machine is ready to continue its operation.

Side rolls are provided at each side of the bending rolls and these may be swiveled to any angle according to the radius of the curve to which work is being bent. These side rolls can also be adjusted in or out to meet the requirements of different classes of work. They effectually prevent side twisting or buckling of the work during the bending operation and enable the piece to come out perfectly true. The rolls are made of high-carbon steel and the outside sections slide in or out to provide for handling any width of work that comes within the capacity of the machine. The shafts carrying these rolls are exceedingly heavy and all the front bearings that carry the roller shafts are bushed with bronze. The driving gears are made of steel with cut teeth. With the exception of differences in size, the design of all three of these machines is the same. Each machine is provided with a scale and pointer to show just where to set the rolls for bending work to any desired radius of curvature, which is an important feature in simplifying the setting of the machine for any given job.

NILES-BEMENT-POND AXLE LATHE

The No. 3 axle lathe which is shown in the illustrations that accompany the following description is one of the recent products of the Niles-Bement-Pond Co., 111 Broadway, New York City. It is intended for machining axle forgings as well as rough machined axles. It will be seen that the work is center-driven and wheel seats and journals can be simultaneously turned at both ends of car axles. The tracks for the carriage consist of a wide flat way at the back of the bed and an improved compensating V-way at the front; the vee has an angle of 15 degrees at the back and 70 degrees at the front. The form of this way is clearly shown in the end view of the machine Fig. 2. The 15-degree angle at the back of the vee serves a double purpose; namely, it presents a thrust surface at right angles to the combined forces of the tools, eliminating all tendency of the carriage to climb under heavy cuts, and it automatically compensates for wear in both the carriages and the lathe bed.

Mention has already been made of the use of a center driving head on the lathe. This head is of massive construction, completely encloses the main driving gear, and forms an oil reservoir in which the gear runs. The head is clamped to the bed by six large bolts and it may be adjusted longitudinally along the bed. The main drive is by means of a large steel herringbone gear and pinion which are carried between the bearings in the head. The axle is driven by a steel equalizing driving plate having lugs cast integral which engage both ends of the double driving dog. By means of this driving plate crooked or irregular axles can be machined without setting up bending strains.

Two carriages are provided which have power longitudinal feeds by a right- and left-hand screw that is positively driven by gearing. Split nuts engage the lead-screw and are provided with automatic devices which release them when the carriages come into contact with set collars on a tappet rod at the front of the machine. Two clamps are provided at the front of the carriages, one of these being used for clamping the carriage to the bed when turning against shoulders and facing the ends of axles, and the other clamp is under the bridge and further decreases the tendency of the carriage to lift while the burnishing operation is being performed. The tool-slides are provided with a trough which is connected with channels in the carriage bridge for carrying off the lubricant; and the aprons are of double wall construction, so that all mechanism except the operating levers is completely enclosed and all shafts are supported at both ends. The feed gears are located at the right-hand end of the bed and are completely enclosed. A lever which controls feed changes is placed at the center of the machine within easy reach of the operator and three changes of feed are available; namely 1/16, 3/32, and 3/16 inch.

In machining axles on this lathe, the work is carried on dead centers mounted in two heavy tailstocks which are adjustable longitudinally along the bed and can be clamped in the desired positions by four large anchor bolts. To prevent slipping a pawl is provided that engages a rack cast in the bed. The lathe may be driven by a three-step cone pulley having a maximum diameter of 32 inches and carrying a belt 7 inches in width. A two-speed countershaft gives six speeds to the driv-

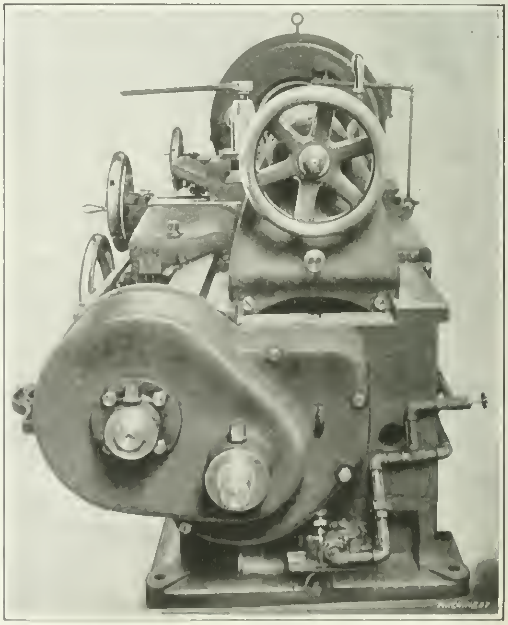


Fig. 2. End View of Niles-Bement-Pond No. 3 Axle Lathe

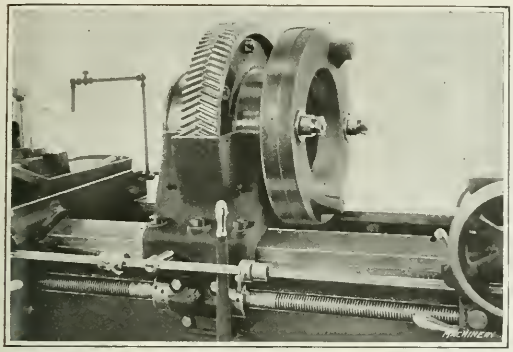


Fig. 3. Arrangement of Head to drive Work from Center

ing head ranging from 16 to 48 revolutions per minute. When so desired, single-pulley drive may be furnished and in such cases a pulley 26 inches in diameter is employed, which carries an 8-inch belt. Power is transmitted through a speed-box mounted at the left-hand end of the lathe bed which furnishes four changes of speed to the driving head, ranging from 16 to 48 revolutions per minute. A constant speed alternating-current motor may be used to drive the machine and in such cases the motor is mounted on a speed-box at the left-hand end of the lathe bed and power is transmitted by gearing from this speed-box to the driving shaft. This arrangement gives four changes of speed, ranging from 16 to 48 revolutions per minute. When so desired, an adjustable speed motor for direct current, with a speed variation of 3 to 1, may be mounted on a baseplate attached to the left-hand end of the lathe bed. This motor is geared direct to the driving shaft giving speeds to the driving head ranging approximately from 16 to 48 revolutions per minute. A crane for handling axles in and out of the lathe can be furnished as special equipment, which greatly facilitates the lifting of heavy pieces.

The principal dimensions of this machine are as follows: swing over bed, 30½ inches; swing over tool-slide, 13 inches; diameter of hole through driving head, 13 inches; maximum distance between centers, 9 feet, 3 inches; length of bed, 14 inches; diameter of tailstock spindles, 5 inches; traverse of right-hand tailstock spindle, 9 inches (left-hand tailstock spindle is stationary); number of longitudinal carriage feeds, 3; and rates of feed per revolution of driving head, 1/16, 3/32, and 3/16 inch.

JACKSON DUPLEX DIE-SINKER

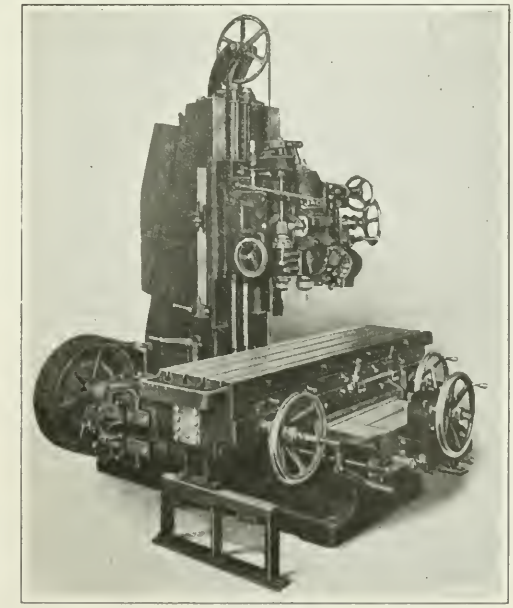
The steadily increasing use of drop-forgings in machine construction makes it important to devise methods of making drop-forging dies as rapidly and inexpensively as possible. The No. 10 duplex die-sinking machine shown in the accompanying illustration has been developed by the Jackson Machine Tool Co., Jackson, Mich., to provide for making in an inexpensive way all drop-forging dies from the smallest sizes up to those weighing 4000 or 5000 pounds each. This result has been obtained by designing the machine with all control levers easily accessible, by providing an adequate range of cutting speeds and feeds, and by having all parts so proportioned that they possess ample strength and rigidity. By reducing the cost of dies, it is possible to make machine parts of drop-forgings which would otherwise have to be made of some other material. With this die-sinking machine, it is possible to finish intricate shapes with little or no hand labor. Semicircular depressions with straight ends are easily made by one special cutter used on this machine.

Briefly described, the machine consists of a base, column, and head. On the base there is carried a cross-rail which supports the table, and to the base there is also bolted a column that carries the head. The cross-rail, table, and head are furnished with both hand and power feeds in all directions, so that a die-block bolted to the table may be brought under any of the cutting tools. A rapid traverse power feed in all directions is also available, with automatic disengagement of this feed when the rapid traverse is thrown into operation. An interlocking device prevents the rapid traverse being engaged in the same direction as the feed; this rapid traverse can be brought into operation only to back the tool out of its cut.

Cutting tools used for die-sinking are carried by two spindles. There is a large centrally located spindle in the head which carries the larger sizes of milling cutters and at the right-hand side of the large spindle there is a cherrying tool driven by suitable mechanism, by means of which narrow or wide semicircular depressions with straight or nearly straight ends can be quickly and accurately cut. The practical application of this device is for squaring up the ends of depressions in dies for shafts, etc. The range of diameters of these cutters runs from 1/4 to 4 inches, each cutter making a semicircular depression equal to its own diameter and a width equal to its thickness. A long semicircular depression may be produced from solid stock and finished with a longitudinal movement of these cutters. An interlocking device between the large spindle and cherrying tool mechanism makes it possible by the movement of a single lever to engage either one with the driving shaft and simultaneously lock the other in a stationary position. In this way danger of engaging both mechanisms at the same time is avoided.

The speed-changing mechanism is contained in a box-shaped bracket bolted to the side of the bed and nine changes of speed are obtained by means of gears sliding endwise on two shafts, the arrangement being similar to the speed-changing device of an automobile. This mechanism provides speeds ranging from 40 to 413 revolutions per minute for the large spindle and from 80 to 826 revolutions for the smaller spindle; 13 to 138 cutting strokes per minute of the cherrying tool are available. The feed-changing mechanism is similar in design and construction to the speed-box. It is bolted to the base but on the opposite side from the speed-box and nine changes of feed are provided, the range of which is as follows: In a horizontal direction, from 0.0014 to 0.0187 inch per revolution for the large spindle and from 0.0043 to 0.0562 inch per cutting stroke of the cherrying tool; in a vertical direction, from 0.0002 to 0.0031 inch per revolution for the large spindle and from 0.0007 to 0.0093 inch per cutting stroke of the cherrying tool. These feed ranges are ample for average requirements.

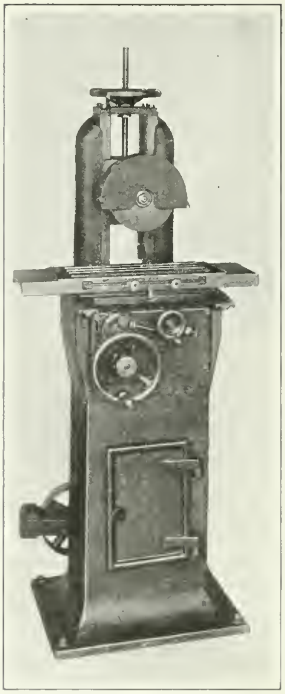
The cherrying tool and mechanism for operating it are among the most interesting features of this machine. The



Duplex Die-sinking Machine built by the Jackson Machine Tool Co.

tools are made in the form of semicircular disks and usually have a thickness which is small in comparison to their diameter. The sides of the cutter have a taper in order to enable the proper draft to be formed in the depression in the die-block. Cutting teeth are formed on the periphery and sides of the cutter, and projecting from what corresponds to the flat edge of the semicircular disk there is a round shank, which is inserted and secured in the tool-holder. This holder is a flat piece of steel of triangular shape, having a flat surface at the apex of its lower corner. In this flat surface there is a hole in which the shank of the cutter is inserted; and on each side of the tool-holder and integral to it there is a curved strip moving in circular guides in the cherrying tool housing. The center of these circular guides coincides with the center of the cherrying tool. The holder is given an oscillating motion by means of a connecting-rod attached to a projection from its upper edge, and the cherrying tool housing also has a small vertical movement, which is so timed that the cutter is lifted from the metal on its return stroke and lowered ready for the cutting stroke. When the cutter is inserted in the cutter-holder, the plane of the cutter of semi-disk form is the same as the plane of the tool-holder. An oscillating motion is imparted to the cutter corresponding to that of the holder. The center of oscillation is, of course, the center of the semicircular cutter.

When in operation, the cutter starts on its forward or cutting stroke, and at the same time it lowers into a position for removing metal from the die-block. When near the end of the cutting stroke, the cutter rises from its cutting position and remains up until it again starts on its cutting stroke. The cutter may be fed by hand or power vertically downward into its cut or longitudinally in the direction of the axis of the cutter, which is raised and lowered on its return and cutting strokes by means of a cam located inside of the head. Its action is such that the cam lifts the cutter out of the working position and a strong spring pulls the cutter into position. The strength of this spring is such, however, that the cutter cannot be overloaded by taking too heavy a cut, as the spring will yield before any damage can be done, to enable a shallower cut to be taken. In working out the design of this machine, especial attention has been paid to the location of all control levers so that they may be easily reached from the operator's position which greatly facilitates the handling of die-sinking operations.


Surface Grinding Machine built by the Bridgeport Die & Machine Co.

BRIDGEPORT SURFACE GRINDING MACHINE

To meet the requirements of grinding work of small and medium sizes, the Bridgeport Die & Machine Co., of Bridgeport, Conn., have recently placed on the market a 5- by 8- by 14-inch surface grinding machine which is illustrated and described herewith. It is claimed that this machine is large enough to handle a majority of tool-room grinding operations, and that, as the machine is of moderate size, it occupies only a limited amount of floor space. A machine of this size also takes less power to operate. This grinding machine was originally developed for use in the Bridgeport Die & Machine Co.'s shops for use in grinding tools, dies, gages, and small machine parts. It was developed to meet the need of a small surface grinding machine which would have sufficient capacity to handle a large majority of the parts going through this company's shop which required grinding. The machine proved so satisfactory in service that it was decided to build it for the market.

The spindle is made of chrome-nickel steel, hardened, ground, and lapped, and it runs in phosphor-bronze bearings provided with means for adjustment for wear. The handwheel that provides for raising or lowering the grinding wheel is furnished with a collar graduated to read to 0.0005 inch, and the machine is equipped with a grinding wheel 7 inches in diameter by a 1/2-inch face width. The table is 24 inches long by 6¾ inches in width, and it has a working surface 14 by 5 inches in size with three 7/16-inch T-slots. The movements of the table are automatic, the range being as follows: longitudinal feed, 14 inches; cross-feed, 5 inches; and vertical adjustment 8½ inches. The net weight of this grinding machine is 575 pounds.

AMERICAN AMPLIFYING GAGE

To meet the requirements of gaging work in either the tool-room and production departments of a plant, the American Gage Co., of Dayton, Ohio, has developed an amplifying gage which is illustrated and described herewith. In placing this gage on the market, the purpose has been to provide means of accurately and economically gaging cylindrical or flat work. One of the features of this gage is the fine adjustment that can be accurately and rapidly obtained, and another important point is the arrangement of the "gaging end," which is of small size, making it possible to measure close up to large

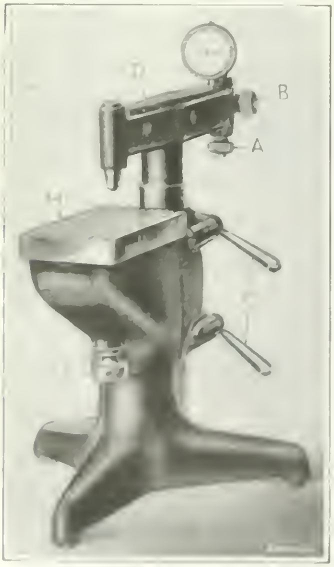


Fig. 1. Amplifying Gage made by the American Gage Co.

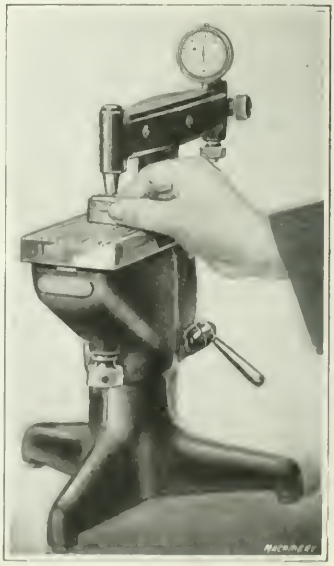


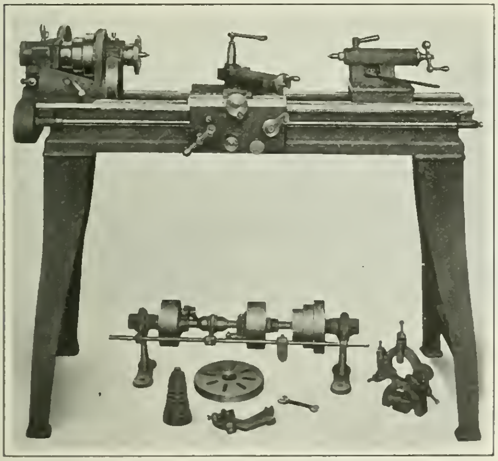
Fig. 2. Method of setting American Amplifying Gage

shoulders, etc. The amplifying levers are housed in the cross-arm, which is made of box section, providing a rigid enclosed space for these levers, from which all dust and other foreign matter is excluded.

Adjustments are made by means of screw *A*, after which clamping screw *B* is tightened to maintain the required setting. Levers *C* are used for clamping cross-arm *D*, and screw *E* provides for holding platen *H* or other attachments that may be used on the gaging machine. It will be seen that the machine is furnished with a base having a three-point bearing, which enables it to stand firmly on any bench or table. Rubber pads are provided to absorb vibration. For use on this gaging machine, an indicator is provided which is graduated to read in 0.0001 inch, with a range of 0.005 inch each side of the zero mark. A concentricity testing attachment and test centers for holding work up to 10 inches in length by 4 inches in diameter can be furnished for use with this machine. One of these gaging machines with a suitable set of master gages or models makes an ideal measuring system for use in toolrooms or in manufacturing departments where extreme accuracy is required.

DAVIS ENGINE LATHE

The 11-inch engine lathe which forms the subject of the following description has recently been placed on the market by the C. F. Davis Machine Co., Inc., 133 Andrews St., Rochester, N. Y. This machine is well adapted for the requirements of tool and experimental shops engaged in the production of small work. The spindle has a 1⅜-inch hole extending for its entire length and is carried in babbitted bearings which are bored and scraped to fit the spindle accurately. An offset type of tailstock used on this lathe enables the compound rest to be swiveled into a position parallel with the bed, and the tailstock may be set over to provide for the performance of taper-turning operations. Longitudinal- and cross-feeds for the carriage are operated from the front of the apron and the cross-feed is graduated to 0.001 inch. A compound rest is furnished for use on the machine, which is graduated in the usual way. The regular equipment furnished with this lathe includes large and small faceplates; steadyrest and follow-rest; a countershaft and wrenches; and a full set of change-gears for cutting threads from 4 to 80 per inch.

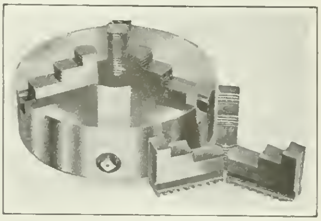


Eleven-inch Engine Lathe built by the C. F. Davis Machine Co., Inc.

The principal dimensions of this lathe are as follows: capacity between centers, up to 32 inches; swing over bed, 11¼ inches; swing over carriage, 6½ inches; diameter of hole through spindle, 1⅜ inch; size of front spindle bearing, 2 1/16 inches in diameter by 2¾ inches long; size of rear spindle bearing, 1⅞ inch in diameter by 1⅞ inch long; width of driving belt, 1¼ inch; ratio of back-gears, 7 to 1; diameter of tailstock spindle, 1 3/16 inch; travel of tailstock spindle, 5¼ inches; length of carriage on bed, 12 inches; travel of compound rest, 4½ inches; size of lathe tools, 1/2 by 1 inch; capacity for thread cutting, 4 to 80 threads per inch; capacity of center rest, 3 inches; range of spindle speeds, 26 to 460 revolutions per minute; and net weight of machine, 650 pounds.

TERKELSEN & WENNBERG CHUCKS

Terkelsen & Wennberg, Boston, Mass., are now manufacturing a line of universal geared scroll chucks of the type which is illustrated and described herewith. These chucks are made with either inside jaws or outside jaws, and chucks may be furnished with two sets of jaws to provide for holding work from either the inside or the outside. A chuck provided with one of these extra sets of jaws is shown in the accompanying illustration. These chucks are made in ten different sizes with capacities of 2½, 3, 4, 5, 6, 7½, 9, 10½, 12, and 15 inches.

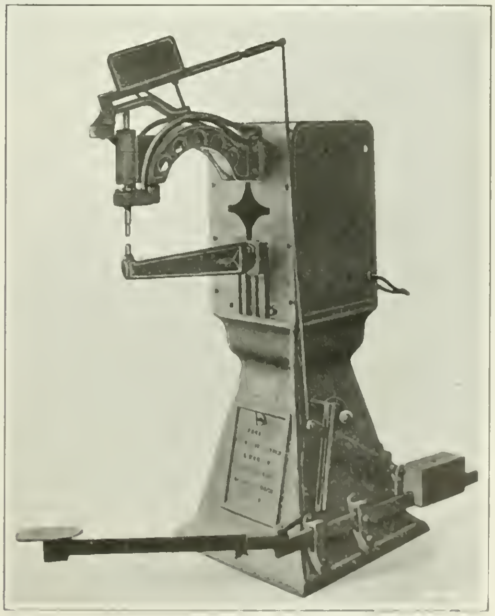


Scroll Chuck made by Terkelsen & Wennberg

PACIFIC ELECTRIC SPOT-WELDER

The Pacific Electric Welder & Mfg. Co., Seattle, Wash., are now building a type SA-10 spot-welding machine which has a capacity for work ranging from 30 gage up to 11 gage. In other words, it is able to weld together two pieces having a combined thickness up to 1/4 inch. This machine has a depth of throat of 20 inches and the horn is adjustable through a distance of 6 inches, the maximum opening between the welding points being 3½ inches. The height from the floor to the welding points is 45 inches and the welder has an over-all height of 60 inches. Crated for shipment it weighs approximately 1000 pounds.

Machines of this type are used for performing the familiar operation of spot-welding, which is employed to electrically



Type SA-10 Electric Spot-welding Machine built by the Pacific Electric Welder & Mfg. Co.

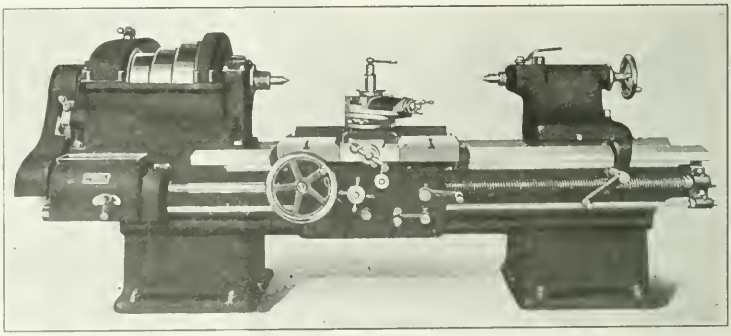
fuse together two or more metal sheets without any preliminary preparation of the stock. It is the mechanical equivalent of riveting, although spot-welding may be more quickly and, therefore, more economically accomplished. In spot-welding on one of these machines, the material is placed between the electrodes at the point where it is desired to make the weld, after which pressure is applied with the hand or foot lever, so that the metals are squeezed together. The weld is made almost instantly. Welding rods or wire in the form of a cross, etc., can also be done on the spot-welding machine. Single-phase alternating current is used in operating this spot-welding machine. Pacific electric spot-welders are made in other sizes that are adapted for welding thicker metal.

SIDNEY HIGH-DUTY LATHE

The Sidney Tool Co., Sidney, Ohio, are now building the 25-inch, double back-geared, high-duty lathe which is illustrated and described herewith. This machine is equipped with semi-quick-change gears and a 10-foot bed, but these lathes are also provided with quick-change gears and with beds 10, 12, 14, 16, 18, and 20 feet in length. The bed is made with heavy double-wall cross-girts, spaced 2 feet apart, and one large way is cast on the bed at the front and a smaller way at the back. A 20 per cent steel mixture is used for casting these ways on the bed, thus providing a very hard metal for the carriage bearings, so that any wear which develops will be largely confined to the carriage. The carriage vee in front is 3 inches wide, and the vee in the rear is 2½ inches wide. The length of the carriage is 36 inches, and it is drilled to receive a taper attachment and also grooved to receive the tongue on the taper attachment which maintains alignment. The racks are made of high-carbon steel and secured to the lathe bed with pins and bolts.

Full-length taper gibs with end screw adjustment are provided on both the cross-slide and compound-rest slides, these gibs being placed on the negative side, where they do not receive the thrust of the tool. The compound rest is designed with a completely circular swivel which is graduated in degrees, and the compound rest is clamped to the cross-slide by means of heavy bolts. Provision is made for securing the tailstock spindle in any position by means of a clamping bolt without in any way affecting its alignment. It will be seen that the headstock is of the enclosed type, and the spindle is made of 50-point carbon steel and supported in phosphor-bronze bearings. The spindle bearings are equipped with sight-feed oil-cups, and all other bearings are provided with Brown & Sharpe oil plugs. By having the apron of the double-plate type, two bearings are provided for all studs carrying gears. The apron is grooved, pinned, and bolted to the carriage, and the feed rods are supported on both ends. All apron gears, as well as those in the gear box, are made of steel, and the lead screw is made of 40-point carbon steel. The quick-change gear mechanism furnished on this machine forms a complete unit, being mounted at the front end of the machine and secured by means of a tongue and groove to maintain alignment.

The principal dimensions of this lathe are as follows: swing over shears, 27 1/2 inches; swing over carriage, 19 inches; distance between centers for 10-foot bed, 4 feet, 6 inches; diameter of hole through spindle, 2 3/16 inches; ratio of first back gears, 4 1/4 to 1; ratio of second back gears, 11 1/2 to 1; travel of tailstock spindle, 10 1/2 inches; travel of compound rest, 5 inches; capacity of steadyrest, 8 inches; size of tools used on machine, 7/8 to 1 3/4 inch; and weight of machine with 10-foot bed, 7000 pounds.


High-duty 25-inch Engine Lathe built by the Sidney Tool Co.

NEW MACHINERY AND TOOLS NOTES

Shell Conveyor: Lamson Co., 100 Boylston St., Boston, Mass. A shell conveyor of the gravity type, which is furnished with rollers that are "spool" shaped, furnishing a channel down which shells can run lengthwise. To insure ease of operation, ball bearings are used to carry the roller spindles.

C-clamp: William G. LeCount, South Norwalk, Conn. A line of drop-forged C-clamps provided with a screw made of high-grade steel hardened and tempered, with United States standard threads. These clamps are made in seven sizes, varying in length from 3 to 12 inches, all sizes having a throat depth of 3 inches.

Planers: Amalgamated Machinery Corporation, Chicago, Ill. Planers especially built for use in planing the beds of large gun boring machines. The beds of these planers are made of reinforced concrete. Although these are special-purpose machines, the same method of construction could be applied in building standard planers.

Motor-driven Scrapers: Modern Mfg. Co., Bridgeport, Conn. A motor-driven equipment developed to obviate the necessity of scraping aluminum and brass castings by hand. The outfit consists of an electric motor and a flexible shaft that drives the scraping tool, which may be of a variety of forms to meet different requirements.

Moisture Separator for Compressed Air Lines: Griscom-Russell Co., 90 West St., New York City. A device designed to remove moisture from compressed air carried in pipe lines in an industrial plant. This device operates similar to a steam separator and is particularly adapted for use in air lines serving sand-blast machines and pneumatic tools.

Turret Screw Machine: Defiance Machine Works, Defiance, Ohio. A No. 4 turret screw machine equipped with a geared friction head, automatic chuck, bar feed, and hand longitudinal feed to the cut off. On this machine, all of the gears are completely enclosed and the head has the cone type of drive with friction back-gears, giving two spindle speeds for each step on the cone-pulley; that is to say, a total of six speed changes.

Electric Truck: Elwell-Parker Electric Co., Cleveland, Ohio. An industrial truck equipped with electric motor drive, which is designed on the four-wheel steer and two-wheel drive principle. This is known as a type WB truck. Three changes of speed are obtainable in either direction, ranging from 400 to 650 feet per minute, and the truck has a capacity for loads up to 4000 pounds.

Cylinder Grinding Machine: Baxter D. Whitney & Son, Winchendon, Mass. This company has recently purchased from the Brown & Sharpe Mfg. Co., the manufacturing rights on its No. 23 cylinder grinding machine and will take up the building of this machine for the market. With the manufacturing rights, the Whitney Co. has acquired the designs, and the jig and fixture equipment used in making the grinder.

Gun Boring Lathe: Amalgamated Machinery Corporation, Chicago, Ill. A line of gun boring lathes which are made in three sizes; namely, a No. 26 machine which has a 6-inch spindle and swings 27 inches; a No. 46 machine, which has an 8-inch spindle and swings 39 inches; and a No. 66 machine, which has a 10-inch spindle and swings 48 inches. These machines are adapted for the performance of boring operations on field guns.

Crane Cab Heater: Cutler-Hammer Mfg. Co., Milwaukee, Wis. This company has recently applied the electric heater of its manufacture for use in warming crane cabs during severe winter weather. In this way the crane operator is enabled to work under comfortable conditions. These heaters are also being used in gas valve houses, meter houses, on the charging bridges of coke ovens, and in other similar locations.

Universal Milling Machine: Becker Milling Machine Co., Hyde Park, Mass. A No. 3 universal milling machine that is driven by a three-step cone-pulley and back-gears which are located at the rear of the machine. The range of power feed movements on this machine are as follows: Longitudinal, up to 30 inches; cross, up to 10 inches; and vertical, up to 19 inches. The maximum distance from the center of the spindle to the table is 19¼ inches.

Locomotive Gantry Crane: Brown Hoisting Machinery Co., Cleveland, Ohio. A crane having a capacity of thirty tons, which is used for unloading materials and carrying them around a shipyard. It has a fixed boom 30 feet long and travels on the top of the gantry on tracks spaced 22½ feet between centers. The span of the gantry is 40 feet, which is sufficient to reach over three railroad tracks, and a clearance of 20 feet is provided over the rails.

Shell Lathes: Gisholt Machine Co., Madison, Wis. A 16-inch lathe for machining shells, that has been designed to meet simplified conditions of operation in the manufacture of high-explosive and shrapnel shells. This is a single-purpose machine enabling the design to be greatly simplified, and thus making the machine well adapted for operation by female labor. Various auxiliary equipments are furnished for this lathe to adapt it for the performance of various machining operations that must be performed on shells of different types.

Reclaiming Tang: Mailometer Co., Detroit, Mich. A device for reclaiming cutting tools from which the tang has been twisted off. The device consists of a new tang which is provided with a shoulder so that the shank of the tool to be reclaimed can be ground to fit this shoulder. In this way, the tool is provided with a new tang enabling it to be fitted into the commonly used forms of drill sockets, or mounted directly in the machine spindle. It is claimed that the new tang has exactly the same driving power as the one originally provided on the tool.

* * *

ELECTRIC HOIST MANUFACTURERS ASSOCIATION

The Electric Hoist Manufacturers Association has recently been organized with the object of coordinating the total experience of the electric hoist manufacturers of the United States and making available for the user the best in electric hoist design and practice. The association holds monthly meetings for the purpose of studying the specific needs of the hoist user and promoting the standardization of electric hoists. The War Industries Board has requested information concerning the ability of the electric hoist manufacturers to handle the volume of business offered them, and it is thought that the association can be of great assistance to the Board. The members of the association are: Brown Hoisting Machinery Co.; Detroit Hoist & Machine Co.; Euclid Crane & Hoist Co.; Franklin-Moore Co.; Link-Belt Co.; Roeper Crane & Hoist Works; Shepard Electric Crane & Hoist Co; Sprague Electric Works; and Yale and Towne Mfg. Co. The officers are: F. A. Hatch, chairman, Shepard Electric Crane & Hoist Co.; F. W. Hall, vice-chairman, Sprague Electric Works; and C. W. Beaver, secretary-treasurer, Yale & Towne Mfg. Co. The membership of the association is confined to those engaged in the manufacture of monorail electric hoists.

* * *

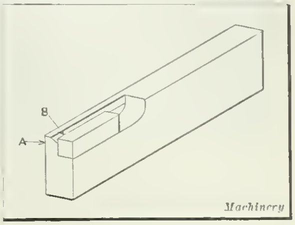
LONG SERVICE WITH SAME CONCERN

In these days when we hear so much about labor turnover, it is interesting to note that there are instances where employes remain for a long time with the same company. The C. C. Bradley & Son, Inc., Syracuse, N. Y., have had a satisfactory experience in keeping many of their employes for a long period of time; thus, for example, there are seven men in the Bradley shops who have been with the concern for over forty years; four who have been with them from thirty to forty years; eight, from twenty to thirty years; and seven, from fifteen to twenty years; or, in all, twenty-six men who have been with the concern for over fifteen years. It is also interesting to note that the sons of many men who are now working in the Bradley shops are also employed there, and, indeed, some of the grandsons of employes have also been working in the shops. The labor turnover is apparently not a problem with this concern.

BRAZING STELLITE TO STEEL SHANKS

The accompanying illustration shows a method of brazing stellite to steel shanks. A thin web *A* is left on the side of the shank opposite the cutting edge of the bit; the thickness of this web is governed of course, by the width of the bit, and it should be chamfered, as shown at *B*, at about 45 degrees and to a depth of approximately one-fifth the depth of the bit. Leaving this web insures enough copper in the joint prior to lifting the tool from the fire.

The stellite tip and shank are placed in the forge and allowed to soak in the fire until white-hot, when a thin sheet of copper should be placed between the steel shank and the stellite tip, borax being freely applied. The tool is then brought to a white heat, or to such a point that it will soften the stellite slightly, additional copper being melted from time to time, either from a piece of copper tube or copper sheet, and allowed to flow in the chamfer *B*. In this way the copper will run down and wash away any dirt, and at the same time exclude the air and do away with oxidation. When the tool begins to soften slightly, it should be removed from the fire and squeezed slightly in a vise or with a pair of tongs.



Method of brazing Stellite to Steel Shanks

The process is entirely practicable, but it requires some little practice, and a person should not be discouraged if his first braze is not all that he could wish. Tools made in this manner are capable of standing any stress up to the point of breaking the shank. It follows, of course, that the short end of bar stock can be entirely used by following this method.

* * *

CONVENTION OF AMERICAN GEAR MANUFACTURERS' ASSOCIATION

The second annual convention of the American Gear Manufacturers' Association will be held at Green Brier Hotel, White Sulphur Springs, W. Va., on April 18, 19, and 20. The principal subject of discussion will be the standardization of gearing. The hardening and heat-treating of gears will receive attention, and papers will also be read on uniform cost accounting and on hobs and hobbing machines. An address by a representative of the United States Chamber of Commerce, of which the association has just become a member, will also bring matters of timely interest before the association.

* * *

SAFETY PRECAUTIONS IN DROP-HAMMER OPERATION

The National Safety Council has issued some rules relating to the safe working of steam hammers and drop-hammers which, if followed, would minimize the number of accidents in forge shops to a great extent. The most important of these rules are as follows: Shut off all power and wait until the moving parts come to a standstill before oiling or cleaning the machine and before adjusting any part of the machine. Be sure that all parts of the body are out of the path of the hammer when the treadle is operated by foot. Use a screen guard in back of the drop to prevent sparks flying. When adjusting the dies, keep the foot off the treadle. Before tripping the treadle, see that no person is working on top of the drop. Keep sprue cutters in proper adjustments to prevent breaks and injury to the operator from flying parts or fragments. When putting work into the die, keep the mind and eyes on the operation.

* * *

The total amount of money in the United States at the beginning of 1918 was estimated at $6,256,198,271, or an increase of $1,244,000,000 during the year 1917. The per capita circulation on January 1, 1918, was estimated at $48.76, as against $43 a year before.

VERTICAL AND OVERHEAD WELDING BY THE OXY-ACETYLENE PROCESS[1]

BY S. W. MILLER[2]

Recently, the statement was made that the electric-arc metallic electrode was the only means by which vertical and overhead welding could be done. But every experienced oxy-acetylene welder knows that both vertical and overhead oxy-acetylene welding are being done in hundreds of shops and that much work could not be done if such welding were impossible by this process. The oxy-acetylene process is used for repairing locomotive firebox sheets—welding cracks and applying patches—yet the work on the side and flue sheets and back heads, as well as the work of welding the flues to the flue sheets, is entirely on vertical surfaces. Many shops apply new side sheets by this process, when overhead welding is necessary in the case of radial stay construction, while almost all automobile frame breakages have at least part of the weld thus made. However, overhead welding should not be resorted to unless necessary. It is more usual to weld steel in these ways than other metals; but a really expert welder is able to handle cast iron, brass, and aluminum. In the case of heavy castings much handling of hot castings can be avoided if the operator is able to weld vertically and overhead.

The feasibility of this work depends on the surface tensions of the metal and the slag on its surface; the temperature range of partial solidification of alloys on cooling from the liquid state, which may be called their freezing range; the fact that pure metals solidify instantly as soon as the proper temperature is reached, so that they have no freezing range; and the heat-conducting power of the metal. That liquids have a surface tension is easily seen by drawing a needle between the fingers to give it a slight coating of oil, and then laying it carefully on the surface of the water in a dish. Not only will the needle float, but its weight will depress the surface of the water so that the needle will lie in a hollow. It will be found that quite a little force is needed to make the needle break through the water surface, although when it does it at once sinks to the bottom. This supporting property is possessed, to some degree, by all liquids, including molten metals and it is for this reason that all liquids form into round globules when in small quantities. All pure metals, on cooling from the melted state, solidify instantly as soon as their freezing temperature is reached; alloys, however, solidify gradually through a range of temperature. Thus pure iron solidifies at 2730 degrees F., while steel containing 1 per cent of carbon, which is an alloy of carbon and iron, begins to solidify at about 2600 degrees F. but is not entirely solid until 2175 degrees F. If one end of a cast-iron rod and one end of a copper rod of the same diameter and length are heated in a fire, the other end of the copper rod will become hot much sooner than will the other end of the iron rod, because copper is a better conductor of heat than cast iron. It is clear then that more heat will be required to weld a copper piece than a cast-iron one of the same size, because, while their melting points are not very different, the conducting power of the copper is much higher and the heat is taken from the weld faster.

Everyone who has tried knows that it is much harder to weld vertically and overhead than in the usual way and that overhead work is the harder of the two. The difficulty also increases as the fluidity of the molten metal; that is, steel is the easiest to weld, then come aluminum, cast iron, and brass. A comparison of the factors that affect the welding of cast iron and steel is shown in the accompanying table. While the effect of these factors is not equal, the comparison shows that steel is the easier to weld overhead.

When a small area of steel is melted, the good heat conductivity of the metal tends to prevent this melted area from becoming too great, so the high surface tension acting on a small amount of molten metal tends to prevent its running away, which tendency is increased by the rapid solidification. The surface tension of the slag has but little effect, because its melting point is lower than that of steel.

When a small area of cast iron is melted, the poor heat conductivity tends to hold the heat in the vicinity of the melted part, which with the large range of solidification, makes it hard to keep the molten metal in place. The slag has a higher melting point than the metal, and its high surface tension helps to keep the metal from running away. Any welder knows that if he uses flux on overhead cast-iron welding, he cannot keep the metal in place because the flux makes a slag melting at a low temperature and exposes the metal. If too much metal is melted, its weight will exceed the surface tension of the metal and it will drop away. The blast from the torch and the breaking of the slag film with the welding rod also increase the trouble. On the other hand, the great solidification range makes it unnecessary to heat cast iron to so high a temperature, in the same way that a plumber succeeds in wiping a solder joint. If it were not for the pasty condition of the solder, which is due to part of the alloy being melted while the rest is not, such a joint could not be readily made. If the metal to be welded is preheated until very hot, a smaller torch tip and less blast will be required, a smaller area of metal will be melted, and there will be less weight to break down the surface tension of the slag and metal.

In the case of cast aluminum, the range of solidification of the usual aluminum-copper alloys is large and the surface tension of the oxide (slag) covering of the melted metal is very great. Every welder of this material knows that the oxide film is so strong and persistent that it has to be broken with a puddling rod in order to get the metal to unite; also, its heat conductivity is high, so that in the writer's opinion, it is the easiest metal, aside from steel, to weld overhead.

OVERHEAD WELDING QUALITIES OF CAST IRON AND STEEL

Factors Affecting Welding	Steel	Cast Iron	Effect on Overhead Welding of	
			Steel	Cast Iron
Surface tension of metal	High	Low	Good	Bad
Surface tension of slag	Low	High	Bad	Good
Range of solidification	Small	Great	Good	Good and Bad
Heat conductivity	Good	Bad	Good	Bad

Machinery

The overhead welding of brass (the term brass here includes all metals having copper as a base) depends so much on the composition of the alloy that it is not possible to say much about the subject. As a general rule, it is a difficult matter, although with a proper welding rod and proper handling a fairly good job may frequently be made. The quality of the welding rod has probably more to do with the successful welding of these alloys than in the case of any other metal, although some of the alloys cannot be successfully welded even when the weld is on top, let alone overhead.

The usual good welding methods and ordinary welding materials do not permit of as good results in overhead welding as in ordinary work. Usually, good welding practice requires a large pool of molten metal, so that the slag can rise to the surface, the use of proper fluxes in the case of cast iron and brass, and of a welding rod of lower melting point than the original material; all of these are opposed to the conditions of overhead work. The best results can be obtained by thoroughly preheating the parts, using no larger a tip than is necessary, avoiding the use of flux, keeping as small a pool of molten metal as possible, keeping the metal as far from the upper part of the solidifying range as is consistent with a good union, (that is keeping it in a partly pasty condition), and keeping the welding rod in the molten metal. To meet these conditions requires great skill, which can only be acquired by experience.

• • •

An association of machine tool importers has been formed in France to guard the interest of its members and to afford the necessary cooperation with the Government for the proper distribution of machines needed in national defense. Membership in the association is limited strictly to individuals, firms or companies of allied nationalities.

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[1] For information on this and allied subjects previously published in MACHINERY, see "Autogenous Welds of Boiler Plates," September, 1917, and articles there referred to.

[2] Address: Rochester Welding Works, 406 Orchard St., Rochester, N. Y.

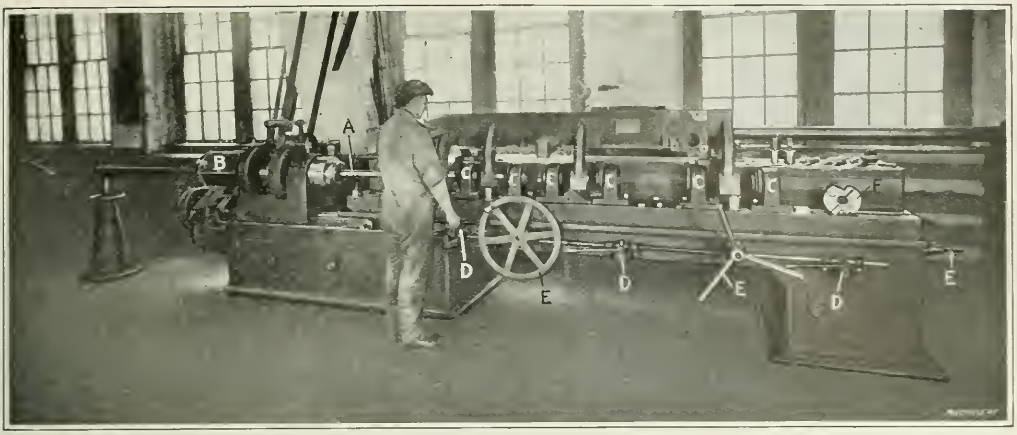

Fig. 1. Horizontal Boring Machine designed for boring Camshaft Arms of Automatics

SPECIAL HORIZONTAL BORING MACHINE

BY J. P. BROPHY[1]

In all lines of business it is sometimes impossible to purchase a machine suitable for the work under consideration. Some time ago, when it was necessary to procure a machine for boring the camshaft arms of the Cleveland automatics, it was impossible to find a machine that would perform this operation on all the sizes of automatics, or that could be changed over for this work. This made it necessary to design a machine, as shown in Fig. 1, that would bore the camshaft arms for all the sizes of automatics from the 3/8-inch up to the 7¾-inch size. The aim when designing this machine was to simplify in the extreme, thus doing away with any possibility of mistakes in measuring by the operator, with the result that the machine shown is fool-proof in this respect.

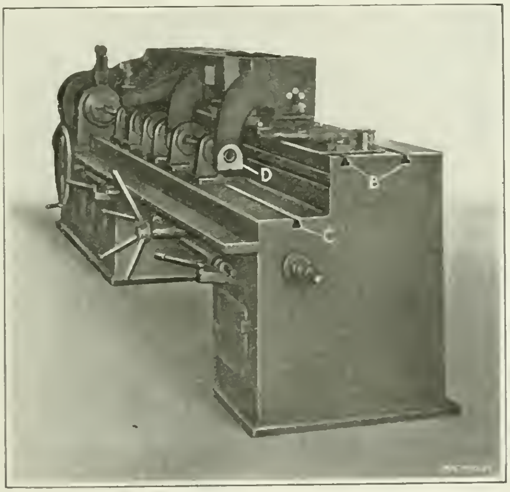

Fig. 2. End View of Horizontal Boring Machine

With this machine, it is possible to obtain different speeds for the boring-bars, which can be fed in either direction, in the boring operations. As shown in Fig. 2, the top of the bed has two plain surfaces with slots *B* and *C* running the entire length. In order to use the machine for all sizes of automatics, the different shaped elevating blocks shown in Fig. 3 are employed. These have a tongue on the bottom that fits the bed of the boring machine, and a tongue on the top that fits the bed of the automatic. Each block is marked for the size of automatic machine with which it is to be used. When these blocks are clamped in position on the bed, the camshaft arms of the automatic machine that they support drop down to the correct position in front of the steadyrests *C*, Fig. 1. These steadyrests carry hardened and ground bushings, and the boring-bars are made from high-carbon steel and are ground. Bars are provided for the different sizes of machines and the cutters are correct for each size of hole; each bar is marked for the machine on which it is to be used.

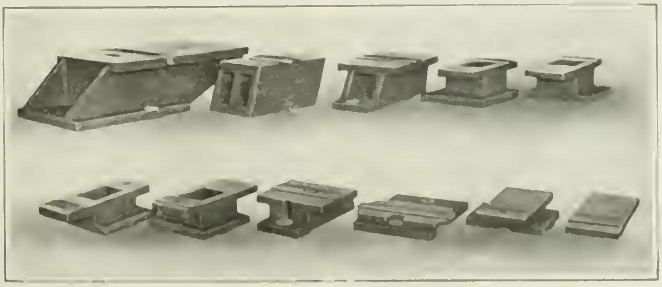

Fig. 3. Adjustment Blocks used on Horizontal Boring Machine

A hinged facing head *F*, Fig. 1, may be placed on the boring-bar in any position in a short space of time and clamped ready for the facing operation, as shown at *D*, Fig. 2. The spindle head *B*, Fig. 1, carries the boring-bar *A*; on the end are change-gears, similar to those on a lathe, that control the feed of the different boring-bars. The boring-bars have a longitudinal movement. The spindle head *B* can be moved horizontally 15 inches and clamped in any position desirable; this adjustment makes it possible to bring the boring-bar into the proper location in setting up. The operator can handle the boring-bar in either direction when setting up and locating the tools in their correct position from any of the positions marked *E*. Levers *D* along the front of the bed throw in the clutch for operating the feed; these clutches are placed in different positions to save the operator walking back and forth, thus saving time.

The elevating blocks, Fig. 3, are accurately made, and when the operator desires to change, for instance, from a 3/8- to a 2-inch machine all he has to do is change the elevating blocks. Then the machine camshaft arms locate themselves by the finished surface where the spindle and turret heads are located.

The end view, Fig. 2, shows the design of the bed, which is very heavy and properly ribbed to do away with springing.

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[1] Vice-president and General Manager, Cleveland Automatic Machine Co., Cleveland, Ohio.

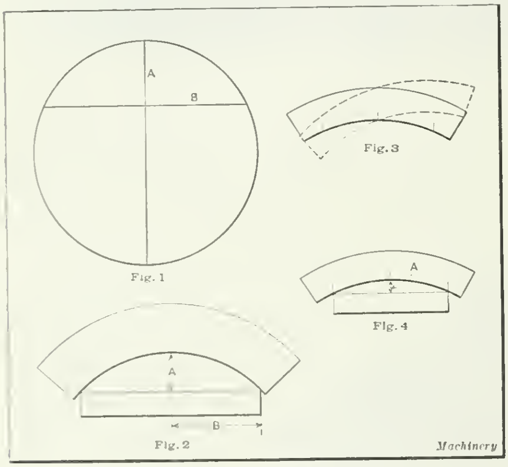
As there are only plain surfaces there is practically no wear. After the elevating blocks are placed in position and the steadyrests are located, they remain fixed, as the boring-bar furnishes the movement for finishing the camshaft holes.

* * *

FINDING THE RADIUS OF A CONCAVE ARC

BY GUY H. GARDNER[1]

A carpenter needed to know the radius of a concave arc on a piece of work. To the eye of a machinist who was an interested spectator, it appeared to be something like 2½ or 3 feet, so he was not surprised to see the woodworker replace his center-square in the chest after a moment's consideration of its inadequate length. While the bystander wondered whether an extemporaneous tool of wood was to be made, the object of his curiosity was engaged in profound meditation. As his subsequent procedure showed, he had some acquaintance with plane geometry, but accurate and reliable recollections of his knowledge responded but slowly to his call. Realizing with how much greater facility the human mind deals with the concrete and visible than with the abstract and immaterial concept, he seized a convenient bit of board, on which he drew the diagram shown in Fig. 1; then, evidently remembering that "When two chords intersect in a circle, the product of the segments of one equals the product of the segments of the other," he thus calculated:



Figs. 1 to 4. Method of finding Radius of Arc

$$A(2R - A) = B^2 \qquad 2RA - A^2 = B^2 \qquad 2RA = B^2 + A^2$$

$$R = \frac{B^2 + A^2}{2A}$$

Having now provided a firm mathematical foundation, the next step was to get a straight bit of board, which he made 18 inches long, marking its center of length with his jackknife. Laying this against the arc and measuring from its center the distance *A*, Fig. 2, which he called 1⅜ inch (though it was somewhat greater according to the machinist's later calculations), he was ready to find the length of radius by substituting this value and the half length of his board for *A* and *B*, respectively, in his formula. He found it to be about 30.14 inches. Driving two nails at points 30⅛ inches apart through a strip of wood, he laid the job on the bench, found a center and tried the arc with his tram. As the radius proved too long, he moved one nail to a point 30 inches from its fellow, and success was his.

The writer once saw an inspector in a machine shop tackle a similar problem. He had a number of pieces the radius of whose (concave) arc should have been 7.875 inches. The number of pieces was so small that it was not thought worth while to turn up a templet by which to try them. His plan was to clamp each in turn to a cube on the surface plate and scribe three lines 1½ inch apart with a height gage, as shown in Fig. 3, then turn the cube over, bringing it into the position shown in Fig. 4, when the height of the middle line above the others would, he thought, give the dimension *A*. Further thought convinced him that this plan would work only if the part were in exactly the proper position. If, for instance, it occupied the position indicated by the dotted lines in Fig. 3, the chordal distance would not be exactly 3 inches, and his conclusions in regard to the length of radius would be unreliable. He, therefore, clamped to the cube a parallel, as in Fig. 4, leveling it by the height gage and indicator. Then each part could be laid on the parallel and the distance *A* measured.

In this, as in all machinists' work, much depends on the accuracy of the tools used, the trueness of the corners of the parallel being of especial importance in this case. Moreover, while for certain radii a slight error in *A* may be negligible, in other cases a fraction of a thousandth inch corresponds to a considerable variation in the length of the radius. Evidently the inspector in the case cited, needing to know only whether or not the radius of the piece was that called for by the drawing, did not need to follow the carpenter's method of calculation, but had merely to know what *A* should be, and then determine its accuracy or inaccuracy.

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[1] Address: New London, N. H.

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PICKLING SHIP STEEL

BY MARK MEREDITH[1]

The preparing, or pickling, of ship steel is becoming more common than heretofore. Whatever compounds may be used for coating steel, it is very necessary that the mill scale be thoroughly cleaned from the plates and the bars beforehand. The British Admiralty specifications require the removal by immersing the steel for some time in a bath that contains one part of hydrochloric acid to nineteen parts of water. When the steel is taken out, fresh water is poured over it from a hose as it is scrubbed with steel brooms. The material is then coated with linseed oil and exposed to the effects of the weather for some days. In merchant ship work, this has usually been considered an unnecessary expense. The usual practice is to put the material together without removing the mill scale and allow it to rust until the ship is ready for painting. The rust and scale are then scraped off and the paint applied. The underwater part of the ship is not painted before the ship is launched, and the sea water accelerates the rusting, with the result that when the vessel is placed in drydock a very good surface can be obtained for the application of the anti-corrosive paint.

There are three principal methods of cleaning forgings, namely, pickling, tumbling, and sand-blasting. Pickling is much better than sand-blasting, for all the surfaces are cleaned thoroughly from oxides or foreign substances that are detrimental to the machining operation, while in tumbling and sand-blasting fine sand is hammered into the surface. As a result, the cost of machining is three or four times as great for a forging cleaned by sand-blasting as for one cleaned by pickling. In addition, drop-forgings that have small holes or indentations are not properly cleaned except by pickling. It has been found that the additional cost of pickling is more than offset by the saving in the cost of machining.

It is not uncommon nowadays to find merchant ship owners specifying that the steel used in their ships shall be pickled. It is well known that the rusting process is not absolutely effective, and the extra expense of pickling is probably easily saved in the smaller amount of corrosion occurring and consequent smaller upkeep cost for the renewal of steel. At the present time there is another strong argument in favor of pickling. Ships are rushed through very quickly and, if possible, drydocking near or on completion is dispensed with. This means that the bottom of the vessel has to be properly painted before it leaves the stocks, and it is doubtful if the rusting process has gone far enough to insure a good application of paint. In such cases, therefore, it is better to be on the safe side and pickle the steel before erection.

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[1] Address: 67 Dale St., Liverpool, England.

ENGINEERING COLLEGES AND THE WAR

BY FRED H. RINDGE, JR.[1]

"When a professor of zoology is called from his recitations to advise the war authorities on armor for soldiers" says Frank Fackenthal, secretary of Columbia University, "the climax in college opportunity in the war has been reached." No less startling is the remarkable rapidity with which the engineering schools in the country, immediately on the declaration of war, placed their resources at the disposal of the Government. Many professors and students, of course, immediately went into actual service in various departments of the Government, Army or Navy. Many who remained began to serve the nation directly through mechanical, chemical, physical and other experiments of great scientific and war value. Most significant of all was the immediate readaption of various college curricula to include military drill, first-aid, etc. Specialized courses were organized in military aeronautics, military history and strategy, field engineering, map reading and sketching, military organization, and administration. Such colleges as the University of Illinois, Cornell, and Princeton organized aviation schools. Splendid wireless courses were organized at Harvard and ordnance courses at the University of Pennsylvania. A number of college students, in uniform, are taking a special military or naval course after which they have reasonable hopes of passing examinations that will result in their securing commissions. Columbia University has a special United States Navy gas-engine school (from which more than seven hundred men have entered into service since last June) and also a school of military cinematography.

The recent order from Washington permitting the engineering students in good standing to complete their courses before entering government service will greatly help the situation among the students in the engineering schools. Meanwhile, students have been encouraged to remain in school by such advice as the following from the Bureau of Education: "Engineers are needed in every important military operation, in transportation, in communication, in most of the supporting industries. The chemist and physicist are in greater demand than ever before both at the front and behind it." President Wilson has said: "It would seriously impair America's prospects of success if the supply of highly trained men were unnecessarily diminished. There will be need for a larger number of persons in the various fields of applied science than ever before. I have no hesitation in urging colleges and technical schools to maintain their courses."

In view of this, it is particularly important to have carefully planned engineering education. Students must be encouraged to complete their courses and, should be aided in doing so by the Government. The curriculum must include something besides technique; a large place must be given to the human side. Industry and the war demand engineers and officers who can handle men as successfully as they can handle materials. To help train men in this sort of thing, it is important that engineering students occasionally take time to study industrial conditions and human relationships and engage in practical service with the types of men with whom they will deal after graduation. One good plan would be for engineering students to spend one or two evenings a week, for example, teaching English or citizenship to a class of foreigners; or they might lead a group of American workingmen in mathematics, mechanics, or some other technical subjects; or handle a group of working boys in a club; or engage in other kinds of industrial service. How many of the engineering inspection trips that are regularly planned by most of the engineering colleges include an inspection of the human side of the industries visited? How much human engineering material is included on college bulletin boards or in their libraries? More important still, to what extent are professors actually including instruction in the human side in regular or special courses?

Now as never before it is necessary to train engineers who can understand the other fellow's point of view, and the other fellow is, in large measure, the working man. The engineering schools must produce leaders who, with this understanding, can help bridge the gap between capital and labor. They must produce men who realize that the interests of capital and labor are essentially identical and who can mold all their dealings with both great parties in industry with this clearly in mind. If we are to win this war there must be less misundertsanding and more cooperation in industry. No man is more strategically situated than the engineer who can look both ways, can understand both points of view, and can promote both cooperation and democratization in American industry. In the future, engineering schools will be expected to produce men with ideas and ideals who will help solve these vital and fundamental problems.

* * *

MACHINE PARTS SENT BY EXPRESS

The Express Traffic Association, composed of all the large express companies in the United States and Canada, have issued a statement relating to the marking requirements for express matter that is of considerable importance to the machinery trade. The regulations relating to castings, machine parts, shafting, pipe, rods, bars, and other metal articles are as follows:

1. When boxed, barreled, crated, or trussed, the container must be marked with pen, brush, stencil, waterproof crayon, or by label securely attached with glue or equally good adhesive.

2. When not boxed, barreled, crated, or trussed, and there is sufficient smooth surface for the purpose, the address must be plainly marked on the article with durable paint. Such shipments must not be accepted unless marks are thoroughly dry.

3. When not boxed, barreled, crated, or trussed, or when not possible to mark as provided in preceding paragraph, shipments must be marked with not less than two wooden, leather, metal, cloth, rope stock or sulphite fiber-tag-board tags. Rope stock or sulphite fiber-tag-board tags must test not less than 14 point, 50 per cent rope, have reinforced metal eyelets and must be attached by wire not less than No. 23 gage, or strong tarred cord. Tags must be attached wherever possible to unexposed parts of the article in order that they may not become detached in handling.

4. Rods, shafting, bars, pipe, iron bed sides, automobile springs and other articles of like character marked with tags as provided in Paragraph 3 must have the tags securely wired to the article, and, in addition, a concealed tag, bearing the same address, must be bound to the article with burlap covering, the latter securely wired at each end.

5. When metal articles are shipped in sacks, the address must be shown on the tag conforming to the specifications in Paragraph 3, attached either by wire or strong cord, and an additional tag bearing the same address must be enclosed in the sack.

It is of importance that these regulations be adhered to, as the express companies will not receive for transportation packages not so marked. A representative of the Express Traffic Association stated that there are today 75,000 metal articles in the warehouses in New York City alone which cannot be forwarded to their respective addresses because of insecure tagging or insufficiently clear marking.

* * *

MARCH MEETING OF A. S. M. E.

The March meeting of the New York Section of the American Society of Mechanical Engineers, held at the Engineering Societies Building, 29 W. 39th St., New York City, Tuesday, March 19, was devoted to the subject of "Terminal Facilities of New York," and dealt specifically with the development of land and water terminal facilities, existing deficiencies and their correction, and agencies necessary in the future solution of the terminal problem. The subject was attacked from a number of different points of view, speakers representing the harbor authorities, the railways, the dock companies, the governmental commissions for relieving terminal congestion, and the several engineering fraternities, each presenting their views in brief statements. The purpose of the meeting was to secure practical suggestions and a method of applying them to the solution of present and future problems concerning the Port of New York. The subject is of the greatest importance to all the industries of the whole nation, inasmuch as one-half of all the import and export trade of the nation passes through the Port of New York.

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[1] Address 124 E. 28th St., New York City.

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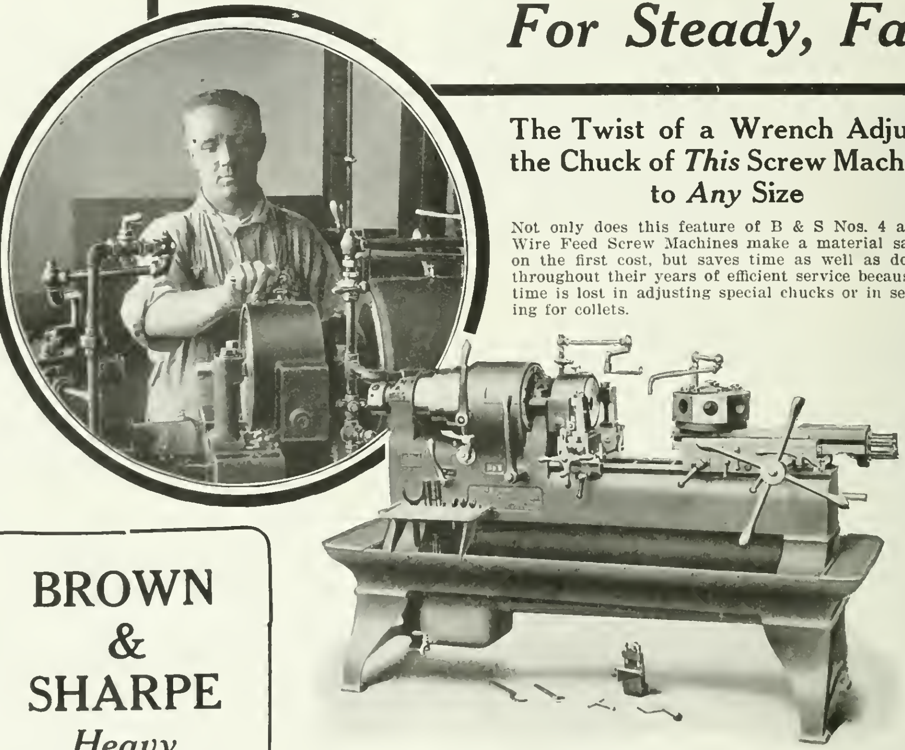

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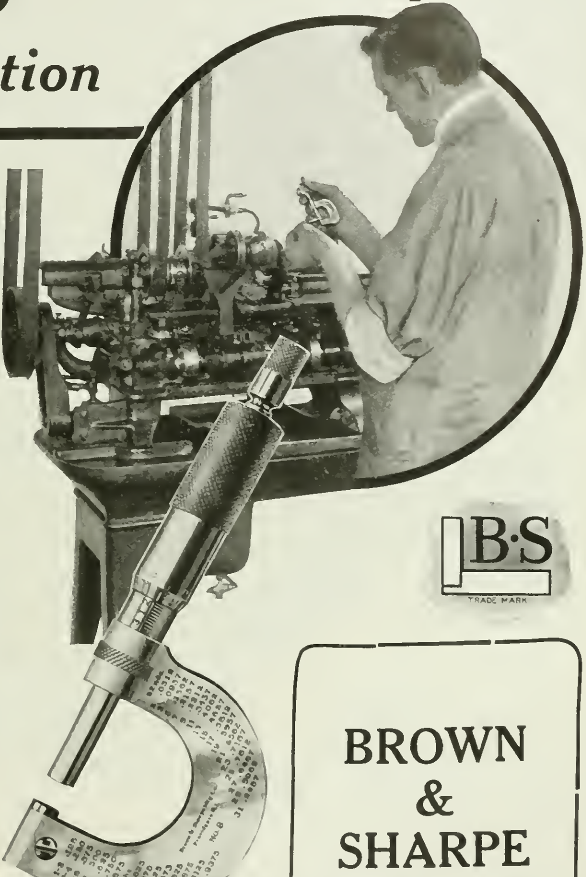

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ESTABLISHMENT OF MUNITION DISTRICTS

In order to bring about decentralization and closer contact with munition manufacturers, General Wheeler, acting chief of the Ordnance Department, has divided the country into ten munition districts. The Boston district comprises the states of Maine, New Hampshire, Vermont, Rhode Island, and the eastern part of Massachusetts; the district chief is Levi H. Greenwood, of the Wakefield Rattan Co.

The Chicago district comprises the states of Illinois, Wisconsin, Minnesota, and that part of Indiana north of Warren, Tippecanoe, Clinton, Howard, Grant, Blackford, and Jay counties; the district chief is E. A. Russell, vice-president of the Illuminating Co.

The Cincinnati district comprises the southern parts of Ohio and Indiana; the district chief is Charles L. Harrison, of the Cincinnati Chamber of Commerce.

The Cleveland district comprises the northern part of Ohio and Erie, Crawford, and Mercer counties in Pennsylvania; the district chief is Samuel Scovil, president of the Cleveland Otis Elevator Co.

The Detroit district comprises the state of Michigan; the district chief is Fred J. Robinson, president of the Lowrie & Robinson Lumber Co.

The New Haven district comprises the state of Connecticut and the western part of Massachusetts; the district chief is Waldo C. Bryant, president of the Bryant Electric Co.

The New York district comprises that part of New York state south of Rensselaer, Albany, Schoharie, and Delaware counties and that part of New Jersey north of Mercer and Ocean counties; the district chief is Samuel G. Allen, chairman of the Lima Locomotive Works.

The Philadelphia district comprises the eastern part of Pennsylvania, the southern part of New Jersey, and all of the state of Delaware; the district chief is John C. Jones, of the Harrison Safety Boiler Works.

The Pittsburg district comprises the state of West Virginia, the western part of Pennsylvania, except Erie, Crawford, and Mercer counties, and Belmont and Jefferson counties in Ohio; the district chief is Ralph M. Dravo, member of the firm of Dravo Bros. steel constructors.

The Rochester district comprises all of the state of New York not contained in the New York district; the district chief is F. S. Noble, of the Eastman Kodak Co.

* * *

CONSERVATION OF SKILLED LABOR BY THE ARMY

In regard to the second draft, Provost Marshal General Crowder says that men will be inducted into the service in very small groups from week to week or from month to month, as they can be assimilated by the Army. The whole industrial and agricultural situation is being carefully studied to discover any means that may be taken to protect and augment the labor supply without precluding the prompt and orderly progress of the military plans. As the need of the several armed forces for men highly skilled in technical and mechanical pursuits is greater than in any former war, the necessary numbers of such skilled men will be obtained first by assigning men already in the military service who have special skill to staff organizations and departments where their skill is needed. Men classified by the selection board, though they may have been placed in a deferred classification, will be withdrawn with great care from the industries of the nation for special service in staff corps and departments. Besides, young men of draft age with certain technical qualifications, will be inducted into the service and sent to universities, colleges, technical and secondary schools to be instructed in technical arts until they have acquired such proficiency as will justify their assignment to the special units. Ten thousand skilled artisans and as many young men graduates of grammar schools, will be sent to various technical and other schools throughout the United States for a two months' course of training. Thereafter, an increasing stream of selected men will be sent to educational and other training institutions for this purpose.

HELPING UNCLE SAM

The U. S. Civil Service Commission has announced an open competitive examination for appointment to the positions of architectural, mechanical, and structural steel draftsmen, for ship work. Full information and application blanks may be obtained from the U. S. Civil Service Commission, Washington, D. C.

The aviation section of the Signal Corps of the United States Army requires immediately 10,000 machinists, mechanics, chauffeurs, and other skilled workers. Men registered in the draft may volunteer for this service by applying to their regular local draft board. Men not registered may enlist at a recruiting office. Further information may be had by applying to the Air Division, Personal Department, Washington, D. C. Men accepted will be sent to San Antonio, Tex., where they will be given a brief course of instruction at the flying fields. They will also be sent to the various factories making aircraft, and will be organized into squadrons mostly for overseas service. The present call is especially for machinists, automobile and engine repairmen, gunsmiths, blacksmiths, tinsmiths, electricians, coppersmiths, sheet-metal workers, wireless operators and constructors, welders, and makers, repairers, and installers of magnetos, ignition systems, watches and clocks, instruments, and typewriters.

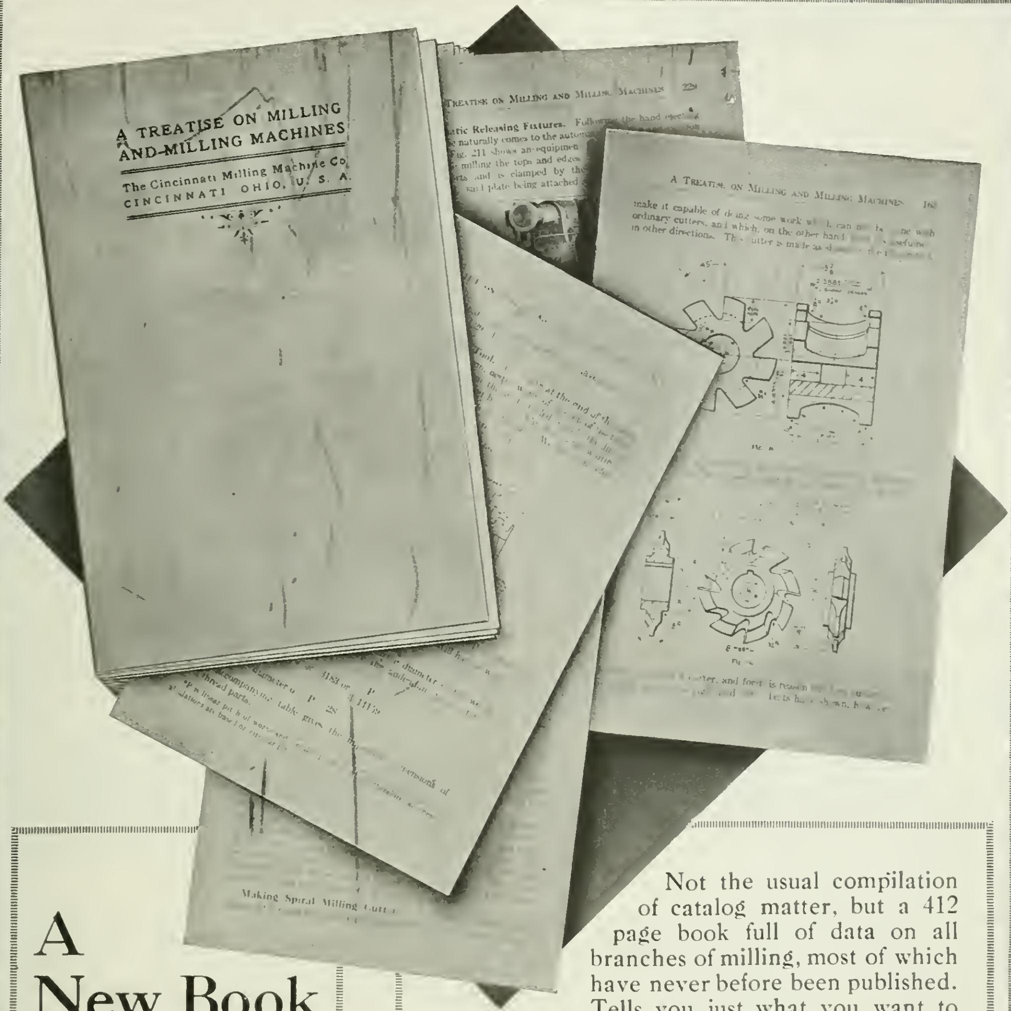
Civilian workers are wanted by the Ordnance Department as inspectors on ammunition of different classes, as metallurgical chemists, as assistant inspectors on motor vehicles, and as engineers and assistant engineers for testing ordnance materials. These men should have a high-school education, some shop training, and a natural ability to adapt themselves to new work. Those who have the required technical training will be placed and advanced as quickly as their ability justifies. Machinists who are accustomed to accurate machine work are also required. The positions are under the Civil Service regulations, but the applicants will not be required to report for examination at any place. They will be rated in accordance with education and general experience. Applications should be directed to C. V. Meserole, Special Representative of the Ordnance Department, Room 800, 79 Wall St., New York City.

It may be of interest to the readers to know that MACHINERY has received a great number of letters from the various Governmental departments expressing appreciation of the cooperation that MACHINERY has given the Government by the publication of reading notices and advertisements relating to Governmental activities. As the service is finally rendered through the readers of MACHINERY themselves, we believe that it will be of interest to them to reproduce the following letter received from the National War Savings Committee, Treasury Department, Washington, D. C., which is but one of many similar communications.

> We hasten to acknowledge with thanks the very interesting advertisement which appeared in your issue of March devoted to the United States Shipping Board and the National War Savings Committee.
>
> You may be sure that the Committee is fully appreciative of this valuable cooperation, which we feel sure will reflect itself in assisting both the Shipping Board and this Committee. It is just such cordial and patriotic assistance as is manifested by this contribution that is making the War Savings Campaign throughout the country such a great success.

* * *

The great saving that is made possible by standardizing designs is well exemplified in the new motor truck designed by the Quartermaster Corps for the United States Army. In addition to being used as a war truck for army supplies in the Quartermaster Department, it will also be used by the Medical, Signal, Ordnance, and Marine Corps, by the Navy Department, by the Bureau of Docks, and by the Post Office Department. In addition, when fitted with a passenger body, it may be used as a passenger car for the use of army officers.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Complete Tables for Indexing, Spiral Milling, Cam Milling, Rack Milling, Trigonometric Functions, Etc.

Invaluable to the superintendent, foreman, milling machine operator and draftsman.

Price $1.50 Postage Prepaid.

OBITUARIES

Frank J. Hurley died at the home of his parents in East Orange, N. J., March 10, after a long illness, from Hodgkins disease, aged twenty-nine years. Mr. Hurley was well known in the pneumatic tool field, having traveled for a number of years from the New York office of the Independent Pneumatic Tool Co.

Colonel Edwin A. Stevens died February 8 in the Providence Hospital at Washington, D. C., where he was serving as a shipyard inspector. He was born in Philadelphia, March 14, 1858. In 1879 he graduated from Princeton University, and later entered the Stevens Institute of Technology, which was founded by his father, graduating with the degree of M. E. Colonel Stevens was the designer of the *Bergen*, the first screw propeller ferry boat. Many other inventions of a mechanical nature are credited to him. He was at one time vice-president of the American Society of Mechanical Engineers and vice-president of the Society of Naval Architects and Marine Engineers, and was also a member of the Institute of Naval Architects in Great Britain. He is survived by his wife, six sons, and one daughter.

William Sloane Accles, for more than twenty years European manager for the Niles-Bement-Pond Co., New York, died in London, January 26, aged sixty-one years. Mr. Accles served his apprenticeship at the Colt Works, in Hartford, Conn., and was later with the Pratt & Whitney Co. He was a member of the Institute of Mechanical Engineers, a Fellow of the Royal Geographical Society, and a member of the American Chamber of Commerce. Mr. Accles was widely known and greatly liked by railway men and manufacturers all over Europe, having devoted many years to the cultivation of personal relations with buyers of the tools manufactured by his company. Besides the business friendships which he acquired over this period of years, he also had interests and a wide personal acquaintance in other fields, as is indicated by the organizations of which he was a member.

PERSONALS

Sidney Diamant, 60 W. 129th St., New York City, has withdrawn his financial and other interests from the DeMant Tool & Machine Co., 79 E. 130th St., New York City.

Joseph Utz, formerly with Marshall-Huschart Machinery Co. of Indiana, has taken a position as salesman with the Federal Machinery Sales Co., 14 N. Jefferson St., Chicago, Ill.

J. B. Howell of the Sales Department of the Bound Brook Oil-less Bearing Co., Bound Brook, N. J., has entered active service in the United States Army, and is now in training at Camp Dix.

Herman Weyrauch has been appointed superintendent of the works of the American Spray Co., at Elizabethport, N. J. Mr. Weyrauch was formerly with the Babcock Printing Press Co., New London, Conn., and with R. Hoe & Co., New York City, for sixteen years.

W. H. Thompson, for many years prominent in the heavy electric traction work of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has resigned to take the position of works manager with the Fairmont Mining Machinery Co. of Fairmont, W. Va., makers of coal mining equipment.

Claude H. Davies has assumed the management of the general publicity for S. F. Bowser & Co., Fort Wayne, Ind. Mr. Davies has been connected with the company for twelve years, and during the past two years has been managing the New York district. His headquarters will be at the home office in Fort Wayne, where he will be in close touch with the general sales and publicity work of the firm in its entire field.

William T. Price has resigned as manager and chief engineer of the De La Vergne Machine Co., Oil Engine Department, to become president of the P-R Engine Co., Inc., New York City, and second vice-president of the Rathbun-Jones Engineering Co., Toledo, Ohio. The latter company will undertake the sale and manufacture of Price-Rathbun stationary and marine oil engines, which incorporate a method of fuel injection developed by Mr. Price.

Paul T. Irvin, who has been associated with the Wells Bros. Co. and the Greenfield Tap & Die Corporation, Greenfield, Mass., for twelve years, has resigned his position as sales manager of the Gage Division to become general sales manager of the Lincoln Twist Drill Co., Taunton, Mass., of which Edward Blake, Jr., formerly of Wells Bros. Co. is vice-president and general manager, and Frank O. Wells and Frederick H. Payne, president and vice-president of the Greenfield Tap & Die Corporation, are directors.

Herbert S. Lester, formerly with Manning, Maxwell & Moore, Inc., who volunteered in the 27th Division U. S. Army last June, has been commissioned Second Lieutenant, U. S. R., in the Ordnance Department, and assigned to active duty with the Engineering Bureau, Motor Equipment Section, Washington, D. C. Lieutenant Lester is an ex-member of the First Armored Motor Battery N. Y. N. G. and served as despatch rider for Adjutant General Stotesbury during the mobilization of the New York National Guard last spring.

L. S. Neuschul, managing partner of the Mett Engineering Co., Petrograd, who recently arrived from Russia, expects to be in this country about sixty days and will then return. He can be reached while here, at the company's New York office, 1 Madison Ave. Mr. Neuschul is optimistic about the future of Russia, believing that the good sense of the Russian people will in time assert itself, and result in a stable and progressive government; but he acknowledges that it will be some time before conditions approach normal. When they do, he expects a gradual but strong industrial development in his country.

Loyall A. Osborne, vice-president of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., and chairman of the Executive Committee of the National Industrial Conference Board, has been appointed by the Secretary of Labor a member of a committee on industrial peace during the war. This committee which consists of five representatives of employers, five labor leaders and two public men, will provide a definite labor program in order that there may be industrial peace during the war, thus preventing interruption of industrial production vital to the war.

Leon O. Hart has been elected treasurer and a director of the Driver-Harris Co., Harrison, N. J. Mr. Hart was graduated from Stevens Institute of Technology, and after graduation worked as a cadet engineer with the Public Service Gas Co. of New Jersey for about a year. He became associated with the Driver-Harris Co. as electrical engineer in 1908, and served in that capacity until March, 1917, when he was elected assistant treasurer. Mr. Hart is widely known throughout the electrical industries, and is a member of the American Electro Chemical Society and the American Society of Electrical Engineers.

COMING EVENTS

April 10-12—Sixth annual meeting of the Chamber of Commerce of the United States of America, at the Congress Hotel, Chicago, Ill.

April 18-20—National Foreign Trade Council conference in Cincinnati, Ohio, Gibson Hotel, headquarters. Secretary, O. K. Davis, 1 Hanover Square, New York City.

April 18-20—Second annual convention of the American Gear Manufacturers' Association, held at Greenbrier Hotel, White Sulphur Springs, W. Va. F. W. Sinram, care of Van Dorn & Dutton Co., Cleveland, Ohio, president.

April 24-25—Annual Convention of the National Metal Trades Association at the Hotel Astor, New York City. Homer D. Sayre, secretary, 1021 Peoples Gas Bldg., Chicago, Ill.

April 25—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137 Sibley Block, 328 Main St. E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

May 15-17—Joint convention of the National Supply and Machinery Dealers' Association, Southern Supply and Machinery Dealers' Association and the American Supply and Machinery Manufacturers' Association at Hotel Hollenden, Cleveland, Ohio. Secretary of the American Supply and Machinery Manufacturers' Association, F. D. Mitchell, Woolworth Bldg., New York City.

May 16-17—Spring meeting of the National Machine Tool Builders' Association at the Marlborough-Blenheim Hotel, Atlantic City, N. J. Charles E. Hildreth, care of Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass., general manager.

June 20-22—Fifth annual convention of the American Drop Forge Association held at the Iroquois Hotel, Buffalo, N. Y. E. B. Horne, "The American Drop Forger," 108 Smithfield St., Pittsburg, Pa., secretary.

October 7-12—Joint convention of the American Foundrymen's Association and the American Institute of Metals in Milwaukee, Wis. Concurrent with these meetings there will be an exhibition of foundry equipment, machine tools, and accessories.

SOCIETIES, SCHOOLS AND COLLEGES

Grove City College, Grove City, Pa. Catalogue with calendar and courses of study for 1917-1918.

School of Mines and Metallurgy, University of Missouri, Rolla, Mo. Bulletin for October, 1917, containing register of graduates and a list of the university men now in military service.

Polytechnic Institute of Brooklyn, College of Engineering, Brooklyn, N. Y. Catalogue 1918-1919, containing calendar and course of studies.

NEW BOOKS AND PAMPHLETS

Annealing of Carbon Steels. By R. R. Fehr. 17 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the Pennsylvania State College, Harrisburg, Pa.

Heat Transmission Through Building Materials. By J. A. Moyer, J. P. Calderwood, and M. P. Helman. 9 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the Pennsylvania State College, Harrisburg, Pa.

Purchasing Coal by Specification and Methods of Sampling. By J. A. Moyer and J. P. Calderwood. 10 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the Pennsylvania State College, Harrisburg, Pa.

Empirical Method of Analysis of Coal—Dry and Wet Coal in House Heating Boilers. By J. P. Calderwood and J. J. Light. 25 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the Pennsylvania State College, Harrisburg, Pa.

Percentage of Extraction of Bituminous Coal with Special Reference to Illinois Conditions. By C. M. Young. 173 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the University of Illinois, Urbana, Ill., as Bulletin No. 100.

Electric Pumping with Results of Tests and Operating Records. By H. W. Wagner. 80 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, as Bulletin No. 46.

Broaches and Broaching. By Ethan Viall. 221 pages, 6 by 9 inches; 187 illustrations. Published by the McGraw-Hill Book Co., Inc., New York City. Price, $2.

This book is compiled mainly from articles relating to the subject of broaching that have appeared from time to time in the "American Machinist," and contains a variety of information on the subject. It is divided into seven distinct sections, one dealing

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with broaching and broaching tools in general, and another with standard types of broaching machines. The other sections take up, in order, examples of pull broaching work and practice, push broaching work and practice, the design of pull broaches, the design of push broaches, and the making of broaches. In view of the interest in information on the subject of broaching and broaches, it is likely that many toolmakers will find suggestions of value in this book.

Horizontal Cylindrical Tank Gaging. By J. B. Morrow. 68 pages, 4¼ by 7¼ inches. Published by S. O. Spencer, Oakland, Cal. Price, $10.

This book presents in convenient form rules, tables and explanations by the use of which the contents of horizontal cylindrical tanks may be computed and tabulated. The method introduced in this book is very simple; only one basic table is needed for accurately finding the contents of horizontal cylindrical tanks of any diameter and at any level, whether the heads of the tanks be bulged or flat. The method is based on ratios or percentages, and therefore the results may be obtained with equal ease in any unit of volume. The book should be of especial value to anyone who has use for formulas and tables for quickly and accurately determining the volume of partially filled horizontal cylindrical tanks. In addition to the information applicable to problems of this kind, the book contains a number of miscellaneous problems and examples, as, for example, car tank dome capacity, computation of the capacity of the compartments of a wagon tank, etc.

American Lubricants. By L. B. Lockhart. 236 pages, 6 by 9 inches; numerous illustrations and tables. Published by the Chemical Publishing Co., Easton, Pa. Price, $2.

This book has been prepared from the standpoint of the consumer, and is intended as an aid to the user and buyer of lubricants. Throughout the book information of value to the user rather than to the refiner is given, making it possible for the former to select oils and greases intelligently. The book covers a wide field, and for convenient reference is divided into twenty-seven chapters, having, in addition, a section of viscosity, Baume gravity, and other useful tables. The field covered by the book is best indicated by the chapter headings which are as follows: Crude Petroleum; Refining of Petroleum; Refined Products; Friction and Lubrication; Lubrication of Internal Combustion Engines; Automobile Lubrication; Lubrication of Electrical Machinery; Lubrication of Steam Cylinders and Steam Engines; Lubrication of Steam Railways; Lubrication of Cotton Mills and other Textile Mills; Lubrication of Miscellaneous Plants and Machines; Physical Methods of Testing Lubricating Oils; Chemical Methods of Testing Lubricating Oils; Lubricating Greases; Methods for Testing and Analysis of Greases; Animal and Vegetable Oils; Methods of Testing Fatty Oils; Specifications for Fatty Oils; Specifications for Cylinder Oils; Specifications for Special Engine and Machine Oils and Car Oils; Specifications for Cutting Oils; Specifications for Greases, Graphite, Boiler Compound, and Cotton Waste; Specifications for Burning Oils; Specifications for Gasoline and Fuel Oil; Gasolines; Kerosene; and Tables.

NEW CATALOGUES AND CIRCULARS

Foster Machine Co., Elkhart, Ind. Catalogue containing detailed description of Foster countershafts of the friction clutch type, and tables of dimensions.

Ibsen & Co., 404 Keefe Ave., Milwaukee, Wis. Bulletin of I. & C. gage standards which are made in sets of any desired combinations varying by steps of fractions of inches or millimeters.

N. Y. Revolving Portable Elevator Co., 343-351 Garfield Ave., Jersey City, N. J. Calendar for 1918 showing pictures of the "Revolvator" in use piling bales, loading trucks, piling in freight cars, etc.

Swan & Finch Co., 165 Broadway, New York City. Circular entitled "Solving that Difficult Machine Problem," treating of the lubrication of machinery and of the characteristics of "Slo-Flo" lubricant in particular.

U. S. Smelting Furnace Co., Belleville, Ill. Circular of a new non-crucible smelting furnace which is claimed to be a cost-reducer for brass foundries. The furnaces will be built in various sizes, having capacities of 200, 500, 1000 and 2500 pounds.

Bruno Mfg. Co., 61 Terrace, Buffalo, N. Y. Circular descriptive of the Bruno slotting attachment for shapers and planers by means of which dies or jigs requiring internal machining of irregular form can be readily machined, as well as exterior surfaces.

Nelson Tool Co., Inc., 781-783 E. 142nd St., New York City. Catalogue entitled "A Modern Die Making Plant" illustrating the die, jig, gage, hardening, grinding, inspection, and manufacturing departments of the plant, and examples of some of the [illegible] by the company.

General Electric Co., Schenectady, N. Y. Circular [illegible] describing the Tungar rectifier for public garages and battery charging stations. The Tungar rectifier will charge from one to ten three-cell starting and lighting batteries at a six-ampere rate from an alternating current supply.

Krantz Mfg. Co., Inc., Brooklyn, N. Y. Circular [illegible] illustrating safety auto-lock switches intended for use on circuits wherever the ordinary knife switches may be applied. They are so designed that it is absolutely impossible to touch the live parts regardless of the position of the switch or of the door.

Krasberg Mfg. Co., Chicago, Ill., who are specialists in the manufacture of all kinds of tools and [illegible] work of every kind, have removed from 412 [illegible] St. to Lake Shore Drive and E. Ohio St. Their rapidly increasing business has demanded more space, and the new shops occupy four floors of a large, well-lighted, modern building affording 88,000 feet of floor space.

Royal Mfg. Co., Rahway, N. J. Catalogue entitled "Producing the Fittest in Waste", describing Royal cotton waste which, it is claimed, has been so made as to be of uniform quality and to have the maximum of absorbency. The catalogue is illustrated with views showing the stacking, sorting and grading, mixing, pulling, screening, machining, inspecting, weighing, and baling.

Parker Mfg. Co., Ann Arbor, Mich. Circular of Parker Morse taper and straight arbors, Morse taper shanks, and high-speed drill chucks. The drill chuck shanks are classified into groups according to the tapers in the back of the chuck. The names of chucks which are interchangeable on Parker arbors and the arbors and the groups to which they belong are tabulated to facilitate ordering arbors.

Vulcan Engineering Sales Co., 1765 Elston Ave., Chicago, Ill. Catalogue 3, illustrating and describing Hanna pneumatic riveters. Particular attention is called to special machines to be used in fabricating structural shapes and forms for the shipbuilding program. Many designs for use in automobile plants, boiler, tank and locomotive shops are presented. The catalogue also includes tables giving capacities, dimensions, weights, etc.

Oakley Machine Tool Co., Cincinnati, Ohio. Circular illustrating and giving specifications for the Oakley No. 2 universal cutter and tool grinder. The internal grinding attachment, surface grinding attachment, and gear-cutter grinding attachment, are also illustrated, and views are included showing the machine in use grinding parallel blocks, snap gages, flat forming tools, spiral mills, angular cutters, saws, taps, inserted-tooth mills, and other work.

Rogers Fibre Co., 121 Beach St., Boston, Mass., have been incorporated with a capitalization of $2,500,000, and have taken over the business of the National Fibre Board Co., the Leatheroid Mfg. Co., and the Mousam Counter Co., manufacturers of leather products. The officers of the new corporation are Elliot Rogers, president; Louis Rogers, vice-president; Stephen Moore, treasurer; Eric O. Hallberg, assistant treasurer; and Leon B. Rogers, general manager.

Cling-Surface Co., 1018 Niagara St., Buffalo, N. Y., manufacturers of belt preservatives, have issued a chart by means of which the loss due to slipping belts may be easily determined in dollars and cents. As the power loss due to slipping belts is one of the simplest losses to overcome, and as belts are used to such a great extent, it will pay to look into the losses due to this cause. The chart supplied shows the extent of the loss in a very graphic manner, and indicates how the annual coal or power bill may be reduced.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Reprint of articles entitled "Electrically Heated Japanning Ovens," by O. F. Hirshfield, and "Heat Calculations for Baking and Drying Ovens," by Wirt S. Scott. These articles treat of general considerations of electric heating for japanning and drying ovens and outline a detailed method of calculation for the amount of heat required to raise the temperature of the work, of the supporting and carrying parts such as trucks, and of the ventilating air.

TRADE NOTES

Fulflo Pump Co. have moved their main office and factory from Cincinnati, Ohio, to their new plant at Blanchester, Ohio. All future communications should be addressed to Blanchester.

Amalgamated Brass Co. have moved their main office and factory from Cincinnati, Ohio, to their new plant at Blanchester, Ohio. All future communications should be addressed to Blanchester.

Cyril J. Bath & Co., Cleveland, Ohio, machinery dealers, have removed their offices from the Leader-News Bldg. to 721 St. Clair Ave., N. E., where a representative stock of machine tools is maintained.

Cochrane-Bly Co., Rochester, N. Y., have broken ground for a large one-story brick addition to their present plant. This will give double the present floor space and facilitate the building of their universal die shapers and cutting-off machines.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., have removed their Arizona office from Phoenix to Tucson. The representatives of the company, J. H. Knost and W. G. Willson, will have headquarters in the Immigration Building.

Long & Allstatter Co., Hamilton, Ohio, have purchased the buildings and grounds of the Bentel & Margedant Co., of Hamilton. The expansion of the works of the Long & Allstatter Co. was made necessary by the increasing demand for their power punches and shearing machinery.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., have leased the Baxter Stove Co., Mansfield, Ohio, for a period of years with the intention of consolidating at this plant the manufacture of their heating appliances now being carried on at some of the other Westinghouse plants.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., have recently secured the exclusive sales agency in the United States for Frankel solderless connectors, which are widely used for joining electrical wires and cables. The Westinghouse Electric & Mfg. Co. will also act as distributors of the Frankel testing clips.

Keiser Machinery Co. have consolidated with W. H. Robinson & Co., exporters and importers of general material, whose offices are in the Real Estate Trust Bldg., Philadelphia, Pa., and have added a Machinery, Engineering and Hardware Department which will handle all exports and domestic problems for machinery. Paul R. Ketzer is manager of the new department.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., have moved the Pittsburg Service Department from its former location on Amberson Ave. to new quarters at 6905 Susquehanna St., in the Homewood district of Pittsburg. Express and freight should be consigned to East Liberty, Pa., via P. R. R. The Automobile Equipment Service Department has also moved to the new location.

Greenfield Tap & Die Corporation, Greenfield, Mass., on March 5 formally opened their new office building and shipping room and recreation building. The erection of these two buildings marks the complete amalgamation of the various units and divisions of the Greenfield Tap & Die Corporation in different parts of Greenfield. About five thousand persons visited the buildings during the afternoon and evening. Souvenir booklets describing the new buildings were distributed.

Walter H. Wade, 311 Atlantic Ave., Boston, Mass., manufacturer of bench lathes and special tools and equipment, has bought the name of the American Watch Tool Co., Waltham, Mass., together with the patterns, drawings, attachments, and accessories of the No. 3 bench lathe made by that company. He has also acquired the bench profiling machine made by the American Watch Tool Co. Mr. Wade will continue manufacturing these machines in his present factory in Boston.

Betts Machine Co., Rochester, N. Y., will carry on the business formerly handled by the Betts Machine Co., Wilmington, Del., and continue to build this company's line of boring mills, slotters, planers, etc.; this line will be improved and additions will be made to it. A. H. Ingle, who is president and manager of the new Rochester concern, on February 1 bought the patterns, jigs, fixtures, and parts, as well as good will of the Betts Machine Co. of Wilmington. The business will be located in a new brick and concrete building which is being erected adjacent to the plant of the Bridgeford Machine Tool Works, of which Mr. Ingle is also president and manager.

Fulton Steel Corporation, 165 Broadway, New York City, announce that the officers of the company are: president, H. O. Beaver, formerly assistant to the president of the Allis-Chalmers Co. and general manager of the Bullock Electric Mfg. Co.; vice-president in charge of production, William B. Morrison, formerly of the MacIntosh-Seymour Co. of Auburn, N. Y.; treasurer and secretary, Safford A. Crummey; metallurgist, Irving R. Valentine; and superintendent, Clarence L. Cline, formerly with the Latrobe Electric Steel Co. and the Firth Sterling Co. The company occupies a main building 80 by 240 feet with crane runway extensions of an additional 820 feet, on which is operated a ten-ton Shaw crane. Plans are being made for the extension of the plant, which will give additional melting capacity up to 50 tons per day.

Worthington Pump & Machinery Corporation, 115 Broadway, New York City, have made the following changes in the personnel of the organization: James E. Sague has been made vice-president in charge of engineering and manufacturing. Leon P. Feustman has been made vice-president in charge of general commercial affairs, including contracts, prices, purchases, traffic, etc. Frank H. Jones has been made vice-president in charge of sales, and William Goodman has been made assistant to vice-president James E. Sague. William Schwanhausser has been made chief engineer. Edward T. Fishwick has been made general sales manager, and Charles E. Wilson, assistant general sales manager. Neil O. Lamont has been made works manager of the Laidlaw Works with office at Elmwood Place, Cincinnati, Ohio.

Swan & Finch Co., 165 Broadway, New York City, manufacturers of special oils and greases, have recently celebrated their sixty-fifth birthday. The business was started in February, 1853 in a small building at 44 Water St., New York City, and it has grown until today the main plant at Bayway, N. J., covers over fifteen acres with piers at which tank boats and ocean-going steamers dock. The original business of the company consisted of the sale of illuminating oils and lubricants, including fish and animal oils, sperm and other whale oils, sea elephant oils, black fish and lard oils. At the present time 107 distinct oils and greases are manufactured. The entire development of the company has been along "service idea" lines. A corps of chemists and field engineers is maintained whose duty it is to analyze the needs of each customer and supply the special product required, and, where necessary, to develop new products to meet new needs.

Whitman & Barnes Mfg. Co., Akron, Ohio, have made the following changes in their Sales Department: A. B. Hall, vice-president of the company, will have supervision of the company's sales. Mr. Hall has been connected with the company for the past twenty-one years in various sales and official capacities. His early connections were with the company's Chicago sales office as manager, which position he held until his transfer to the general office at Akron. H. S. Carter, district representative of the company, with headquarters in Pittsburg, has been promoted to the position of sales manager and will have direction of the twist drill and reamer sales from the general office. H. E. Fisher, formerly with the Pittsburg Model Engine Co., Pittsburg, Pa., will succeed H. S. Carter as mechanical engineer and will have charge of sales in the Pittsburg district. Paul E. Thomas of Chicago, who has been prominent for years in railroad circles in the traffic department of the Seaboard Air Lines, has been made sales manager of the company in charge of the department of wrenches and spring cotters.

MAY MACHINERY 1918

Salvaging Tools in War Time

By Edward K. Hammond*

Metal-cutting tools which have been worn or damaged in a way that makes them unfit for service can be economically reclaimed by firms making a specialty of tool salvaging operations. Current prices of tools are far above the catalogue list prices, and this condition has led many manufacturers who formerly discarded worn-out tools to adopt the practice of having them salvaged. The savings made possible by this method are so manifest, however, that it seems certain that many who adopted this as a war-time measure will continue the practice when industry once more returns to normal conditions. This article explains the charges made for salvaging tools, the savings made possible by this practice as compared with selling worn-out tools at their junk value and buying new ones, and gives a brief outline of the method of procedure in salvaging several commonly used types of metal-cutting tools.

IN operating a manufacturing plant in a country that is rich in natural resources, the practice of thrift in the use of raw material is likely to be regarded as unnecessary; but as the resources of that country become less plentiful, and prices rise as a consequence, thrift very naturally becomes a matter of necessity. The rise in prices of materials, which naturally follows the depletion of supplies as a country grows older, is brought about artificially in war time, due to an increased demand for materials, to the reduction in purchasing power of money, and to various other causes. As a result, the practice of thrift in the management of an industrial plant in war time becomes even more necessary than in times of peace, owing to the absolute dependence of every army upon the product of the manufacturing plants in the country for which it is fighting.

American manufacturers have made one noteworthy change in their methods of management during the last two decades. When raw materials were more plentiful and cheaper than they are today, the improvement of rates of production was the factor that was constantly demanding attention. Now, the maintenance of production rates is still of the utmost importance, but reduction of production costs through the conservation of materials has been assuming a steadily increasing importance, until today it ranks with keeping up the rate at which product is turned out. Numerous examples could be cited of the way in which this change has affected manufacturing practice in general, and machine shop practice in particular. In this article it is the intention to describe the salvaging of various types of cutting tools that are used in the machine shop, and to explain the saving that is effected through salvaging these tools as compared with selling the worn-out tools for junk and replacing them with new ones. Economic conditions existing shortly before the war had demonstrated the need of eliminating serious losses which resulted from the quite general practice of discarding worn-out cutting tools; but with the outbreak of war, and the great increase of the price of tool steel, due to reasons that have already been mentioned, tool salvage became one of the important factors in meeting the greatly increased demand for milling cutters, reamers, etc., to satisfy the requirements of industry during war time.

Established Practice in Salvaging Tools

In some shops, a tool is regarded as worn out when the teeth have been ground down to a point where it is under size or where there is insufficient space for the escape of chips. When a tool has reached this condition, there is generally a lot of good steel which could be utilized by salvaging the tool to adapt it for further service. Two methods of procedure are possible in salvaging tools, *i.e.*, the steel may be annealed and the tool recut and rehardened, or a grinding wheel may be used to regrind the teeth to the required depth without the necessity of any heat-treatment. It is almost universal practice to employ the latter method, because trouble is likely to be experienced in attempting to reheat-treat a tool—particularly in the case of high-speed steel. Most manufacturing plants find it more economical to send out their old tools to be salvaged by concerns making a specialty of this work than to attempt to salvage them in their own shops. When one begins to consider the various factors which enter into handling the work of tool salvaging, it at once becomes apparent that the requirements of this work are somewhat peculiar. In the first place, cutting tools are sent out from a manufacturing plant to be salvaged after they have been worn under size or become scored, bent, or otherwise made unfit for service. There are three possibilities in handling the work in so far as the size of the reclaimed tools are concerned: (1) This size could be the same as the original size of the worn tools which are to be reclaimed. (2) The tools could be ground down to the largest size possible without employing special treatment to expand them back to the original size. (3) The tools could be ground down to the next standard size by intervals of 1/8 inch on the diameter and by 1/16 inch on the width of face.

In practice, there are two methods which are almost universally followed with the exception of methods used in reclaiming reamers. In handling all kinds of cutters, it is almost the universal practice to reduce them to the next standard size by intervals of ⅛ inch on the diameter and by intervals of 1/16 inch on the face width, because most manufacturers have their tool cribs arranged with cutters classified according to size, and with such an arrangement there would be confusion if the salvaged tools were of bastard sizes. In reclaiming reamers, this practice of reducing to the next standard size is also followed, but to meet the requirements of manufacturers who have certain standard reaming operations to perform, and who therefore require their reamers to be reclaimed back to these standard diameters, the Peninsular Tool Salvage Co., Detroit, Mich., have developed a method of swaging the reamer blades to increase the diameter of the tool so that it can be ground back to the original standard size. On the other hand, there are many firms who are using a variety of sizes of reamers, and such firms can use their reamers satisfactorily when they are salvaged by grinding down to the next standard diameter by intervals of ⅛ inch.

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As an example of practice in reducing milling cutters to the next standard size, the following instance will explain just how the proposition works out. Take the case of a milling cutter 6 inches in diameter by ¾ inch width of face. This cutter will be about 5 9/16 inches in diameter by 11/16 inch wide when received by the tool salvage concern. The diameter will be reduced 1/16 inch to 5½ inches, which is the nearest standard diameter, while the width of face will be left 11/16 inch; in other words, no reduction is necessary on either the diameter or the width of face, unless it is necessary to reduce the size of the cutter to the next standard ⅛-inch interval on the diameter, or the next standard 1/16-inch interval in width. The work is done within commercial limits. Mills for cutting splined grooves in shafts are regularly salvaged and held to the original width. Where special instructions are given to leave both the diameter and width of face as large as possible, tools can be salvaged to within 0.005 inch of each of the dimensions of the tools as they were received at the salvaging shop. The diameter of reamers is usually reduced to the next standard size by intervals of 1/16 inch, although the practice of reducing to the next standard size by ⅛ inch may be followed or the diameter may simply be reduced 0.005 inch.

Care Taken to Avoid Burning Steel while Salvaging Tools

When firms making a specialty of salvaging tools first started to solicit business, they were told that it would be impossible to grind tools down to form new teeth, because the heat generated during the processes of grinding would burn the steel and make the tools unfit for further efficient service. This criticism calls attention to a point that is of great importance in salvaging tools, as it is certainly most necessary to take great care in conducting the grinding operation to avoid burning the steel, if tools are to be successfully salvaged. Various precautions are observed by the different firms engaged in this work, but generally speaking, these include the use of a soft free-cutting wheel that will break down rapidly enough both to maintain sharp cutting edges on the abradant and to prevent creating a glazed condition of the wheel that is likely to result in burning the work. So far as the use of a coolant is concerned, there is considerable diversity of opinion. Many operations are performed dry with satisfactory results, provided the right kind of grinding wheel is used; but for certain classes of work, some tool salvaging firms maintain that better results are secured through the use of a liberal volume of coolant on the grinding wheel and work, while others claim that the use of coolant on high-speed steel results in producing small cracks that will cause the tool to fail soon after it has been placed in service.

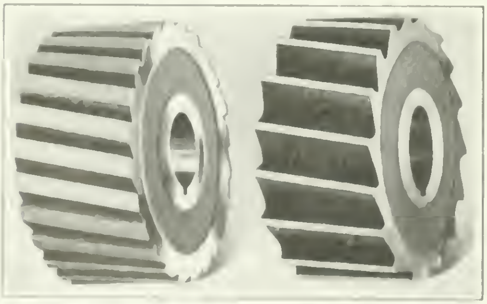

Fig. 1. Plain Milling Cutter before and after it was recut by Peninsular Tool Salvage Co.

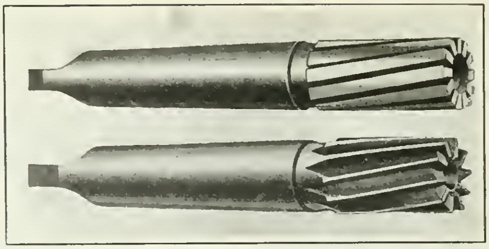

Fig. 2. Taper Shank End Milling Cutter before and after it was recut by Peninsular Tool Salvage Co.

Consideration of Salvaging Requirements when Designing Tools

Some tools of a given type lend themselves much better to the requirements of salvaging than other tools, because the tooth form, arrangement of clearances, etc., are so arranged that salvaging is quite easily accomplished. In other tools, which are capable of giving equally satisfactory results when new, the design may be such that the salvaging possibilities of the tool are quite limited. The Goddard & Goddard Co., Detroit, Mich., do a business both in the salvaging of old tools and the manufacture of new ones. The new tools are especially designed with a view to their subsequent salvaging, and with these tools far more service can be obtained than is possible with many other types of cutters. The trade name "Go and Go" has been adopted by this company to designate its tools, because it is claimed that salvaging may be continuously repeated so that the tool diminishes in size until practically all of the steel is "gone." For instance, it is possible to start with one of the "Go and Go" side milling cutters and reduce this cutter several times to smaller sized cutters of the same type; then it can be converted to a slitting saw which is capable of being salvaged several times more.

Cost of Salvaging Tools

Purchasing agents of manufacturing plants have become so accustomed to receiving quotations which are list prices and subject to certain discounts that firms engaged in the tool salvage business have adopted a similar method of quoting prices for the service which they render. These concerns conduct their business along the following lines: The manufacturing plant which desires to have its tools salvaged sends them to the shop making a specialty of this work, and they are listed in the receiving room according to the original sizes which are stamped on the tools. The salvaging process is then carried through to completion and the tools are shipped back to the customer. The financial end of the transaction is carried through just as if the salvage firm were selling new tools to the customer, the price charged being the list price of new tools of the original size, less a discount, which is usually 60 per cent. In other words, the salvaging concern generally charges 40 per cent of the cost of new tools of the original size for the work of putting them back into condition for rendering subsequent service; but it is important to note that this is based on the old list price and not on the much higher prices at which all high-speed cutting tools are now selling.

Before the tools are returned to the customer, the old marking has been removed and they are marked with the size to which they have been reduced by salvaging—except in the case of chucking reamers which may be swaged out so that they may be reclaimed to the original size—and when these tools come back to the shop for the next salvaging process, the charge for the work is, of course, based upon the size to which they were reduced during the previous treatment. The same method of charging for work is followed in the case of both high-speed and carbon steel tools, so that the remuneration received for salvaging carbon steel tools is necessarily much less than in the case of high-speed steel tools, in fact, the average price received for salvaging carbon steel tools represents just about the cost of doing the work, no profit being made in many cases.

Money Saved through Salvaging Worn-out Tools

When consideration is given to the relative merits of selling worn-out tools as junk and buying new tools, or of having the worn-out tools salvaged, the question will quite naturally be asked, "How much can be saved by going to the trouble of packing up old tools and shipping them to a salvage shop?" In order to answer this question we have obtained information from tool salvage firms which shows the actual saving in specific instances. The table presented in connection with this article gives complete data concerning the salvaging of different types of tools that are handled by the Peninsular Tool Salvage Co. of Detroit, Mich. It will be seen that two or more examples are given for each type of tool, and it will be evident from the preceding discussion that the cost of salvaging is 40 per cent of the list price of the tool when new, while the saving by salvaging the tool is obtained by subtracting the cost of salvaging from the list price of a tool of the size obtained by salvaging the worn-out tool. Owing to the exceptional demand which now exists for all types of cutting tools, current market prices are greatly in excess of the list prices given in manufacturers' catalogues. Consequently, a column is included in the table giving the present market prices of high-speed steel cutters of the recut size, and the saving effected by salvaging the tools has been calculated both for the list price of each tool of the recut size and for the present market price of this tool. An exception is noted in the case of chucking reamers, where the cost of bringing the tools back to the original diameter is 50 per cent of the list price when new, instead of 40 per cent as in the case of other tools.

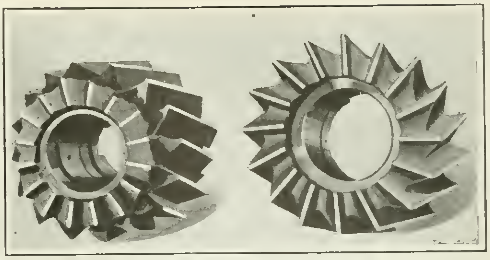

Fig. 4. Shell End Milling Cutter before and after it was recut by Peninsular Tool Salvage Co.

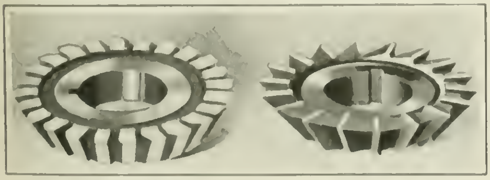

Fig. 3. Angular Milling Cutter before and after it was recut by Peninsular Tool Salvage Co.

As another example of the possible saving through salvaging, consider the case of the pile of tools shown in the heading illustration, which were salvaged by the Goddard & Goddard Co. When new, this pile of cutters cost $232.35, and the value of the same cutters after being salvaged was $185.79. The junk value of the worn-out cutters was $14.35, and the cost of recutting was $43.68. This means that $142.11 was saved by salvaging the tools instead of selling them for junk. In all cases where the salvaging proposition is receiving consideration, particular attention is called to the fact that in addition to the actual saving in dollars and cents, there is the added advantage of being able to secure a quicker delivery on tool orders. This is a matter of great importance at the present time, because both the supply of tool steel and the services of toolmakers are inadequate to meet the demand. Tools can be salvaged ready for additional service much more quickly than they can be made new.

DATA SHOWING MONEY SAVED BY SALVAGING WORN-OUT TOOLS

Name of Tool	Size When New, Inches	List Price When New, Dollars	Size When Recut, Inches	List Price When Recut, Dollars	Present Price When Recut, Dollars	Cost of Salvaging, Dollars	Saving Based on List Price, Dollars	Saving Based on Present Price, Approximately	Weight, Pounds	Junk Value of Old Tools, Dollars
Plain Mills	3 by 2 by 1	9.00	2½ by 2 by 1	6.90	17.25	3.60	3.30	13.65	2½	0.55
	3½ by 4 by 1¼	19.30	3 by 4 by 1¼	13.80	34.50	7.72	6.08	26.78	5¾	1.27
Side Mills	8 by 1 by 1¼	37.30	7½ by ⅞ by 1¼	31.50	78.75	14.92	16.58	63.83	11 5/16	2.49
	6 by ¾ by 1¼	15.35	5½ by 11/16 by 1¼	14.25	35.62	6.14	8.11	29.48	4	0.88
Interlocking Side Mills	6 by 1⅞ by 1½	37.10	5½ by 1¾ by 1½	31.50	78.75	14.84	16.66	63.91	10½	2.31
	4 by 1¼ by 1	18.90	3½ by 1 by 1	13.90	34.75	7.56	6.34	27.19	2¾	0.61
Solid End-mills, Taper Shank	¾ by 1⅝, No. 9 t.s.	3.85	9/16 by 1 7/16, No. 9 t.s.	2.50	6.25	1.54	0.96	4.71	1¼	0.28
	1¾ by 2½, No. 9 t.s.	8.30	1 7/16 by 2¼, No. 9 t.s.	6.85	17.12	3.32	3.53	13.80	2¾	0.61
Shell End-mills	2⅜ by 2¼ by 1	8.55	2 by 2 by 1	6.90	17.25	3.42	3.48	13.83	2⅛	0.47
	4½ by 4 by 1¼	33.15	3¾ by 3¾ by 1¼	25.10	62.75	13.26	11.84	49.49	11½	2.53
Angular Cutters	2½ by ½ by ⅞	4.10	2¼ by ¼ by ⅞	3.85	9.63	1.64	2.21	7.99	½	0.11
	3¼ by ½ by 1½	6.15	3 by 7/16 by 1½	5.10	12.75	2.46	2.64	10.29	¾	0.17
Metal-slitting Saws	3 by ⅛ by 1	2.50	2½ by ⅛ by 1	2.35	5.87	1.00	1.35	4.87	5/16	0.07
	6 by 3/32 by 1	5.85	5½ by 3/32 by 1	5.00	12.50	2.34	2.66	10.16	¾	0.17
Fluted Chucking Reamers[1]	½ by 2	5.25	½ by 2	5.25	13.12	2.63[1]	2.62	10.49	¼	0.05
	¾ by 2½	7.25	¾ by 2½	7.25	18.12	3.63[1]	3.62	14.49	¾	0.17
	1 by 2¾	11.00	1 by 2¾	11.00	27.50	5.50[1]	5.50	22.00	1½	0.33
	3 by 5¼	90.00	3 by 5¼	90.00	225.00	45.00[1]	45.00	180.00	4¾	1.05

Machinery

Solving the Tool Salvage Problem

The practice of several manufacturers who have worked out the best solution of their tool salvage problem is as follows: A regular tool salvage desk is established and every requisition for tools is routed to pass over this desk before going to the purchasing department. At the time the requisition comes to the tool salvage desk, reference is made to a card index which shows a daily inventory of all worn-out tools that are in stock. An experienced mechanic is placed at the tool salvage desk, and it is his duty to pass on every requisition for tools and compare it with the inventory of worn-out tools, in order to see whether it is not possible to fill the requisition by salvaging some of the worn-out tools that are on hand. In some plants the man at the tool salvage desk is placed on a bonus basis in order to encourage him to make a showing, and where this plan is followed some remarkable results have been obtained.

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[1] Cost of salvaging is 50 per cent of list price when new.

There are no especial precautions to be observed in shipping tools to the salvaging shop, except in the case of sets of milling cutters which are used in a gang. In such cases the entire set of cutters should be secured together with a wire which will not be cut or broken in transit, and a tag should be attached to the cutters marked with the word "gang." The reason for this is that such a set of cutters must be salvaged with the sizes of different cutters in the set bearing the correct relationship to each other. A little thought given to the subject will show that in cases of this kind, it is the relation of the sizes of cutters to each other which is the important point, and not the actual size of the individual cutters.

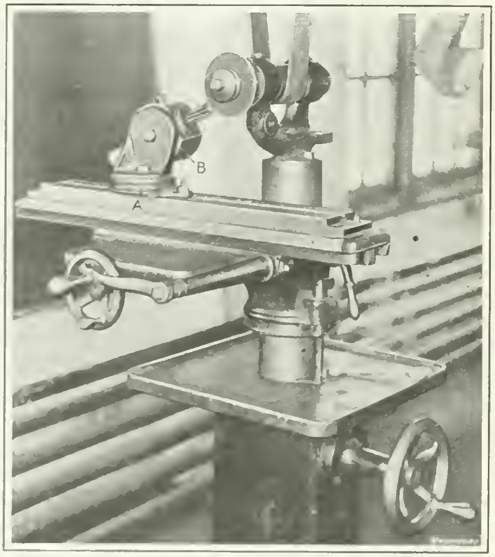


Fig 5. F. E. Wells Tool and Cutter Grinding Machine used by Detroit Reamer Salvage Co. for End-cutting Operation on End Milling Cutters

There is one point in connection with tool salvaging to which attention should be called in order to avoid possible misunderstandings between firms which are having their tools salvaged and the management of the shops in which the work is done. This is in regard to testing tools for hardness. It is an established fact, although not as well known as it should be, that high-speed steel containing a considerable percentage of chromium will show "soft" to a file test under certain conditions of heat-treatment, although the tools which appear to be soft when tried with a file are capable of giving satisfactory service. The only reliable way to make sure that a tool is unsatisfactory is to try it out under actual working conditions; then, if the tool fails to give efficient service, there is a justifiable reason for returning it and making a claim against the shop which did the salvaging.

Discussion of Work Involved in Salvaging Cutters and Reamers

Probably a good idea of the results which are secured in salvaging various types of cutting tools, will be obtained by referring to the title illustration of this article and Figs. 1 to 4. At the left-hand side of the title illustration there is shown a group of worn-out cutters which were sent to the Goddard & Goddard Co. to be salvaged, and at the right-hand side there is shown the same group of tools after they have been salvaged. In these two groups the worn-out tool and the same tool after it has been salvaged are placed in corresponding positions, thus making it easy for the reader to appreciate just what has been accomplished in each case.

Mention has already been made of the fact that there are two possible methods of procedure in salvaging the different types of milling cutters, namely, to anneal the steel, recut the teeth and then reharden and resharpen the tool, or else to grind the teeth down ready for subsequent service without the performance of any heat-treating process. The latter is so nearly the universal method of procedure that the practice of recutting is hardly worthy of detailed consideration in this article. Where cutters are salvaged by grinding down without heat-treating, it is obvious that the original properties of the steel produced by the heat-treatment given the tool in the shop where it was made, is responsible for maintaining the tool in its original condition.

In order to give the reader a comprehensive idea of exactly what work is done in salvaging the different types of cutters, drills, and reamers, the different operations involved in salvaging several types of tools will first be tabulated in order that those who are considering the reclaiming of their worn-out tools will better appreciate the exact amount of service which they are obtaining for the money paid to the tool salvaging concern. Many of these operations are rather ordinary examples of toolmaking practice, and so it is proposed first to make a brief reference to all of the operations, in order to show clearly the amount of work involved in salvaging the different classes of tools, and then to discuss in some detail those operations which involve the use of mechanical principles of sufficient interest to warrant their being called to the attention of MACHINERY's readers. Many of these operations will also be illustrated, so that the reader will obtain a fairly comprehensive idea of the method of procedure.

Fig. 6. View in Goddard & Goddard Co.'s Sand-blasting Room where Salvaged Tools are so treated that Workmen cannot tell them from New Tools

Order of Operations in Salvaging End-mills

For the purpose of discussion, we shall consider a case in which the end mill to be salvaged has the tang twisted off the shank, and describe the way in which the Detroit Reamer Salvage Co. of Detroit, Mich., would proceed to reclaim such a tool. The order of operations is as follows: (1) List according to original size. (2) Cut off end to remove defects in the teeth, using a Mattison cutting-off machine equipped with a vulcanite wheel. (3) Gum teeth in side flutes on a

Wilmarth & Morman universal tool and cutter grinder, the object being to thin the teeth slightly to compensate for the effect of sharpening, and also to increase the chip clearance; the machine is equipped with a soft silicate wheel and no water is employed. (4) Notch end of cutter at points corresponding to spaces between teeth, with a 1/32-inch elastic vulcanite wheel used on an F. E. Wells plain tool and cutter grinder; the reason for performing this operation is that in grinding out the tooth spaces a formed wheel is used, and the corner of this wheel cannot be kept sharp enough to produce clean corners for the tooth spaces. (5) Grind new teeth at the end of the cutter, using a formed silicate grinding wheel on an F. E. Wells plain tool and cutter grinder and performing the operation dry. (6) Grind hemispherical relief at fluted end of cutter on F. E. Wells universal tool and cutter grinder equipped with an internal grinding attachment; no water is used. (7) Back off side tooth clearance on a Wilmarth & Morman No. 2 universal tool and cutter grinder, performing the operation dry. (8) Back off ends of teeth on a Wilmarth & Morman No. 2 universal tool and cutter grinder. (9) Polish taper shank to remove surface defects, the operation being performed on an F. E. Wells speed lathe with emery cloth. (10) Slush cutter with anti-rust compound. (11) Wrap in waxed paper ready for shipment.

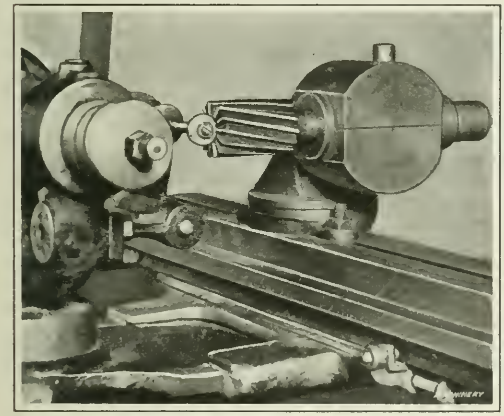


Fig. 7. F. E. Wells Tool and Cutter Grinding Machine used by Detroit Reamer Salvage Co. for grinding Hemispherical Relief in End Milling Cutters

Fig. 5 shows the operation of cutting notches in the cutter on an F. E. Wells plain tool and cutter grinder equipped with a vulcanite wheel 1/32 inch in width, in order to provide clearance spaces in which the formed grinding wheel can grind the tooth spaces and produce sharp corners of the required form. It will be apparent from this illustration that the grinding machine is equipped with a work-holding fixture that has swivels at *A* and *B* to provide for presenting the end of the cutter to the wheel at any angle which may be desired. Otherwise, the arrangement of the equipment is standard and requires no detailed explanation. The 1/32-inch vulcanite grinding wheel is run dry, and the tool may be revolved in the fixture to bring it into the required positions for grinding successive notches.

Fig. 7 shows an F. E. Wells tool and cutter grinding machine equipped with the same work-holding fixture and work shown in the preceding illustration, but in this case the machine is set up to provide for grinding a hemispherical relief at the front end of the cutter. The grinding machine is furnished with an internal grinding attachment to drive the small wheel required for cutting the hemispherical "pocket" or relief in the cutter. This small grinding wheel is dressed to the required radius so that when the work is revolved in the fixture, provision is made for grinding the required clearance in the tool.

For backing off the ends of the teeth, the work is set up on a Wilmarth & Morman No. 2 universal tool and cutter grinder as shown in Fig. 8. It will be seen that the same work-holding fixture is employed on this machine as that shown in Figs. 5 and 7, and a spring index finger is provided to locate successive teeth in position to have the clearance ground. The work is done dry.

Salvaging Chucking Reamers to Next Smaller Size

In taking up a discussion of the Detroit Reamer Salvage Co.'s practice in reclaiming chucking reamers, we shall consider a case in which the tang has either been twisted off the shank or at least has been so badly damaged that it is unfit for further use. In reclaiming such a reamer, the order of operations is as follows: (1) List reamer according to original size. (2) Cut off damaged tang on Mattson cutting-off machine equipped with an elastic vulcanite wheel. (3) Center-drill the tang end on F. E. Wells centering machine. (4) Cut off part of fluted end, if ends of teeth are damaged, on Mattson cutting-off machine equipped with elastic vulcanite wheel. (5) Grind 60-degree male center on fluted end of reamer, this operation being performed on a special grinding machine equipped with a formed wheel. (6) Straighten reamer on P. A. Gier straightening press and test straightness with dial indicator. (7) Mill new tang on reamer, holding work in special fixture mounted on lathe carriage and driving milling cutters on arbor between centers. (8) Rough-grind diameter of fluted end within 0.010 inch of standard size on redesigned Ott plain cylindrical grinding machine. (9) Grind relief between fluted end and taper shank on Ott No. 8 plain cylindrical grinding machine, equipped with special Norton grinding wheel which is adapted for grinding both high-speed and machine steel with satisfactory results. (10) Grind tapered shank to new finish on Modern universal grinding machine, and test work with Morse taper gage, using Prussian blue to assure accuracy of 0.0005 inch for taper fit. (11) Gum flutes on redesigned Wilmarth & Morman surface grinder to provide original amount of chip clearance; the machine is equipped with a formed wheel that engages all around the flute and is flooded with grinding compound to cool the wheel and work. In performing this operation one flute is finished at a time. (12) Finish-grind fluted end to required diameter on Brown & Sharpe No. 10 plain cylindrical grinding machine, the limit of accuracy on this operation being 0.0002 inch. (13) Grind side tooth clearance on Norton tool and cutter grinding machine. (14) Grind 45-degree end cutting clearance on Norton tool and cutter grinding machine. (15) Test diameter with micrometer caliper. (16) Mark salvaged size of reamer and salvage firm's name on Dwight Slate marking machine. (17) Slush with rustproof oil. (18) Wrap in waxed paper ready for shipment.

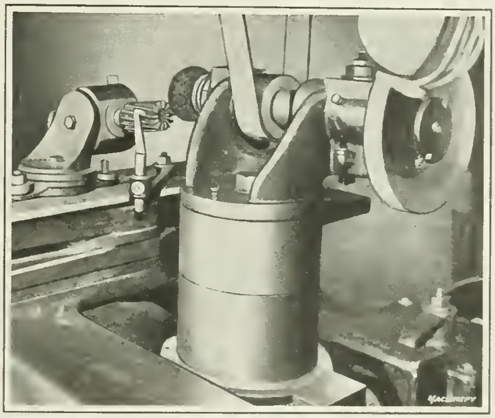


Fig. 8. Wilmarth & Morman No. 2 Universal Tool and Cutter Grinding Machine used by Detroit Reamer Salvage Co. for backing off Ends of Teeth of End Milling Cutters

In salvaging a chucking reamer where the ends of the teeth have been damaged so that it is necessary to cut off a portion of the fluted end, it will at once be obvious that the center hole is ground away, and as a result, there is no provision for

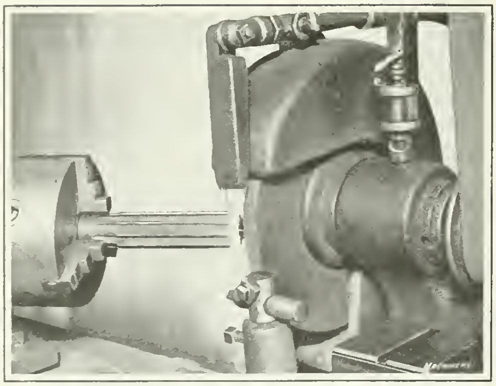


Fig. 9. Special Grinding Machine used by Detroit Reamer Salvage Co. for grinding Male Center on End of Chucking Reamers

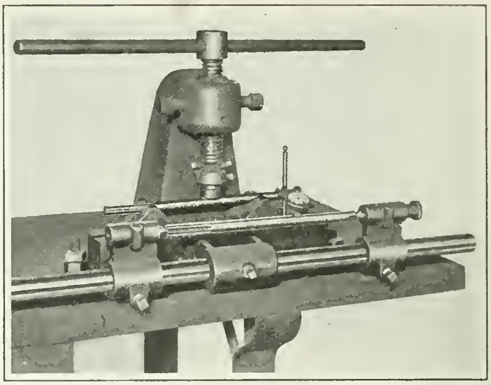


Fig. 10. P. A. Gier Straightening Press used in Shop of Detroit Reamer Salvage Co. for straightening Chucking Reamers

holding the reamer between centers ready for the performance of subsequent operations required in the process of reclaiming the tool. To overcome this trouble, the Detroit Reamer Salvage Co. use a special grinding machine equipped with a Cushman three-jaw chuck which holds the reamer at an angle to the grinding wheel, so that the wheel may be fed across the end of the reamer from the periphery to a point close to the center, to produce a male center on the reamer which fits a corresponding female center used on grinding machines for the performance of those subsequent operations where it is required to hold the reamer between centers. It will be seen that provision is made for delivering lubricant to the wheel and work during the performance of this grinding operation. Fig. 9 shows the special grinding machine equipped with a formed wheel for grinding the 60-degree male center on the end of the reamer.

The next operation in the process of salvaging reamers according to the practice of the Detroit Reamer Salvage Co., is to transfer the work to a P. A. Gier straightening press on which the reamers are tested with a dial test indicator to assure that they are perfectly straight, and if any error is discovered, the necessary correction is made until the accuracy of alignment is within 0.001 inch. Fig. 10 shows the straightening press in operation.

For gumming the teeth of reamers to provide the same amount of clearance as was originally allowed for the escape of chips, the reamer is set up between centers on a redesigned Wilmarth & Morman surface grinder, as shown in Fig. 11. This machine is of essentially standard design, except that a crank drive is provided for reciprocating the table instead of using the rack and pinion drive ordinarily furnished on the machine. The reason for making this change is that with a rack and pinion drive there is an appreciable amount of shock at each end of the stroke where reversal takes place, and this may result in leaving grinding marks on the reamer. On the special Wilmarth & Morman machine used for gumming the flutes of reamers, substitution of a crank drive for the rack and pinion arrangement enables the angularity of the crank to gradually slow down the table and bring it to a stop and then gradually accelerate it, so that there is no shock at the points of reversal and no tendency to leave grinding marks on the work. The arrangement of this crank drive is shown in the illustration, the guards having been removed from gears *A* and *B* in order to expose the table driving mechanism of the machine. Connected to the far side of gear *B* there is a slotted disk *C* in which an adjustable crankpin may be secured in the desired position to give the necessary crank throw and consequent traverse for the reciprocating table. The grinding wheel used to gum the flutes in the reamers is formed to give a full contact all of the way around one flute, and both the wheel and the work are flooded with a copious supply of grinding compound in order to cool the wheel and work, and thus prevent the steel from being burned. The gumming of one flute is completely finished before the work is indexed to bring the reamer into position for grinding the next flute.

Obviously, the finish-grinding of the diameter of the fluted end of the reamer is an operation for which the greatest accuracy is necessary, because the accuracy of holes finished with the reamer is dependent upon the precision attained in the performance of this operation. The limit of accuracy

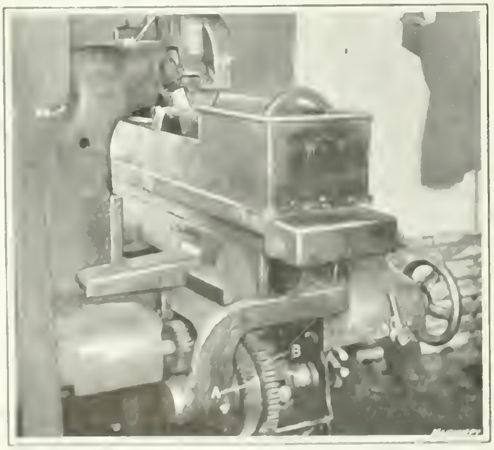


Fig. 11. Redesigned Wilmarth & Morman Surface Grinding Machine used by Detroit Reamer Salvage Co. for gumming Flutes of Chucking Reamers

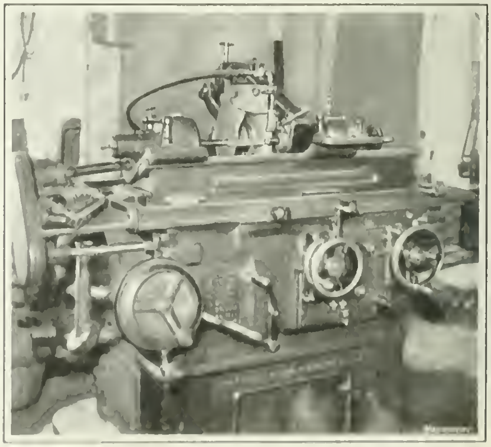


Fig. 12. Brown & Sharpe No. 10 Plain Cylindrical Grinding Machine used by Detroit Reamer Salvage Co. for finish-grinding Chucking Reamers to Diameter

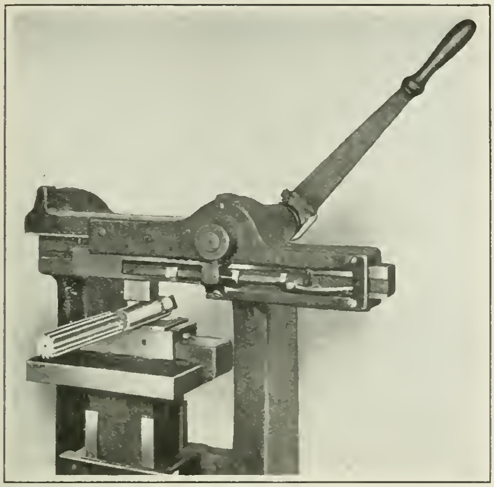


Fig. 13. Dwight Slate Marking Machine used by Detroit Reamer Salvage Co. for marking New Size on Shank of Chucking Reamers

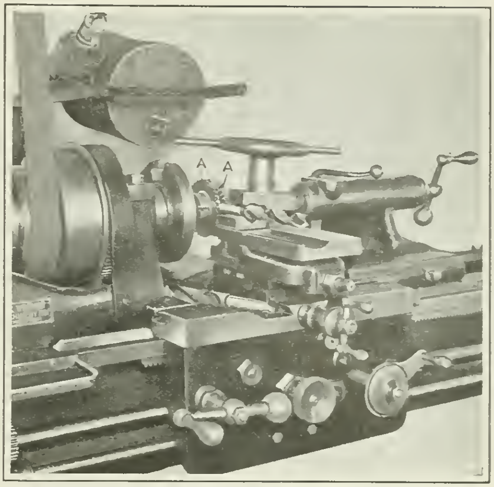


Fig. 14. Engine Lathe equipped with Special Work-holding Fixture and Form Tools for milling New Tang on Shank of Twist Drills

required is 0.0002 inch; this result the Detroit Reamer Salvage Co. obtain with a Brown & Sharpe No. 10 plain cylindrical grinding machine. The set-up for this operation is shown in Fig. 12, in which it will be apparent that the water guards have been removed in order to show the work.

For marking the salvaged size on the reamer, and also stamping it with the name of the firm that did the salvaging, use is made of one of the Dwight Slate marking machines built by the Noble & Westbrook Mfg. Co. of Hartford, Conn. Those who are familiar with this machine know that a die is used on which the desired marking is cut in relief, so that the work may be rolled under the die with the application of sufficient pressure to impress the marking. This machine is shown in Fig. 13 engaged in marking a reamer.

Practice Observed in Salvaging Twist Drills

For the sake of discussion we shall consider the case of a drill which has the tang twisted off, the cutting edges chipped, and the periphery somewhat worn, and outline the order of operations necessary in salvaging such a drill to bring it back into condition for further service. This order of operations is as follows: (1) List drill according to original size. (2) Cut off damaged tang on Mattson cutting-off machine equipped with a 12-inch elastic vulcanite wheel. (3) Drill center in cut-off end of shank on F. E. Wells centering machine. (4) Resharpen point by hand on F. E. Wells plain tool and cutter grinding machine. (5) Test straightness of drill on P. A. Gier straightening machine equipped with dial test indicator, and straighten if necessary. (6) Mill new tang with drill held in fixture on carriage of engine lathe and milling cutters mounted on arbor between centers. (7) Rough-grind diameter of fluted end within 0.005 inch of required size on Modern No. 2 universal cylindrical grinding machine equipped with special chuck to hold point of drill. (8) Finish-grind fluted end to required diameter on Brown & Sharpe cylindrical grinding machine, holding work to within 0.0002 inch of required diameter and providing a back taper of 0.001 inch per inch. (9) Grind side clearance on F. E. Wells cutter grinder equipped with special fixture for holding drill in required relation to wheel and rotating drill as it is moved across face of wheel. (10) Measure diameter of drill with micrometer caliper. (11) Mark salvaged size and salvage company's name on Dwight Slate marking machine. (12) Slush with anti-rust oil. (13) Wrap in waxed paper ready for shipment.

Fig. 14 shows the engine lathe set up for milling a new tang on the drill shank. Referring to this illustration, it will be seen that the drill is secured in a work-holding fixture carried on the lathe carriage. This carriage is disconnected from the longitudinal feed, but the cross-feed is employed to

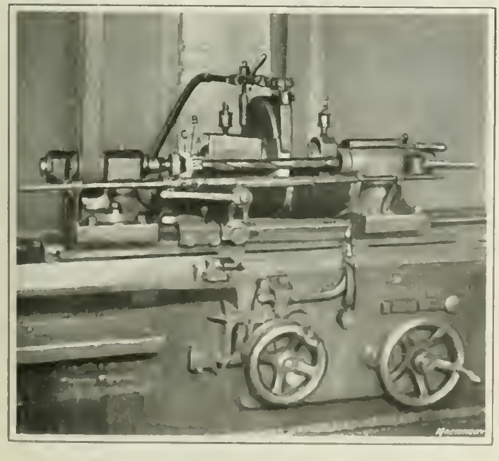


Fig. 15. Modern Tool Co.'s Grinding Machine with Special Chuck, used by Detroit Reamer Salvage Co. for rough-grinding Fluted End of Twist Drills

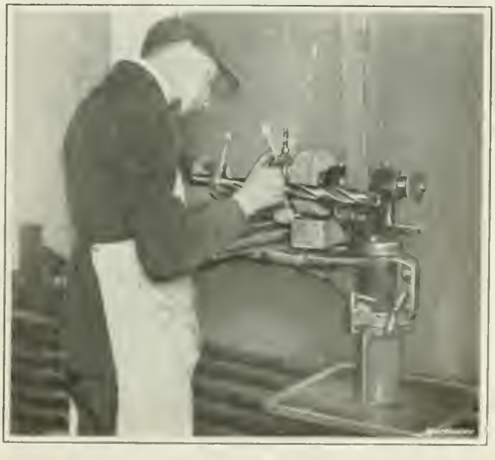


Fig. 16. F. E. Wells Cutter Grinding Machine equipped with Fixture for grinding Side Clearance on Twist Drills in Shop of Detroit Reamer Salvage Co.

feed the end of the drill shank between two form milling cutters *A*, which are carried on an arbor with the necessary space between them to provide for milling a tang of the required size on the work. This simple arrangement enables the operation to be performed very rapidly and with the required degree of accuracy.

For rough-grinding the fluted end of the drill to the required diameter, use is made of a Modern No. 2 universal grinding machine which is equipped with a special chuck, shown set up on the machine in Fig. 15, for gripping the point of the drill; the shank end is held on an ordinary center. It will be seen that this chuck has two small jaws *A* that enter the flutes of the drill at each side of the point and serve as a substitute for the usual form of center used for holding work on a cylindrical grinding machine. These jaws are pivoted at *B* and they are furnished with extensions *C* that run back on the tapered body of the chuck, so that when the body is screwed up to force the tapered end between the ends of jaw extensions *C*, jaws *A* secure a firm grip on the drill. The Detroit Reamer Salvage Co. have been granted a patent on this chuck. Aside from the use of this special chuck on the grinding machine, the operation is an ordinary cylindrical grinding job and requires no discussion.

For grinding the side clearance on the drill, use is made of an F. E. Wells cutter grinder, equipped with a special fixture as shown in Fig. 16. It will be seen that this fixture serves the double purpose of holding the drill in the required relation to the grinding wheel to grind the clearance surface and of rotating the drill as it is drawn across the face of the wheel, so that a uniform clearance surface is provided for the entire length. A ball bearing *A* is pressed lightly onto the tapered shank of the drill so that the operator can hold the outer race of this bearing comfortably in his hand while he draws the drill across the face of the grinding wheel and causes it to rotate. This rotation of the drill is accomplished by means of a pin carried by yoke *B* of the work-holding fixture, which enters the spiral flute of the drill and as the latter is drawn across the face of the grinding wheel, it necessarily causes the drill to rotate. It will be apparent that the required side clearance is obtained by having the axis of the twist drill located at a level slightly below the axis of the grinding wheel.

Miscellaneous Operations in Salvaging Milling Cutters

In the following illustrations there are shown methods used by the Goddard & Goddard Co., of Detroit, Mich., for performing various operations which are involved in salvaging different types of milling cutters. It will, of course, be understood that these are merely typical operations and that they do not in any sense tell the story of the work which is involved in placing a worn-out cutter back into condition for service.

Fig. 17 shows the work of gumming out the tops of the teeth of a side milling cutter, and standing on the table beside the centers that support the work there will be seen one of the cutters which has been completely ground. It will be apparent from this illustration that the grinding wheel is formed to engage all of the way around the space between two adjacent teeth, so that as the cutter is traversed back and forth under the wheel, the entire space is ground. It will also be seen that the customary form of spring-finger *A* is used to index the cutter for the performance of successive grinding operations. The entire set-up of the work is clearly shown in the illustration, and no further reference is necessary except to call attention to the exhaust hood *B* which carries grindings and abrasive away, and assures against the creation of conditions that would be detrimental to the health of the machine operator. All machines in the shop of the Goddard & Goddard Co. are equipped with these air hoods.

Fig. 18 shows a Wilmarth & Morman plain surface grinder set up for gumming the side teeth of the same type of cutter as is shown having the tops of the teeth ground in Fig. 17. Here it will be seen that the grinding machine is equipped with a special fixture for holding the cutter. It will be noticed that this fixture is furnished with three swivels *A*, *B* and *C*, which enable the arbor carrying the cutter to be set at any desired angle for grinding the side teeth. A spring index finger *D* is employed to index the cutter for successive grinding operations, and as in the previous case, the grinding wheel is so formed that it comes into contact with the work all of the way around the space between two adjacent teeth.

Everyone who has had experience in serving workmen who come to the window of a tool-crib to get the necessary cutters, etc., for handling their work, knows that disputes often arise between the tool-crib attendant and workmen,

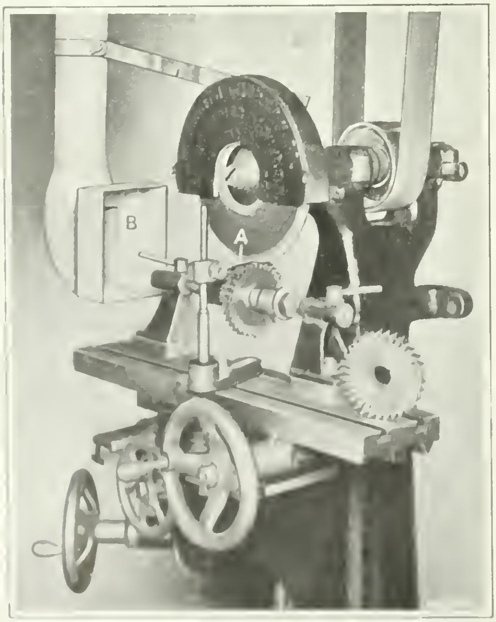


Fig. 17. Wilmarth & Morman Plain Surface Grinding Machine equipped for gumming Tops of Teeth of Side Milling Cutters in Shop of Goddard & Goddard Co.

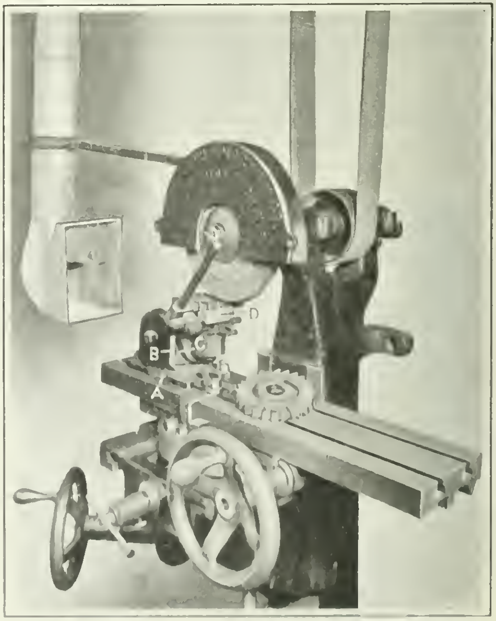


Fig. 18. Wilmarth & Morman Plain Surface Grinding Machine equipped for gumming Sides of Teeth of Side Milling Cutters in Shop of Goddard & Goddard Co.

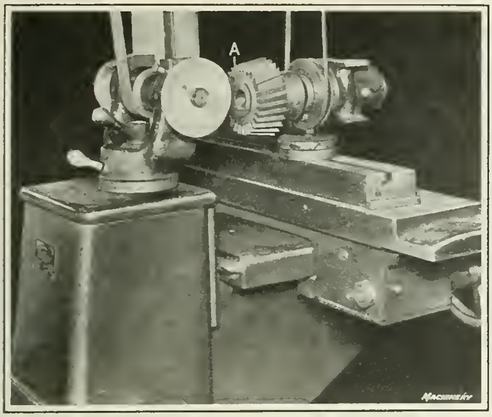


Fig. 19. Grinding Relief A on End of Angular Milling Cutter in Shop of Goddard & Goddard Co. Cutter revolves while being ground, thus making Operation Continuous

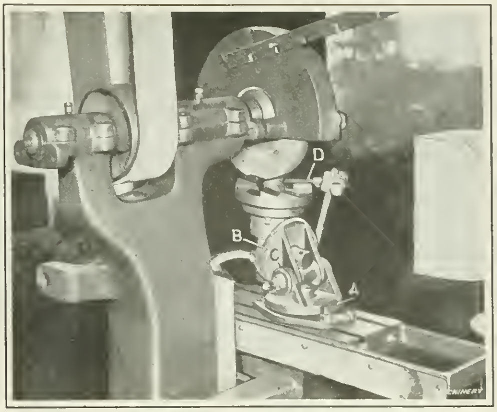


Fig. 20. Wilmarth & Morman Plain Surface Grinding Machine equipped for gumming Teeth of Spot-facing Cutters in Shop of Goddard & Goddard Co.

because the men feel that they are not getting the proper tools for their work, or that the quality of the tools handed them is below par. When salvaged tools first began to make their appearance in tool-cribs, workmen conceived an unjust prejudice against them, which became so strong that it was oftentimes difficult for the tool-crib attendant to get the men to take them. Two methods of procedure were adopted to overcome this trouble. One of these consisted of placing superintendents and foremen on a profit-sharing basis, so that an incentive was offered to reduce production costs as far as possible. Of course this step had far broader significance than its reference to the use of salvaged tools, but it created the necessary incentive to get the heads of manufacturing departments to see to it that salvaged tools were used wherever possible, because their value was only 40 per cent of the cost of the same tools when new, and so if a salvaged tool was broken the charge made against the department was much less than would have been the case if it had been a new one.

The other step toward overcoming the prejudice against salvaged tools, to which reference has been made, was the adoption by salvaging shops of the practice of sand-blasting the reclaimed tools before they are sharpened. In this way the tools are made to look just about as they did when new, so that when the tool-crib attendant hands an employe a salvaged tool, the man does not know the difference. In justice to salvaged tools it must also be stated that if the work of reclaiming them has been properly done, the service rendered will be as good as in the case of new tools, so that sand-blasting to give the same appearance as new is entirely legitimate. Fig. 6 shows part of the Goddard & Goddard Co.'s sand-blasting rooms.

Fig. 19 shows the operation of grinding the clearance surface *A* back of the end teeth on an angular milling cutter. Here it will be seen that the grinding machine is equipped with a wheel of suitable width for grinding the required clearance without traversing the table. The cutter is held by a fixture furnished with a spindle that may be driven so that rotation of the cutter in contact with the wheel provides for grinding the required annular clearance.

Referring to the equipment of the Wilmarth & Morman plain surface grinding machine which is shown in Fig. 20 engaged in gumming the teeth of a spot-facing cutter, it will be seen that the work is supported by a fixture furnished with three swivels, *A*, *B* and *C*, which enable the cutter to be brought into contact with the wheel at any required angle. Indexing is accomplished by means of spring-finger *D*, which locates the successive teeth in position to be gummed.

Advantages of Tool Salvaging in War Time

The activity and competition in many lines of industry is now so keen that advantage must be taken of every possibility of saving, in order that this competition may be met and still leave a reasonable margin of profit after all manufacturing expenses have been paid. In war time the machine shop manager is faced with an unprecedented condition as regards both a scarcity of steel and an inadequate supply of skilled toolmakers. The demand for high-speed steel used in the production of tools for various lines of munition work has resulted in increasing the price according to the familiar principle of supply and demand; and the scarcity of toolmakers has been due both to an abnormal demand for tools and to a further depletion of the supply of men due to the draft. As a result, the provision of means for obtaining further service from cutting tools is of exceptional importance in war time, and has led many manufacturers to take advantage of this opportunity of saving, who might not have thought the incentive sufficiently great to consider the proposition in times of peace. Many of those who adopted the practice as a war measure, however, are securing such satisfactory service from their salvaged tools that there is little doubt that they will continue salvaging their high-speed steel cutting tools as a proved method of economy which is equally applicable in times of war and of peace.

* * *

PACKING FOR EXPORT

The American Consul General at Rio de Janeiro reports that in a shipment of 2000 cases arrived at the Brazilian port from the United States, 600 were found to be damaged. In another instance, out of 450 cases, 113 were damaged due to improper packing for export trade. Tin plate, for example, arrives from the United States in lots of 112 sheets packed in cases of very thin wood and insufficiently hooped with light iron bands. This does not provide protection against handling when the cargo is discharged, and the case is often broken, and the sheets are bent and exposed to the weather conditions. The necessity for packing goods for export differently from those intended for the domestic trade has been emphasized for years, but American manufacturers seem to be slow to appreciate that if we are to obtain a sufficient share of the foreign trade after the war, we must meet the foreign trade requirements as well as do other nations.

* * *

In an investigation made by the *Engineering News-Record*, four questions were put to deans and professors of engineering schools and colleges with a view to ascertaining what demands there were at the present time for graduates in civil, electrical, mechanical and chemical industries; to what extent there was any dearth or over-supply of engineers; and whether there was any apparent improvement in the status and pay of engineers. The replies obtained from a great number of educators indicate that there is a strong demand for young graduates, but no startling dearth of engineers, and that there is little or no support for the view that engineering will be particularly rich in financial reward.

MACHINING A NOSED-IN SHELL[1]

BY M. H. POTTER[2]

Many shops have had considerable trouble machining nosed-in shells. This trouble is due to the method used rather than to the machine tool equipment. The method described here, though having more operations than most methods, has been found very satisfactory in a number of large factories. While the operations given are those for a six-inch British high-explosive shell, the method is adapted to any kind of nosed-in shell; the gaging instructions are also worthy of careful study. The shell is in a horizontal position, except during the tenth, twenty-second, and twenty-third operations, when it is vertical.

Operation 1—Cut off open end; gage depth of bore.

Operation 2—Center; gage depth of center.

Operation 3—Rough-turn; gage diameter.

Operation 4—Bore; gage diameter and depth of bore.

Operation 5—Face base, rough; gage thickness of base.

Operation 6—Recenter; gage depth of center.

Operation 13—Finish-turn; gage diameter of body and nose and profile of nose.

Operation 14—Thread nose; gage diameter of threads.

Operation 15—Weigh; make allowances for weight of stock removed in following operations, the weight being determined by actual trials.

Operation 16—Bore out base and form head; gage diameter, depth of bore, and form of head.

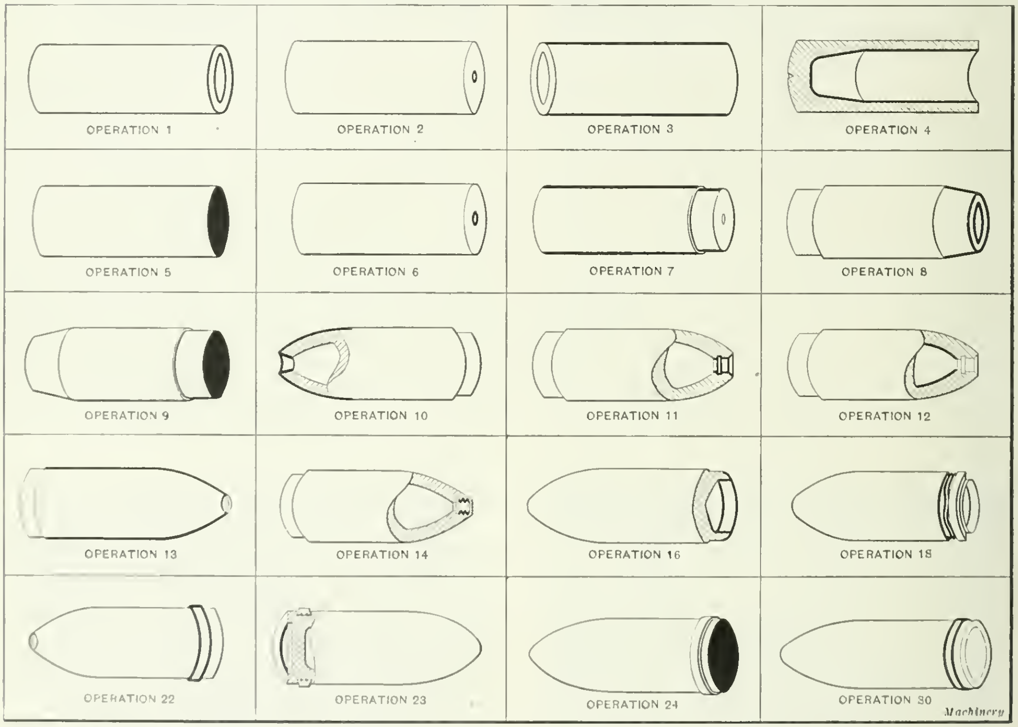
Operation 17—Check weight to determine that shell is within the required weight at this stage.

Operation 18—Groove and wave; gage width and diameter of groove and distance from base; also diameter and height of ribs and angle of under-cut.

Operation 19—Sand-blast interior; wash and clean exterior.

Operation 20—Preliminary shop inspection. After collecting shells in series, gage diameter of body, base, and groove in body, width of groove, distance from base, and thickness of walls and base.

Operation 21—Preliminary government inspection.



Machining Operations on 6-inch British High-explosive Shell (Heavy Lines and Solid Black Surfaces indicate Machining Operation)

Operation 7—Rough-turn body a second time and finish base diameter to size; gage diameter of body and base and width of base diameter.

Operation 8—Bevel and face open end to length; gage form of bevel and over-all length of shell.

Operation 9—Reface base; gage thickness of base.

Operation 10—Nose in; gage over-all length of shell, outside diameter at nose, profile of nose, diameter of hole in nose, and thickness through nose.

Operation 11—Bore fuse hole and recess; gage diameter of fuse hole above and below recess, diameter of recess, distance from nose, and angle of fuse hole.

Operation 12—Finish inside contour; gage thickness through nose.

Operation 22—Apply band; gage diameter of band.

Operation 23—Rivet baseplate; examine for tightness.

Operation 24—Face base; gage thickness of base and radius at edge.

Operation 25—Stamp base.

Operation 26—Hand retap threads and ream angle of fuse hole; gage threads, angle of fuse hole, and thickness through nose.

Operation 27—Wash and clean inside and outside.

Operation 28—Varnish.

Operation 29—Bake varnish.

Operation 30—Turn band; gage diameter of band, form, width, and distance from base.

Operation 31—Final shop inspection; gage diameter of base, profile of nose, and concentricity of shell.

Operation 32—Final government inspection.

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There are in use in the United States 435,000 motor trucks with an average capacity of 2.6 tons.

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[1] For previous information on shell manufacture, previously published in MACHINERY, see "Manufacture of the U. S. 75-millimeter Shell," March, 1918, "[illegible] Shell Making Machines," November, 1916, "High-explosive Shell Manufacture," December, 1915, "The Heat-treatment and Testing of Shrapnel Shells," September, 1915, and "Shrapnel and Shrapnel Manufacture," April, 1915.

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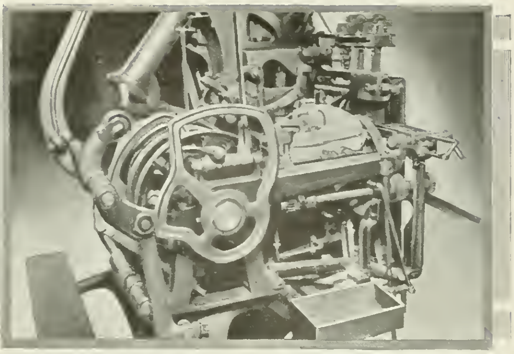
Ingenious Mechanical Movements

By Franklin D. Jones[1]



First Installment of an Article on Mechanisms for Transmitting, Modifying, and Controlling Motion to Secure Changes of Velocity, Direction, and Time of Action[2]

In the development of new types of machines or inventions, the real problem, in many instances, is to obtain a certain motion or combination of related movements. The stresses involved or the power to be transmitted, and the proportioning of the different parts to resist the stresses without excessive distortion or breakage, are frequently of little importance when compared with the action of the machine or the mechanical movement. The designer or inventor conceives the idea of accomplishing some result by mechanical means, and the first question that arises is: How can the desired result or effect be obtained mechanically? It may be apparent from the nature of the work to be done that certain changes in the velocity of different parts are necessary, and that the direction of motion must be varied at given intervals. It may also be essential to modify the motion so that it is either irregular, intermittent, or both, with changes of action occurring at uniform or variable intervals of time. If the problem were confined entirely to mechanical action, it would be greatly simplified in many instances, but, unfortunately for the designer and inventor, it is of the utmost importance to consider the cost of manufacturing whatever machine or mechanism is being developed. If expense could be disregarded, it would be possible to do almost anything mechanically. The problem, then, is how to accomplish a certain result without employing a mechanical device which is so complex that it costs more than it is worth. Many of the most ingenious mechanisms in existence are very simple and direct in their action, although they were not all simple when first constructed. When a mechanical device is first being developed, the operation it is to perform may quite naturally overshadow the question of manufacturing cost, and frequently the simplifying or the elimination of unnecessary parts begins afterward. It is evident, however, that at the very beginning the simpler the mechanism is, the better, and failure to recognize this fact is responsible for many inventions without commercial value. The study of mechanical movements is of especial importance at the present time, owing to the increasing use of automatic and semi-automatic machinery in almost every line of manufacture. No attempt will be made in this article to present a comprehensive treatise on mechanical movements, but rather to describe a variety of mechanisms which are considered ingenious in their design and which embody valuable principles that may be applied to various other mechanical devices.

Reciprocating Motion which Automatically Varies

The first mechanism to be described is arranged to impart a reciprocating motion to a slide or bar in such a way that the length of the stroke is constantly increasing or decreasing from the minimum to the maximum, and *vice versa*. The fly frames used in the manufacture of cotton goods are equipped with a mechanism of this kind for traversing the rovings or slightly twisted slivers of cotton as they pass between the rolls of the fly frame, which is used to make the rovings more slender and give them a twist. The reason for traversing the roving as it passes between a steel and a leather-covered roll is to prevent wearing the leather covering at one place. On some machines, this reciprocating or traversing motion is obtained from a crank or a cam. This simple arrangement distributes the wear, but, if the length of traverse is uniform, the tendency is for the leather covering to wear the most at the points of reversal. In order to distribute the wear more evenly, the mechanism shown in Fig. 1 was designed. With this arrangement, the length of traverse gradually increases until it reaches a maximum and then decreases until the shortest length of traverse is obtained; the gradual increasing and decreasing of the stroke are then repeated.

The diagram *A* illustrates graphically the action obtained with a crank motion, and diagram *B* illustrates the variable stroke derived from the mechanism to be described. The guide-bar *C*, which extends the full length of the rolls, has small holes opposite each roll section through which the rovings pass, and it is this guide-bar which receives the reciprocating motion. The automatic variation of the traversing movement is derived from two eccentrics *D* and *E*, which revolve at different rates of speed. These eccentrics are formed on the hubs of gears *F* and *G*, which are adjacent to each other, and are both driven by one worm *H*, as shown by the end view. The motion of the eccentrics is transmitted to guide-bar *C* through rods *J* and *K* and the bracket *L*. One of the gears meshing with worm *H* has one more tooth than the other, which causes the gears to rotate at a varying speed. The result

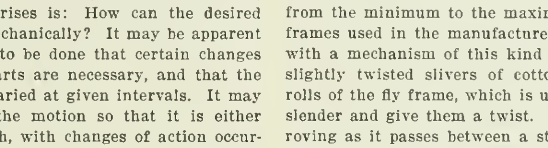


Fig. 1. Double Gear and Shifting Eccentric Combination for automatically varying Traversing Movements

is that the eccentrics formed on the two gear hubs are continually changing their position relative to each other, which automatically varies the length of traverse for guide-bar *C*. For instance, at one period during the cycle of movements, both eccentrics will move rods *J* and *K* in the same direction, and, at another period, one eccentric rod will be moving backward while the other is moving forward, thus reducing the stroke of the guide-bar. The connections between the eccentric rods and the bracket are adjustable; an adjustment is also provided where the bracket is attached to the guide-bar, so that the maximum traverse may be varied.

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[1] Associate Editor of Machinery.
[2] A chapter that will be included in the author's book "Mechanisms and Mechanical Movements," to be published in the near future.

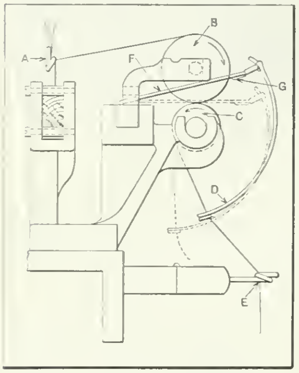

Fig. 2. Tripping Device for Textile Machine

Automatic Tripping Devices for Textile Machines

Some very ingenious tripping mechanisms or "stop motions" are applied to different classes of textile machines. The examples described illustrate the possibilities of the use of comparatively simple devices for automatically controlling the action of machines under conditions which might, at first, seem to be very complex and difficult.

The stop motion shown in Fig. 2 is applied to a machine used for twisting yarn. The yarn passes from the guide wire at *A* around the rolls *B* and *C*, through an eye in wire *D*, and out through the guide at *E*. The wire *D* is attached to another wire *F*, which is normally held by the yarn in the position shown by the full lines. If the yarn or thread should break, the wires fall to the position shown by the dotted lines, thus bringing wire *F* into engagement with the lower roll *C*. Contact with this roll immediately moves the wires to the left until a tongue *G* enters between the rolls and raises *B* out of contact with *C*, which prevents it from revolving and stops the delivery of yarn.

Another stop motion which acts when a thread is broken is shown in Fig. 3. This mechanism is applied to a machine used for winding thread on spools. It is designed to raise the spool out of contact with a flange which drives it by friction, if a thread breaks, thus arresting the motion of the spool without stopping the spindle on which the spool is mounted. The device is also arranged so that the wire which drops when a thread breaks is raised automatically to its normal position for rethreading. The thread *A* passes through the eye of a drop wire *B* and serves to hold this wire in its normal position. Attached to this wire there is a lever *C* pivoted at *D* and connected by link *E* with the catch *F*. The lever *G* is normally held in a horizontal position by catch *F*. If a thread breaks, the dropping of wire *B* releases catch *F* and lever *G* falls to the position shown in the illustration. This lever is connected by a rod *H* with a sleeve *J* pivoted at *K*. The downward movement of lever *G* swings the sleeve *J* about its pivot and brings a pin under the flange *R* of the spool, thus raising it from the supporting disk *L*, as shown in the illustration; at the same time, the flange of the spool engages a rubber disk *M* which stops the rotation. Attached to the shaft of lever *G*, there is a small finger *O* which is given a partial turn when the catch lever falls. As the result of this movement, the finger engages lever *C* and swings it with the drop wire *B* back to the normal position for rethreading. As soon as the catch lever has been engaged again with the catch *F*, the spool drops into contact with its driving flange and again begins to wind the yarn.

Automatic Trip for Wire-winding Machine

Fig. 4 shows an automatic tripping device that is applied to a machine used for winding small wire onto spools. In this illustration, *A* represents the reel which contains the stock of wire, and *B* is the spool upon which the wire is wound. This spool is driven at a constant speed. If, for some reason, the wire should not uncoil easily from reel *A*, it might be broken or the mechanism damaged, assuming that the wire passed directly from the reel to the spool. In order to avoid trouble from any resistance to uncoiling which may occur, the wire, after leaving the reel, is guided by idler pulleys, so as to form a loop; at the end of this loop there is an idler pulley *C* mounted on a lever *D*, which is free to swing about fulcrum *E*. When the uncoiling and winding is proceeding under normal conditions, the weight of lever *D* is sufficient to prevent the wire from lifting it; any abnormal resistance, however, such as might be caused by a kink on reel *A*, will result in swinging lever *D* upward into contact with trip *G*, which, by disengaging a clutch, stops the machine.

Electro-mechanical Tripping Device

Certain classes of textile machines are equipped with some form of electrical control for automatically stopping the machine when it is operating under abnormal conditions. A simple method of controlling a machine electrically is found on some drawing frames. The upper and lower sections of the machine frame are insulated from each other, and one pole of a small dynamo is connected to one frame section and the other pole to the other section. The cotton, which is a nonconductor and is constantly passing between the different pairs of rolls, prevents the completion of the electrical circuit except when the cotton breaks and both rolls of a pair come directly into contact with each other. When this occurs, the electrical circuit thus formed, acting in conjunction with an electromagnet, swings a lever into the path of a revolving trip or catch, which, as its rotation is stopped, either shifts a belt from the tight to the loose pulley or disengages a clutch by means of suitable mechanism.

A very simple form of electro-mechanical device is shown in Fig. 5. This is applied to looms and operates whenever a thread breaks. The steel spring wire *A* is normally held between two threads in the bent position shown to the left. If one of the warp threads should break, the spring wire is immediately released and flies over to the left into engagement with rod *B*, as shown to the right, thus closing an electrical circuit. This circuit is a comparatively weak one and stops the machine by means of an electro-mechanical type of mechanism. The actual force required for stopping the machine is sometimes considerable, and it is derived by a moving part of the loom, the electrical mechanism being used simply to cause a locking effect that enables the other part of the mechanism to operate.

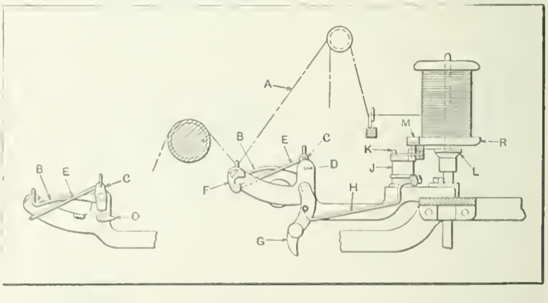

Fig. 3. Another Tripping Device or Stop Motion for Textile Machine

Automatic Speed-limiting Devices for Engines

A speed limiting device which is governed by the inertia of a weight and the tension of a spring is shown in Fig. 6. This automatic stop was designed for application to steam engines, but devices operating on the same general principle could doubtless be applied to other classes of machinery. This mechanism is primarily a safety device and is intended to stop the engine and prevent damage such as might be caused by a bursting flywheel, in case the governor failed to operate. The lever *A* is pivoted at *B* to the engine cross-head and is normally prevented from swinging about pivot *B* by the spring *C* attached near the upper end. The inertia of weight *D*, which may be adjusted along the lever *A* tends to swing the lever to the right when the motion is suddenly reversed and the cross-head moves to the left. When the cross-head is at one end of its stroke, the upper end of lever *A* is quite close to the catch *E*, which engages latch *F*. Rod *G* attached to this latch connects through whatever additional rods or levers may be needed, with the tripping mechanism used in conjunction with a quick-closing valve which controls the flow of steam to the engine cylinder. This valve and its operating mechanism is shown in detail at the left of the illustration. Rod *G* is connected in any convenient way with bellcrank lever *H*, from which rod *J*, carrying weights at its lower end, is suspended. This rod passes through trip-lever *K*, which normally engages lever *L* connected with the quick-closing valve *M*. If, for any reason, the speed of the engine becomes excessive, the lever *A* and its attached weight resists the sudden reversal of motion at the end of its stroke sufficiently to overcome the tension of spring *C*, and lever *A* strikes catch *E*, thus releasing latch *F;* as rod *J* drops, the flange on it strikes trip *K* and allows the steam valve to be closed by the weighted lever *N*. This speed-limiting device may be adjusted by varying the tension of spring *C* and also by changing the position of weight *D*. The greater the spring tension and the nearer the weight is to the pivot *B*, the faster the speed will have to be to overcome the tension of the spring at the point of reversal. The handle *O* is for resetting the steam valve, and handle *Q* for tripping the valve by hand. If remote control is required, this may be obtained by the use of rods or cables directly connected to latch *K*, or by the use of a solenoid *R*, as indicated by the illustration. This automatic safety stop is recommended as being simple, positive in action, adjustable, inexpensive, and easily applied to almost any engine.

The automatic speed-limiting device described in the following was designed for application to gas or gasoline engines. In case the speed becomes excessive, owing to the failure of the governor, this tripping mechanism, which is of the centrifugal type, operates by breaking the ignition circuit. It may be attached either to the secondary shaft or to the main shaft. The controlling element is a weight *A*, Fig. 7, which is attached to a rod connecting with a spring *B* on the opposite side of the hub. This weight is located within a casing *C* carried by a stud *D* screwed into the end of the shaft. Pivoted near the casing is a latch *E* which normally holds the weighted trip-lever *F* in the position shown. The ignition switch is located at *G*, and when lever *F* is held up by latch *E*, the ignition circuit is closed. If the speed of the engine is increased to such an extent that the action of centrifugal force causes weight *A* to fly outward against the tension of spring *B*, the end of rod *H*, by striking catch *E*, releases lever *F* and allows it to fall, thus breaking the ignition circuit.

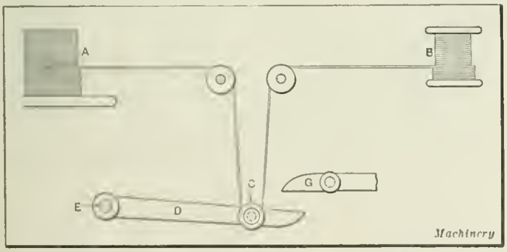

Fig. 4. Safety Tripping Device for Wire-winding Machine

Automatic Ratchet Reversing Mechanism

The simple design of ratchet reversing mechanism illustrated in Fig. 8 enables a ratchet wheel to be automatically reversed after making a predetermined number of revolutions, and the arrangement is such that the time of reversal or the number of revolutions made by the driven ratchet prior to reversal may be varied at will throughout a wide range. The double pawl *A* is carried by an oscillating arm, and this pawl engages the driven ratchet *B*. Mounted concentrically with *B* there is a smaller controlling ratchet *C*, which is normally restrained from rotating by suitable frictional resistance. The larger diameter of ratchet *B* prevents pawl *A* from engaging the smaller ratchet *C*, except when the deep notch *D* is reached by the pawl, which then drops down into engagement with *C*.

The reversal of motion is effected by the engagement of the extension on pawl *A* with one of the trip-dogs *E*. The view to the right shows the pawl at the point of reversal. The number of revolutions made by ratchet *B* prior to reversal depends upon the number of deep notches *D* and the position of the trip-dogs *E*. When this mechanism is in operation, ratchet *B* receives an intermittent motion from the oscillating pawl *A*, and the controlling ratchet *C* remains stationary until one of the deep notches *D* is engaged by pawl *A;* then ratchets *B* and *C* rotate together an amount depending upon the motion of the pawl. Controlling ratchet *C* then remains stationary until another deep notch is engaged. The repeated movements of ratchet *C* each time the pawl drops into a deep notch finally bring one of the trip-dogs *E* into contact with the projection on the pawl; the latter is then swung around so that its opposite end engages ratchet *B*, and, consequently, the direction of rotation is reversed. The time of reversal may be controlled by varying the distance between the trip-dogs and by having one or more deep notches in the driven ratchet.

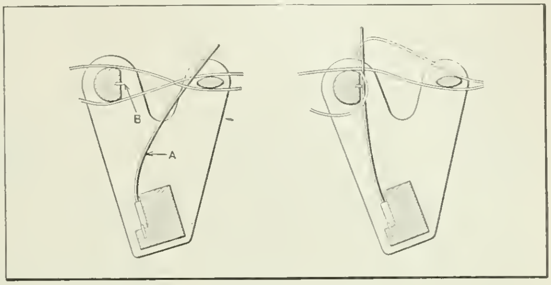

Fig. 5. Simple Form of Electrical Control for stopping Loom when Thread breaks

Automatic Variation in Point of Reversal

One of the many interesting mechanisms found on textile machinery is the one employed on fly frames for controlling the winding of the roving on the bobbin. The speed of the bobbins, in revolutions per minute, is decreased gradually as the continued winding of the roving increases the diameter, so that the peripheral speed remains practically constant. As the bobbins revolve, they are given a vertical reciprocating motion, in order to wind the roving onto them in successive helical layers. This winding of the roving onto the bobbin involves, in addition to decreasing the speed as the diameter increases, a decrease in the traversing speed of the bobbin and a gradual shortening of the bobbin travel as one layer of roving is wound upon another. The bobbin should move a distance equal to the diameter of the roving while it rotates relative to the "flyer" a distance equal to one revolution; therefore, as the bobbin speed gradually diminishes, it is also necessary to decrease the rate of traverse, so that each layer of the roving will be coiled closely. The change in the point of reversal in order to shorten the stroke as the bobbin increases in diameter is required in order to form conical ends on the wound bobbin and a firm winding that will not unravel and cause trouble, such as would be the result of attempting to wind each layer the full length of the bobbin. These changes occur simultaneously, although they will be referred to separately in describing the "builder motion" illustrated diagrammatically in Fig. 9.

The plates *B* and *C* engage a screw *A*, which has a right-hand thread extending along half its length and a left-hand

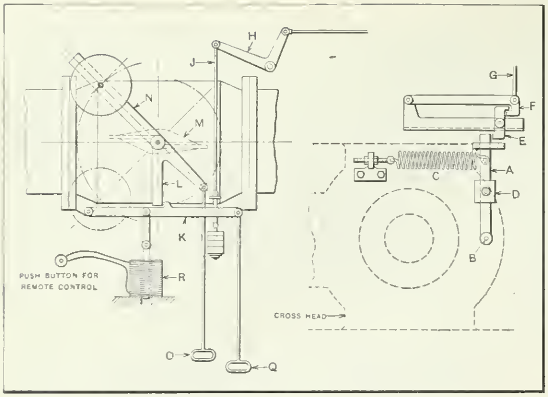

Fig. 6. Automatic Speed-limiting Mechanism for Steam Engines

thread along the remaining half. These plates and the screw are traversed vertically with the bobbin carriage. The vertical shaft *D* carries a dog *E* having two arms located 180 degrees apart. At each end of the stroke, shaft *D* makes a half turn, which motion is utilized for reversing the motion, for shifting the cone belt slightly in order to decrease the speed, and also for shortening the stroke of the bobbin. As the plates *B* and *C* move vertically, one end of the tumbling dog *E* bears against them until it slides off at one end. Prior to the disengagement of the dog with one of the plates, gear *F* on the cone-pulley shaft revolves idly in a space on the rim of gear *G* where the teeth are omitted. There are two of these spaces located 180 degrees apart, as the illustration indicates. One of the projection pins on the disk *H* at the lower end of shaft *D* is in engagement with a lever *J*, which has attached to it a spring that holds the lever against a pin and tends to turn shaft *D*. When dog *E* slides off one end of a plate, shaft *D* is turned far enough by the action of the spring and lever *J* to bring gear *G* into mesh with pinion *F*; consequently, gear *G* is revolved one-half turn, or until pinion *F* engages the space on the opposite side where there are no teeth. The partial rotation of shaft *D* shifts the reversing gears through a connection at the lower end and starts the bobbin carriage and plates *B* and *C* in the opposite direction. As the opposite end of the tumbling dog *E* swings around, it engages one of the plates and again causes a reversal of motion as it slides off the opposite end.

The shifting of the belt on the cone pulley at each reversal, for gradually decreasing the speed as the bobbin winding increases its diameter, is obtained by connecting rack *M* with shaft *D* through the pinion *N* and the train of gearing shown. This rack *M* has a fork attached to it that connects with the cone belt, and it is traversed slightly each time dog *E* slides off a plate and allows shaft *D* to turn one-half revolution. The reduction in the length of the carriage traverse is obtained by revolving screw *A* at each reversal and thus shortening the distance between the plates *B* and *C*. This rotation of the screw is effected by pinion *P*, which engages rack *M* and transmits motion through the other gears shown to the extension *Q* on the screw, which is made square and is free to slide through the gear hub as the carriage moves vertically. As the plates *B* and *C* are moved toward each other, the tumbling gear *E* has a shorter surface to traverse before it is disengaged. These two plates both move the same distance, so that the point of reversal decreases at each end and the bobbin is wound conical at both ends. The roving delivered by the front roll is either tightened or slackened by engaging pinion *R* with one of the three gears shown.

Operation of Clutches for Reversing Motion

When a reversal of motion depends upon the action of a clutch which is shifted from one gear to another revolving in an opposite direction, it is essential to operate the clutch rapidly and to secure a full engagement of the clutch teeth. Provision should also be made against disengagement of the clutch as the result of vibrations incident to the operation of the machine. There are two common methods of controlling the clutches used in connection with the bevel-gear type of reversing mechanism. One form of control may be defined as the swinging-latch type and the other as the beveled-plunger type. The general principle of operation is the same in each case, and is as follows: When the work-table, or whatever part is to be reversed, approaches the end of its stroke, a spring is compressed, and then a latch or trip allows this compressed spring to throw the reversing clutch suddenly and rapidly from one gear to the other. Reversing mechanisms of this general design are often called the "load-and-fire" type, because the spring is first loaded or compressed and then tripped to secure a rapid movement of the clutch and a reversal of motion at a predetermined point within close limits. The action of the compressed spring also insures a full engagement of the clutch teeth and prevents the clutch from stopping in the central or neutral position, which might occur if a spring were not used and the momentum of the part to be reversed were insufficient to carry the clutch across the space intervening between the two reversing gears.

The reversing mechanism illustrated in Fig. 11 is a bevel-gear type equipped with the swinging-latch form of clutch control. This mechanism is applied to a cylindrical grinding machine for reversing the motion of the work-table, and is located at the rear of the machine. The rockshaft *H* extends through to the front of the machine and has attached to it a lever which is engaged by dogs on the work-table, the distance between these dogs being varied according to the length of stroke required. At the rear end of rockshaft *H* there is a lever *G*, which, by means of link *J*, transmits motion to the reversing mechanism. As the work-table approaches the end of its stroke, lever *G* swings either to the right or the left, as the case may be. If the motion is to the left, tappet *A*, connected to link *J*, compresses spring *L* on rod *M* and forces block *D* against a square shoulder on the lower side of latch *B*. Continued movement of tappet *A* to the left causes the beveled side of *A* to lift latch *B*, thus releasing block *D*, which, with rod *M*, is thrown rapidly to the left under the impulse of the compressed spring *L*.

After the movement of shaft *M* to the left, the shoulder on latch *C* drops in behind block *E*. The fork *N* on rod *M* also throws shaft *O* to the left and with it the reversing clutch *F*, which is keyed to this shaft. The motion that prior to reversal was transmitted through bevel pinion *P* to the main gear *R* is now from pinion *Q* to *R*, so that the movement of the work-table is reversed. When the work-table approaches the end of its stroke in the other direction, tappet *A* is moved to the right, thus compressing spring *S*. Then latch *C* is lifted by the beveled edge on *A*, and the parts *M*, *N*, and *O* are quickly shifted to the right by spring *S*, thus again reversing the motion.

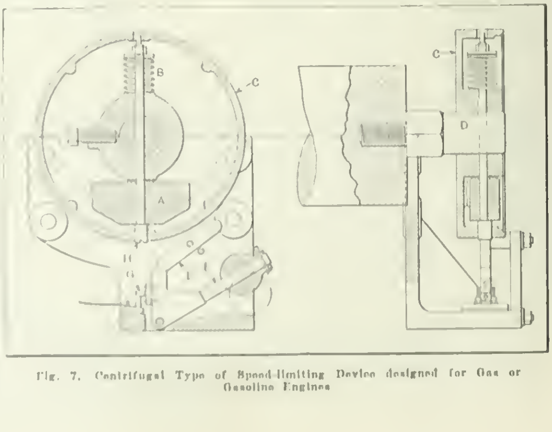

Fig. 7. Centrifugal Type of Speed-limiting Device designed for Gas or Gasoline Engines

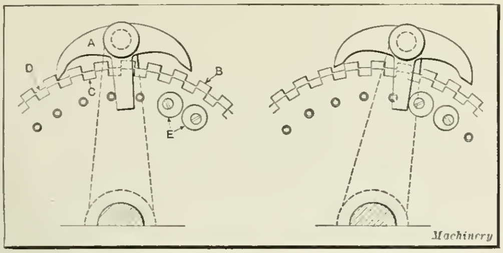

Fig. 8. Ratchet Mechanism that will automatically reverse after making a Predetermined Number of Revolutions

If the operator desires to stop the traversing movement at the end of the stroke, this may be done by the movement of a knob located in the center of the table-traversing handwheel at the front of the machine. This knob is connected with a plunger *T*, which, by pressing the knob, may be held under pressure against the reversing clutch *F*. When this clutch is shifted at the end of the stroke either by springs *L* or *S*, plunger *T* drops into a groove in clutch *F*, thus holding it in the central or neutral position. The knob previously referred to may be set at any part of the stroke to stop the traversing movement at the end of that stroke. The withdrawal of the knob again starts the traversing movement without any further action of the operator. The shaft connecting with bevel gear *R* extends to the front of the machine, and, through suitable gearing, transmits a rectilinear motion to the work-table of the grinding machine. The load-and-fire reverse mechanism is of especial value on grinding machines having a traversing movement.

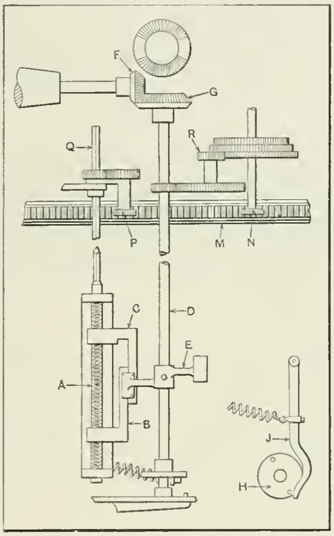

Fig. 9. Mechanism for varying Point of Reversal and Speed of Rotation

"Pattern Chain" for Variable Clutch Control

When clutches are engaged or disengaged automatically, their action is usually controlled either by cams or some form of revolving carrier having one or more lugs or dogs that engage the clutch-operating lever. The ingenious method of controlling clutches illustrated at *A* in Fig. 10 is applied to a textile machine known as a "twister," which is used for producing fancy yarns. The variations in the yarn are obtained by controlling the action of two sets of delivery rolls. The lower rolls *r* and *s* of each set support the upper rolls *c* and *d*. Splined to the end of roll *r* is a shifting clutch member *e*, which revolves the roll when engaged with the clutch teeth on the hub of gear *f*. A similar clutch and gear combination is located at *g* for driving the lower set of delivery rolls. The upper clutch is connected with lever *q*, pivoted at *h*, and the lower clutch with lever *j*, pivoted at *k*. The action of these clutch levers is governed by a pattern chain *l* suspended on a drum *m*. As this drum revolves, the rollers of the pattern chain come into engagement with the lower ends of the clutch levers, thus shifting the clutches into and out of engagement. By changing the position of the rolls or risers of the pattern chain, the pattern of the yarn may be varied and different fancy effects obtained. The chain drum is revolved by means of change-gearing for varying the speed according to requirements. The clutch gears are rotated continuously, and the delivery rolls are only stopped when a knot is being formed, both sets of rolls being rotated while the yarns are being twisted together between the knots.

Another application of an endless chain for controlling the engagement and disengagement of a clutch at predetermined intervals is illustrated at *B*, Fig. 10. This mechanism is applied to a loom. The vertical shaft *a* is driven through bevel gearing (not shown) at the lower end, from the driving shaft of the loom. The upper end of shaft *a* carries a clutch member *b*, which is engaged by the shifting clutch member c splined to shaft *d*. Shaft *d*, through the bevel and spur gearing shown, is connected with the chain drum or cylinder *e* carrying the clutch controlling chain *f*. Above this chain there is a lever *g*, pivoted at *h* and connected by link *i* with another lever *j*, pivoted at *k*. The pin *l* connecting the link and lever engages a slot in bellcrank *m*, the movements of which are controlled by a spring *n* and a connector o, which extends to another part of the machine. The vertical slot in lever *m* has a short horizontal section at the upper end.

The action of the mechanism is as follows: When the clutch members are engaged, the chain drum and chain revolve, and when one of the links *p* engages lever *g*, the lower lever *j* is raised, thus locating pin *q* in the upper part of the annular groove of the shifting clutch member. As soon as pin *l* at the end of lever *j* reaches the upper end of the vertical slot, the bellcrank lever *m* swings over under the action of spring *n*, thus engaging pin *l* with the horizontal part of the slot and locking the lever *j* in the upper position. As soon as the lever *j* is raised, a projection engages pin *q* and disconnects the clutch, thus stopping the rotation of shaft *d*. The link *p* on the pattern chain is no longer under the roller of lever *g*, but this lever is still held in the upper position by the engagement of pin *l* with the horizontal slot in bellcrank lever *m*. The clutch remains disengaged until the connector o swings the vertical part of lever *m* to the right, allowing upper clutch member c to engage the lower part again. The movements of the connector are controlled by another chain, which operates on the same general principle as the one referred to.

Full-stroke Mechanism to Insure Completion of a Movement

Mechanisms are sometimes so arranged that hand-operated movements are, to some extent, controlled mechanically, to prevent motion in the wrong direction or incomplete action. The full-stroke ratchet mechanism shown in Fig. 12 is used on the Ellis adding typewriter to prevent the operator

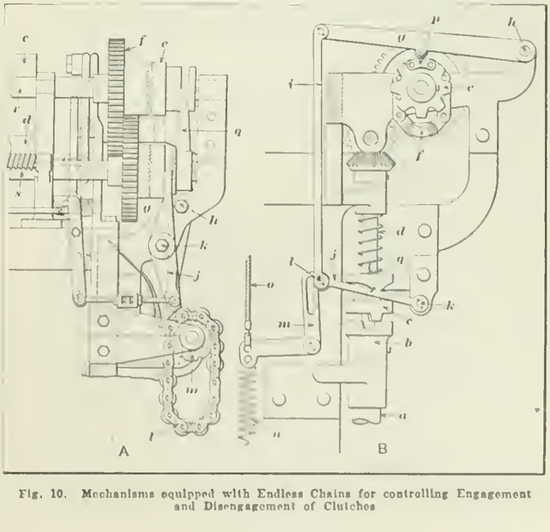

Fig. 10. Mechanisms equipped with Endless Chains for controlling Engagement and Disengagement of Clutches

from starting handle *A* and not completing the required movement. For instance, if handle *A* is in the upper position, as shown at the left, any downward movement must be continued until the handle has made a complete stroke before it can be reversed for returning it to the original or upper position. Similarly, if the lever is at the lower end of its stroke, as shown by the view to the right, any upward movement must be completed before the direction of motion can be reversed. This positive control of the action of handle *A* is obtained in a very simple manner. As the handle is moved downward or upward, pawl *B* is carried with it. This pawl is pivoted to part *D* and normally held in a vertical position by a spring. When handle *A* is at the upper end of its stroke, as shown at the left, and a downward movement is started, pawl *B* engages sector *C* and its upper end swings to the right; as the downward movement of handle *A* continues, pawl *B* engages successive notches in sector *C*, and locks into one of these notches if an attempt is made to return handle *A* before the downward stroke is completed. When handle *A* has been pushed all the way down (as shown to the right), pawl *B* drops into the enlarged notch *E* of sector *C*, where there is enough room to permit the pawl to swing around to the vertical position; consequently, as soon as handle *A* is moved upward, the top of pawl *B* swings to the left and again engages successive notches in sector *C*, thus preventing any return of handle *A* to the lower position until the pawl has cleared the upper end of the sector and again swings to a vertical position.

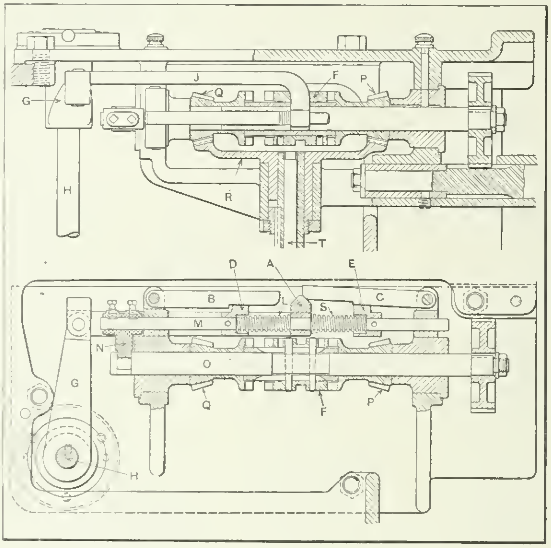

Fig. 11. Spring and Latch Type of Reversing Clutch Control

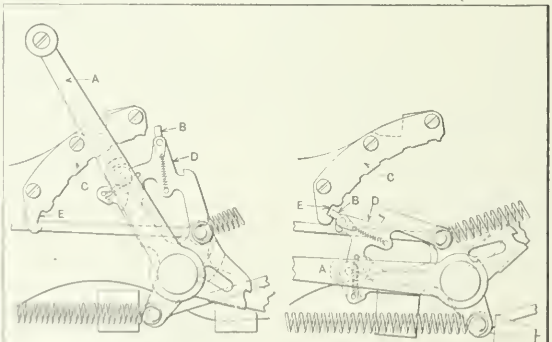

Fig. 12. Full-stroke Mechanism to prevent starting Operating Lever and not completing its Movement

Two-speed Intermittent Rotary Motion

The fast and slow motion of the pattern cylinder of a certain type of loom is derived from the reversible intermittent gearing shown in Fig 13. The large gear *A* is mounted on the pattern cylinder shaft, and receives its motion either through the segment gear and crank combination *B* or through a similar combination *C*, these two combinations being used to reverse the direction of rotation. Gear *D* is the driver for this train of mechanism. Whether the motion is transmitted from gear *D* to the pattern gear *A* through the crank and segment gear combination *B* or through combination *C* depends upon the position of a sliding key *F*. An intermittent fast and slow motion is obtained with either combination. When key *F* locks the crank and gear *B* to the shaft, the pattern gear is rotated at a relatively slow speed when the segment pinion is acting as the driver, and at a faster speed when the crank pin *L* comes around into engagement with one of the radial slots in the pattern gear. When this direct drive is employed, the gears *G* and *H* revolve idly with the upper crank and gear combination *C*. When a reversal of motion is required, sliding key *F* is pushed in to engage gear *H*, which then drives gear *G* and the combination at *C*.

Intermittent Movement Derived from Crank and Cam Combination

The interesting form of mechanism illustrated in Fig. 14 is used on moving picture cameras and also for feeding films through printing machines. It is commonly referred to as a "claw" mechanism or movement. The claw or hook *A* is double and engages evenly spaced perforations along each edge of the film. When this device is applied to a moving picture camera, the film is drawn, from a roll in the film box, down in front of the lens and then passes to a reel in the receiving box. The film remains stationary during each exposure and is drawn downward between successive exposures, which are made at the rate of sixteen a second. The hook *A*, which engages the film and moves it along intermittently and with much rapidity, receives its motion from a crank and cam combination. The two gears *B* and *C* revolve in opposite directions. Gear *B* has a crankpin upon which the hook is pivoted. An extension of this hook has a curved cam slot that engages a pin on gear *C*. As the two gears revolve, the hook is given a movement corresponding approximately to the D-shaped path indicated by the dotted lines. While this mechanism is shown in a horizontal position, it is normally vertical, with the hook uppermost, when in operation. Some of the other claw mechanisms in use differ from the one shown in regard to the arrangement of the operating crank and the cam or curved slot for modifying the crank motion. For instance, the cam, in some cases, is a separate part that is placed between the crank and the film hook, a pin on the hook lever engaging the cam slot. Another type of claw mechanism derives the downward motion for moving the film and the in and out motion of the film hook from separate cam surfaces.

Rapid Intermittent Motion of Moving Picture Projector

A very rapid intermittent motion is required on moving picture projectors. The film is not moved continuously, but each view or positive on it is drawn down to the projecting position while the shutter is closed, and the film remains stationary for a fractional part of a second while the picture is exposed on the screen; then, while the shutter is again closed, the next successive view is moved to the projecting position. It is apparent, therefore, that moving pictures are, in reality, a series of stationary pictures thrown upon the screen in such rapid succession that they are, in effect, blended together, and any action or movement appears continuous. It is important to give the film a very rapid intermittent motion, because it is

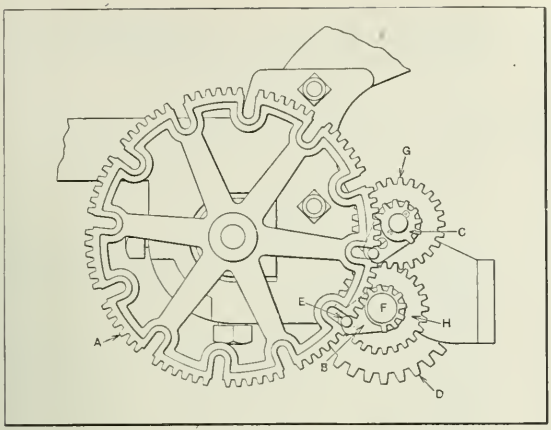

Fig. 13. Two-speed Reversing Intermittent Gearing

necessary to have the shutter closed when this movement occurs; and the length of time that the shutter is closed should be reduced to a minimum. This shutter is in the form of a wheel or disk, and it has a fan-shaped section which passes the projector lens while the film is being shifted. In order to avoid flicker on the screen, the shutter has two additional fan-shaped sections. With these three equally spaced sections, the light is not only shut off from the screen during each successive film movement, but it is also shut off twice between each movement at uniform intervals. By closing the shutter twice while the picture is on the screen, the flicker that would be visible and annoying if the shutter were only closed while moving the film is multiplied to such an extent that it becomes almost continuous and is practically eliminated as far as the observer is concerned, assuming that the projector is operated at the proper speed. The width and area of that section of the shutter which is passing the lens when the film is being moved is governed by the time required for the film movement. Theoretically, the area of each section or segment of the shutter should be equal, although, in practice, the two extra sections are made of somewhat smaller area than the main one, in order to increase the open space and the percentage of area left for the passage of light.

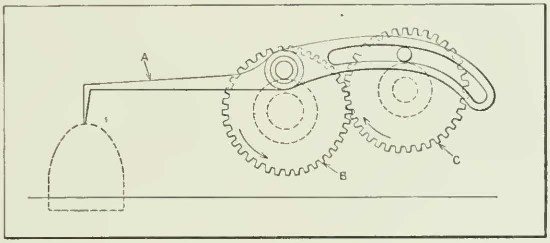

Fig. 14. Crank and Cam Combination for operating Claw Mechanism of Moving Picture Camera

There is an important relation between this shutter wheel and the intermittent motion or gearing of the projector. This is due to the fact that the shutter must be closed while the film is being shifted. With the mechanism to be described, the film movement is very rapid, so that the shutter blades may be proportionately reduced in area, leaving more open space for the light. The intermittent motion referred to is shown in Fig. 15 and is used on the Power moving picture projector. This mechanism is composed of a disk or wheel *A*, having an annular flange or ring *B*, which has two diagonal slots across it as shown; this wheel, which is the driver, imparts an intermittent motion to the follower *H*, which carries four equally spaced pins or rollers that engage the ring *B* on wheel *A*. Each time this wheel makes one revolution, the follower *H* is turned one-quarter revolution and in the same direction, as indicated by the arrows. The follower is stationary except when it is engaged by the slots or cam surfaces formed on one side of ring *B*. During this stationary period, the ring *B* simply passes between the four pins on the follower, two of these pins being on the outside and two on the inside of the ring.

The quarter-turn movement is obtained in the following manner: When the projection or cam surface *G* on the revolving wheel *A* strikes one of the pins, the rotation of the follower begins, and the pins are so spaced that one on the outside moves through a diagonal slot in ring *B* while a pin on the inside moves outward through the other slot. For instance, if the pins *C* and *D* are on the outside and *E* and *F* on the inside, pin *D* will first be engaged by cam surface *G* and, as the follower revolves, pin *C* will pass in through one diagonal slot while pin *E* is moving to the outside of the ring through the other slot. At the completion of the quarter-turn movement, pins *C* and *F* will be on the inside and *D* and *E* on the outside. As wheel *A* continues to revolve, ring *B* simply passes between these closely fitting pins, which lock the follower against movement until projection *G* again comes around and strikes the next successive pin on the follower.

The follower operates a toothed wheel or sprocket which connects with the film and moves it downward each time the shutter is closed. Above and below the intermittent gearing there are other sprockets which rotate continuously, and these are so timed that a loop of film is formed above the intermittent gearing that is just large enough to provide for one film movement, which is equivalent to the length of one view or positive. As the film is drawn down rapidly by the intermittent mechanism, a loop is formed below it which is taken up by the lower sprocket as the film is wound upon the lower receiving reel. The normal speed of wheel *A* is sixteen revolutions per second, and it has been operated at two or three times the normal speed. The time required for turning the follower one-quarter revolution is approximately one-sixth of the time for a complete revolution, or 1/96 second, when running at normal speed. With the well-known Geneva wheel, which has been applied to many projectors, approximately one-quarter of the time is required for the intermittent action; therefore, the shutter blades must be of larger area than when the film movement occurs in one-sixth of the time. However, with the mechanism shown in Fig. 15 there is less tendency to subject the film to injurious stresses. The locking of the follower during the stationary period is also more secure, especially at the critical time when near the operating point. The three holes in ring *B* are to compensate for the slots on the opposite side and to balance wheel *A*.

The concluding installment of this article will deal with mechanisms for the conversion of rotary and rectilinear motions and devices for automatically disengaging a driven member whenever resistance to motion increases excessively.

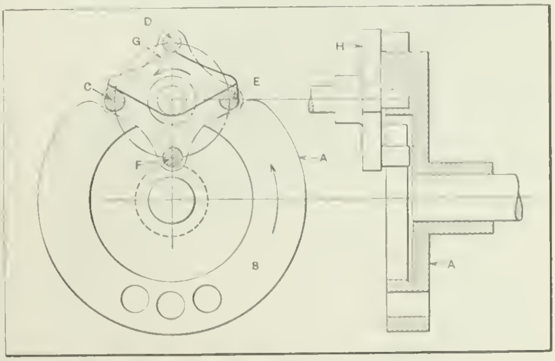

Fig. 15. Rapid-acting Intermittent Gearing of Moving Picture Projector

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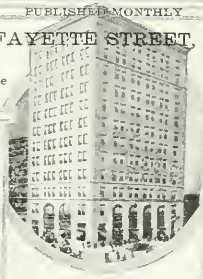

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

SALVAGING OF TOOLS

There is not enough steel in the world today to go around. Anything tending to economize steel is a measure of vital importance. The salvaging of tools—making new tools from old—saves steel. It has developed into quite a business; it should be developed further. The subject, which is of national importance, is covered comprehensively in the leading article in this number of Machinery. Salvaging of tools is not only valuable because of the individual economies that it may effect; it is valuable, above all, because it prevents the waste of badly needed materials on an enormous scale throughout the country.

Primarily, of course, saving of material by the salvaging of tools is a war measure; but it also has been found profitable in itself by those who have adopted it in their factories. Hence, its survival after the war is over is assured—which proves once more that, terrible as war is, it has made us realize how wasteful we are as a nation; but now that we have learned our lesson at awful cost it will be of inestimable value to us when peace reigns anew over our land.

* * *

THE LABOR PROBLEM

How should the labor problem be handled? Ask any employer. Ask any employe. The chances are that each will have an opinion different from that of any other employer or employe. The only way to get at the consensus of opinion is by a thorough investigation of the whole problem both from the employers' and the employes' point of view. Such an investigation has been carried out by the President's Mediation Commission. It has reported that the main causes of labor difficulties in the United States are: refusal of many employers to deal with the men collectively; absence of disinterested agencies to which resort may be had for peaceful settlement of labor disputes, ignorance of both capital and labor regarding their respective needs; grievances as to hours and wages that create a permanent attitude of ill will and misunderstanding. To remedy these evils the committee recommended the following: collective bargaining; machinery for settling disputes; the eight-hour day; unified administration of governmental labor agencies, abandonment of output restrictions; elimination of profiteering.

The question of labor is the most important problem confronting the management of present-day industrial undertakings. You cannot side-step it. You cannot solve it by outworn ideas. Be you employer or employe, you must meet it with an open mind and a willingness to recognize fundamental factors. If the problem is tackled in such a spirit there is no reason why it should not be settled without labor disturbances and to the mutual advantage of employer and employe.

* * *

THE MACHINE TOOL INDUSTRY AFTER THE WAR

There is no good ground for pessimism about the machine tool industry after the war. The indications are that peace will bring a heavy demand for machine tools, especially in the four following directions:

The railroads, the equipment of which has dropped below par, must necessarily get it back into first-class condition. The building of ships is not going to stop with the war. On the contrary, not for many years will the world's merchant marine be built up sufficiently to meet the requirements of the world's trade. The motor truck industry has come into its own during these stormy years. Its development when peace returns bids fair to surpass even the extraordinary development of the passenger automobile trade ten years ago. We shall have an airplane industry after the war. The airplane when used under normal conditions is a safe, reliable means of conveyance and it is probable that it will be put to various uses; for instance, as a mail-carrier.

There, then, are four industries in which the demand for machine tools will be great when the war is over. These and other great national activities, to which the war has lent impetus, have in store for them a long period of continued activity in the coming years of peace.

* * *

DIFFICULTY IN OBTAINING PIG IRON

Manufacturers are finding it increasingly difficult to obtain pig iron for use in their foundries. Some blast furnace operators, seeking to protect themselves, request manufacturers to state where their castings are to be used, before supplying the raw material. It is not always possible for a manufacturer to state that the castings which he expects to make are for immediate use in the manufacture of war material, although the product of most manufacturers of machine tools and attachments just now will ultimately be used by the Government, even if the latter has not ordered it at the moment when the castings are made.

The Government, it would seem, might introduce some method for the distribution of iron and coke to the blast furnaces that would permit furnace operators to sell pig iron to manufacturers without requiring the latter actually to show an order from the Government for the material which they intend to manufacture. If every manufacturer must wait for a Government order before he can buy pig iron for making his castings, serious delays will result. If nobody makes any machine tools, chucks, pumps, etc., for stock, nothing will be provided ahead of the immediate needs of the Ordnance Department, so that, when the Government wants to equip a factory for making some specified ordnance material, months will drag along before even the necessary machine tools can be obtained.

The Government's theory seems to be that everyone who is selling goods to the United States has a big contract on hand, requiring months to complete, the exact tonnage for which can be figured in advance. Many manufacturers of machine tools know, however, that small orders from the Government have been the rule rather than the exception. When it is possible to fill such orders from stock, everybody is benefited and the Government obtains its war materials more rapidly.

If a manufacturer is engaged in the making of essential articles, such as machine tools, attachments or other devices used in manufacturing war materials, he should be permitted to obtain pig iron irrespective of whether or not his product, at the particular time when he places his order for the raw material, is actually contracted for by the Government. Restrictions in the supplying of pig iron like those outlined above seriously hamper the conduct of the war.

PLANNING FOR WAR WORK

MAKING ESTIMATES FOR MANUFACTURING FOR THE GOVERNMENT AND EQUIPPING A FACTORY FOR WAR WORK

BY ALFRED SPANGENBERG[1]

A manufacturer who wants to undertake the making of war materials or other supplies for the Government may either be in the position of having a factory that can be turned into a war establishment already equipped for the period of the war, or he may have facilities for building and equipping a new factory to undertake such work. In case he has a factory already equipped, it is, of course, important that he select the right kind of work for the machine tool equipment on hand. Even if he is to equip a new factory, it is the best plan to select some class of work that can be made with general-purpose machine tools, as then, when the war contract is completed, the equipment may be used for the manufacture of some other line. In general, therefore, it may be said that when possible a contract that can be completed mainly by an equipment of lathes, milling machines, grinders, planers, boring mills, drilling machines, and gear-cutters is of the greatest advantage. The bid can be made lower because the machine tools can be diverted into other uses after the completion of the work. The contract can be completed more rapidly, as special machinery need not be ordered, and on the whole both the Government and the manufacturer are best served by the selection of such a contract as the present equipment is best fitted to handle.

Factors to Consider in Estimating on a Contract

Having determined upon the class of work best fitted for the organization and equipment already on hand or most easily obtainable, the next thing is to secure from the Ordnance Department at Washington complete blueprints and specifications of the work to be done. As soon as the amount of material needed for a given contract has been determined, it is necessary to secure immediately from the sources of supply information concerning prices and deliveries of the materials required and of the additional machine tool equipment necessary. The size of the contract to be undertaken, that is, the number of parts or units for which the manufacturer should bid, is determined by several factors: (1) By the available buildings, if no further additions are desirable; (2) by the available equipment and the dates of delivery of new equipment to be bought; (3) by the available and possible labor supply; (4) by the available working capital, which, of course, determines several of the factors above; (5) by the dates of delivery of the material, devices, or machines to be made for the Government.

Quite frequently, the most desirable work suitable for the organization or machine tool equipment cannot be selected for bidding, because it is impossible to secure early enough deliveries of the additional machine tool equipment needed.

Estimating Cost of Work

In order to determine the cost of the work as a basis for the bid and also the number or sizes of machine tools required, each part to be made must be considered separately with regard to the various machining operations. The time required for every operation must be estimated. If this time estimate is carefully made and recorded it will prove of considerable value in setting the piece rates. Having made the time estimate, it will be possible to determine how many machines of each type and size are required, how much the overhead cost will be, and, in consequence, the total cost of the work, so that the proper bid can be made. In obtaining the time estimates it has been found that the machine tool builders are generally willing to cooperate by suggesting designs of special equipment for their machines and giving the approximate time in which operations can be done with such attachments.

Selecting Machine Tool Equipment

The war will not last forever, and for that reason the machine tool equipment, if it has to be bought for the work, should be selected with this idea in view. Mainly, general-purpose machine tools should be installed instead of special machines, so that the factory can be used for commercial work after the war. In doing so, a few of the guiding principles would be as follows: Instead of putting in a number of machines of one size, although all the work could be done on that size, it is an advantage to consider future requirements and to put in a variety of sizes. As an example, assume that eight No. 2 milling machines would be satisfactory for the work in hand. A more balanced equipment for future use would be provided, however, if the equipment selected included four No. 2 machines, two No. 3 machines, and two No. 4 machines. This, of course, would not be quite as economical on the present contract as would eight machines of the smaller size, but in most instances the more balanced equipment would prove more useful in the manufacturing to be undertaken after the war.

Machines that are suited to a number of different operations are preferable to those that can be used for one or a few operations only, although some of these different operations may not be required for the contract in hand. While single-purpose machines may be more economical for the present work, the guiding principle is an unknown future factor, and as in many instances it is not possible at this time to determine what work the shop will eventually do when peace comes, it is better to provide for a wide variety of operations.

Even though it may cause some delay in delivery, it is worth while to try to obtain machines from one manufacturer, as it is then possible to use the attachments and other auxiliary equipment on the interchangeable plan. This is quite an important factor in equipping any factory. Heavy machines are advantageous, even though the present contract could be done satisfactorily on lighter machines, because it is likely that in the future machine tools will be required to stand up under cuts that are as heavy as stellite or high-speed steel tools will permit, and for this reason the heavier the machine the better. Motor-driven machines are in many instances an advantage, but at the present time they can only be obtained at a sacrifice in time of delivery, on account of the difficulty of obtaining electrical equipment.

While some of the work to be made may be quite special in its nature, attachments for standard machine tools will generally make it possible to carry out the operations satisfactorily when the contract is not large enough to warrant the purchasing or the designing and making of special machinery. For example, a circular arc can be milled on a plain milling machine by a special attachment. Less expensive machine tools can also often be utilized to advantage for special operations. A lathe, for example, can be temporarily utilized as a horizontal boring machine by providing means for guiding boring-bars. Automatic machines may not be warranted on account of the comparatively small number of parts to be made, and while it will take more time to make these parts on a standard machine tool, it may sometimes be advisable to do so, as the investment in the automatic machine might greatly increase the cost of the parts. As a rule, there are many small parts which can be more advantageously sublet than made in the shop, such as small screws, bolts, studs, and nuts. It is often also an advantage to have a firm specializing in graduating do such work, if the contract requires graduations to be made. While waiting for the material to be delivered, jigs and fixtures for the contract are designed and the machine tool equipment may be kept employed on the fixture work.

Arrangement of Machines

The grouping of the machine tools will be found most effective for general requirements if done according to the kind of machine or class of operation to be performed. Of course, in the making of shells, fuses, or similar war work, where thousands of interchangeable parts are passed through the shop daily, grouping according to kinds of machines would not be advisable, as in the latter case the grouping should be such that the material may pass in one continuous flow through the shop. When a comparatively small number of complete machines or devices are to be made, however, grouping according to class of machine tool has several advantages, one of which is that it permits group drive from a short lineshaft driven by an electric motor. In this way, the lineshaft for the same class of machines may be driven at the most suitable speed for this type of tools.

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Tool Equipment and Jigs

The tool-room is the heart of the shop, and should be well equipped. Interchangeable manufacture, the fundamental principle of economical production, can only be secured by making jigs and fixtures that are accurate. Hence, the tool-room equipment should include the necessary outfit of surface plates, test indicators, vernier height gages, parallels, block gages for obtaining accurate measurements, and checking up gages for maintaining the required standard of accuracy. In purchasing the tools the same principles should be applied as in the selection of the machine tool equipment. Tools of general application should be used in preference to special tools when possible, and those of the same class should preferably be purchased from one manufacturer. It is well to have the tool equipment complete and a full line of standard sizes of reamers, drills, counterbores, and taps greatly facilitates the work in the shop, the making of jigs and fixtures, and the repairs on the machine tool equipment. Time is saved in not having to wait for sizes not on hand, and an ample supply of high-speed milling cutters, including plain, side, and end mills is required, as well as an ample supply of lathe and planer tools of standard shapes. Each lathe, planer, and shaper should have its own complete equipment of these tools, with several sets of duplicate tools kept ground to the proper shape in the tool-room. The practice of having the workmen grind their own tools should be discouraged.

While the advantage of having fixed gages cannot be denied, work of the nature referred to in the preceding paragraphs can be more economically done by using adjustable limit gages, because these may be utilized for future work when the present contract is completed.

* * *

STANDARD METHODS FOR DIMENSIONING DRAWINGS

The engineering departments of large manufacturing concerns have come to realize the necessity of adopting standard methods of dimensioning drawings. This necessity arises from the frequent mistakes made in reading dimensions on drawings when the draftsman is allowed to use any method that he prefers. It is only natural where many draftsmen are employed that widely different methods will be used that confuse the foremen and machinists to whom the drawings are given. To avoid these mistakes, the engineering department of a large concern manufacturing war munitions, furnishes each member of the engineering department with a copy of a data sheet giving the following directions:

All dimensions of 48 inches and under are to be shown in inches; dimensions over 48 inches are to be shown in feet and inches.

The inch sign is not to be used upon gage drawings or upon tool equipment drawings, when the sizes are below 48 inches.

Upon drawings for buildings, floor plans, etc., the foot and inch signs will be used, but will invariably be given the reverse slant, in order to avoid confusion with the minute and second signs of subdivisions of the circle.

The decimal subdivisions of the inch will be used invariably upon all drawings of machine and tool equipment; but the fractional subdivisions of the inch will be used upon drawings of buildings, floor plans, etc.; also in notes calling for standard taps, reamers, bolts, etc. Decimal points should be made heavy.

When a dimension is not to scale, it is to be underscored with a heavy black line.

If more than two views of a piece are shown, the distances between the projected views are to be equal, care being taken that views are neither crowded nor too far apart.

Unimportant dimensions, if any, should be left blank, so that workmen will know where to work close.

Over-all dimensions should always be given.

Arrow heads should be made free-hand and about 60 degrees between wings.

Limits of Variation from Exact Dimensions

As it is impractical to work to the exact dimensions given on the drawings, the limits of variation permissible will be indicated by the number of decimal places used, upon the following basis:

Figures carried to one decimal place indicate that the total limit is 0.1 or ±0.05. Figures carried to two decimal places indicate that the total limit is 0.01 or ±0.005. Figures carried to three decimal places indicate that the total limit is 0.001 or ±0.0005. Figures carried to four decimal places indicate that the total limit is 0.0001 or ±0.00005.

When a dimension is followed by the plus sign (+), it indicates that any variation from the given dimension must be over size within the total limit.

When a dimension is followed by the minus sign (—), it indicates that any variation from the given dimension must be under size within the total limit.

When a dimension is followed by an "approximation sign" (ap), it is to be understood that any reasonable limit of variation will be permitted.

When the variation permissible is different from that given above, the dimension is to be followed by the plus and minus sign (±), the plus sign (+), or the minus sign (—), and the amount of limit, thus:

1.2±1 indicates that total limit is 0.2 or, plus or minus 0.1.

1.82±2 indicates that the total limit is 0.04 or, plus or minus 0.02.

1.258±5 indicates that the total limit is 0.010 or, plus or minus 0.005.

1.0937±3 indicates that the total limit is 0.0006 or, plus or minus 0.0003.

1.1875±20 indicates that the total limit is 0.004 or, plus or minus 0.002.

1.3906+30 indicates that the dimension must not be under size, but may be 0.003 over size.

0.1285 — 20 indicates that the dimension must not be over size, but may be 0.002 under size.

0.281^{+2}_{-1} indicates that the total limit is 0.003 and that the dimension may be 0.002 over or 0.001 under size. A.

* * *

AN INDICATOR USED FOR CUTTING INTERNAL THREADS

BY ALFRED E. CARTER[1]

On old lathes there are often found deep file marks on the bed, which were used to indicate the stopping place while cutting internal threads. This was done by many early mechanics in order to tell when the bottom of a hole was reached, and also to avoid breaking the tool. When there is a squared bottom or shoulder in a threaded hole, it is customary to recess to the depth of the thread in order to clear the point of the tool, but whether this is done or not, the following is a positive way of telling when the tool has reached the same place every time, and without breaking the tool in doing so:

Run the tool in the hole to the correct depth with the lead-screw engaged before beginning to cut. Then mark the lathe bed, with chalk, as close to the carriage as possible; fasten a heavy wire to the lathe bed by means of a clamp, or by placing it under one of the screws of the headstock, so that it points across the side of the jaw chuck in line with the operator's eyes. Next, mark the side of the chuck opposite the end of the wire and proceed to cut the thread as usual. It is apparent that if the operator will carefully watch the mark on the bed, until the carriage is approximately the width of one thread short of the full distance, the mark on the chuck will also be seen just passing under the pointer. The operator should next watch for the mark on the chuck coming over again, and as it reaches the pointer, which is exactly as first set, disengage the tool and reverse the lathe, thus avoiding all possibilities of destroying the tool and the work.

Owing to the large outside diameter of the chuck, the mark would have to be some distance either side of the pointer to make an appreciable variation in the tool travel. This method is more accurate than if the tool were visible to the operator. If there is a large recess, it is possible to do without the pointer, as there is little difficulty in gaging the position of the mark with the eye.

* * *

It is sometimes necessary to discard precedent and adopt unusual methods in order to facilitate manufacturing processes. An example is to be found in the new method of building and launching concrete boats which is being employed in Norway. It has been found that the boats are cast much more easily when built bottom side up. When this method is employed the boats are launched upside down, and as the air is permitted to escape from the air-tight chambers in the interior, the vessel automatically rights itself.

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MEASURING TEMPLETS AND SCREW THREADS WITH A MICROSCOPIC MEASURING MACHINE[1]

CONSTRUCTION AND ADJUSTMENT OF MEASURING MACHINE AND APPLICATION FOR TESTING ACCURACY OF TEMPLETS OR CONTOUR GAGES AND SCREW THREADS

BY FRANKLIN D. JONES[2]

MICROSCOPIC measuring machines provide a convenient and accurate means of measuring certain forms of templets and gages which, because of their shape, cannot readily be measured by other forms of precision measuring instruments. The microscopic measuring machine referred to in the following is used in conjunction with end measuring gages, and it differs in this respect from the type that depends upon the accuracy of a screw for determining the length measurements. This machine is shown in Fig. 1 with a hob between the centers, as it is, of course, used for testing tools of this kind and plain screw threads, as well as templets or gages, form tools, or any edge or contour, the accuracy of which cannot be tested by ordinary means.

The machine has a rigid box-shaped bed upon which is mounted a table *A*, fitted with centers for holding all tools having centered ends. The center seen at the left has a crosswise adjustment which enables the part being tested to be lined up accurately. When taking length measurements, table *A* is adjusted along the bed whatever distance may be required. This distance is determined by placing standard measuring rods or gage-blocks between hardened contact pieces. One of the contact pieces is attached to the end of table *A* and the other one is fixed to block *B*. The microscope is mounted on a compound slide-rest having movements parallel with, and at right angles to, the table slide. The microscope may be adjusted vertically, of course, for focussing, and it is fitted with two hair-lines. One of these may be rotated with the outside tube, whereas the other one rotates with the eye-piece. The outer tube has a large dial *C*, which is graduated in half degrees. The eye-piece carries a vernier graduated for taking readings to one minute, so that the angle between the two hair-lines may be determined with considerable accuracy.

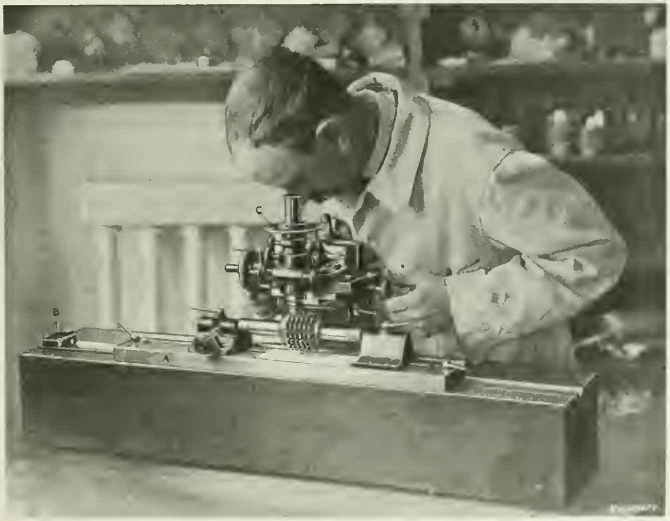

Fig. 1. Microscopic Measuring Machine testing Accuracy of Hob

This machine is shown in Fig. 2 fitted with an apparatus for illuminating whatever edge or contour on the work is under observation. The object of using this apparatus is to obtain a better illumination than is afforded by uncontrolled lighting. The rays of light from an electric bulb are directed onto the surface of a mirror located directly beneath the side or edge of the work under observation. The light rays are reflected upward by the mirror, thus showing the profile of the work in distinct relief when viewed through the microscope. This illuminating attachment is carried by a bracket bolted to the rear side of the bed. The electric bulb is located inside and at the outer end of the tube shown. At the other end of this tube there is a collecting lens, and midway between the bulb and the lens is a metal partition having a small hole through which the light passes and is then diffused by a piece of ground glass fitted over the hole. The light tube can be adjusted in a lengthwise direction for varying the strength of the illumination. The rod which carries the mirror has a rack-and-pinion adjustment for locating the mirror in the correct position relative to the work.

Length Measurements

When making a plain length measurement with this machine, the work is clamped to the table, which, in turn, is clamped to the bed after a measuring rod or one or more gage-blocks has been placed between the two compact pieces. The microscope is then focussed on the end or edge of the part to be measured and is adjusted until the hair-lines coincide with the particular point from which the measurement is to be made. The table is next adjusted a distance equal to the required measurement, by means of other measuring rods or blocks. The position of the hair-line relative to the work then shows whether the distance between the points on the work corresponds to the actual measurement or to the difference between the lengths of the two measuring rods. If there is any variation, the amount of error can be determined readily by adjusting the compound slide of the micrometer until the hair-lines exactly coincide with the second point on the work; the graduated dial of the micrometer slide then indicates the error. As the hair-lines can both be rotated, they can be set to coincide with whatever edge or profile the measurement is to be taken from.

Measurement of Templets

The gage or templet shown in Fig. 3 is an example of the class of work which may easily be measured by this machine. The particular measurements indicated in the illustration, however, would be rather difficult to check with any other form of gage or measuring instrument. This templet is clamped to the table with its long sides parallel to the edges of the table and with one of the angular edges or ends of the recess under the microscope. One hair-line is adjusted to cover the long side of the templet and the other is located at right angles, the intersection coinciding with the outer corner from which the measurement is to be made. (We shall assume that two end-measuring rods are used having a difference in length of 2½ inches.) The table is next moved along the bed and reclamped with the longer measuring rod in position. Since

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[1] For additional information on thread testing, see "Projection Method of Testing Screw Threads," April, 1918, and articles there referred to.

[2] Associate Editor of MACHINERY.

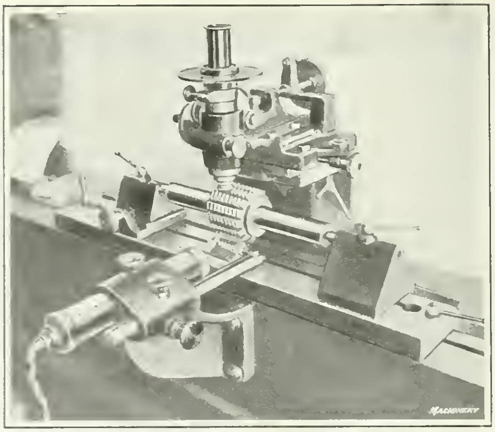


Fig. 2. Microscopic Measuring Machine equipped with Apparatus for illuminating Work

this gives a movement of 2½ inches, which is somewhat greater than the distance to be measured on the gage, the compound slide is used to obtain the exact adjustment required. For instance, if the measurement is between the outer corners of the high-limit side of the gage, the compound slide will have to be adjusted an amount equal to 2.5 — 2.422 = 0.078 inch.

The hair-line should first be set to coincide with the work before taking the reading. If the micrometer is first adjusted to the required dimension and an observation is then made to see if the hair-lines coincide directly with the work, slight errors in the reading are more likely to occur. By repeating the adjustments previously referred to, the length of the notch or recess at the bottom can also be determined. The depth of the recessed portion is tested by simply setting one hair-line to cover the outer edge and then adjusting the compound slide until this hair-line coincides with the inner edge, the reading between the two positions being noted.

When setting the long sides of the gage or templet parallel to the table, the hair-lines may be used to advantage. One of the hair-lines is set parallel with the table edge, and at the same time the templet is held by hand so that it also coincides with this edge. The table is then moved slowly in an endwise direction, and by adjusting the hair-line and templet with the table movement a parallel setting can be obtained. After the templet is clamped to the table, its position should be tested again.

The form of templet shown in Fig. 4 is another interesting example of the class of work for which the microscopic measuring machine is adapted. In this case, a measurement equivalent to 2.6043 inches is taken near the upper end of the templet. The measurement is taken between two points along the curved sides instead of attempting to measure from one corner of the gage to the other, which is difficult, especially when, as in this case, the corner is formed by the intersection of a curve and a straight line. As the illustration shows, the measurement is taken at points located 5 inches from the base of the templet. It is necessary first to determine this dimension (2.6043 inches) by calculation. The templet is then carefully set with its two straight sides parallel with the edges of the table and with the shorter side under the microscope. The hair-lines are set at right angles to each other, and with one of them covering the edge or short side. The microscope is then moved over 0.190 inch in this particular case, and an ordinary length measurement is taken from one curve to the other by the method previously described for plain length measurements. The width of the base is measured without any calculation, as the tangent to the curve is at right angles to the base line, so that it is easy to set the hair-lines to coincide with these edges. One hair-line is adjusted to coincide with the base or lower edge, and the other one is set at right angles. The length is then measured in the usual way.

Still another example of templet measurement is illustrated in Fig. 5, which shows the master templet for a gear hob forming tool. After this templet is cut out, the angle of the flanks is tested and also the thickness at the pitch line, the width at the top, and the other dimensions indicated.

Measurement of Screw Threads

The microscopic measuring machine may be used for testing the pitch, depth, and angle of screw threads or the teeth of hobs, taps, or chasers. If the threads are finer than six per inch, the pitch and angle can be measured in one operation. The coarser threads require two operations, one side of the thread being used while measuring the pitch. To test the angle of a thread, the microscope is focussed on the thread profile, and one hair-line is rotated until it coincides exactly with one side of the thread; the other hair-line is then adjusted to coincide with the other side of the thread. In order to do this, an adjustment of the compound slide may be necessary. The thread angle is indicated by the reading on the graduated dial *C*, Fig. 1. In order to test the pitch, the table is next moved endwise any whole number of inches up to twelve. After this adjustment, if the hair-lines again coincide exactly with a thread, this indicates that the pitch is accurate, although to detect local errors or those that might exist between adjacent threads or in relatively short lengths of the screw would require repeated observations. The depth of thread is easily determined by superimposing one hair-line on the other and then setting the hair-lines to coincide first with the tops and then with the roots of the thread. The micrometer dial of the compound slide-rest indicates the depth and whatever error there may be.

When measuring a hob or tap, the microscope can be focussed directly on the sharp profile or cutting edge of the tool, but if a plain screw thread is to be tested, the focussing is a little more difficult. A simple method of obtaining the correct focus is to use a small block of steel or other material having two parallel faces lapped to a polish. The distance between these parallel faces should be equal to the height of the work-holding centers of the measuring machine. On one of the faces a fine line should be scratched, and then the microscope can be accurately focussed on this line before placing the work between the centers.

The machine illustrated in Fig. 1 is made by Alfred Herbert, Ltd., Coventry, England. This machine was used at first in the tool-room for the accurate measurement of form tools,

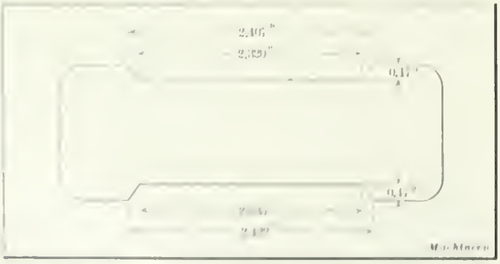


Fig. 3. Gage or Templet measured by Microscopic Measuring Machine

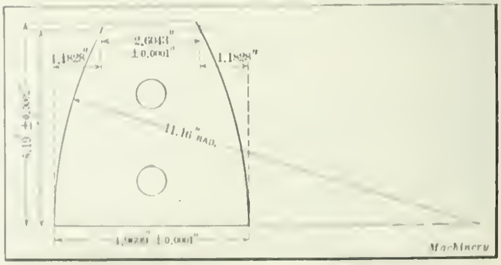


Fig. 4. Another Example of Gage or Templet Measurement

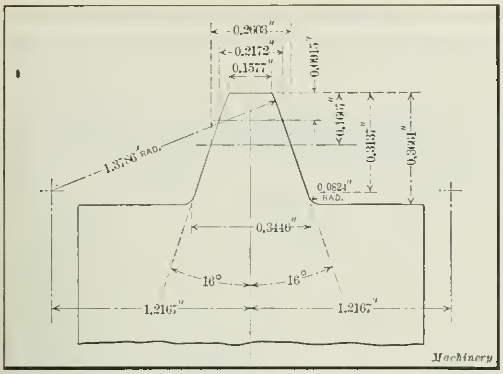


Fig. 5. Master Templet for a Gear Hob Forming Tool

gages, screw threads, etc., and proved to be so valuable for this work that it was placed on the market. The machine will measure lengths up to a maximum of 12 inches, and the microscope has a magnification of 25 diameters.

* * *

ADVANTAGES OF COMPARING MANUFACTURING METHODS

BY D. M. PERRILL[1]

Recently the superintendent of a large shipbuilding concern that has three plants on the Great Lakes found that in one of the shops it took twice as long to perform a certain drilling operation as it did in one of the others. For some time it had been noted that, while the drilling department of one plant was able to keep its work moving under the present demands, the other department was constantly behind. An investigation showed that one shop was using coarser feeds; by adopting the same feeds, the other drilling department was able to increase its production so that no further delays on this account were experienced. A further comparison of the results obtained in all the departments of the three plants resulted in a great saving.

Recently a machine tool company made a comparison of present rates of production with those obtained in previous years and was surprised to learn that in a great many cases these rates had decreased. Changes in foremen, men, and methods had sometimes resulted in lowered production on individual pieces even when general results were greatly improved. By giving special attention to these pieces, the previous results were secured or bettered with a corresponding saving. In another instance, a lathe manufacturer with lathe departments in two adjoining shops found, on comparing methods used in manufacturing similar pieces, that they were often entirely different, sometimes one shop and sometimes the other producing the better results. By using the better method in each instance, a general improvement of the output was secured.

Where a comparison in methods or results can be made, it is very valuable. There is no man with several duties to perform who can resist centering his attention in some one direction, and it is only natural that every foreman should have some pet jobs on which he fixes his attention, to the neglect of other work that should be given equally close study. This work may be the very one on which some other man is working, so that a comparison of the results obtained by each man will be mutually beneficial. Then, too, when the matter is presented to him in the right way, a foreman who finds that he has been overlooking certain jobs will usually try to avoid neglecting others in the future. Often when a man has been doing a thing in one way for years, it becomes almost impossible for him to think of it in any other way; it becomes the only way to him. When this sameness is disturbed in one instance, it is much easier for him to obtain a new viewpoint on all of his work.

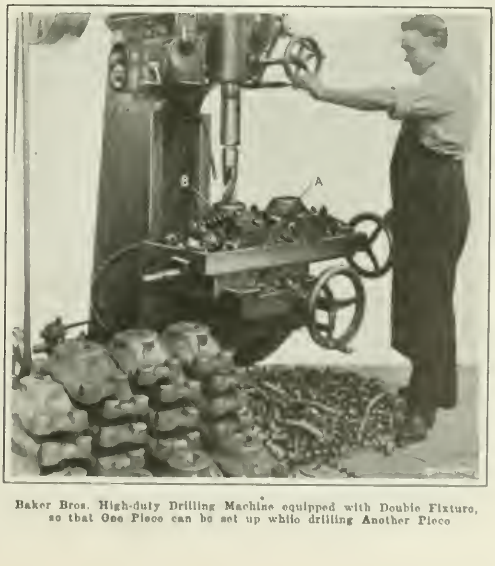
Some of the improvements and methods that will be found will simply be a matter of speeds and feeds; others will be results that can be obtained with tools already in stock. If the writer's experience is any criterion, there are few shops engaged in a general line of manufacture that are realizing anywhere nearly full capacity from modern machine tools and tool steels. Where the improvements are obtained simply by changing the feeds or speeds or using tools already in stock, any time saved is clear gain. Any pressure used in securing such results can hardly be other than conducive of greater profits. Where the new methods require special tools, fixtures, or additional machinery, however, the matter becomes one of deciding whether the additional profit justifies the expense, and if it does, whether it is the best way in which the money can be spent.

* * *

DESIGNING FIXTURES TO INCREASE PRODUCTION ON DRILLING MACHINES

In cases where the time required to set work up on a drilling machine and the drilling time are both considerable, a satisfactory rate of production cannot be expected where one operator devotes his entire time to a single drilling machine, unless special means are provided to keep the operator employed during the time that the drilling operation is being performed. If attention is not paid to this point, the drilling machine is idle during the time required by the operator to set up the work and the operator has nothing to do while the machine is actually performing the drilling operation. Such an unnecessary waste of time by both the machine and the operator can be avoided where work-holding fixtures are so designed that the operator can set up a piece in one section of the fixture while the drilling operation is being performed on a piece held in another section of the fixture; then when the drilling operation has been completed and the drill backed out of the hole, the fixture is adjusted to bring the next piece of work into the drilling position, so that the machine can immediately start upon the next operation. In the accompanying illustration there is shown one of the high-duty drilling machines built by Baker Bros. of Toledo, Ohio, which is equipped with a fixture that enables the machine to be operated on this principle. As shown, the operator has set up a piece *A* ready for the next operation and the drill is being backed out of the finished part *B*. The fixture will next be run over to bring work *A* into the drilling position and while the hole is being drilled in this piece, the operator will remove the finished part *B* from the fixture and substitute a new piece. In this way both the machine and operator are kept busy nearly all of the time and the rate of production is very greatly increased.

E. K. H.



Baker Bros. High-duty Drilling Machine equipped with Double Fixture, so that One Piece can be set up while drilling Another Piece

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[1] Address: 846 Probasco Ave., Cincinnati, Ohio.

Inspection of the U.S. 75-Millimeter Shell

Third of a Series of Articles Describing Approved Methods Employed by the American Shell Co. in the Making of U. S. Ammunition — By Erik Oberg[1]

IN the preceding articles in this series, the manufacturing and heat-treating methods in the making of the U. S. 75-millimeter shell by the American Shell Co., Paterson, N. J., have been described; in the present article, the inspection methods and gages will be reviewed, including both the company's inspection and that of the United States Government in accepting the shells. The inspection may be divided into three distinct parts: (1) The inspection that takes place after each operation to prevent defective shells from passing to succeeding operations unless the previous ones have been properly performed. (2) The complete shop inspection of the finished shell in which all dimensions are gaged before the shell passes to the government inspectors. (3) The government inspection which largely duplicates the final shop inspection, but also includes a few additional gaging operations.

Inspection after Various Machining Operations

On page 595 of the March number of MACHINERY, the order of operations in the making of the U. S. 75-millimeter shell was given, together with the order of the various inspections during the process of manufacture. After the forging has been cut off on a power hacksaw, it is inspected for length simply by measuring it roughly by a scale. The first actual shop inspection takes place after the first rough-turning of the entire outside of the shell, for which gage No. 1, Fig. 1, is used. This is a limit snap gage, as indicated. The shells pass from the machines on gravity conveyors to the inspector's table. In addition to inspecting the shell for size, the inspector, who is assisted by a checker, records the number of accepted and rejected shells from each operator. Each shell as it comes to the inspector has the operator's number marked on it in chalk, and as the inspector gages it, he calls off the number to the checker, who records it. The number of accepted shells passing the inspector's table is also recorded by pressing an electric switch once for every shell accepted, the number being thus recorded in the production office by means of a productograph. This office, therefore, has, at all times, an absolute record of the number of shells in operation throughout the shop, and should the production fall off at any one operation,

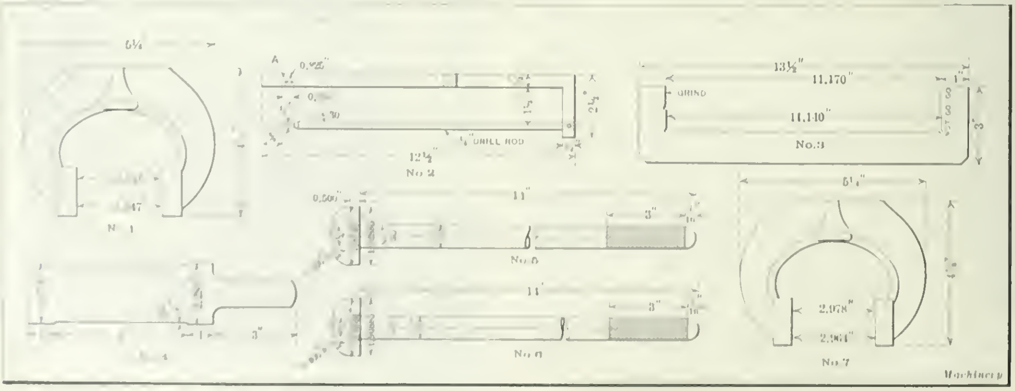

Fig. 1. Gages used in Inspection of U. S. 75-millimeter Shell referred to in Article as Nos. 1 to 7

the cause can be immediately investigated and the difficulty remedied. The checking and recording is repeated at every inspection table.

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[1] Editor of MACHINERY.

The next operation is the rough-facing of the base, after which the thickness of the base is inspected by means of gage No. 2. This gage is provided with two lines at *A* indicating the limits of variation permissible for the base thickness. When the stem of the gage is inserted into the shell, the base surface of the shell must come within the distance indicated by the two limit lines. One inspector and one checker are used for this inspection. The inspector stamps on the bottom of the shell the lot or code number of the shell forging which, in the saw shop, was stamped on the face at the open end of the shell, this number being the same as that on the forging when it comes to the shops from the forging plant. The reason for transferring this stamp to the base is that in the next operation the open end will be faced and the number removed.

After having rough-faced the open end, the length of the shell is gaged by the limit snap gage No. 3. One inspector can do both the gaging and the checking off of the number of shells at this operation.

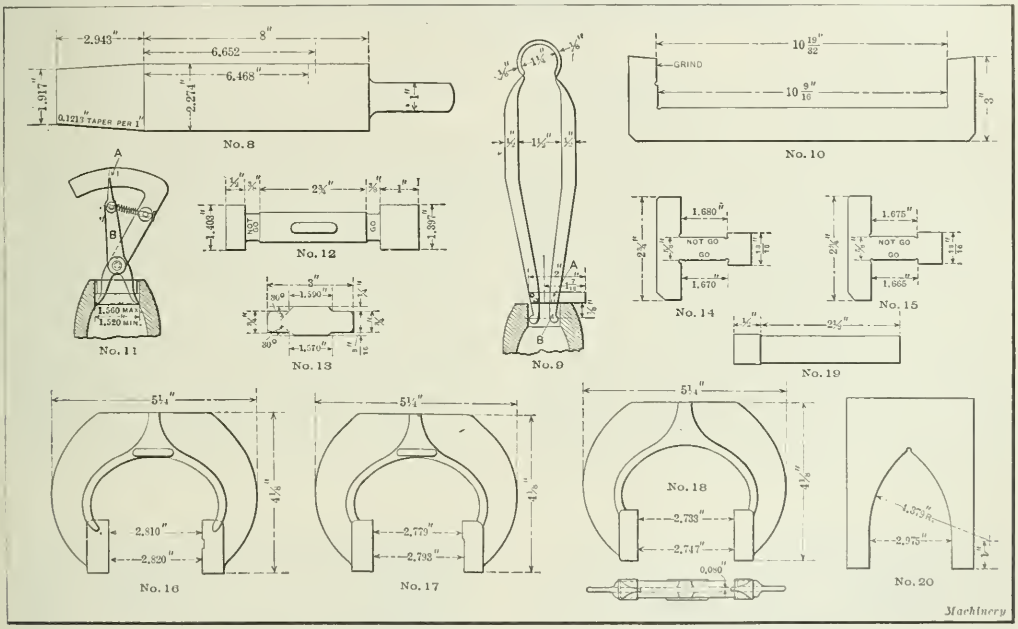


Fig. 2. Gages used in Inspection of U. S. 75-millimeter Shell referred to in Article as Nos. 8 to 20

After the shell has been rough- and finish-reamed and the inside bottom has been finished, it is inspected by gage No. 4 to test the diameter of the bore, and by gages Nos. 5 and 6 to determine the accuracy of the bottom. Gage No. 4 is a flat limit gage made from 3/16-inch stock, the lower end of which will enter and the upper end of which will not pass into the shell. Gage No. 6 must strike fully on the bottom of the shell. This is readily determined by the inspector, who can judge, both by sound and "feel," if the gage strikes fully on the bottom or stops against the side wall or bottom radius of the shell. Gage No. 5 is used in the same manner, but must stop against the side wall or bottom of the shell. In addition to the inspection by the gages, the inside of the shell is also subjected to a visual inspection for roughness of bore, by inserting an electric light into the bore. Two inspectors and one checker are employed at this inspection table.

The next inspection takes place after the second rough-turning of the entire outside, limit snap gage No. 7 being used. One inspector and one checker are employed on this inspection, the inspector also stamping on the shell a letter indicating the number of the working shift during which the shell was passed. The lot or code number of the forging is also transferred at this point from the end of the shell to the side, two stampers being employed on this work.

First Government Inspection

As the shell is now ready for the heat-treatment, it is subjected to a government inspection at this point. This inspection consists of a visual inspection of the inside and outside of the shells to see that they are not too rough, comparison of the stamps on the side and the bottom of the shell to see that the lot number has been properly transferred, and gaging of the taper of the bore, the diameter of the bore above the taper, and the cavity of the bore at the base. Gage No. 8, Fig. 2, is used for testing the taper, this gage being made from flat stock 3/16 inch thick. A gage similar to No. 4 is used for testing the diameter above the taper, and gages Nos. 5 and 6 are used for gaging the cavity of the bore at the base, the repetition of the inspections previously made by the company providing a double check to insure that no shells are heat-treated that are not of correct dimensions. The government inspector stamps the shell with the government inspection stamp and passes it to the nosing presses.

After the nosing-in operation, gage No. 9 is used for roughly determining that the opening at the end of the shell is of the right diameter. The lines at *A* on the cross-bar indicate the maximum and minimum limits between which the line *B* on the gage must come. The length of the shell after the nosing-in operation is also tested by the limit snap gage No. 10. After the heat-treatment, 10 per cent of the shells are subjected to a Brinell test, and physical tests of the metal are also made. These will be dealt with later.

Inspecting Machining Operations after Heat-treatment

The first machining operation after heat-treatment is the finishing of the base and the under-cutting of the boss for the center. The thickness of the base after this operation is tested by a fixture similar to that shown in Fig. 8, provided with a shoulder at the upper end of the measuring rod *A*, which must come between two limit shoulders *D* and *E* on the fixture when the thickness of the base is correct. The fixture used in the present operation, however, has a hole in the bottom at *B*, where the fixture in Fig. 8 is solid, to provide clearance for the boss for the center. One inspector both inspects and checks off the number of shells at this operation.

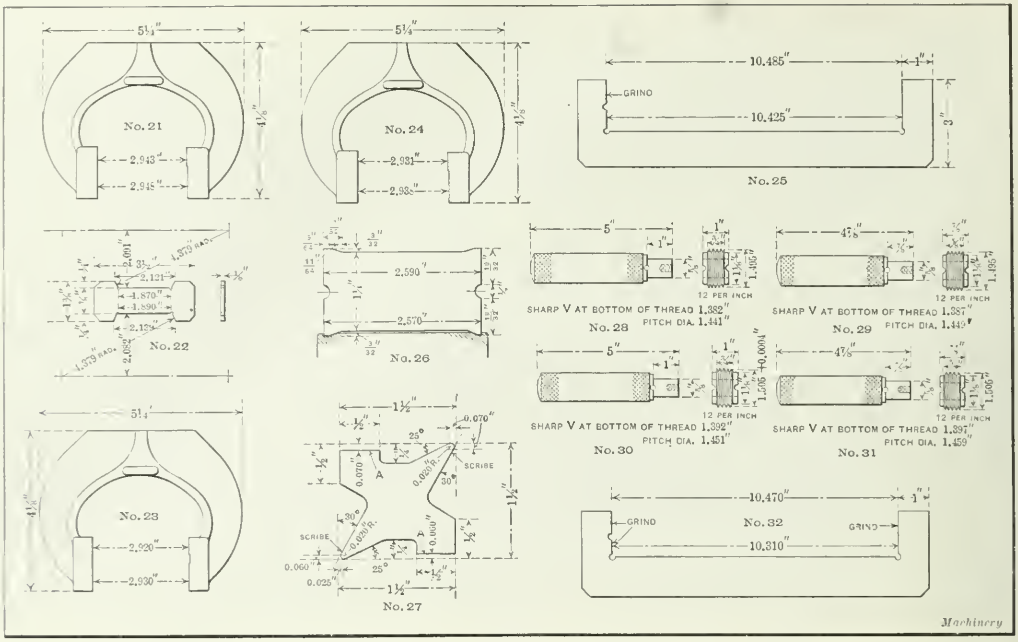


Fig. 3. Gages used in Inspection of U. S. 75-millimeter Shell referred to in Article as Nos. 21 to 32

The next machining operation consists of boring, recessing, facing, and beveling the hole for the fuse. These operations are inspected by gages Nos. 11, 12, and 13. Gage No. 11 checks the diameter of the recess below the thread. This gage has limit lines scribed on it at *A*, and if the diameter of the recess is within the prescribed limits, the pointer will indicate between these lines. Gage No. 12 checks the maximum and minimum diameter of the bore for the thread, while gage No. 13 checks the maximum and minimum diameter of the beveled part in the nose end. This gage is made from 1/8-inch flat stock. One inspector and one checker are employed for this work.

After the rough-grooving, the position of the groove for the band is tested by the limit snap gage No. 14. After the finish-grooving, a similar gage, No. 15, is used. The diameter of the band seat after the rough-grooving is inspected by the limit snap gage No. 16. A similar gage, No. 17, is used after the finish-grooving for testing the diameter in the center of the band groove, while gage No. 18 is used for testing the diameter at the sides of the finished band seat between the ridges in the bottom of the groove and the sides. It will be noted that the jaws of this gage are pointed so that they will enter into the narrow spaces between the ridges and the sides. Finally,

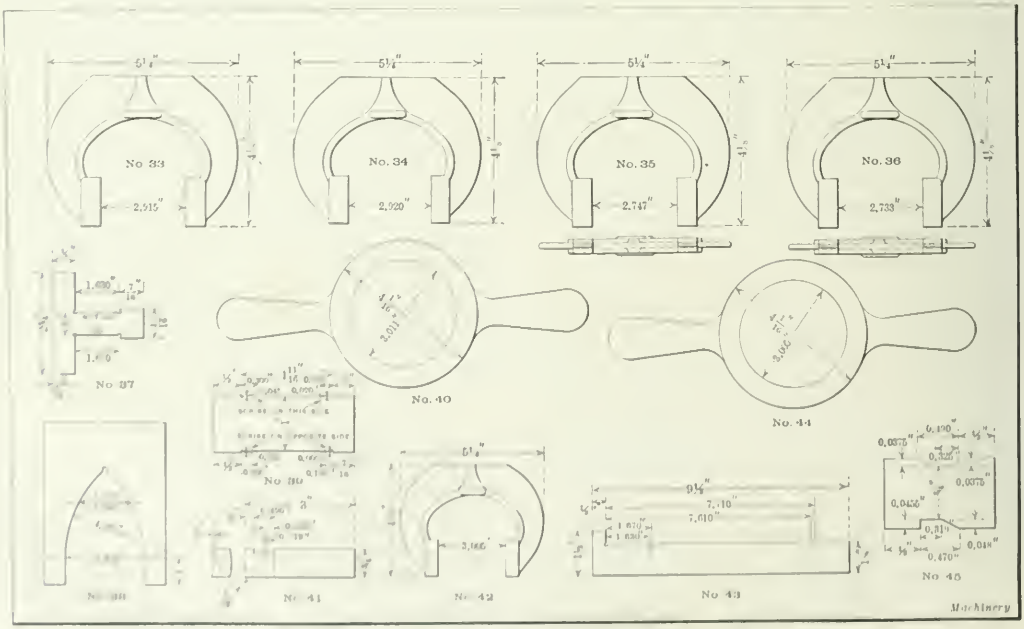


Fig. 4. Gages used in Inspection of U. S. 75-millimeter Shell referred to in Article as Nos. 33 to 45

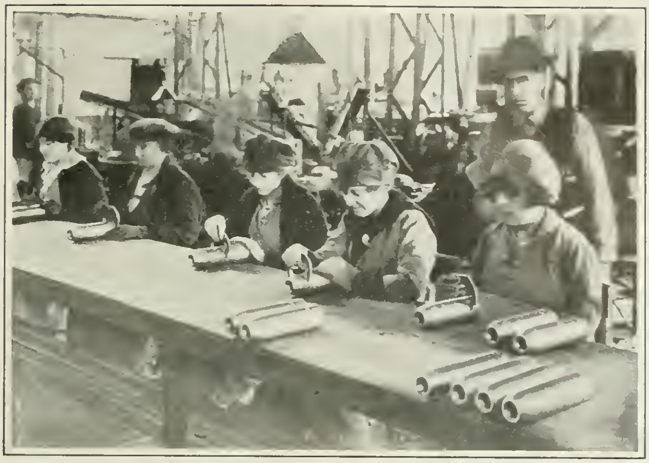


Fig. 5. Table at which General Shop Inspection takes Place previous to Shells passing to Government Inspection Department

gage No. 19 is used for testing the maximum and minimum width of the band groove. Two inspectors are employed in making these tests.

The next gaging operation is that of the rough-profiling of the nose of the shell, for which gage No. 20 is used. After the finish-profiling, the diameter of the bourrelet is gaged by the limit snap gage No. 21, Fig. 3, and the maximum and minimum diameter at the end of the nose by gage No. 22. At this time the stamp for the lot number is also changed from the base to the nose of the shell by a government inspector. Two inspectors are employed for this gaging, in addition to the government inspector.

The body is now finish-turned above and below the band groove, gage No. 23 being used for testing the maximum and minimum diameter. On the side of the shell is now stamped the government code number corresponding to the number of the material stamped at the steel mill. After beveling the body for the cartridge case, the inspector checks the beveling by gage No. 39, Fig. 4, and also stamps the working shift number on the end of the shell in order to identify the shift during which the shell passed through these operations. The bourrelet is now ground, the diameter of the bourrelet after grinding being inspected by gage No. 24, Fig. 3. Two inspectors are employed for this work, and, in addition to gaging, they stamp the working shift mark on the shells.

After the refacing or finishing of the base surface, the total length of the shell is inspected by the limit snap gage No. 25, after which the groove in the base for the cover is cut. This groove is inspected by gages Nos. 26 and 27, which are both made from 1/16-inch flat stock. Gage No. 26 is a limit gage for testing the diameter of the groove, while gage No. 27 is a limit gage that is used for testing the depth and the undercut of the groove. The surfaces at *A* rest on the plain surface at the center of the base when making this test. There are two inspectors employed for making this inspection.

After the thread milling, the maximum and minimum thread gages Nos. 28 and 29 are used. It has also proved satisfactory to use a thread plug for the minimum dimension only, and to use a plain plug gage for the "Not Go" test. Gages Nos. 30 and 31 are the thread gages used for the final inspection after the thread has been sized. The difference between the four thread gages shown is simply in the dimensions of the thread. The lead of the thread of the gages must be accurate within a limit of 0.0002 inch in length of thread. Three inspectors are required for testing with threaded plug gages after the thread milling, and one inspector for testing with a plain "Not Go" plug gage. One checker is also employed for the inspection after the thread milling. The shells are now subjected to the hydraulic test, which is done under government supervision, and which will be dealt with later in connection with the general government inspection.

General Shop Inspection

The shell is now complete, except for the application of the copper band, and is subjected to a general shop inspection in which practically all the previous inspections are repeated. This inspection takes place at a long table, Fig. 5, with the inspectors seated at both sides. Before the inspection proper takes place, a visual inspection with a small electric lamp is made to see that the shells are clean on the inside. The diameter of the thread is measured by a "Go" thread gage

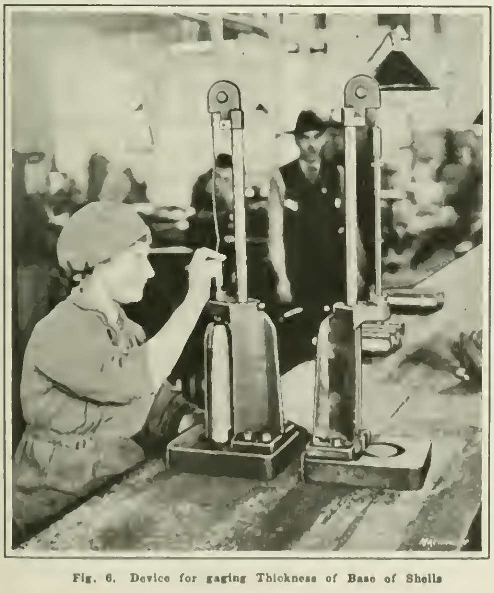


Fig. 6. Device for gaging Thickness of Base of Shells

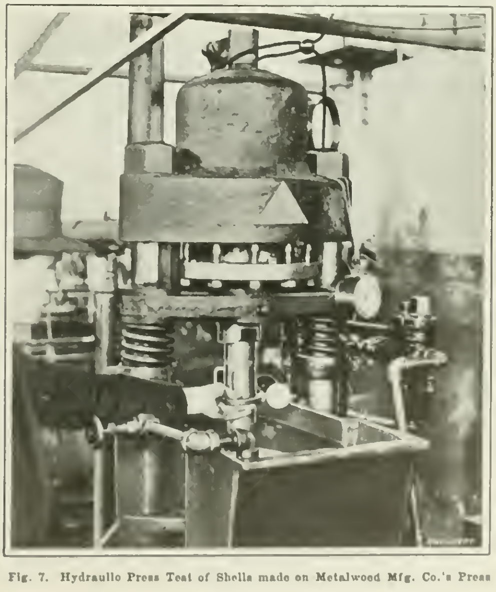


Fig. 7. Hydraulic Press Test of Shells made on Metalwood Mfg. Co.'s Press

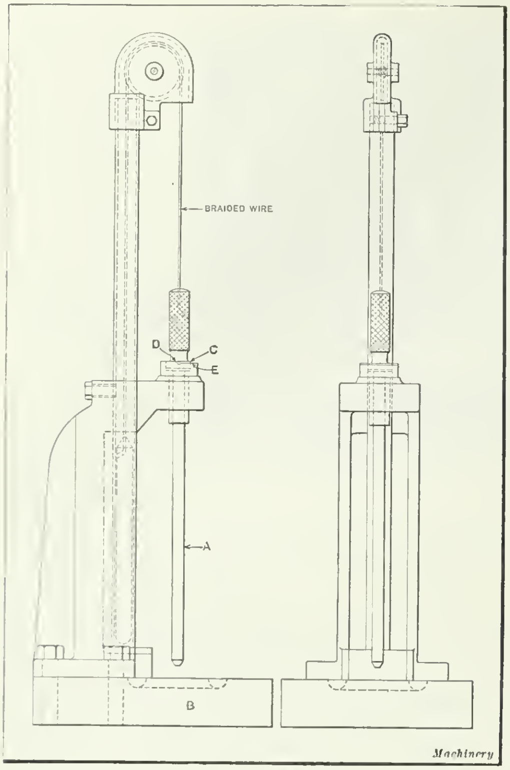


Fig. 8. Diagram of Device shown in Fig. 6, used for testing Thickness of Base of Shells

and a "Not Go" plain plug gage; and the length of the thread is inspected with a snap gage. The thickness of the base is gaged with the measuring machine shown in Fig. 8, the application of which is shown in Fig. 6. This measuring device is provided with a counterweight so that, when not used for gaging, plunger *A* will always be out of the way for the insertion of a shell on the base of the device. The inspector then grips the handle and pushes the plunger into the shell for gaging the thickness of the base. The shoulder at *C* is so located that it must always come between the two shoulders *D* and *E* when the thickness of the base is correct.

The total length of the body is gaged by the maximum and minimum snap gage No. 32, Fig. 3. The diameter of the body is gaged with a "Go" ring gage, as well as with a "Not Go" snap gage, No. 33, Fig. 4. The bourrelet is tested with a "Go" ring gage and a "Not Go" snap gage. The minimum diameter at the base is tested with snap gage No. 34. The band groove is inspected in the same way as after the finishing of the groove, except that two gages Nos. 35 and 36, one maximum and one minimum, are used. The maximum and minimum position of the band seat is tested by gage No. 37. The shell is inspected visually for roughness. The position of the bourrelet and the diameter of the nose are measured, and the profile of the nose tested, by gage No. 38. The length of the bevel at the base and band for the cartridge case is inspected by means of gage No. 39. The base groove and its shape are inspected by gages similar to those used after the machining operations. The thread of the fuse is inspected visually. The thickness of the wall is tested by the gage shown in Fig. 9, which has a movable measuring point *A* provided with a line which must come between two lines at *B* when the wall thickness is between the maximum and minimum limits. For this general shop inspection eighteen inspectors and seven helpers are employed. The capacity of the inspection table is 9000 shells in eight hours.

After this inspection, the shells pass immediately to the second or general government inspection, details of which will be given later. After this, the shells again enter the shop for pressing the copper band into place. After the band has been turned, the ring gage No. 40, Fig. 4, is used for the maximum or "Go" gage, while a "Not Go" snap gage is employed. Two inspectors are employed for the "Go" inspection and two for the "Not Go." In addition, the position of the band is tested by one inspector and the width of the band by another inspector, using gage No. 41. The "Not Go" snap gage for the copper band is shown as No. 42. The gage for the position of the band, which also tests the position of the bourrelet is made from 3/16-inch flat steel and shown as No. 43. In the government inspection the minimum diameter of the band is also measured by a ring gage No. 44. The profile and length of the band is tested by the gage No. 45.

Each operator of band turning machines has a red and blue electric light in front of him, and the inspectors have switches mounted on the inspection table so that they can light either lamp, according to whether the bands are high or low. In this way, the operator is immediately notified that he must readjust his tools. The blue light indicates a high band, and the red light, a low band.

After this inspection in the shop, the shells pass again into the government inspection department where the copper band is inspected, and then back into the shop for marking the number on the shells, lacquering, and packing into cartons. Previous to packing, the shell is given a visual inspection.

Government Inspection

The first government inspection, which takes place immediately before the nosing or bottling, has already been referred to. The next government test is that for the physical properties of the metal in the shell after heat-treatment. Two shells out of a thousand are selected, a test piece being cut from each and subjected to tests to determine the elastic limit, ultimate strength, and elongation; an Olsen testing machine is used. The test piece must show a minimum elastic limit of 45,000 pounds per square inch, a minimum ultimate tensile strength of 90,000 pounds per square inch, and an elongation of 15 per cent in two inches. Ten per cent of the shells are also subjected to a Brinell test on an Olsen hardness testing machine. This test is, strictly speaking, only an additional check on the physical test. One government inspector on each shift observes the Brinell tests and reads off the diameter of the impression made by the test ball in the shell. A flat surface must be ground on the shell for this test, ½ inch below the bourrelet. The pressure of the testing machine is 3000 kilograms, which is applied for thirty seconds. The depression should be between 3.8 and 4.2 millimeters, corresponding to Brinell hardness numbers 255 and 207. This test merely determines whether or not the steel is too hard to machine, and there are practically no rejections at this point if the lot of heat-treated shells has passed the physical tests. Should a shell not pass the Brinell test, it is still accepted if it passes the hydraulic test applied later.

Hydraulic Test

Ten per cent of the shells are subjected to a hydraulic test on a Metalwood Mfg. Co.'s shell-testing hydraulic press as shown in Fig. 7. A gage is held so that the expansion of the shell while under pressure will be indicated on an ordinary dial indicator. The pressure is 10,000 pounds per square inch and the shell is subjected to this pressure for fifteen seconds. After the test, the dial indicator must not show a permanent

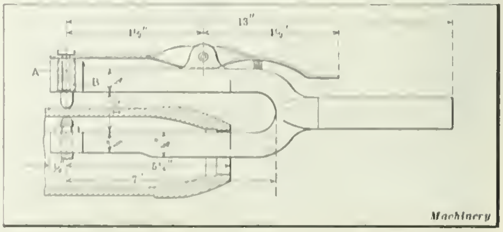


Fig. 9. Gaging Device used for determining Thickness of Wall of Shells

set of the shell exceeding 0.003 inch. While the pressure is on, the expansion of the shell may be from 0.004 to 0.006 inch. Seldom, however, does the permanent set reach the limit prescribed, but it ordinarily averages between 0.00025 and 0.0005 inch. Very few shells ever fail in this test. The company operates this test, but a government inspector uses the inspecting gage.

Second or General Government Inspection

All the government inspection in this plant is under the direction of J. M. Lennon, chief army inspector of the United States Government at the American Shell Co. The gages used are mainly the same as those employed in the general shop inspection by the company, but in addition a number of other tests are made. The government inspection room employs thirty-two inspectors, all of whom are women, and has a capacity for inspecting 8000 shells in eight hours. The shells enter the government inspection room from the shop inspection table on a conveyor and are automatically counted when entering. The inspection continues, each inspector checking one dimension only, and marking the shells if not passed. At the end of the inspection table a sorter is placed who picks out the marked shells and puts them on a temporary rejection table from which they are sent back into the shop for repairs. Upon entering the inspection room the shells are first inspected visually on the interior and on the outside for cracks, seams, and flaws, a magnifying glass being used for this purpose. A ringing test is also made with a small four-ounce hammer. A dull sound indicates cracks. The fuse hole thread is next inspected by means of a special gaging machine designed by the American Shell Co. The thread gage is held by hand, but the shell is rotated. By pressing a foot-lever, the direction of rotation will be reversed, so that the gage is unscrewed. An automatic knock-out pushes the shell out of the chuck that holds it during this operation. The machine has a capacity for gaging 4000 shells in eight hours.

After this test, the following inspections are made in the government inspection room: Diameter of band groove ("Go" and "Not Go" snap gage); diameter of body above band ("Go" and "Not Go" snap gage); diameter of body below band ("Go" and "Not Go" snap gage); diameter of bourrelet ("Not Go" snap gage); position of band groove ("Go" and "Not Go" snap gage); width of band groove ("Go" and "Not Go" plug gage); position and angle of taper for cartridge case ("Go" and "Not Go" snap gage); position of band groove and bourrelet ("Go" and "Not Go" hook gage); diameter of recess below thread (limit gaging fixture); length over all of shell body ("Go" and "Not Go" snap gage); wall thickness (limit gaging fixture); diameter of bourrelet ("Go" ring gage); outside diameter of base of shell ("Go" and "Not Go" profile gage); root diameter of fuse hole thread ("Not Go" plug gage); length of thread ("Go" and "Not Go" snap gage); profile of shell nose ("Go" profile gage); length of recess below thread (limit gaging fixture); thickness of base (limit gaging fixture); diameter of rear of band ("Go" ring gage); diameter of base cover groove ("Go" and "Not Go" snap gage); depth of base cover groove ("Go" and "Not Go" gage).

Shells which are within the limits of accuracy allowed pass directly to a stamping machine where the government stamp is placed upon them. A Bliss No. 8 power press is used for this purpose, provided with a knock-out which throws the shell automatically onto a belt conveyor, carrying it back into the shop, the shells being counted automatically as they pass out.

Final Government Inspection

The third or final government inspection which takes place after the copper bands have been pressed into place and turned to the correct shape consists in counting the shells as they enter the government inspection room and then gaging the diameter of the band ("Go" ring gage and "Not Go" snap gage); the profile of the band ("Go" and "Not Go" profile gage); and the position of the finished band ("Go" and "Not Go" snap gage). The shells at this time are also placed into a so-called "coffin gage," which is made 0.005 inch over the maximum dimensions in all directions and in which the shell is rolled to see that it is within this limit. It is also tested with a concentricity gage having a threaded plug which enters the fuse hole and which indicates that the body of the shell is concentric with the thread. The shells are next weighed by being rolled over the platform of a Toledo platform scale arranged for this purpose; 15,000 shells can be weighed in this way in eight hours. The weight must be correct between the limits of 9 pounds 3½ ounces and 12 pounds 3½ ounces. The shells are then stamped with a government stamp, counted, and passed out for packing and shipping.

Additional Government Inspections

In addition to the inspection activities detailed in the foregoing paragraphs, the Government employs one man who checks the number of forgings received with the government shipping list. The company makes out a requisition to this inspector before the forgings pass into the shop. This man also attends to the shipping of the finished shells and observes the packing of the shells. Another government inspector is employed on each shift for observing the heat-treatment. Every half hour he takes a reading of the pyrometer of each furnace and notes the company's manner of heat-treatment for each shell. He also takes out the shells required for the physical tests.

One government inspector in each shift transfers the government stamp indicating the heat number of the forging from the body to the base after the finish-profiling of the nose. One man is also employed on each shift for transferring the same mark from the base to the body after the grinding of the bourrelet.

On all the government inspection where gages are used, duplicate gages are employed, so that when one or two of the gages are in use, one or two duplicate gages are checked by the government gage checker. A view in the government inspection room is shown in the heading illustration. At the time when this article was prepared, A. G. Preen was chief army inspector at the American Shell Co., and the author is indebted to him for the information relating to the government inspection in the plant.

* * *

EMPLOYMENT OF GIRLS IN DRAFTING-ROOM

Women workers have entered not only into the shop, but also into the drafting-room. There are a number of firms who have employed girls as tracers for a period long enough to determine the success of the arrangement. Among these is the Reed-Prentice Co., Worcester, Mass., where women have been employed in the drafting-room for over a year. The idea that girls could be so employed was conceived by F. K. Hendrickson, mechanical engineer of the company, who about a year ago, engaged eight girls, starting them on tracing. These girls had no previous experience, but the experiment has proved so successful that now practically all the tracing of the company is done by girls, and it has been found that the most experienced can trace any drawing handled in the company's drafting-room. In fact, the management of the Reed-Prentice Co. is quite enthusiastic about the experiment. The girls on the whole work more rapidly than the men formerly employed, and the quality of the work will, in the long run, be fully as good, if not superior, to that turned out by the men tracers. An indication of the progress made is shown by the fact that one girl has already left the employ of the company to take charge of the tracing department with another concern. It is, of course, evident that tracing is a class of work for which women could be assumed to be unusually well fitted, and it is quite likely that as the war demands the services of more and more young men either at the front or in capacities in the shop for which men are better fitted than women, a greater number of girls will be employed in drafting-rooms.

* * *

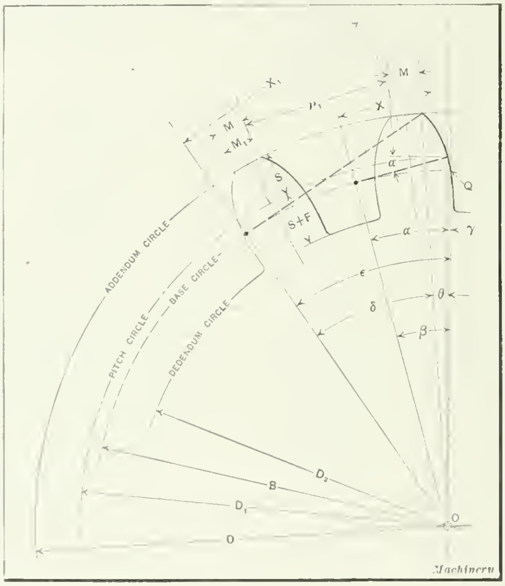
A recently patented bearing alloy, which, it is claimed, requires little lubrication, contains copper, 4 parts; antimony, 2 parts; nickel, 1 part; and lead, 1 part.

THICKNESS OF INVOLUTE GEAR TEETH ON ADDENDUM CIRCLE

A METHOD OF ACCURATELY GENERATING SILENT GEARS

BY REGINALD TRAUTSCHOLD[1]

THE degree of perfection demanded of gearing for use in the high-class modern automobile has materially elevated the plane of commercial gear cutting, and has, at the same time, drawn attention to certain faults that had previously passed unnoticed or unheeded. Automobile gears must be accurate in every respect, or they will be noisy and give trouble. Accuracy means, above all else, that the teeth of the gears are identical and correctly proportioned. Measurements are perforce made on the pitch circle of the gears, the elusive dimension that governs the speed ratios, etc., but the difficulties of accurately measuring the pitch diameter have not proved insurmountable. The measurement of the distance between pins proportioned so as to rest on the pitch lines of adjacent spur gear teeth, placed in diametrically opposite tooth spaces, accurately checks the pitch diameter; the outside gear diameter and the dedendum diameter can also be accurately checked. Notwithstanding accuracy in pitch diameter, addendum, and dedendum dimensions, there is hardly an automobile manufacturer who has not been troubled with noisy gears. Some sets of gears, apparently as carefully cut as is commercially possible, with all pitch dimensions accurate and the addendum and dedendum dimensions correct will not run together quietly, while other sets, cut on the same machines and with the same care, will run together with much less noise. This is quite a common experience and can only be explained by variations in the profiles of meshing teeth. But a slight variation in the pressure angle of the teeth of the respective gears will cause appreciable noise.



Top Measurement of Involute Spur Gear

The spur gears used in automobile construction, with which the greater amount of annoyance is encountered, are almost exclusively of the type with teeth cut to the involute standard. The very simplicity of this involute curve is probably responsible in large measure for the prevalent errors, for, though lending itself admirably to generating processes, it is governed by inflexible conditions of obliquity, which, if deviated from in the least degree will result in sufficient variation in tooth profiles to cause unsatisfactory gear operation. The profiles of all involute gear teeth are developments of a rack tooth with perfectly flat sides inclined to its center line at a definite angle of obliquity, or pressure angle, so that variations in profile curvature are due to a difference in pressure angle of the developing rack tooth.

There are three general methods of cutting gear teeth: with regular standard involute cutters; by the Fellows gear-shaper method, and with generating machines of the Bilgram gear generating machine variety. Each of these is open to the possibility of error in maintaining a constant and correct pressure angle.

The use of standard rotary involute cutters results in error to the greatest extent, for, whether the eight-cutter or the fifteen-cutter set is employed, it is impossible for a rotary cutter to be correct for more than one specific number of teeth. For instance, a No. 4 cutter, in the eight-cutter set, cannot be correct for thirty-four teeth if correct for twenty-six teeth; nor, in the fifteen-cutter set, correct for twenty-nine teeth as well as for twenty-six teeth. If the cutter is correct for twenty-six teeth, only twenty-six tooth gears can be accurately produced with it. Add to this the possibility of a slight alteration in the cutter profile each time the tool is ground and the difficulties of producing gears with teeth of accurate pressure angle with standard rotary involute cutters can be easily recognized.

In the case of the Fellows gear shaper, chances for error are greatly reduced, for the teeth of the cutter are accurately ground after hardening to true involute form. This assures the production of true and accurately proportioned involute gear teeth, and the teeth of the cutter retain their correct shape as the cutter is sharpened. The reason for this is that the involute curve has the virtue of running correctly at varying center distances. Therefore, as the cutter is ground down by sharpening, it is operated with the gear blank at a different center distance than when it was new, but still produces exactly the same tooth shape. Noisy gears in automobile transmission boxes are caused mostly by inaccuracies in the location of the shafts and the mounting of the gears.

The use of a truncated, straight-sided cutting tool, such as that employed in the Bilgram spur-gear generating machine, permits the regrinding of the cutting edges of the tool with more accuracy and less difficulty than is possible when sharpening form cutters. For this reason, gears generated by Bilgram machines are less liable to variations in pressure angle, though the danger is not entirely eliminated. The slope of both sides of the reciprocating tool must be similar and constant to assure uniformity of output, so there always remains a possibility of variation in pressure angle, even in the gears generated on Bilgram machines.

The chances for variation in the pressure angles of spur gearing, no matter how efficiently the gears are produced, have been emphasized in order to show the importance of accurate checking of the pressure angles of any spur gearing that must be precise to be satisfactory. The logical check for this highly important consideration is the circular thickness of the involute teeth on the addendum circle, for any generated spur gear tooth or one cut with a standard involute cutter that is correct on both the pitch circle and the addendum circle must also be correct as far as pressure angle is concerned, provided the diameters of these circles are also correct.

The illustration shows the dimensions that must be calculated in the derivation of an equation by which the circular thickness M of the involute tooth on the addendum circle can be readily ascertained. The formula to be presented is based on the facts: (1) that a normal to any point on the tooth profile, between the base and the addendum circles, will be tangent to the base circle; (2) that for similar gears there is a constant ratio between the lengths of tangents between similar points of contact on the tooth profiles and their points of tangency on the base circles; (3) that there is a constant ratio between the angles subtended between radial lines to the intersection of the profile tooth curves with the base circles and radial lines to the tangent points on the base circles of normals to similarly located points on the same tooth profiles of similar gears.

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Notation

Pitch diameter	D_1
Addendum	S
Dedendum	$S + F$
Outer diameter	D
Base circle diameter	B
Dedendum circle diameter	D_2
Pressure angle	α
Normal to pitch circle, length	X
Angle subtended by arc equal to normal to pitch circle	β
Angle difference between β and α	γ
Thrust angle at top of tooth	δ
Normal to addendum circle, length	X_1
Angle subtended by arc equal to normal to addendum circle	ϵ
Angle difference between and $\delta + \gamma$	θ
Thickness of tooth on addendum circle	M
Chordal thickness of tooth on addendum circle	M_1
Backlash, total	L
Backlash angle	λ
Thickness of tooth with backlash on addendum circle	M_2
Number of teeth	N
Diametral pitch	p
Circular pitch	p_1

Derivation of Formulas

$$B = D_1 \cos \alpha \qquad (1)$$

$$B = 0.96815\, D_1,\ \text{14.5-degree involute tooth} \qquad (2)$$

$$B = 0.93969\, D_1,\ \text{20-degree involute tooth} \qquad (3)$$

$$X = 0.5\sqrt{D_1^2 - B^2} = 0.5\sqrt{D_1^2 - (D_1 \cos \alpha)^2}$$

$$X = 0.5\ D_1\sqrt{1 - (\cos \alpha)^2} \qquad (4)$$

$$X = 0.12508\, D_1,\ \text{14.5-degree involute tooth} \qquad (5)$$

$$X = 0.17099\, D_1,\ \text{20-degree involute tooth} \qquad (6)$$

$$\beta = \frac{360\, X}{3.1416\, B} = \frac{57.296\sqrt{1 - (\cos \alpha)^2}}{\cos \alpha} \qquad (7)$$

$$\beta = 14.8046 \text{ degrees, 14.5-degree involute tooth} \qquad (8)$$

$$\beta = 20.8527 \text{ degrees, 20-degree involute tooth} \qquad (9)$$

$$\gamma = \beta - \alpha \qquad (10)$$

$$\gamma = 0.3046 \text{ degrees, 14.5-degree involute tooth} \qquad (11)$$

$$\gamma = 0.8527 \text{ degrees, 20-degree involute tooth} \qquad (12)$$

$$D = D_1 + \frac{2}{p},\ \text{standard proportions} \qquad (13)$$

$$X_1 = 0.5\sqrt{D^2 - (D_1 \cos \alpha)^2} \qquad (14)$$

$$X_1 = 0.48408\sqrt{1.0667\, D^2 - D_1^2},\ \text{14.5-degree involute tooth} \qquad (15)$$

$$X_1 = 0.46985\sqrt{1.1325\, D^2 - D_1^2},\ \text{20-degree involute tooth} \qquad (16)$$

$$\epsilon = \frac{360\, X_1}{3.1416\, D_1 \cos \alpha} = \frac{114.59\, X_1}{D_1 \cos \alpha} \qquad (17)$$

$$\epsilon = \frac{57.296\sqrt{1.0667\, D^2 - D_1^2}}{D_1},\ \text{14.5-degree involute tooth} \qquad (18)$$

$$\epsilon = \frac{57.296\sqrt{1.1325\, D^2 - D_1^2}}{D_1},\ \text{20-degree involute tooth} \qquad (19)$$

$$\text{Sin}\ \delta = \frac{2\, X_1}{D} \qquad (20)$$

$$\theta = \epsilon - (\gamma + \delta) = \epsilon - \gamma - \delta \qquad (21)$$

$$\theta = \epsilon - \delta - 0.3046 \text{ degrees, 14.5-degree involute tooth} \qquad (22)$$

$$\theta = \epsilon - \delta - 0.8527 \text{ degrees, 20-degree involute tooth} \qquad (23)$$

$$M = \left(\frac{180}{N} - 2\,\theta\right)\frac{3.1416\, D}{360}$$

$$M = \frac{(1.5708 - 0.01745\,\theta\, N)\, D}{N} \qquad (24)$$

$$\text{Tan}\ \lambda = \frac{0.5\, L}{D \cos \delta} \qquad (25)$$

$$M_2 = M - 2\left(\frac{3.1416\, D\lambda}{360}\right) = M - 0.0175 D\, \lambda \quad (\lambda \text{ in degrees}) \qquad (26)$$

$$M_1 = D \sin \frac{57.296\, M}{D},\ \text{14.5 degrees, with no backlash} \qquad (27)$$

$$M_1 = D \sin \frac{57.296\, M_2}{D},\ \text{20 degrees with backlash} \qquad (28)$$

Discussion of Formulas

The length of the normal X to the pitch circle, that is the length of the tangent from the point of tangency on the base circle to its normal contact on the pitch line of the tooth profile, is equal to one-half the square root of the difference between the square of the pitch diameter and the square of the diameter of the base circle. As the diameter B of the base circle is equal to the pitch diameter D_1 multiplied by the cosine of the pressure angle α, the length of the normal X to the pitch circle is a definite proportion of the pitch diameter D_1.

The angle β subtended between a radial line to the intersection Q of the base circle with the tooth profile and a radial line to the point of tangency on the base circle of the normal to the pitch circle is measured by an arc of a length equal to the length of the normal to the pitch circle. The difference between this angle β and the pressure angle α is equal to the angle γ between a radial line to the pitch line on the profile of the tooth and the radial line to the intersection Q of the base circle with the same tooth profile.

The length of the normal X_1 to the addendum circle, that is the length of the tangent from the point of tangency on the base circle to its normal contact on the tooth profile at the addendum circle, is equal to one-half the square root of the difference between the square of the outer diameter D of the gear and the square of the diameter B of its base circle.

The angle ϵ subtended between a radial line to the intersection Q of the base circle with the tooth profile and a radial line to the point of tangency on the base circle of the normal to the addendum circle is measured by an arc of length equal to the length of the normal X_1 to the addendum circle. The difference between this angle ϵ and the sum of the angle γ between a radial line to the pitch line on the profile of the tooth and a radial line to the intersection Q of the base circle with the same tooth profile and the thrust angle δ at the top of the tooth measures the angle θ subtended by the involute tooth profile between the pitch and addendum circles.

The thrust angle δ at the top of the tooth is the angle included between the plane of pressure at the top of the tooth and a plane tangent to the addendum circle at that point. Its sine is equal to twice the length of the normal to the addendum circle divided by the outer diameter of the gear.

The angle subtended on the addendum circle by the top of the involute teeth is then equal to one-half the pitch angle (180 divided by the number of teeth) minus twice the angle subtended by the involute profile of the tooth between the pitch and addendum circles. The angle subtended by the top of the tooth on the addendum circle multiplied by the outer circumference of the gear divided by 360 gives the circular thickness of the involute tooth on the addendum circle.

The chordal thickness M_1 of the involute tooth on the addendum circle is equal to twice the outer radius multiplied by the sine of half the angle subtended by the circular thickness of the tooth on the addendum circle, or is equal to the product of the outer diameter of the gear by the sine of half the same angle.

The backlash angle λ, twice which must be subtracted from the angle subtended on the addendum circle by the top of an involute tooth without backlash to obtain the angle subtended on the addendum circle by the top of an involute tooth with backlash, is the angle the tangent of which is the quotient of one-quarter the total amount of backlash L divided by the cosine of the thrust angle δ at the top of the tooth divided by one-half the outer diameter D of the gear. This equation can be simplified to the form: the tangent of the backlash angle λ equals one-half the total backlash L divided by the product of the outer diameter D of the gear multiplied by the cosine of the thrust angle δ at the top of the tooth.

The circular and chordal thicknesses on the addendum circle of involute teeth with backlash are then obtained from the angle subtended on the addendum circle by the top of the teeth with backlash.

Formula (24) gives the value of the circular thickness of true involute teeth on the addendum circle, which are also correct in their circular thickness on the pitch circle, that is, for gears with no backlash. It is advisable at times to allow a certain amount of backlash, however, and this seriously affects the circular thickness of the teeth on the addendum circle; though, if the backlash is properly provided for, there will be no modification in the angles subtended by the lengths of the normals to the tooth profiles, as measured along the base circle from their respective points of tangency on that circle. When a definite amount of backlash is provided for, the backlash should be divided between the two engaging gears so that one-half is provided by the decrease in the thickness of the teeth and one-half in the increased width of the tooth spaces; that is, a quarter of the total backlash is removed from each of the profiles of engaging and correctly proportioned teeth. The thickness of metal removed to provide the desired play must be normal to the tooth profiles and of constant thickness, so that the reduction in circular thickness of the teeth on the addendum circle is much more marked, for a given amount of backlash, than the reduction in the circular thickness of the teeth on the pitch circle. The increased reduction in the circular thickness, due to the fact that the angularity of the pressure angle at the corner of the tooth on the addendum circle—referred to as the thrust angle δ at the top of the tooth to distinguish it from the pressure angle α at the pitch circle—is considerably greater than the pressure angle α at the pitch line of the teeth, materially facilitates accurate measurement of backlash. Backlash that would be scarcely noticeable on the pitch circle becomes quite apparent when measured on the addendum circle. Fomula (26) gives the circular thickness M of involute teeth on the addendum circle with backlash proportioned equally between the teeth and the tooth spaces of involute spur gears.

Although measurements on the addendum circle are obviously made with a greater degree of accuracy than corresponding measurements can be made on the pitch circle, provided, that the addendum dimensions of the gear are accurate, even greater accuracy can be secured by taking chordal measurements than by circular measurements. Reliance on chordal measurements permits the use of simple gages with high and low limits for checking purposes.

Example—Required the thickness of the teeth on the addendum circle of a standard 25-tooth involute gear, 5-inch pitch diameter, and 20-degree teeth, with 0.002 inch backlash.

$$D = 5 + \frac{2}{5} = 5.4 \text{ inches} \qquad (13)$$

$$X_1 = 0.46985\sqrt{1.1325 \times 29.16 - 25} = 1.3309 \text{ inch} \qquad (16)$$

$$\epsilon = \frac{57.296\sqrt{1.1325 \times 29.16 - 25}}{5} = 32.4593 \text{ degrees} \qquad (19)$$

$$\text{Sin } \delta = \frac{2 \times 1.3309}{5.4} = 0.4929 \qquad (20)$$

$$\delta = 29 \text{ degrees } 32 \text{ minutes}$$

$$\theta = 32.4593 - 29.5333 - 0.8527 = 2.0733 \text{ degrees} \qquad (23)$$

$$M = \frac{(1.5708 - 0.01745 \times 2.0733 \times 25)\,5.4}{25} = 0.1439 \text{ inch} \qquad (24)$$

$$\text{Tan } \lambda = \frac{0.5 \times 0.002}{5.4 \times 0.87007} = 0.00021 \qquad (25)$$

$$\lambda = 0 \text{ degrees } 0 \text{ minutes } 44 \text{ seconds}$$

$$M_1 = 0.1439 - 0.0175 \times 5.4 \times 0.01222 = 0.14275 \text{ inch} \qquad (26)$$

$$M_1 = 5.4 \sin \frac{57.296 \times 0.14275}{5.4} = 5.4 \times 0.02643 = 0.1427 \text{ inch} \qquad (28)$$

The example cited, the conditions governing which are very similar to the requirements for the main driving pinion of a leading type of motor truck, forcibly brings out the accuracy in checking pitch-circle measurements by measurements taken on the addendum circle. A backlash of 0.002 inch is specified; that is, a reduction of 0.001 inch in circular thickness of the teeth on the base circle is called for. Such a small reduction in the standard thickness of the tooth could be measured only with difficulty on the pitch circle, but when measured on the addendum circle the reduction in circular thickness amounts to approximately 1/64 inch, an amount that can readily be measured. The multiplication of such dimension is by no means constant, of course, as it is dependent upon the number of teeth and the addendum dimension of the gear, but in every case the dimension is considerably larger when measured on the addendum circle than on the pitch circle.

The aggravation of profile variations on the addendum circle shows up accurately any variation from the specified pressure angle. An increase in pressure angle, although other proportions are correct on the pitch circle, will result in quite an appreciable reduction in the circular thickness of the teeth on the addendum circle; while a decrease in pressure angle will be apparent by a noticeable increase in the circular thickness of the teeth. A very slight variation in pressure angle, such as may readily be caused through the resharpening of the cutting tool, will cause an apparent variation in the circular thickness of the teeth on the addendum circle.

In fact, so accurately will any variations in pressure angle, backlash, etc., of involute gear teeth be shown by check dimensions made on the addendum circle that the addition of the required circular, or chordal, thickness of the teeth on the addendum circle to the specifications for precise gearing will eliminate much of the present trouble due to noisy and unsatisfactory gearing. As an inspection check for manufacturers of accurate gearing, it will definitely establish the correctness of the cutting edges of generating tools, etc., and will allow the manufacturer to guarantee with assurance, the silent operation of his accurately generated gears, when properly mounted. The justifiable objections of his customers will be greatly reduced, if not entirely eliminated, and danger of possible rejection of consignments avoided. High-class generating machines, built on theoretically correct principles, will become more valuable and more efficient, as the correct proportions of their generating tools can be assured.

* * *

LAY-OUT FOR MULTIPLE-SPINDLE DRILLS

The weakest feature of multiple-spindle drills of the cluster type is the universal joints in the spindles. A universal joint should never be run at an angle much greater than 30 degrees, but there are many drilling machine operators who do not realize how important it is to avoid setting the spindles so that the joints exceed this angle. The result of excess angularity is worn and broken joints and dissatisfaction with the machine. The National Automatic Tool Co., of Richmond, Ind., provides with each machine sold for a special job a chart showing the lay-out of the spindles and the position of the spindle holders. The cluster plate is reproduced in a drawing on a large fiber sheet, the proper spindle groups being shown, so that no one need go wrong. The result of this practice is that the machines are set up in accordance with the manufacturer's plan, and no universal joint is set at an angle beyond which it should not be worked. This means long life of the joints and better satisfaction all around.

* * *

It is reported that an invention has been made by the Lux Co., in Stockholm, Sweden, making it possible to use alcohol made from sawdust and other wood refuse in engines designed for gasoline. By introducing acetylene into the alcohol, satisfactory ignition qualities are obtained. It is stated that, by adding from five to six pounds of calcium carbide to 100 pounds of 92-per cent alcohol, acetylene is produced which is absorbed by the alcohol, and the resulting mixture has the required qualities for use in automobiles designed for gasoline. Automobiles can make use of this mixture without any change whatever in the engine. The invention is said to be fully developed, and has been patented by H. Rustige.

THREAD ROLLING

CONCLUDING INSTALLMENT OF A SERIES ON DIFFERENT METHODS OF FORMING SCREW THREADS BY ROLLING, VARIOUS TYPES OF THREAD-ROLLING MACHINES, ADVANTAGES OF ROLLING PROCESS, AND GENERAL APPLICATION

BY FRANKLIN D. JONES[1]

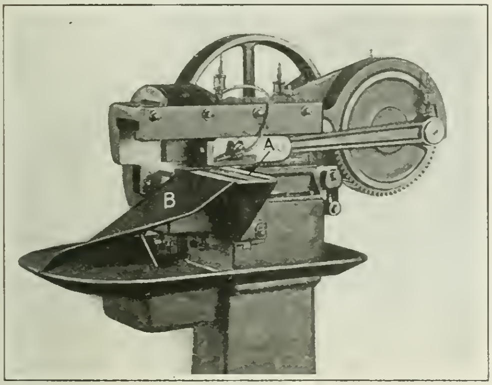

Fig. 16. Side-feed Type of Thread-rolling Machine designed for rolling Threads on Ends of Slender Wire Rods, etc.

THE general method of rolling screw threads between flat dies was described in the first installment of this article (see the April number, page 690) which included information on reciprocating thread-rolling machines of the type which has been used extensively, the adjustment of these machines, the operation of semi-automatic and automatic blank feeding mechanisms, and some of the more important features of the thread-rolling process. In this concluding installment, other types of thread-rolling machines are described, and the advantages and range of the thread-rolling process are considered. As thread rolling is sometimes done in automatic screw machines or turret lathes, the article deals with the special tools and method utilized in connection with this branch of thread-rolling practice.

Side-feed Type of Thread-rolling Machine

The design of thread-rolling machine shown in Fig. 16 is intended especially for rolling threads on the ends of comparatively long slender parts, such as wire rods, the spokes of wire wheels, and other similar classes of work which cannot be handled to advantage in a machine in which the work is held vertically while the thread is being rolled. With the side-feed type of machine, the work is rolled while in a horizontal position so that long slender parts can be operated upon without difficulty. When this machine is in operation, the blanks to be threaded are placed against edge *A* on the table bracket and against a depth gage which may be adjusted for any length within the capacity of the machine. The part to be threaded is then started between the dies automatically by means of a push-finger the same as on the machines previously referred to. As each threaded part leaves the dies it rolls down the inclined plate *B* and into a receptacle.

Vertical Type of Thread-rolling Machine

The thread-rolling machine made by the National Machinery Co., Tiffin, Ohio, is a vertical design. This machine (see Fig. 17) occupies a comparatively small floor space and it is claimed that the dies, which are also in a vertical position, last longer than horizontal dies because the scale and foreign matter are more readily washed away by the lubricant, which continually floods the dies. The front and side elevations of the machine shown in Fig. 18 illustrate the arrangement of the different parts. The stationary die is located at *A* and is provided with adjustments at the side and back. The reciprocating slide which carries the moving die *B* is operated by a yoke *C* connecting with the crankshaft of the machine. This yoke is pivoted at *D* and engages block *E* mounted on the crank-pin. The oscillating motion of yoke *C*, which is connected with the reciprocating slide by rod *F*, gives a slow downward stroke to the die and a quick return movement.

The blank upon which a thread is to be rolled is inserted horizontally in a gap between the dies at the top and against the end of gage *G* at the rear. Then the starter *H* which derives movement from cam *J* on the main shaft, pushes the blank between the dies at the right moment, after which the downward motion of the moving die causes the blank to roll between the dies until it drops out at the lower end with a complete thread formed on it. In order to reduce friction and wear to a minimum, the movable slide is backed by a train of hardened steel rollers *K*. The frame carrying these rollers is moved up and down by the double rack and pinion mechanism shown at *L*. The machine is driven by a belt operating on the flywheel pulley *M* which drives the crankshaft through pinion *N* and gear *O*. This flywheel is not positively connected to its shaft but drives through frictional surfaces which act as a safety relieving device for the machine. For instance, if the dies should become loose through neglect on the part of the operator or the machine should stall as the result of some accident, the flywheel would slip between the friction flanges and thus dissipate its excess energy so as to avoid damaging the parts of the machine. A lubricating pump *P* connecting with the oil reservoir *Q* keeps the dies flooded continually with oil, thus removing scale and dirt from the grooves in the die faces.

Rotary Thread-rolling Machine

The rotary thread-rolling machine made by the Acme Machinery Co., Cleveland, Ohio, differs radically in its design from the types previously described. This rotary machine, which is illustrated in Fig. 19, is so called because one of the dies revolves continuously in one direction. This revolving

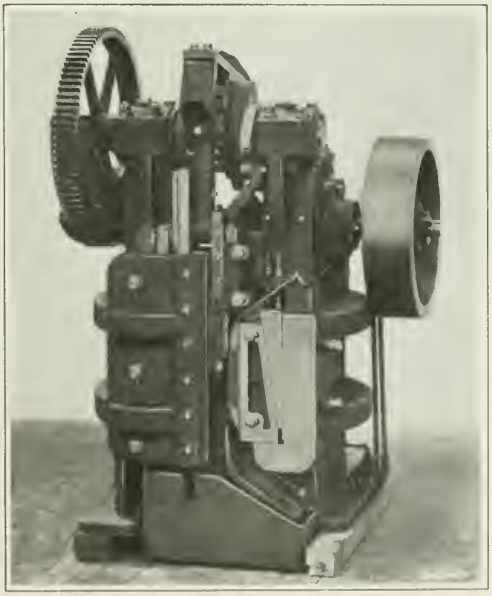

Fig. 17. Vertical Type of Thread-rolling Machine

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[1] Associate Editor of MACHINERY.

die is cylindrical, forming a complete circle, whereas the other die is the segment of a circle. The segment-shaped die remains stationary. The part upon which a thread is being rolled passes between the revolving die and the fixed die. The adjustment of the distance between the two dies for securing diameter variations is regulated by means of the handwheels shown. The segment-shaped die is carried by a heavy casting that is eccentric with the shaft. By loosening one of the handwheels and tightening the other, the segmental die is advanced toward or withdrawn from the circular die. The bolt or other part to be threaded is placed in a holder and the operator, by moving a handle, moves the work forward to a point where it is caught between the dies. As soon as the thread-rolling operation begins, the carriage or holder drops back into the feeding position. There are four opportunities for feeding a blank between the dies for each revolution.

A number of advantages are claimed for the rotary type of machine. In the first place, the bolt or rod is fed into the machine while in a horizontal position, so that long rods such as are required for car trusses, bridges, etc., can be threaded with this machine. Other advantages claimed by the manufacturer are as follows: The massive compact construction adapts the machine for rolling larger sizes than has generally been considered possible heretofore. The machine is exceptionally durable because it has a rotary motion constantly in one direction, and for that reason runs much easier and will last longer than a machine having a reciprocating motion. The circular dies are more durable than straight or flat dies because when a bolt is rolled between two flat dies the rolling process always begins at the same point, but with circular dies the bolt enters and the rolling begins at different points; consequently, the breaking-down process or the beginning of the thread-rolling operation is not confined to one particular place on the dies, the result being that the wear is general and uniform over the entire die surface. A further advantage is claimed in regard to the speed of the machine, the contention being that there are four chances in each revolution for feeding a blank, so that the machine does not need to run nearly as fast as when there is but one opportunity to feed a blank for each revolution. At the rear of the main spindle of this rotary machine there are two spiral springs and means for putting them in tension. This is regarded as an important feature, because it keeps the round die in pitch with the segmental die and at the same time provides a certain amount of elasticity for the shaft.

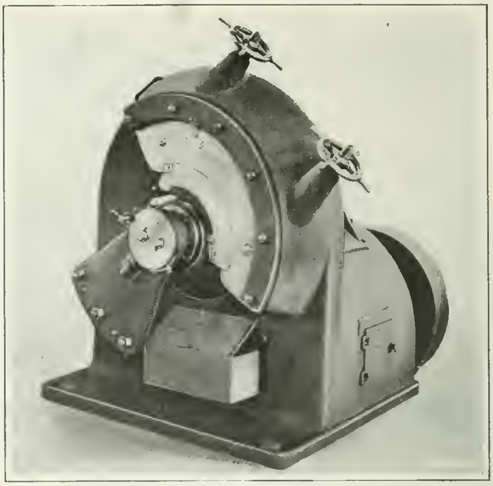


Fig. 19. Rotary Type of Thread-rolling Machine

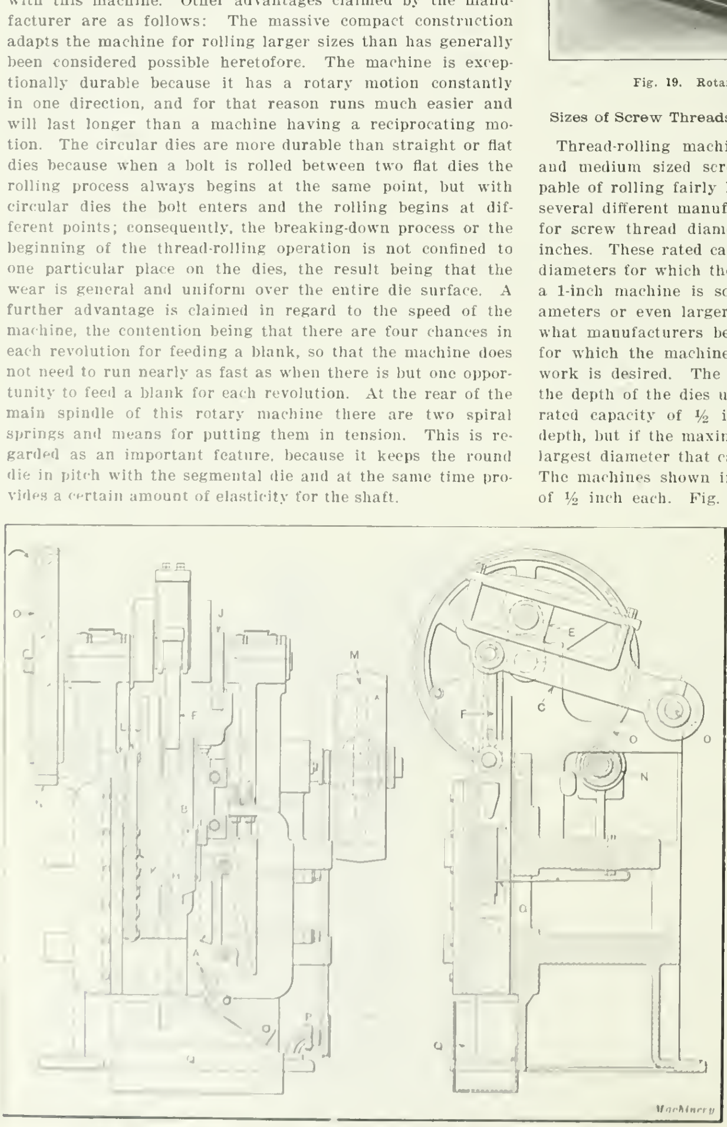


Fig. 18. Front Elevation and Sectional View of Vertical Machine shown in Fig. 17

Sizes of Screw Threads for which Rolling Process is Adapted

Thread-rolling machines are especially adapted for small and medium sized screws, although some machines are capable of rolling fairly large threads. The machines listed by several different manufacturers have nominal rated capacities for screw thread diameters varying from 1/16 inch up to 2 inches. These rated capacities do not represent the maximum diameters for which the machines can be used. For instance, a 1-inch machine is sometimes used for rolling 1¼-inch diameters or even larger sizes. The rated capacity represents what manufacturers believe to be the largest size of thread for which the machine should be used if the best grade of work is desired. The maximum diameter may depend upon the depth of the dies used. For example, if a machine has a rated capacity of ½ inch, this applies to dies of standard depth, but if the maximum-depth dies are used, naturally the largest diameter that can be rolled is diminished accordingly. The machines shown in Figs. 4 and 5 have a rated capacity of ½ inch each. Fig. 7 shows a ⅜-inch size, and Fig. 11 a ¼-inch size. The vertical machine illustrated in Fig. 17 has a rated capacity of 1 inch. This same design is also made in 1½- and 2-inch sizes. The rotary machine shown in Fig. 19 is made in ½-, 1-, and 2-inch sizes.

An interesting type of thread-rolling machine, made by the Waterbury Farrel Foundry & Machine Co. for rolling threads on very small blanks having short shanks is illustrated in Fig. 22. The rated capacity of this machine is 1/16 inch. The important feature of the design is that the die faces are located at right angles to the chute of the automatic feed mechanism, so that the blanks enter between the dies at the lower end without changing from the inclined position in which they lie in the feed chute to a vertical position. With the ordinary arrangement, it is necessary for the blanks to assume a vertical position after leaving the feed chute, because the die faces are vertical instead of being inclined. By locating the dies in the inclined position, short and very small blanks may be fed automati-

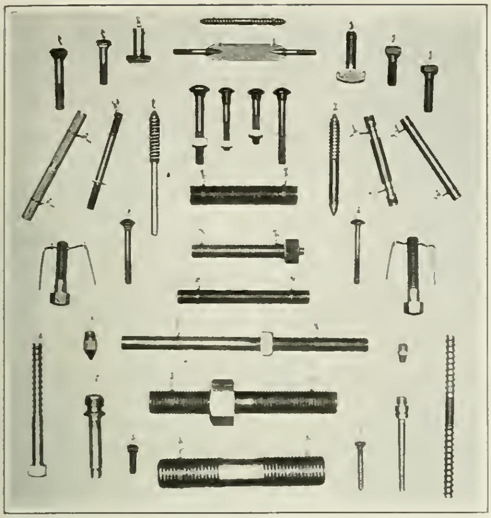


Fig. 20. Miscellaneous Examples of Rolled Screw Threads

cally, and it is not necessary to use a separator or cut-off blade at the foot of the chute, thus simplifying the construction. The pick-up blade in the hopper is provided with a groove or channel along its top instead of a slot for handling the short blanks.

Time Required for Rolling Screw Threads

The time required for rolling screw threads, or the rate of production, varies greatly for machines of different sizes. For instance, the machine shown in Fig. 22, which has a rated capacity of 1/16 inch, is capable of threading screws at the rate of 125 per minute, whereas a 1-inch machine of the same make will roll threads on about 30 pieces per minute. In a general way, these figures represent approximately the maximum and minimum rates of production for thread-rolling machines, the rate of production increasing as the size of the machine decreases. For instance, a 1/4-inch machine may roll 70 or 80 screw threads per minute; a 1/2-inch machine, 45 or 50 per minute; and a 3/4-inch machine, about 35 per minute. A comparison of these figures with the rates of production attained by other methods of forming screw threads will indicate the superiority of the thread-rolling machine for work within its range.

Advantages and Range of Thread-rolling Process

The principal advantage of the thread-rolling process is that it is the most rapid and economical method of forming screw threads, assuming that the work is suitable for a thread-rolling machine. Thread-rolling machines are used extensively for threading machine screws and various forms of special screws, track bolts and numerous other bolts, wood screws, lag screws, slender wires in a great variety of lengths and sizes requiring long or short threads and, in general, almost all small and medium-sized screws and bolts which are required in quantities large enough to warrant the use of a thread-rolling machine. Aside from the speed or efficiency of the thread-rolling process, one of the important advantages claimed for rolled screw threads is their strength as compared with threads formed by cutting. Extensive experiments conducted at one of the leading universities showed that the average rolled thread that was tested had an elastic limit 13 per cent higher than the elastic limit of a cut thread of corresponding size and material. The following explanation of the comparative effects of the rolling and cutting processes on the elastic limit and ultimate tensile strength of screw threads is given by the E. J. Manville Machine Co.

> In rolled or drawn round stock, the fiber or grain of the steel is usually parallel with its axis, its weakest section being at the center of the rod. The outside section of cold-rolled or drawn steel acts as a cover for the inner fibers and preserves the strain developed during the process of drawing or rolling to size. To cut into this wall or outside covering it is apparent that the strain within is somewhat released by cutting the threads, which tends to sever the fibers, and therefore the threaded part of a piece of drawn or rolled steel is of lower tensile strength than the unthreaded portion. In rolling threads on the same material, the blank is subjected to very severe treatment in the operation of cold-forging, which produces a weaving or crimping of the fibers within, thus adding strength and toughness to the material. It is therefore evident in a comparative test of two threaded pieces of the same size and material that the rolled thread blank is invariably of higher tensile strength than the cut thread.

Another advantage of the rolling process which may be of considerable importance in some cases is that no stock is wasted as when a thread is cut, because a blank smaller in diameter than the required screw thread is used when the thread is formed by rolling. The surface of a rolled thread is also harder than the surface of one which is cut, especially if the outer part of the stock has a scale which is rolled into the thread, thus making the surface harder and better able to withstand wear.

A general idea of the range of work which can be threaded to advantage by the rolling process is indicated in Figs. 20 and 21, which show a variety of samples of different shapes, lengths, and diameters. These views illustrate small watch and clock screws, machine screws of various sizes, wood screws, lag screws, studs of small and large sizes, and examples of special work. While thread-rolling machines are designed primarily for producing screw threads, they may be used to advantage in some cases for knurling, lettering, marking, grooving, and even for such operations as forming the teeth of small pinions. When these special operations are performed, the machine must, of course, be equipped with suitable dies. While thread-rolling machines are used principally for threading the ordinary commercial quality of screws,

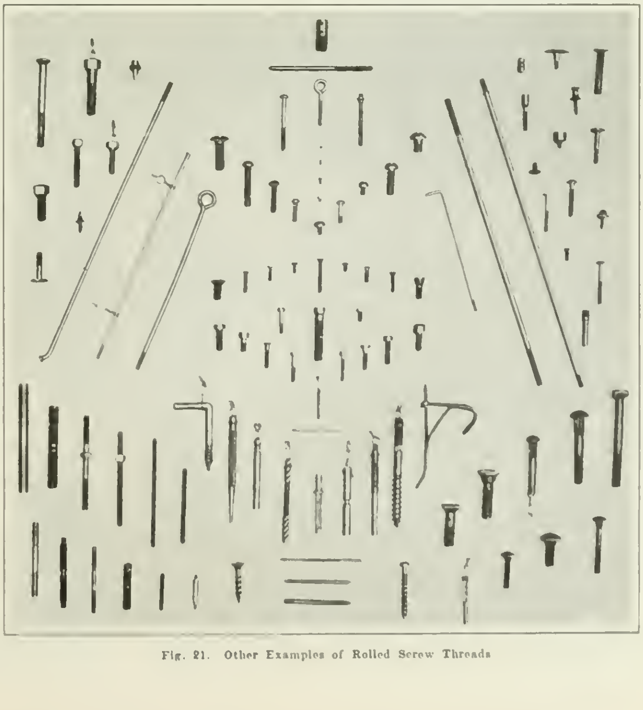


Fig. 21. Other Examples of Rolled Screw Threads

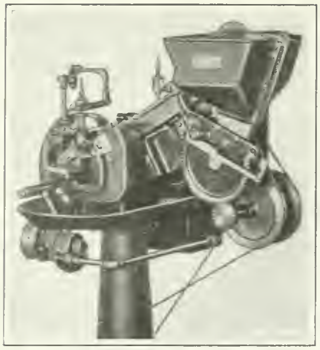


Fig. 22. Machine of Reciprocating Type designed for Very Small Work

bolts, studs, etc., accurate screw threads may be produced by the rolling process, which has even been employed for making screws used for micrometers.

Blanks for Machine Screws

When the threads of machine screws are to extend close to the head as illustrated at *A*, Fig. 24, the screw blank *B* is simply made to whatever diameter will enable a thread of the required size to be produced by the rolling process. If the body of the machine screw is to be threaded only part way, which is the usual practice, the finished screw will appear as illustrated at *C*, provided the form of blank shown at *B* is used. The thread in this case is larger in diameter than the unthreaded body of the screw simply because the upper section of a rolled thread is formed by forcing the metal above the original surface of the blank as explained previously. While the form of screw shown at *C* may be used for many purposes, it is objectionable for some classes of work, and in such cases it is necessary to make the body of the screw full size between the head and the threaded portion. The form of blank shown at *D* may be used to secure a body having the same outside diameter as the screw thread. A modification of blank *D* is shown at *E* and the threaded screw at *F*. In this case there is simply a short bearing surface beneath the head, which is full size or as large in diameter as the threaded part. While a machine screw of this kind is inferior to the form obtained with blank *D* for general use, it may be satisfactory in some cases and has the advantage of being easier to produce in the header.

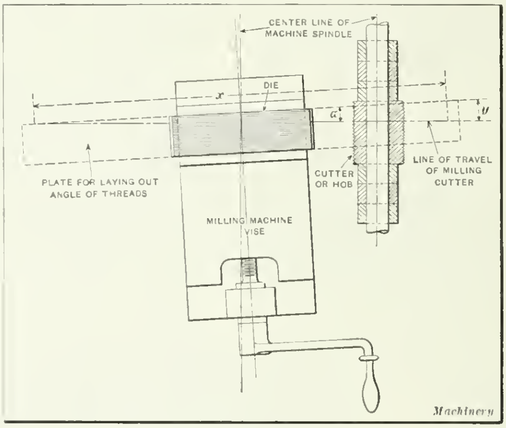

CENTER LINE OF MACHINE SPINDLE
DIE
x
a
y
PLATE FOR LAYING OUT ANGLE OF THREADS
CUTTER OR HOB
LINE OF TRAVEL OF MILLING CUTTER
MILLING MACHINE VISE
Machinery

Fig. 23. Plan View illustrating how Teeth of Flat Thread-rolling Dies are milled

Stock for Thread Rolling

The stock suitable for thread rolling is soft steel, and may contain from about 0.07 to 0.12 per cent carbon. Iron of ordinary quality is not adapted for the thread-rolling process because of its fibrous structure, which makes it likely to split or fracture as the result of the pressure due to thread rolling. According to the E. J. Manville Machine Co., a "liquor-finish" soft steel wire is the stock to use for obtaining the best results with a minimum of wear on both the header and thread-rolling dies. A good grade of annealed and cleaned wire is recommended if the liquor-finished wire cannot be obtained. The stock recommended by the Waterbury Farrel Foundry & Machine Co. is of the following composition: carbon, 0.08 to 0.12 per cent; manganese, 0.35 to 0.45 per cent; phosphorus, 0.03 to 0.04 per cent, sulphur, 0.03 to 0.04 per cent. This material has a tensile strength of about 56,000 pounds per square inch.

Making Flat Thread-rolling Dies

The grooves in the rolling faces of flat dies may be either planed or milled. A simple method is to plane one groove at a time in a shaper. The tool should be shaped on the cutting end to conform to the cross-sectional shape of groove required, and the distance between each groove is made equal to the pitch of the thread. While the dies can be made in this way, it is preferable to mill the grooves by using a milling machine equipped with a multiple cutter. The form of cutter or "hob" commonly used has teeth which are relieved like a form milling cutter and are not helical like the teeth of a tap, but arranged in annular or parallel rows that are perpendicular to the cutter axis. When the parallel grooves are being milled in the face of a die, the latter must be inclined relative to the cutter, so that the angle a, Fig. 23, of the groove will correspond to the helix angle of the screw thread at the pitch diameter. This angle depends, of course, upon the diameter of the thread and its pitch. The tangent of this angle equals the pitch of the thread divided by the circumference of the blank to be threaded which corresponds approximately to the pitch circumference of the screw.

The angle may also be determined without calculation in the following manner: Multiply the circumference of the blank to be threaded by any number that will give a product equal to approximately three times the length of the die and lay off this distance x, Fig. 23, along the edge of a parallel strip or plate which is clamped in the machine vise. The outline of this parallel strip is indicated by the dotted lines in the illustration. The pitch of the thread is next multiplied by the number previously used to obtain dimension x, and a dimension y equal to the product is laid off at right angles to the parallel strip. A diagonal line connecting the points located in this way will represent the angle a to which the milling machine vise should be set. By traversing the diagonal line past the sharp end of a pointer clamped to the cutter-arbor, the angular adjustment may easily be made. The reason for increasing dimensions x and y as previously explained is to reduce by one-third any error of the angle. If the die is wider than the cutter, the entire face of the die may be milled by simply taking two cuts across it. When the die is milled in this way, it is, of course, essential after taking one cut across the die face to match accurately the milling cutter with the grooves previously machined.

The teeth of the dies used for rolling U. S. standard threads, V-threads, or Whitworth threads have a uniform cross-sectional shape from one end of the die to the other, with the possible exception of a short length near the ends which is relieved. This relief is provided at the ends so that the work will roll off the die without being marked by the corner. The teeth of dies intended for rolling square threads or those of special form, such as are found on large screws, are not of uniform cross-sectional shape, but are made V-shaped at the starting end so that the formation of the thread groove is gradual. If dies for rolling threads of the classes referred to

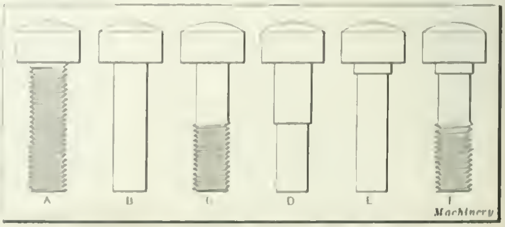


Fig. 24. Three Methods of making Blanks for Machine Screws

were made with teeth of uniform section throughout their length, the flat tops of the teeth would tend to compress the metal inward in a radial direction, instead of displacing it to form a thread, and the blank would be elongated in rolling.

The accuracy of a rolled thread depends largely upon the accuracy of the die and the cross-sectional shape of its teeth. The included angle of the teeth is one of the essential points. This angle should be somewhat less than the included angle of the thread to be rolled. For instance, dies for rolling U. S. standard threads should have teeth with an included angle of about 58½ degrees instead of 60 degrees, in order to produce a 60-degree rolled thread. This reduced angle is necessary on account of the elasticity in the stock, the effect of which is to cause the lower part of a rolled thread to spring back slightly after leaving the die, thus increasing the angle so that it is 1 or 1½ degree larger than the angle of the die teeth.

Thread Rolling in Screw Machine

The circular threading roll or disk that is used when threads are rolled in an automatic screw machine or turret lathe has a thread on its edge or periphery which corresponds in shape and pitch with the thread to be rolled, and this roll is forced against the screw blank while the latter is revolving. Fig. 25 illustrates how a circular roll may be applied. The unthreaded blank is held in the machine chuck and revolves about its axis. In screw machine practice, the threading roll *A* is usually mounted in a holder attached to the cross-slide of the machine. The roll is mounted on a pin or bolt so that it is free to revolve when brought into contact with the rotating piece to be threaded. A thread is reproduced on the work when the roll is forced against it with sufficient pressure to leave an impression of the thread on the roll.

The roll may be presented to the work in either a tangential direction as illustrated at *C*, or radially as shown at *D*. A satisfactory thread may be rolled in either way. When the roll is applied as shown at *C*, it gradually comes into contact with the periphery of the work and completes the thread as it passes across the blank surface in the direction indicated by the arrow. When the roll is presented in this way, the threaded piece should be cut off from the bar of stock before the roll is returned to its starting position to prevent injury to the finished thread. This is done by simply mounting a cutting-off tool on the cross-slide in such a position that it severs the finished piece after the thread is rolled. The cam operating the cross-slide is arranged to move the roll inward quickly until it is nearly in contact with the surface of the blank; the cross-slide and roll are then given a slow feeding movement usually varying from about 0.002 to 0.004 inch per revolution of the work, while the roll is moving a distance x from the point of contact to the central position. The roll is then moved rapidly past the work in order to bring the cutting-off tool into position.

When the roll is in a radial position, as illustrated at *D*, it is simply forced against one side of the work until a complete thread is formed, the roll and work rotating together the same as two gears in mesh. Some roll-holders, instead of being held rigidly, are carried by a swinging arm which receives its motion from some form of cam. The exact method of applying the roll to the work and of holding it in position may depend to some extent upon the relation between the thread-rolling operation and other machining operations.

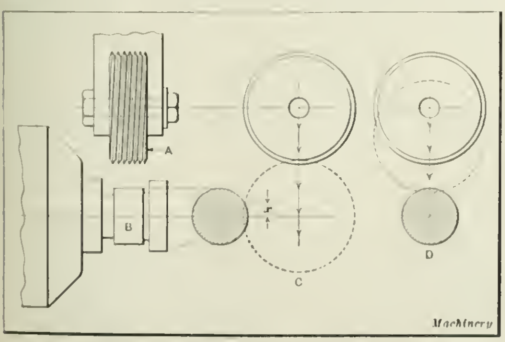


Fig. 25. Methods of rolling Screw Threads on Automatic Screw Machines

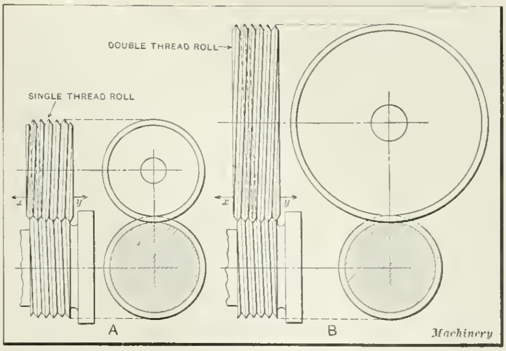


Fig. 26. (A) Threading Roll and Screw Thread of approximately the Same Diameter. (B) Threading Roll nearly Twice as Large in Diameter as Screw Thread

Diameter of Threading Roll

The diameter of the threading roll may be about the same as the diameter of the screw thread it is intended to roll, or some multiple of the screw thread diameter. If the thread to be rolled is larger in diameter than, say, ¾ inch, a roll may be used which is approximately equal to the diameter of the work, but if the required screw thread is much less than ¾ inch in diameter, the roll may be made twice as large or some multiple of the screw diameter. When the roll and the screw thread are about the same diameter, they are practically alike so far as pitch and diameter of the thread are concerned. For instance, the roll for a ¾-inch screw thread might also be ¾ inch minus a slight amount in order to obtain a better rolling action, as explained later. If the screw thread to be rolled were ½ inch in diameter, the roll might be two or three times as large.

Whatever the relation between the size of the screw thread and the roll, it is essential to use a roll having threads that mesh with or follow the threads on the work as the two revolve together. This means that the roll thread must have the same pitch as the screw thread and about the same helix angle. Now when the diameters of the threads on the roll and the work are practically duplicates, the roll for a ¾-inch single screw thread would also have a single thread as shown at *A*, Fig. 26. If the roll is twice as large as the screw, it cannot have a single thread because, for a given pitch, any increase of the roll diameter reduces the angle between the thread and a plane perpendicular to the axis; therefore, if the diameter of the roll is made twice as large as the screw thread, it is necessary to use a roll having a double thread as illustrated at *B*, instead of a single thread. The pitch of the double thread remains the same, but since the lead equals twice the pitch, the helix angle of the thread is the same as for a single thread of one-half the diameter. If a roll three times the size of the screw thread were used, it would require a triple thread, and so on.

If we assume that a roll is used having the same diameter as the thread after rolling, it will rotate at a slower rate than the work at the beginning of the rolling operation because the roll is larger than the unthreaded screw blank and is driven by the blank. As the roll sinks into the blank, its speed gradually increases until, under ideal conditions, the speed is practically the same as that of the thread being rolled. It has been found in practice that better results are obtained when a roll is used that is slightly smaller in diameter than the diameter of the screw thread to be rolled. For instance, if the work has a ¾-inch U. S. standard thread, a single-threaded roll used for this operation might have a diameter of, say, 0.660 inch instead of 0.750 inch. If a larger roll having a double thread were used, its diameter would equal 2 × 0.660 = 1.32 inch instead of 1.50 inch.

The reason for decreasing the diameter of the roll will be more apparent by considering the action of the roll and screw thread when a thread is being formed. As previously mentioned, the roll rotates at a slower speed than the screw blank, especially when the rolling operation begins, because the outside diameter of the roll is in contact with the plain blank, which is about as large as the pitch diameter of the screw. As the rolling of the thread progresses, the roll speed might increase until it was practically the same as the work speed, but on account of frictional resistance between the roll and its holder, the natural tendency is for the roll to lag behind the screw thread. Now any retardation of the roll causes an increase of frictional resistance and the final result may be that the roll speed decreases to such an extent that it no longer meshes with the screw thread properly and, consequently, the thread is marred or spoiled.

The action between the roll and the screw thread will be more apparent by referring to Fig. 26. When the roll lags behind, the more rapidly revolving work, acting as a screw, forces the roll over against the side of the holder, as indicated by arrow x. The resulting increase of frictional resistance causes the roll to revolve still slower. On the contrary, if the roll is a little smaller in diameter than the work, so that it rotates faster, the roll tends to move in the opposite direction, as indicated by the arrow y. If this movement occurs and the roll presses against the side of the holder, thus increasing the frictional resistance, this tends to reduce the speed and cause the roll and work to rotate together properly; consequently, with the roll running a little faster than the screw, any difficulty from side thrust is cared for automatically because then the driven roll tends to move axially in a direction opposite to that in which the screw thread on the work would naturally force it.

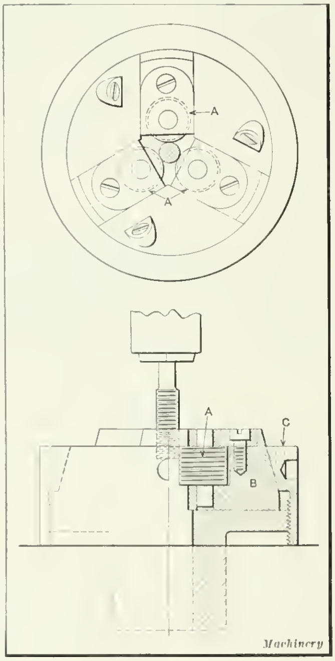


Fig. 27. Rolling Tool for finishing Threads on Taps

Calculating Threading Roll Diameter

The outside diameter of the threading roll may be determined by the following rule: Multiply the depth of a single thread (corresponding to the pitch of the thread to be rolled) by 1.25; subtract the product from the outside diameter of the required thread, and multiply the difference by the number of threads or "starts" on the thread roll. This rule is embodied in the following formula, in which R = outside diameter of roll; N = number of starts or threads on roll; S = outside diameter of finished screw thread; and D = depth of a single thread:

$$R = N(S - 1.25D) \qquad (1)$$

To illustrate the application of the rule and formula, suppose a roll is required for a ⅝-inch U. S. standard thread. Then $S = 0.625$ inch and $D = 0.059$ inch. $0.625 - 1.25 \times 0.059 = 0.5513$ inch, which would represent the diameter of the roll if it were made with a single thread. Such a roll, however, would be too small and the diameter would probably be doubled, which would make it necessary to use a roll having a double screw thread. In that case, diameter $R = 2 \times (0.625 - 1.25 \times 0.059) = 2 \times 0.5513 = 1.100$ inch, approximately.

The following method of determining the roll diameter has been used successfully by a prominent manufacturer of automatic screw machines. *Rule:* Determine the pitch diameter of the thread to be rolled and deduct from it one sixth of the double depth of the thread, then use the constant thus obtained as a multiple for determining the pitch diameter of the thread roll. Ordinarily, the roll would be two, three, or four times the diameter of the screw thread and have either a double, triple, or quadruple thread in order to secure the proper thread helix angle. Expressing the preceding rule as a formula,

$$P = M\left(D - \frac{T}{6}\right) \qquad (2)$$

in which, P = pitch diameter of thread roll;
M = multiple selected with reference to approximate diameter of roll desired (this number also equals the number of threads on the roll);
D = pitch diameter of screw thread;
T = double depth of thread.

Kind of Thread on Roll

The thread or threads on the roll should be left-hand for rolling a right-hand thread, and *vice versa*, so that the thread on the roll and work will incline in the same direction at the point of contact. The roll should also be wide enough to overlap the section to be threaded, provided the latter is necked or turned down at the ends to provide a clearance space, which should be done if possible. The thread on the roll should be sharp on the top for rolling U. S. standard threads as well as V-threads. If the roll thread is made flat, the blunt edge will require too much pressure to force it into the metal and will not produce as smooth a thread. While a roll made in this way will not form a correct U. S. standard thread, the fact that the thread has a sharp bottom, instead of the standard flat form, may be of little importance as compared with the advantages of the rolling process. The bottom of the thread groove on the roll may also be left sharp or it may have a flat, some rolls being made one way and some the other. If the thread groove is sharp in the bottom, the roll is sunk only far enough into the blank to form a thread having a flat top. Some contend that it is preferable to have a flat at the bottom of the threading roll groove in order to roll down the top of the thread and thus obtain a smoother edge or surface.

The ends of the roll should be beveled to an angle of about 45 degrees so that the thread or threads will not chip or break out when rolling a thread. Incidentally, the threads on rolls are usually finished by lapping after hardening in order to make them smooth. As the roll is simply driven by frictional contact with the work, it is essential to reduce the frictional resistance of the roll-holder as far as possible. The pin upon which the roll revolves should be only slightly larger than is necessary to reduce the shearing strain when rolling a thread. For instance, a ½-inch hole in a thread roll 1 inch in diameter might cause considerable trouble owing to the frictional resistance, whereas, a hole ⅜ inch in diameter might prevent trouble resulting from lagging or retardation of the roll.

Finishing Tap Threads by Rolling

The rolling process has been applied to the manufacture of taps for finishing tap threads, although the method to be described has not been satisfactory for all classes of work. The tap thread is first cut to approximately the required shape and size, and then the tap is passed between rollers which compress the metal and give the thread the correct form. The advantage claimed for this finish-rolling process is that it increases the density and hardness of the thread, with the result that a rolled tap will resist wear considerably better than a tap which is finished by a cutting tool. Some contend that small taps having rolled threads are five times as durable as those with cut threads.

The tool used for rough-forming the tap threads prior to rolling has an angle of 57 degrees for a U. S. standard thread and 53 degrees for a Whitworth thread, and the annular ridges on the rolls have an included angle of from 60½ to 61 degrees for a U. S. standard thread and from 55½ to 56 degrees for a Whitworth thread. This increase in the angle of the roll is necessary in order to obtain a 60-degree angle on the tap, when the roughly formed thread is 2 or 3 degrees less than the standard. The object of cutting the thread to this decreased angle is to obtain an increasing degree of compression of the metal from the root to the top of the thread. Owing to the elasticity of the stock, the thread roll has a greater angle than the standard thread angle to compensate for the slight expansion or springing back of the metal after the rolling pressure is released.

The outside of the rough-threaded blank is somewhat under the standard size, the amount depending upon the pitch of the thread and the diameter of the tap. For instance, a 1/2-inch tap would be rolled from a blank having an outside diameter of 0.488 inch. A roughly formed Whitworth thread has a round root, but the crest or top of the thread is left flat. The crest is rounded to the standard radius by the finishing rolls.

Fig. 27 shows a design of thread-rolling tool that has been used in connection with tap manufacture. There are three rollers *A* located 120 degrees apart. The annular ridges on these rollers are perpendicular to the axis, and not helical like a thread. The rollers are mounted in the same plane, but the ridges on successive rollers are located one-third the pitch in advance, so that they will engage the thread to be rolled. The tool illustrated is provided with adjustable blocks *B* in which the rollers are mounted. These blocks are tapering and are backed up by the taper ring *C*, which provides means of adjusting the rolls radially. The blocks are held in position by binding screws inserted in the front face of the holder at an angle of 45 degrees.

When the rolls engage the point of the rough-threaded tap blank, they roll down the first threads slightly below the full diameter, because, when the entire surface of the rolls are in contact with the tap, there is some springing action and the tap diameter is somewhat larger as the result. When the taps are made in sets of three, the rolling process may be applied to "taper" and "plug" taps, but is not satisfactory for the "bottoming" tap, because of the taper rolling at the end. In the case of the taper and plug taps, however, the threads at the end are relieved at the top to such an extent that the slight taper caused by rolling is of no account.

* * *

EXCESSIVE LABOR TURNOVER

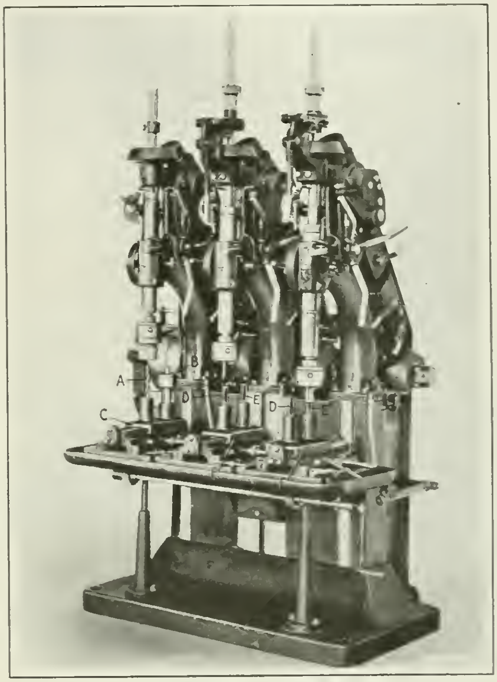
It has been estimated that of the 7,000,000 men composing the industrial labor force of the United States, one-half change their places of employment at least once each year. This constant changing annually costs our industries $140,000,000, if not many times this sum, for it costs from $30 to $200 to train a new man, depending on the nature of the work to be done and the industry, or an average of from 1.5 to 2.5 per cent of the pay roll. In addition, figures gathered from the iron and steel trades by the United States Department of Labor show that of 1000 employes with six months' experience 111.3 are injured while only 42.4 out of 1000 are injured of those having from three to five years' experience. Much money might be saved by eliminating the necessity of discharging labor during slack seasons. In Europe, good results have been obtained by using the quiet season in the home market for manufacturing for foreign trade; the changing seasons of the southern hemisphere bring orders to Europe just at the time when business becomes dull at home.

* * *

American manufacturers planning to enter the Central or South American markets should patent their articles and register their trademarks in each country that they desire to enter before beginning their sales campaign. As a convenience to such persons, the Bureau of Foreign and Domestic Commerce has prepared a list of attorneys in the various countries of Latin America who are qualified to attend to such matters.

DRILLING, FACING, AND TAPPING STUDS

Efficient results are being obtained in drilling and tapping a hole in steel studs and facing the surface around the tapped hole, through the use of a three-spindle 20-inch all-geared drilling machine built by the Barnes Drill Co., of Rockford, Ill., which is tooled up as shown in the accompanying illustration. Here it will be seen that advantage is taken of the inverted principle, the work being rotated in chucks mounted on the drilling machine spindle and fed down onto the top of inverted tools, so that the chips will be readily cleared from the work through the action of gravity. It will be seen that under the left-hand spindle there are a drill *A* and facing tool *B*, which are brought successively into position under the spindle by means of a sliding fixture *C*, which is provided with limit stops to locate either tool. A positive depth stop on the spindle controls the facing operation. The work is fed down onto the tool by the regular feed on the machine, and after the drilling and facing operations have been completed, the work is transferred to either of the other two spindles, where it is held in the three-jaw chuck with which each of these spindles is provided. Under each of these spindles there are a roughing tap *D* and a finishing tap *E* carried on a sliding fixture *F*, so that the tapping operation may be completed by first roughing and then finishing the thread, the lead being governed by a positive leading device on the spindle. With an outfit of this kind, the operator has plenty to do to keep all of the spindles on the machine constantly employed. E. K. H.



Barnes All-geared Drilling Machine tooled up for drilling, facing, and tapping Studs

* * *

The following definition of an eccentric, applied by a lawyer arguing an engineering case before the court, may not be mathematically correct, but it is a fairly good description. The lawyer, having repeatedly referred to an eccentric, the judge at length asked him what an eccentric was; he said he was familiar with the term as applied to individuals, but not as applied to a part of a machine. The lawyer defined it as follows: "An eccentric," he said, "is a circular disk whose center is not in the middle."

STEEL TESTS USED BY WORKMEN[1]

Among the various ways of judging the quality of steel, the most common are: trade or quality stencil marks, labels pasted on the bars, bars painted different colors, general shape of the material, appearance of surface, heft or weight, ring or tone of metal when dropped, feeling, intuition, smell, fracture test, fire and water test, service test, and spark test.

The first two are the most dependable methods, except that if the steel is kept in a damp place, the labels will drop off in the course of time due to rust. The third method is dependable if a general scheme of colors is used for the different brands of steel and the system is intelligently applied. There is, however, in many factories extreme carelessness and indifference in the painting of valuable stock; in one factory seven grades of steel were painted one color.

Many workmen select steel by its general shape; for instance, a hexagon section will represent screw stock and an octagon section will indicate cold chisel steel. But this method of selecting should not be tolerated, because steel can be manufactured into any form or shape desired, except stellite, which is cast into form. It may surprise some engineers to learn that many tool steels are selected by the appearance of the surface. If the bars are smooth and have sharp corners, it is evidence to the workmen of first-class steel. Without other evidence, expensive labor is put upon the tool and usually only when hardening is the mistake discovered. Smooth surfaces and sharp corners indicate work at low temperatures, while rough surfaces and round corners are caused by an iron oxide scale when the metal is laid down at high temperature; therefore, the appearance of the surface does not indicate the quality or composition of the metal.

Many workmen, not satisfied by the shape, appearance and weight, drop the metal on a hard floor or a heavy piece of iron; if the ring is a sharp tone, the metal is thought to be a good quality of steel. The finer the grain, the more homogeneous the structure, and the harder the metal, the sharper is the tone. These qualities are developed by elements in the metal, by working, and by heat-treating at a moderately low temperature. On the other hand, wrought iron will emit a dull tone, owing to the presence of about 2 per cent of slag and the usual methods of working such metal at a high temperature. This method is not reliable or dependable, because work and heat-treatment will affect the tones emitted when the material is struck or dropped.

It is surprising how many expert toolmen will select metal by intuition; and because of their opinion they work the tool into shape regardless of any indication in its cutting properties that the metal may be undesirable. Their mistake is usually discovered when attempting to harden the metal or when putting it into service. It is said that in the southern part of the state a man nicks a bar of stock with a cold chisel, breaks it in two, and immediately smells the fracture, claiming that a good quality of steel smells like ammonia. There is no ammonia in steel. Many of the tests used by workmen are just as reliable.

The fracture test does not represent the true quality of metal, but rather indicates the last heating operation to which the metal was subjected. A fracture that has a coarse granular appearance may not mean that the material is of inferior quality, but that it was laid down at a high heat and the crystals retained the size corresponding to that heat. There are exceptions to this rule, however, for many of the elements in alloy steels prevent or retard crystallization at high temperature. High-speed steel shows an unusually fine grain after being heated to 2250 degrees F.; on the other hand, carbon tool steel heated to its critical temperature and immediately quenched shows a fine silky structure, and it is doubtful if the average mechanic is able to distinguish these metals when they are placed together for comparison. If a small piece of carbon tool steel is heated to just above its critical temperature, about 1450 degrees F., known as a dark cherry red, and immediately quenched in water, it will be hard enough to resist a sharp file, and when fractured, it should show a fine silky structure. If a low or inferior grade of carbon steel is treated in this manner, the surface may be hard enough to resist a file but the fracture will not show a fine structure.

Many workmen as well as the experimental engineer select available material at hand without any determination as to quality, and then put expensive labor upon the part or tool. When finished, it will be tried out in service, and if it fails, something else is tried. Such failures are usually found in the scrap heap. The service test, however, has its advantages if the engineer has a knowledge of the material so tested. This information is invaluable, as it is the combination of successes and failures that gives the empirical knowledge that completes the perfect understanding of theory. A record of the life work of a piece of steel and accurate data are the most powerful tools that an engineer has. Therefore, the scrap heap of failures is the most instructive place about a plant.

The spark method is based on the action of the oxygen of the air on the combustible element present in iron and in many of the alloying elements contained in the different steels, which act explosively when heated to a temperature necessary for combustion. To produce bright sparks as the result of heating finely divided particles of metal, the heat must be intense enough to cause chemical combustion between the oxygen of the air and the particles of metal.

* * *

DEFINITION OF POUNDAL

The expression "poundal" is sometimes used in connection with calculations in mechanics. A good many mechanical handbooks, however, do not define it, because of its limited use. A poundal is a unit of force, and is defined as that force which, acting on a mass of one pound for one second, produces a velocity of one foot per second. A foot-poundal is a unit of energy and is equal to the energy resulting when a force of one poundal acts through a distance of one foot. In order to reduce foot-poundals to foot-pounds, multiply the number of foot-poundals by 0.03108. Dividing the number of foot-poundals by 32.16 (acceleration due to gravity) will also give foot-pounds.

If the well-known formula for energy

$$E = \frac{mv^2}{2} \text{ is written } E = 0.01554mv^2$$

E will be expressed in foot-pounds if m is expressed in pounds and v in feet per second.

When the formula is written in the customary form

$$E = \frac{mv^2}{2}$$

E is in foot-poundals when m is in pounds and v in feet per second. (If in this formula m is in kilograms and v in meters per second, then E will be in joules.)

For metric units the formula may be written as follows:

$$E = 0.00051mv^2$$

in which case, E is expressed in gram-centimeters; m, in grams; and v, in centimeters per second.

If the formula is written

$$E = 0.051mv^2$$

E is in kilogram-meters; m, in kilograms; and v, in meters per second.

These formulas are based upon the standard value of gravity. In the rare cases where a variation in gravity must be considered, the fundamental formula giving E in foot-poundals (or in the absolute system of measurement in joules) must be used.

• • •

The United States now leads the world in the production of ferro-manganese. During the last fiscal year it imported 656,088 gross tons of manganese ore, more than Great Britain ever imported, and had a domestic production of around 80,000 tons. This means a production of 270,000 tons of ferro-manganese in the current year. While it is estimated that 336,000 tons are needed, the shortage can be made up by importations and by a more efficient use of spiegeleisen.

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[1] Abstract from an address by John F. Keller of Purdue University, Ind., delivered in March, 1917 before the Steel Treating Research Society of Detroit, Mich.

SOLENOIDS AND ELECTROMAGNETS

PRINCIPLES, PROPORTIONS, AND APPLICATIONS IN VARIOUS KINDS OF MACHINES

BY CHARLES A. CLARK [1]

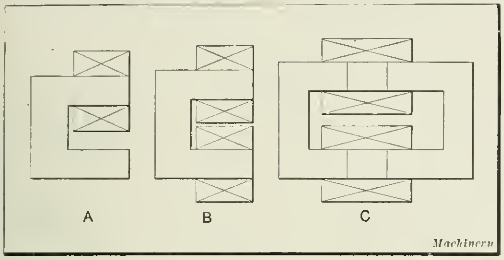

Fig. 1. Simple Types of Electromagnets and Solenoids

SOLENOIDS and electromagnets have been used for years in connection with various kinds of machinery for releasing brakes, actuating clutches, operating valves, shifting gears, controlling the operation of motors, etc. Electromagnets may be of the horseshoe type with one coil, shown at *A*, Fig. 1, or of the horseshoe type with two coils, as shown at *B*. Solenoids, also, are magnets in a general sense and to all intents and purposes. One type has a yoke with two projecting pole pieces that extend into the upper ends of the coils, as shown at *C*, and a pair of plungers attached to a yoke-shaped piece that enters into the coil when it is electrified. This coil is generally termed the armature. The second type, shown in section in Fig. 2, has no projecting pole pieces extending into the upper ends of the coils. Here *A* is the fiber coil or spool end; *B*, the coil set-screw; *C*, the cap; *D*, the solenoid cover; *E*, the ventilating ducts; *F*, the coil tube or spool; *G*, the coil; *H*, the air passage; *L*, the solenoid case; *M*, the lead bushing; *N*, the holes for the pivot; and *O*, the slot for the part to be moved.

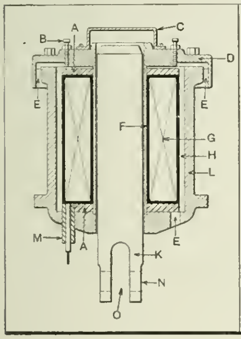

Fig. 2. Section through Solenoid

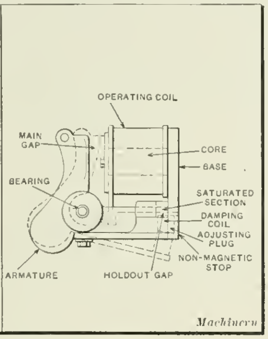

Fig. 3. Contactor Magnet Frame

Electromagnets are used generally where there is a relatively small movement of the armature and a small air gap, such as for operating telephones, electric horns, bells, controller mechanism, automatic switches, etc. They are also used extensively on switchboards of both direct and alternating circuits, and are seen in operation in almost every manufacturing plant. A type commonly used is shown in Fig. 3.

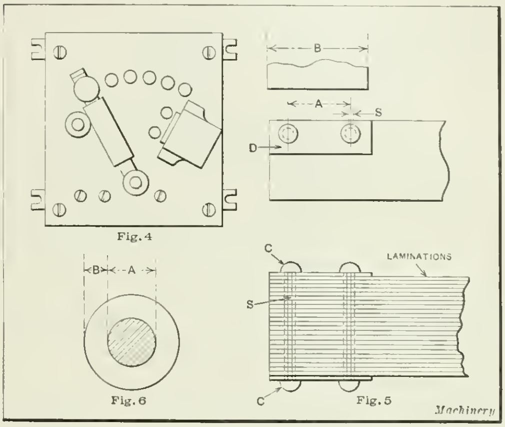

Fig. 4. Starting Rheostat for Direct-current Motors. Fig. 5. Pole Shader. Fig. 6. Section through Magnet Winder

The rheostat for starting direct-current motors, shown in Fig. 4, uses a magnet for holding the switch arm in the running position while the current is on, but when the current is cut off the magnet releases the arm, which is forced back to its off position by a suitable spring. The motor cannot be operated again until the rheostat handle is moved into the running position and held there by the attraction of the magnet. Direct-current magnets have soft iron cores, and their armatures do not require any pole-shading devices like the alternating-current magnets.

The pole shader in an alternating-current magnet is a short-circuiting ring embedded in the pole face to retard the time-phase relation of the magnetic flux within the ring so that

TABLE 1. MAGNETIC QUALITY OF IRON AND STEEL

Magnetic Density per Square Centimeter	Magnetic Density per Square Inch	Sheet Iron, Annealed: Magnetizing Force per Square Centimeter	Sheet Iron, Annealed: Magnetizing Force per Square Inch	Sheet Iron, Annealed: Ampere-turns per Centimeter Length	Sheet Iron, Annealed: Ampere-turns per Inch Length	Sheet Iron, Annealed: Permeability	Cast Steel, Unannealed: Magnetizing Force per Square Centimeter	Cast Steel, Unannealed: Magnetizing Force per Square Inch	Cast Steel, Unannealed: Ampere-turns per Centimeter Length	Cast Steel, Unannealed: Ampere-turns per Inch Length	Cast Steel, Unannealed: Permeability	Wrought-iron Forgings: Magnetizing Force per Square Centimeter	Wrought-iron Forgings: Magnetizing Force per Square Inch	Wrought-iron Forgings: Ampere-turns per Centimeter Length	Wrought-iron Forgings: Ampere-turns per Inch Length	Wrought-iron Forgings: Permeability	Gray Cast Iron: Magnetizing Force per Square Centimeter	Gray Cast Iron: Magnetizing Force per Square Inch	Gray Cast Iron: Ampere-turns per Centimeter Length	Gray Cast Iron: Ampere-turns per Inch Length	Gray Cast Iron: Permeability
1,550	10,000	2.480	16	1.973	5.011	625.0	2.790	18	2.219	5.638	555.5	1.860	12	1.480	3.258	833.3	9.92	64	7.89	20.04	156.3
3,100	20,000	3.565	23	2.836	7.204	869.6	4.340	28	3.452	8.770	714.3	2.325	15	1.850	4.698	1333.3	16.28	105	12.95	32.89	190.5
4,650	30,000	4.310	28	3.452	8.770	1071.4	5.425	35	4.312	10.960	857.1	2.790	18	2.219	5.638	1595.7	25.42	164	20.22	51.36	182.9
6,200	40,000	5.115	33	4.069	10.340	1212.1	6.665	43	5.302	13.470	930.2	3.565	23	2.836	7.204	1739.1	40.61	262	32.30	82.06	152.9
7,750	50,000	6.510	42	5.179	13.150	1190.4	8.370	54	6.658	16.910	925.9	4.650	30	3.699	9.396	1666.6	66.65	430	53.02	139.68	116.3
9,300	60,000	8.215	53	6.535	16.600	1132.0	11 160	72	8.878	22.550	833.3	6.820	44	5.425	13.780	1363.6	112.29	718	88.53	229.49	83.6
10,075	65,000																159.65	1030	127.00	322.60	63.1
10,850	70,000	10.540	68	8.384	21.300	1029.4	15.350	99	10.850	31.010	707.1	10.080	65	8.015	20.360	1076.9					
12,400	80,000	14.570	94	11.590	29.440	851.0	22 630	146	18.000	45.730	547.3	16 120	104	12.820	32.570	769.2					
13,950	90,000	21.390	138	17.020	43.220	652.2	34 880	225	27 740	70.470	100.0	31 000	200	24.660	62.640	450.0					
15,500	100,000	33.170	214	26.390	67.020	467.3	58 130	375	46.240	117 450	266.6	66 650	630	53.020	139.680	232 6					
16,275	105,000											97.650	630	77.680	197.320	166.6					
17,050	110,000	57.970	374	46.110	117.140	294.1	113.150	730	90 010	228 640	150.7	160 450	1035	127 620	324.160	106.3					
17,825	115,000						157.330	1015	125.150	317.900	113.3										
18,600	120,000	112.380	725	89.390	227.070	165.5															
19,375	125,000	166.630	1075	132.520	346.690	116.3															

Machinery

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[1] Address: 2059 Eighth Ave., New York City

there is, at every instant, enough magnetism to hold the magnet closed, as shown in Fig. 5. The area of *A* is two-thirds the area *B* of the pole face. One-eighth-inch brass rivets are shown at *C;* at *D* are the end plates; and at *S* are slots or saw cuts.

One square inch of core surface with 100,000 lines per square inch saturation in an alternating-current magnet with an air gap of 1/8 inch will pull about 140 pounds. The pole face of an alternating-current magnet to have the same pull as a direct-current magnet must have twice the area. The area of the winding *B* of a magnet should be about 59 per cent of the area of the core *A*, as shown in Fig. 6.

Where the magnetic density is not great, it is safe to use cast iron for the cores of an alternating-current magnet, but where the density is high, sheet-iron laminated cores should be used. In all magnets of sixty cycles, where the density is high, transformer iron should be employed. The magnetic density, the magnetizing force, ampere-turns per inch and per centimeter, and permeability of sheet iron, cast steel, wrought-iron forgings, and gray cast iron are given in Table 1.

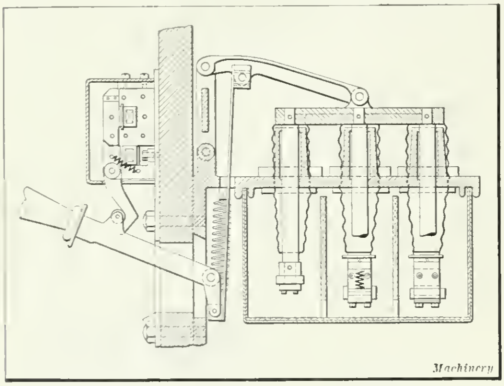


Fig. 7. Oil Switch with No-voltage Release Magnet

Applications of Electromagnets

Fig. 7 shows the application of an alternating-current magnet in holding the handle of a 6600-volt, 200-ampere oil switch in the operating position. The coil is applied to the pole next to the pivot of the armature. There is a relatively small movement of the armature, and a pole shader is placed at the end of the armature. When the armature function is to hold the handle of the mechanism in the running position, both single- and double-coil magnets may be used. One of the many applications of double-coil magnets to pivoted armatures and disks is found in a loud speaking telephone and in the electric horn.

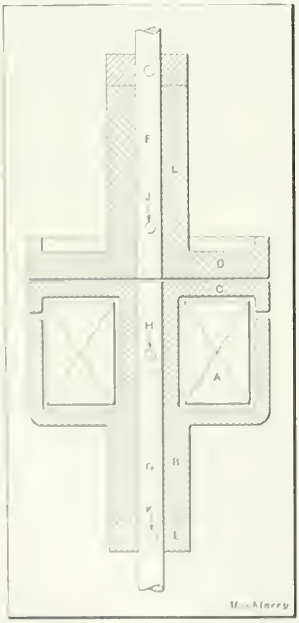


Fig. 8. Magnetic Clutch for Light Work

One of the many uses of the electric magnet in light machine work is shown in Fig. 8, in which a magnet coil is mounted in a fixed case *B*. The core *C* is fastened to a revolving shaft *G* by a pin *H*, and is held in its proper position by a collar *E* fastened to shaft *G* by a pin *K*. Directly opposite core *C* and separated from it by a very small air space is a plate *D* of the same area as the core, having a hub *L* that is pinned to the shaft *F*. The two shafts *G* and *F* are in line. Power is applied continuously to shaft *G*, so that, when it is desired to run shaft *F* with any mechanism, an electric current is applied to the fixed coil *A*, which magnetizes the revolving plate *C*, causing it to attract plate *D* and forcing the latter, with shaft *F*, etc., to revolve, although in reality there is no physical connection between them.

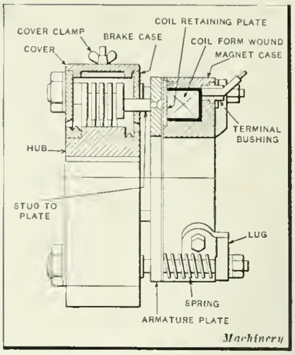


Fig. 9. Magnetic Disk Brake

Another of the uses of the electric magnet is in a magnetic disk brake. The one shown in Fig. 9 consists of a revolving hub carrying plates fastened to it. Below these plates are others connected to an armature plate through the containing case. The armature plates are held against the plates on the revolving hub by springs, one of which is shown, thus retarding and stopping the motion of the hub, but when the electric current is applied to the magnet coil, the armature plates are attracted to the coil and the friction plates are separated as long as the current is applied. These magnetic brakes are used with electrically driven machinery, such as hoists, cranes, ore and coal handling machinery. They are adapted for use when frequent stops and removals are required and when the safety of the machinery depends on the reliability of the brake employed.

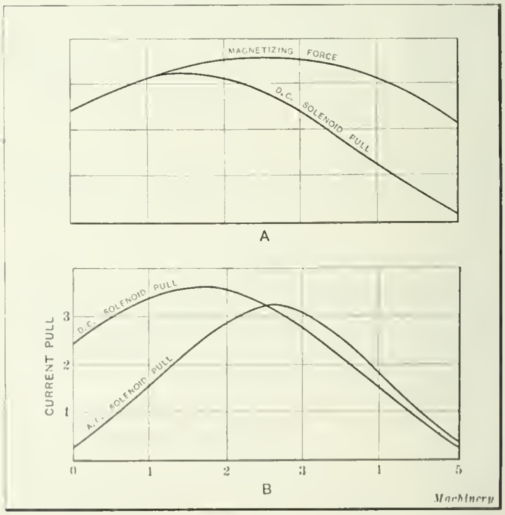


Fig. 10. Charts showing Solenoid Pulls

The Solenoid

As a magnet is a bar or mass of steel to which the peculiar properties of the loadstone have been applied, one generally understands that an electric magnet is such a mass of electrified material that is given these peculiar properties by the application of the electric current. A solenoid, however, is an electric dynamic spiral having the conjunctive wires turned back along its axis so as to neutralize that compound of the effect of the current due to the length of the spiral and reduce the effect to that of a series of equal and parallel circular currents. A magnet then, in simple terms, is a solid attracting body of material, while a solenoid is a hollow coil that has the power of attracting a body of magnetic material into itself or an electric magnetic helix. There are many and varied uses of solenoids in the operation of machinery with both alternating and direct current; but there is quite a difference between a direct-current and an alternating-current solenoid.

At *A*, Fig. 10, is shown the relation between the magnetizing force and the pull of a direct-current solenoid, and at *B* is shown the difference between the direct- and the alternating-current pull as indicated by the position of the core when the pull is greatest. The lift of direct-current series-wound solenoids varies a great deal, as shown in Fig. 11, which indicates clearly the lift at half and at full load.

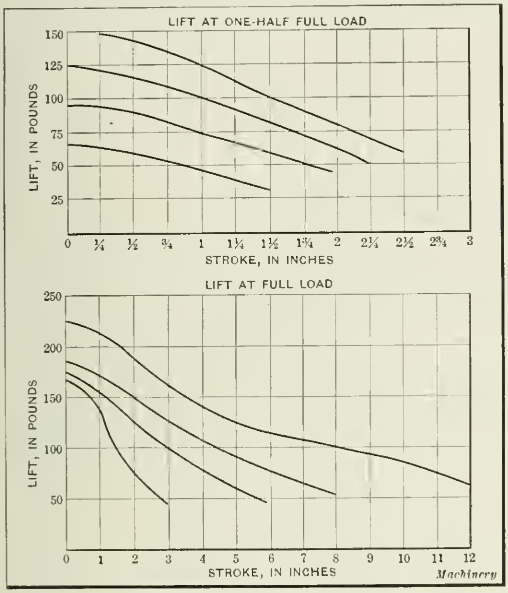


Fig. 11. Lifts of Solenoids at Half and Full Loads

Experiments with alternating-current solenoids having a long stroke show the erratic behavior of the pull characteristic. If a short stop is used, the pull falls off as the air gap closes until at a certain point it rises very rapidly; if a long stop is made, the pull increases greatly with a decrease in the length of the air gap. The pull of an electromagnet varies as the square of the voltage, so that the effective pull at low voltage falls to less than one-half of what it is at the maximum.

Lifting Magnets

The lifting magnet, Fig. 12, may be considered as a number of magnetic turns enclosed in a casing of cast steel. The coil is a device for transforming electric energy into magnetic potential energy. The greater the number of amperes passing through a given coil, the stronger will be the attractive force of the magnet; the greater the number of turns multiplied with the current, the greater will be the lifting capacity; and the greater the actual current taken by the magnet, the higher will be its efficiency, since the proportion of the live load to the dead weight will be increased. It is necessary to locate the maximum number of turns in the least possible space and to carry the maximum safe current in the conductors, so that the more current a magnet of a given size uses, the greater is its lifting capacity. The current cost is a small item, and the greatest gain in efficiency is made because of the increasing of the lifting capacity in proportion to the weight of the magnet. Increased lifting capacity means fewer magnets to handle the material, fewer operations, and fewer cranes.

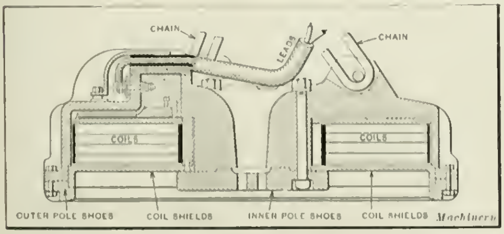


Fig. 12. Outline of Typical Lifting Magnet

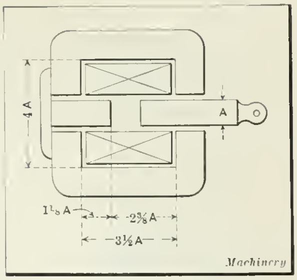


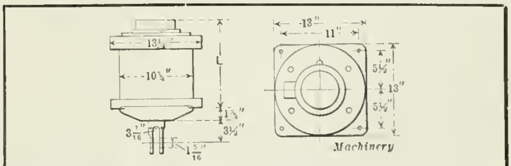
Fig. 13. Proportions of a Standard Solenoid

Proportions and Applications of Standard Solenoids

The proportions of a standard solenoid are shown in Fig. 13; this requires no explanation. The outline dimensions, horsepower, weight, lifting capacity, in pounds, and stroke of a standard solenoid are given in Table 2. One of the many applications of this type of solenoid is shown in Fig. 14, which is a time-limit overload relay with a single dashpot to retard too rapid action; it will be seen that this is an alternating-current apparatus having laminated cores. The function of this apparatus is to break an auxiliary circuit, the contacts being shown at the top, with an overload on either of two phases. Another application of this type is the self-starter shown in Fig. 16; its function is to make a series of electrical contacts, or short circuits. This solenoid has no laminated cores, but has a dashpot to retard too rapid movement.

These solenoids show projecting pole pieces extending to within a certain distance of the upper ends of the coils, which give the magnet a great increase in pull as the plunger approaches the stationary pole, so that it will have more power to do the required work. As a result, there is a rapid acceleration of the plunger, so that if a dashpot were not used, the plunger would strike the stationary pole a hard blow; the frequent repetition of these blows would be likely to injure the apparatus.

TABLE 2. PROPORTIONS AND STRENGTH OF SOLENOIDS



Length, Inches	Horsepower	Weight, Pounds	Lifting Capacity, Pounds	Stroke, Inches
7½	2 to 10	205	170	3
11⅝	10 to 30	255	172	6
13	25 to 75	360	185	8
16	50 to 150	405	225	12

In the other type of solenoids the plunger practically centers itself when drawn into the coil, as in the case of the instantaneous double-coil overload relay shown in Fig. 17. The pull is up and the auxiliary circuit-breaking buttons at the bottom, so that when either coil is energized the auxiliary circuit will be broken by the plunger being raised away from the contact. Fig. 15 shows a series relay standard, which is considerably used at the present time.

Solenoid-operated valves are designed for use where it is desired to operate a valve from remote points, or automati-

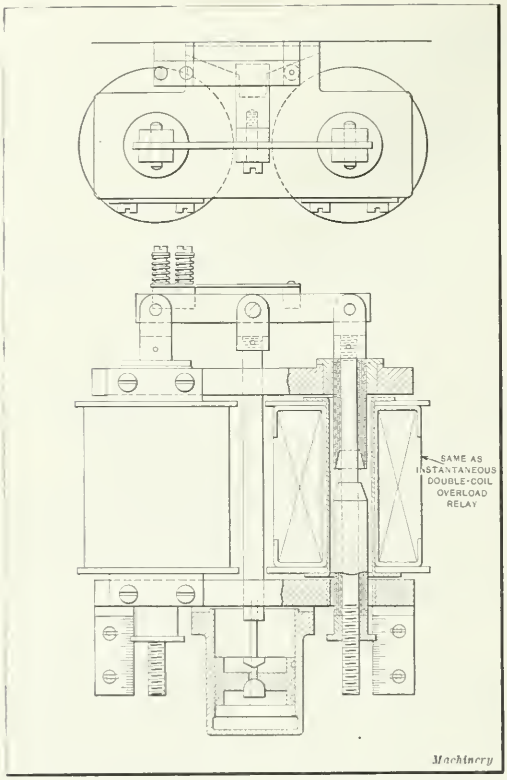


Fig. 14. Time-limit Overload Relay

cally, in connection with motor-driven pumps, compressors, etc. These valves may be used on a steam service where the pressure does not exceed 150 pounds per square inch. They are built in four sizes, 3/8, 1/2, 3/4, and 1 inch, are threaded for standard cast-iron pipe, and have an area of opening equal to that of the pipe. These valves are used for three types of service: continuous, the coils of which will stand the full rated voltage continuously without overheating; intermittent, the coils of which will stand the full rated voltage applied for not over seven out of each thirty minutes; and momentary, the coils of which will stand the rated voltage applied for not over two out of every thirty minutes. When operated from a distance, a knife or snap switch is used to control the solenoid circuit; and by using a special three-position switch, momentary-duty coils may be used for continuous service, this special switch limiting the control of the valve to one point. A relay is required if it is desired to operate the valve from several points, which necessitates the use of one normally closed push-button or equivalent switches at each station. In the solenoid-operated valve shown in Fig. 18, the body *A* has a projecting boss, onto which is secured the piece *B* carrying the frame *C* with its cap or cover *D*. Inside frame *C* is a solenoid *E*, with its insulator *F* and ends *G*, which have leads *H* that pass through cover *D*. Air spaces *J* and *K* are provided to keep the solenoid cool. The core *L* of the solenoid carries on its end a valve seat *M*, which is held to the stem or plunger by a nut *N* and is held down in the closed position by a spring *O*. When the solenoid is energized, the plunger and valve pass into space *P*, thus allowing the valve to open.

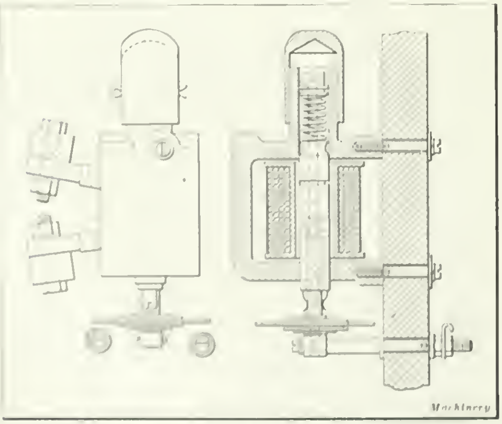


Fig 15 Common Type of Series Relay

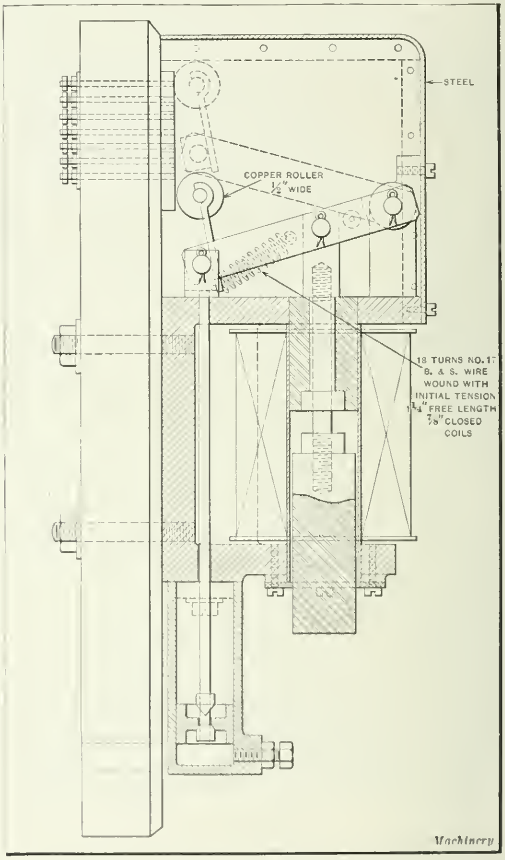

STEEL
COPPER ROLLER ½" WIDE
18 TURNS NO. 17 B. & S. WIRE WOUND WITH INITIAL TENSION 1¼" FREE LENGTH ⅞" CLOSED COILS
Machinery

Fig. 16. Application of Solenoid to a Self-starter

One of the most useful applications of the solenoid is in the magnetic shifting-gear device for automobiles, as shown in Fig. 19. This device consists of a housing having at its ends magnetic windings arranged in pairs, shifter bars guided through the ends of the housings and constituting cores for the end windings, or solenoid and pole pieces for one set of intermediate windings whereby each bar may occupy three positions, with dogs adapted to lock the bars in their respective positions and to be released by another set of intermediate windings.

Table 3 gives the rating of shunt-wound solenoids, voltage, sizes, weights of plungers, in pounds, weight lifted for intermittent and continuous service with no cut-out, intermittent service with cut-out, and periodic service with no cut-out. These weights are the amounts that can be lifted in addition to the plunger. Table 4 gives the stroke, in inches, and weights lifted at half and full loads of series wound solenoids.

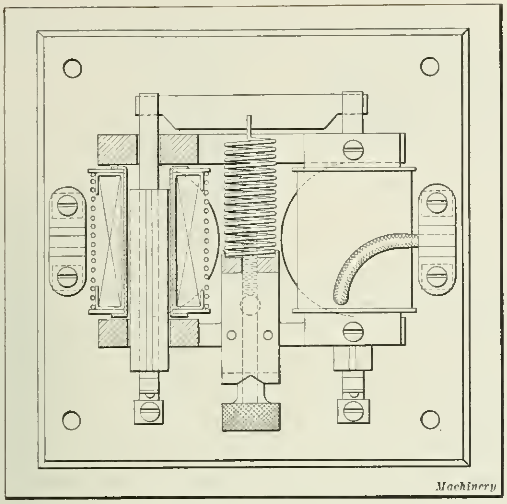


Fig. 17. Instantaneous Double-coil Overload Relay

The horsepower of these solenoids for both standard crane and continuous service is given in Table 5. In Table 6 are given the proportions of another standard solenoid; the pull, number of turns, amperes, and travel of plunger of this solenoid are given in Table 7.

The method generally used in designing electric magnets is as follows: Decide upon the total number of lines of force required and the material to be used for the various parts of the magnetic circuit; then select the magnetic densities, from experience, and obtain the corresponding values of the magnetizing forces from the magnetization curves for the materials used. The sectional areas of the various parts are found by dividing the total flux by the flux densities, and the length of each part is made as short as possihle. The length of the cores depends on the length of the magnetizing coils, which, in turn, depends on the number of turns, the size of the wire, and the depth of the winding. The depth of the winding must be such that the surface of the coil will not radiate more than from 1/2 to 1 watt per square inch. If the lengths of the iron parts are estimated first, they may be corrected afterward if necessary. Since it is the air gap that usually requires the greatest number of ampere-turns, a slight variation in the length of the iron parts will not affect the results much.

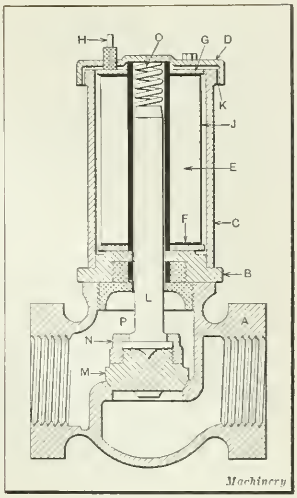


Fig. 18. Globe Valve with Solenoid

Having the areas, lengths, densities, and magnetizing forces for the various parts, the ampere-turns required to produce the given flux in the various parts may be calculated or obtained from ampere-turn curves. The sum of the ampere-turns for all the parts gives the total number of ampere-turns required. Having the current and the number of ampere-turns required, choose a conductor for the coils having such a resistance as to allow the desired current to flow without undue heating. Excessively large conductors must not be used, as it will make the coil too large, costly, and, perhaps, inefficient,

TABLE 3. SHUNT-WOUND SOLENOIDS. TABLE GIVES WEIGHTS IN POUNDS THAT CAN BE LIFTED IN ADDITION TO PLUNGER

A—Intermittent service with no cut-out; B—Continuous service with no cut-out; C—Intermittent service with cut-out; D—Periodic service with no cut-out.

Lift, Inches	Size 1, 31-pound Plunger												Size 2, 43-pound Plunger											
	110-volt				240-volt				550-volt				110-volt				240-volt				550-volt			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
½	129	39	234	181	103	19	209	160	89	9	199	160	127	47	237	180	107	57	214	160	92	37	202	161
1	109	19	231	176	82	5	206	154	69		193	151	120	32	237	172	98	37	212	152	84	25	198	154
1½	69		226	167	46		201	134			184	130	105	14	235	165	84	23	210	145	67	7	192	145
2	39		219	154	23		192	111	16		165	83	79		232	161	67	7	206	137	47		185	133
2½	27		209	112	11		169	74	3		124	62	62		229	151	53		202	127	30		174	127
3	13		194	73	6		119	49			77	30	52		222	142	37		195	119	17		162	104
4			84	33			54	19			39	10	31		203	120	17		177	97			143	92
5			34	4			19				9		17		189	94	2		152	81			133	72
6															163				129				98	
8																								
10																								
11																								

Lift, Inches	Size 3, 45-pound Plunger												Size 4, 52-pound Plunger											
	110-volt				240-volt				550-volt				110-volt				240-volt				550-volt			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
½	132	64	245	181	119	72	220	162	107	62	210	170	148	84	278	211	132	82	238	180	120	75	245	172
1	127	52	245	178	108	55	220	157	91	45	210	164	143	60	275	208	115	58	236	175	102	48	242	168
1½	120	35	245	172	91	35	218	150	75	33	205	155	121	34	272	201	95	31	235	168	88	25	235	156
2	100	12	245	165	75	20	215	145	55	10	197	141	101	21	266	193	76	17	231	156	62	8	225	144
2½	82		242	160	60		213	133	42		190	125	83		258	172	62		225	140	45		212	128
3	70		237	155	49		211	124	26		182	112	71		248	160	48		217	124	34		195	108
4	55		227	145	33		198	105	15		170	95	55		233	150	31		202	108	18		178	90
5	43		222	135	23		188	95	2		160	85	44		225	143	20		194	92	4		171	81
6	35		213	125	13		182	82			152	75	34		224	141	13		186	82			166	76
8													21		218	128	3		158	65			150	61
10													8		179	93			123	44			108	37
11															115	68			75	28			61	22

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because the outside turns will be too far from the core, or the coil will be unnecessarily long.

If the voltage is known, the size of the conductor may be calculated and the mean length of turn obtained by the formula:

$$A = \frac{12LT}{E}$$

where A = area, in circular mils;
L = mean length of turn, in feet;
T = ampere-turns;
E = difference in potential across coil.

At first calculate only approximately the mean length of one turn, and later a more correct value may be used to find A.

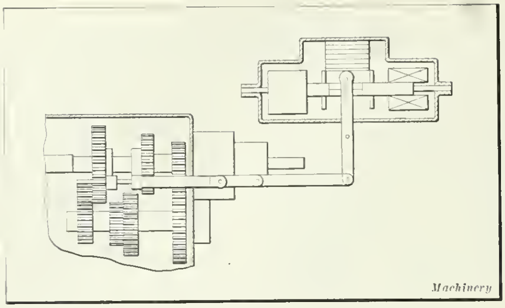

Fig. 19. Magnetic Gear-shifting Device

* * *

SPONTANEOUS COMBUSTION

Spontaneous combustion, more correctly called "spontaneous ignition," refers to a condition where ignition takes place without the employment of any external source of heat. The spontaneous ignition of coal when stored in large quantities is well known, and at the present time, when there is such a serious shortage, great care should be taken in the storage of coal to prevent such ignition and consequent waste.

Spontaneous ignition is probably the cause of many fires, the starting of which cannot be adequately explained. One of the commonest forms in which spontaneous ignition takes place is when a fire starts from a piece of cotton waste or an old rag saturated with oil and left lying in a warm place. Boiled linseed oil is the most dangerous of the oils commonly found around industrial plants. The spontaneous ignition from an oil-soaked rag or waste which has been left in a warm room or in the sun is caused by the rapid oxidation of the oil spread out over the large surface afforded by the threads in the waste or the folds of the cloth. The greater the exposed surface the more rapid the oxidation, until finally the temperature rises sufficiently to cause the oil and waste to ignite and burn with a flame. Mineral oils are not considered dangerous in this respect, but nevertheless the precaution of keeping all oil-soaked waste in metal receptacles should always be observed.

TABLE 4. SERIES-WOUND SOLENOIDS

Figures in table give weights lifted at half and full loads: Y = half load: Z = full load

Stroke, Inches	Size 1, 31-pound Plunger																		Size 2, 43-pound Plunger							
	A		B		C		D		E		O		P		Q		R		F		G		H		S	
	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z
½	23	109	25	119	26	129	44	144	46	159		30		40		53		60	37	117	44	123	55	135		61
1	9	89	9	94	13	109	23	123	27	139		22		27		34		40	22	105	30	110	39	122		42
1½		49		59		69	3	86	3	99						9		11	7	90	15	97	25	110		18
2		29		35		39		49		59										75	3	82	13	97		
2½		9		19		26		35		44										62		70		85		
3				6		13		19		23										42		52		71		
4										3										27		36		56		
5																				17		26		47		
6																										
8																										
10																										

Stroke, Inches	Size 3, 45-pound Plunger														Size 4, 52-pound Plunger					
	I		J		K		L		M		T		U		N		V		W	
	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z
½	60	125	63	135	70	137	75	145	78	148	12	77	26	87	91	168	14	81	25	94
1	45	120	52	127	55	130	62	137	65	142		62	12	75	74	164		48	10	74
1½	30	112	25	115	40	125	42	132	52	135		42		55	48	152		36		88
2	10	95	15	105	22	110	30	119	32	124		23		40	28	135		15		31
2½		82		91		95	7	105	12	118		7		30	8	120				18
3		70		80		85		95		102				15		103				13
4		52		62		67		80		85				2		85				
5		40		49		55		65		72						75				
6		30		39		45		57		62						64				
8																54				
10																33				

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TABLE 5. HORSEPOWER OF STANDARD CRANE AND CONTINUOUS SERVICE

The letters indicating classification of solenoids are those used in Table 4

Size 1, 31-pound Plunger							Size 2, 43-pound Plunger							Size 3, 45-pound Plunger							Size 4, 52-pound Plunger						
Horsepower	Crane Rating			Continuous Rating			Horsepower	Crane Rating			Continuous Rating			Horsepower	Crane Rating			Continuous Rating			Horsepower	Crane Rating			Continuous Rating		
	110 Volt	240 Volt	550 Volt	110 Volt	240 Volt	550 Volt		110 Volt	240 Volt	550 Volt	110 Volt	240 Volt	550 Volt		110 Volt	240 Volt	550 Volt	110 Volt	240 Volt	550 Volt		110 Volt	240 Volt	550 Volt	110 Volt	240 Volt	550 Volt
2.0	C	C	A	R	Q	Q	10	G	F	F	S	S	S	25		M	M		T	T	50	N	N	N		V	V
3.5	E	D	D	O	P	O	15	F	F	F	S	S	S	30		L	L		T	T	75		N	N		V	V
5.0	D	C	C	R	Q	R	20	F	G	F	S	S	S	35		J	K		T	T	100		N	N		V	V
7.5	E	B	B	R	P	Q	25		H	F		S	S	50		I	M		U	T	125		N	N		W	W
10.0	C	D	C	R	R	Q	30		F	F		S	S	75		I	L		T	T	150		N	N		W	V

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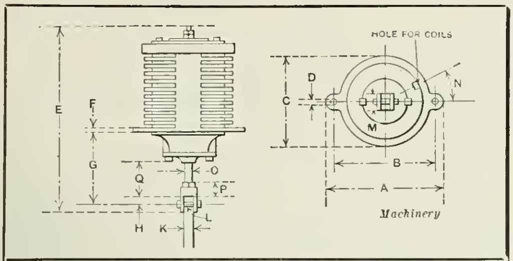
TABLE 6. PROPORTIONS OF A STANDARD SOLENOID



Plunger Diameter, Inches		$3\frac{1}{4}$	4	$4\frac{1}{2}$	$5\frac{1}{2}$	$6\frac{5}{16}$	7
Plunger Weight, Pounds		12	19	28	45	60	80
Total Weight Lifted, Pounds		160	230	325	400	495	565
Dimensions, Inches	A	11	12	$13\frac{1}{4}$	15	$16\frac{3}{4}$	$17\frac{3}{4}$
	B	$9\frac{3}{4}$	$10\frac{3}{4}$	$11\frac{7}{8}$	$13\frac{1}{4}$	$14\frac{3}{4}$	$15\frac{3}{4}$
	C	$8\frac{7}{8}$	$9\frac{13}{16}$	$10\frac{5}{8}$	$12\frac{1}{8}$	$13\frac{1}{4}$	$14\frac{1}{4}$
	D	$\frac{17}{32}$	$\frac{17}{32}$	$\frac{17}{32}$	$\frac{21}{32}$	$\frac{25}{32}$	$\frac{25}{32}$
	E	$18\frac{1}{2}$	$19\frac{3}{16}$	$21\frac{1}{2}$	$23\frac{1}{4}$	$24\frac{1}{16}$	$24\frac{3}{4}$
	F	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{15}{16}$	1
	G	$7\frac{1}{4}$	$7\frac{3}{4}$	$9\frac{1}{2}$	$10\frac{1}{4}$	$10\frac{13}{16}$	$11\frac{1}{4}$
	H	1	1	1	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{4}$
	K	1	1	1	$1\frac{3}{16}$	$1\frac{3}{16}$	$1\frac{3}{16}$
	L	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$
	M	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{3}{4}$	$1\frac{3}{4}$	$1\frac{3}{4}$
	N	30°	90°	25°	29°	28°	28°
	O	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{7}{8}$	$\frac{7}{8}$	1
	P	$1\frac{5}{8}$	$1\frac{3}{4}$	$1\frac{3}{4}$	$2\frac{1}{4}$	$2\frac{1}{4}$	$2\frac{1}{4}$
	Q	$3\frac{7}{16}$	$3\frac{3}{4}$	$4\frac{1}{16}$	$4\frac{3}{8}$	$4\frac{3}{16}$	$4\frac{9}{16}$

Machinery

USE OF BISMUTH

Bismuth is not widely used, partly because of its high price and partly because of its brittleness, which prevents its use for anything that must be tough or malleable. It has two qualities, however, which render it useful for certain purposes. It expands on solidifying from the molten condition, and is, therefore, sometimes used in type metal. It also gives to alloys in which it is used a low melting point, and for this reason is used in the alloys employed in automatic sprinkler heads, in fuses for electric wiring, and in solders. It is also used to some extent in bearing metals.

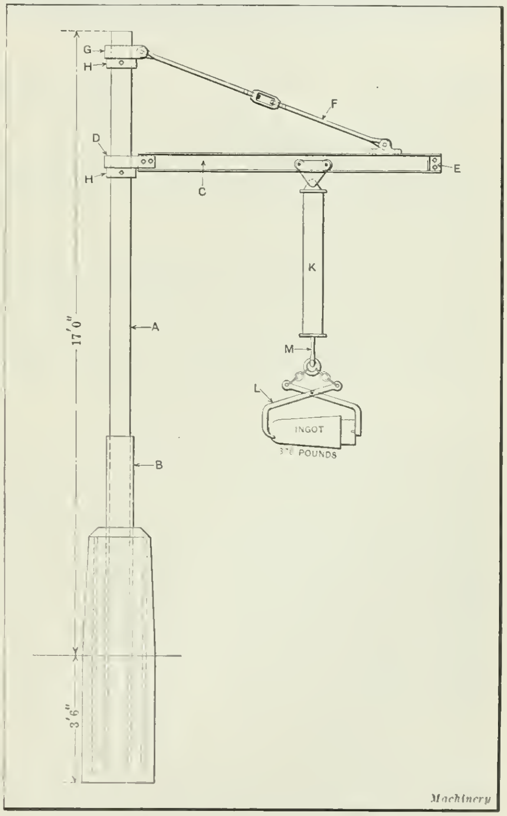
TABLE 7. PULL, AMPERE-TURNS, AND TRAVEL OF PLUNGER OF STANDARD SOLENOID

Number of Turns	Amperes	Number of Turns	Amperes	Pull, in Pounds, with Plunger Travel of					
				1/4 in.	1/2 in.	3/4 in.	1 in.	1 1/4 in.	1 1/2 in.
72	41.7	99	30.3	109	51	22	2	...	...
72	55.5	99	40.4	140	82	46	26	12	...
72	69.4	99	50.5	165	112	72	44	28	13
72	83.3	99	60.6	...	140	96	63	42	25
72	41.7	99	30.3	164	75	32	5	...	...
72	55.5	99	40.4	211	128	68	38	17	...
72	69.4	99	50.5	236	168	107	66	32	18
72	83.3	99	60.6	...	204	144	96	63	37
50	60.0	72	41.7	215	97	41	5	...	...
50	80.0	72	55.5	278	163	89	46	19	...
50	100.0	72	69.4	330	222	141	86	52	22
50	120.0	72	83.3	...	226	288	125	82	47
37	81.5	50	60.0	323	142	58	3	...	...
37	108.0	50	80.0	415	242	130	70	28	...
37	135.0	50	100.0	491	330	207	128	77	30
37	162.0	50	120.0	...	403	279	181	118	67
26	115.0	35	85.6	422	190	77	8	...	...
26	154.0	35	114.0	540	315	171	52	38	...
26	192.0	35	143.0	653	440	278	168	104	40
26	230.0	35	171.0	...	527	372	243	160	90
18	166.0	26	115.0	528	232	91	6	...	...
18	222.0	26	154.0	694	397	209	115	41	...
18	227.0	26	192.0	807	543	341	209	124	45
18	332.0	26	230.0	...	653	457	295	198	115

JIB CRANE FOR USE IN AN OPEN FLOOR SPACE

The crane shown in the accompanying illustration was designed for use in an open floor space where no supports could be attached to the top of the mast. The requirements were that the crane should raise the 370-pound ingots of 9.2-inch shells four feet, from a platform near the ground line, by means of an air hoist and release them at machines for nicking the ends. Afterward, the ingots are placed under a drop-hammer, the nicked ends broken off, and the fractured part inspected.

The mast consists of a six-inch XX pipe *A* set in a reinforced concrete footing and surrounded by an eight-inch XX pipe *B;* the space between the pipes is filled with grouting. The boom *C* is a six-inch I-beam. Bolted to one end is a cast-steel yoke *D* that is bored out large enough to revolve freely on the outside of the mast; the other end is provided with a stop *E* to prevent the hoist from running off. The tie-rods *F* are made of 1-inch iron and are provided with turnbuckles to take up any necessary adjustment. One end of the tie-rod is secured to a cast-steel yoke *G* fitted loosely around the mast similar to the yoke on the end of the I-beam. Cast-steel collars *H* securely fastened to the mast are placed under each yoke piece. The air hoist *K* is 4 inches in diameter, has a 4-foot stroke, and a capacity of 1000 pounds. The tongs *L* attached to the hook *M* on the air hoist are made of forgings. One of the pair has a pin on one end, which fits in a punched hole in one end of the ingot, the other one of the pair has one end bifurcated to fit around the nose of the ingot. G. W. C.



Jib Crane for Open Floor Space without Supports for Top of Mast

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During the year 1917, the capitalization of new American corporations formed was the largest on record. In the eastern states alone, the new companies chartered had an aggregate capitalization of $3,714,105,000.

EYE PROTECTION IN THE MACHINE INDUSTRY[1,2]

CAUSES OF INJURIES TO THE EYE AND METHODS BY WHICH SUCH INJURIES MAY BE PREVENTED

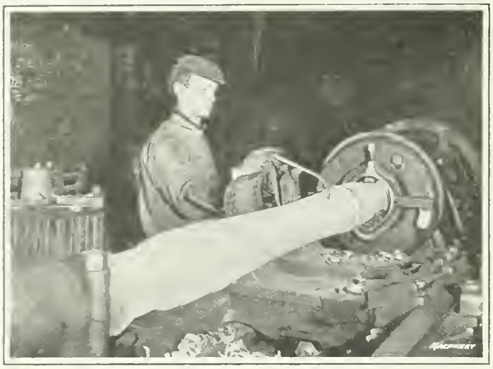
Fig. 1. Guards on Lathe to catch Steel Chips from Tool

Out of 710,571, or one-third, of the non-fatal accidents occurring annually in the United States, 59,436 are injuries to the eye; and in the nation as a whole it is estimated that 200,000 persons annually receive eye injuries. In the decade from 1880 to 1900, which was one of great industrial growth, blindness increased 25 per cent; while approximately 15,000 persons become blind as a result of injury in industrial occupations each year.

Hazards to the eyesight of industrial workers are found chiefly in the following industries and occupations: the manufacture of iron and steel, machine operations, chipping, grinding and polishing, riveting, welding and cutting, mining and quarrying, sand-blasting, woodworking, and where there is exposure to irritating and poisonous dust or fumes and gases, or to intense light and heat. These are not cited in the order of their importance as productive of eye accidents.

Chipping and Machine Operations

In chipping operations there is always danger of the eyeball being penetrated by flying slivers of metal, which sometimes have such velocity that they penetrate very deep and have been known to lodge in the optic nerve. The use of goggles is the most effective means of preventing accidents from this cause. Goggles for chippers usually have side screens for the deflection of chips coming from a lateral direction, but the tendency is to eliminate these side pieces and place screens between adjacent workers. The side pieces contribute to the steaming of the goggles and cause discomfort because of their weight and appearance; steaming, however, may be prevented by the use of the glycerine pencil or a composition of similar nature. Also a sweat-band around the forehead or attached to the top of the goggles to absorb the moisture and prevent perspiration from running into the eyes will help relieve the difficulty. In some shops the soft metal chips are broken off with a hammer instead of being removed by the chisel. By this plan is avoided the hazard from the great velocity given the chips when they are removed with the air-hammer chisel. Moreover, such remnants as must be removed by the latter process are much smaller than the original chips.

Cutting and turning metal in machines produces flying chips, which cause many eye injuries. In the machining of rough castings there is also the hazard of flying sand that has adhered to the metal. As a result, the workmen often rig up protective screens of different kinds; but these in many cases are the cause of accidents. However, a guard properly designed, if made of good material and carefully fitted to the tool rest, will be found an effective preventive. Two satisfactory types of guards are shown in Figs. 1 and 2.

Grinding and Sand-blasting

Statistics compiled by casualty companies show that in recent years there has been a large increase in the number of accidents resulting from the operation of abrasive wheels. This increase is undoubtedly due to the greater use of abrasives, to the failure to provide protective devices, and to the failure of employes to use such devices when the wheels have been equipped with them. The hazards incident to grinding are those due to abrasive dust, fine particles from the work surface that is being ground, and flying parts of a wheel that has been ruptured by an accidental blow. These accidents are rarely unavoidable, and the application of substantial guards, hoods, and exhaust systems to the wheels and the wearing of goggles by the grinders will reduce the number to a minimum. The effectiveness of goggles is shown in Fig. 3. If, for any reason, it is impracticable to equip a wheel with a hood, safety flanges should be used. These bind the wheel on each side and are adapted for straight or tapered wheels. Then, in the event of a rupture, the parts of the wheel are clamped by the flanges.

Goggles should always be worn by grinding machine operators, even when a grinding wheel is protected by a suitable guard. A possible exception, however, is when doing certain kinds of wet precision grinding, for example, automobile crankshafts. Then the point of contact between the grinding wheel and the work is always under a large stream of water, which carries into the tank of the grinder any particles that might otherwise cause eye injuries. The goggles for this work need be neither heavy nor cumbersome; the thickness of the lens should be based upon the kind of grinding on which the workman is engaged. Side screens are of value where protection is necessary to offset the danger of chips from adjacent machines. Flying abrasive particles are white-hot, so when they strike the eyeball they are likely to burn their way into the tissues, thus making their removal more difficult. Though the heat may cauterize the edges of the wound, there results an abrasion that makes it far more easy for bacteria to enter and bring about serious infection.

In numerous plants a pair of goggles is hung beside a grinding wheel for any employe who may use the wheel. This promiscuous interchange of goggles exposes workmen to communicable diseases of the eye. Occasionally a pair is known to have been last worn by a man who had sore eyes. The fac-

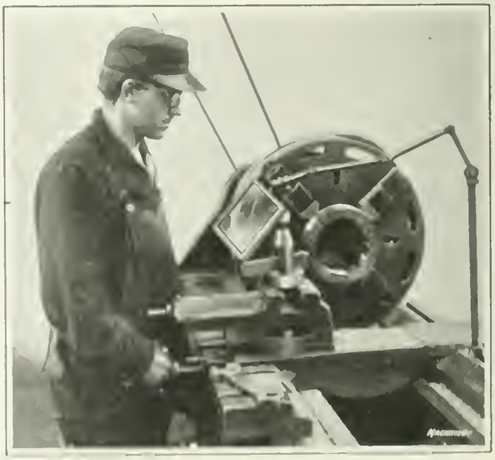
Fig. 2. Glass Chip Shield on Lathe

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[1] Extracts from a report by the National Committee for the Prevention of Blindness.

[2] For other articles in MACHINERY on eye protection, see "Eye Protection for Grinders and Machinists," March, 1915; "Proper Eye Protection," December, 1914.

tor responsible for the inflammation may not be known even to that employe himself, so that any workman who wears these goggles may later develop trachoma or some other serious eye disease.

Dust should be carefully removed from the grinding machines. Constant breathing of air laden with abrasive dust is injurious, and there is an accumulative hazard to eyesight from the constant scarring of the cornea by these fine particles. An exhaust system carefully planned and approaching as close as possible to the source of the dust should be installed wherever much grinding is done.

Frequently the most serious hazard is apparent in shops where the grinding wheels are used only occasionally, perhaps for but a few minutes in a day to touch up some dull tool or to grind off a burr from a casting. In shops where abrasive wheels are in constant use the severity of the hazard is appreciated far more.

Sand-blasting of large areas is generally accomplished by the use of the hose type of apparatus, which permits a stream of sand to be shot with great force against the casting or other object. The operators must be afforded protection for the eyes and face, for the sharp particles of sand are driven with such force against the surface operated upon that they rebound many feet and the surrounding air is constantly filled with dust produced by the driven sand and that removed from the surface being cleaned. Because the particles of silicious sand used would rapidly pit the glass surface of goggles, the helmets provided for the workmen should have windows of fine-wire mesh, mica, or celluloid through which the operator may watch his work. Sometimes these helmets are connected by a hose to a compressed air system in order to give the operator a constant supply of fresh air. Where such equipment is used, care should be exercised that there is not too strong a pressure of moist air, which, in itself, is a hazard to the health of the worker. The eye hazard from irritating dust may be offset if the work is held in a box-like hood with small openings through which the workman puts his hands and arms. These hoods are equipped with exhaust fans to carry off the dust, while glass windows enable the operator to watch his work.

Dangers from Mushroomed Tools

Swages, flatters, fullers, breaking-down tools, chisels, etc., are often used until the heads have spread and split, as shown in Fig. 4. Each blow upon such a mushroomed surface may cause chips to fly off with sufficient force to destroy an eye or to pass through the clothing and into the flesh. Mushrooming may occur on the finest hand-forged tools, as well as on those with the cast heads commonly provided in cheap hammers. An injury of this nature, when caused by a small particle of steel, may seem of little moment at the time; even when the particle has penetrated to the interior of the eye, its presence and effect may be at first non-apparent. Serious infections, however, may result from injuries of this nature when the penetrating particle has carried dirt or germs into the interior of the eye. The location of particles of iron and steel can often be determined only by the use of the X-ray and a steel sliver can frequently be withdrawn only by an electric magnet. One authority has stated that it is often necessary to remove the injured eyeball in order to save the other eye, as the irritation set up is frequently transmitted to the good eye and thus, through sympathetic inflammation, leads to blindness. The good eye may be affected at any time from a few weeks to thirty or forty years after the injury.

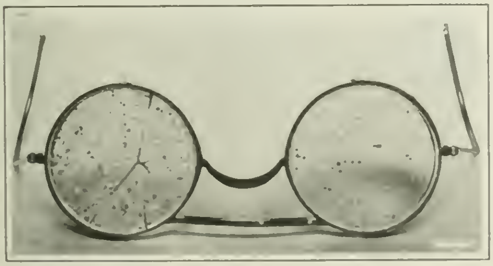

Fig. 3. Emery Particles fused to Goggles

Constant watchfulness on the part of workmen and foremen is essential in order that hammers and tools may be kept properly dressed. The National Safety Council recommends the establishment of a regular tool-room for a certain number of employes, which should be in charge of a competent workman. This man should see that all tools are dressed, ground, and properly repaired, and that they are inspected at least once a week. Such tools as air-hammers, electric machines, etc., should be examined every evening for oiling, testing for grounds, etc.

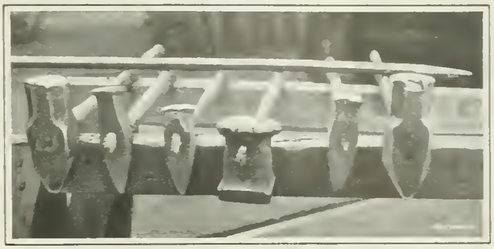

Fig. 4. Examples of Mushroomed Tools

Radiations from Intense Light and Heat Sources

The injurious light radiations furnished by the most powerful commercial illuminants are too small to be dangerous under ordinary working conditions, even when these illuminants are accidentally used without their globes. Artificial illuminants may prove very tiresome through the sharp contractions of the pupil that they produce, and through the premature, though generally temporary, exhaustion of the retina, but, generally speaking, any intense light results in fatigue and inefficiency rather than in demonstrable harm. However, workmen exposed to the radiant energy in arc-welding and in molten metal should be protected by colored goggles. After exposure of the eye to injurious radiations, there is a latent period before any effects become perceptible; this period varies with the severity of the exposure, but the injury is usually apparent within twenty-four hours. The light radiations, however, do not permanently injure the eye; in fact, they seldom cause anything more than a mild inflammation, which disappears in a day or two.

However, the intense light and heat produced in arc-welding, oxy-acetylene and oxy-hydrogen welding, and other operations in which molten metals are concerned, may be quite harmful. Arc-welders must be protected not only from the intense light and heat, but also from the fine particles that fly off from the electrode. In this work there is always a tendency to oxidation and the formation of cinder, and the imprisoned air, bursting its way out of the contact surface, may be the cause of just as serious an injury as the cinders of the hand process of welding.

Welding and cutting by high temperature media should be done in a room separated from other work-places. However, dependence should not be placed on the canvas curtain walls sometimes used. Wear and tear will make such curtains practically worthless, as a means of protecting other workmen from the glare, within a very short time. The operators should be provided with goggles both as a protection against splashes of molten metal, flying sparks, cinders, etc., and against the radiations from superheated metals and high-temperature welding media. Without goggles, there will result marked inflammation of the mucous membranes of the eye, annoying after-images, light-flashes, headaches, and temporary blindness, with consequent loss of time and wages.

The goggles provided generally have dark blue, smoke, or red glasses; unfortunately, these colors are far from being effective. The cobalt-blue glasses especially give but a hazy view of the furnace interior and molten metal and do not absorb those radiations that are at least excessively fatiguing to the eye. Goggles for protection in these operations should provide sufficient reduction of the intensity of the light, should be effective in absorbing the ultra-violet rays, should keep the eye cool, and should transmit as much as possible of the visible spectrum without color distortion. It is an advantage also if the color of the goggle itself is inconspicuous. It has been found that of the infra-red rays emitted by a furnace heated to 1000 or 1100 degrees C., about 99 per cent are obstructed by gold-plated glasses; about 95 per cent, by sage-green or bluish-green glasses; about 60 to 80 per cent, by very deep black glasses; and about 60 per cent, by greenish-yellow glasses. At higher temperatures these data would be somewhat different.

For working molten quartz, operating oxy-acetylene or electric welding apparatus, searchlights, or other intense sources of light, the darkest glasses, whether black, green (not including gold-plated glasses), or yellowish-green should be worn in order to obstruct not only the infra-red, but also the visible and the ultra-violet rays. For working near furnaces of molten iron or glass, if considerable light is needed, a light bluish-green or sage-green glass is advised. Unfortunately, the cost of gold-plated glasses puts them as yet rather out of the range of availability for industrial purposes, and the effects produced in looking through them are not quite so pleasing as through the sage-green ferrous glass.

For outdoor welding, such as work on steel rails, there is a simple protective device in the shape of a small box beneath which the work is accomplished. Correctly tinted glass windows in the box enable the welder to watch his work safely and protect passers-by from injury from the light source or from flying chips and sparks.

Removal of Foreign Substance from Eye

Thousands of infected eyes are due to the neglect of workmen to have foreign substances removed from them immediately. Some of the most dreaded systemic diseases may find a point of entrance through a tiny wound thus caused in the cornea, the individual being in all respects entirely normal and in good health. Another source of infection is the attempt of fellow-workmen to remove substances from the eye. For this purpose the friend may use a soiled handkerchief, match, etc., and in his effort to remove the substance, it may be moved considerably, abrading the surface of the eye. In the abrasion thus formed, micro-organisms from the probe may enter.

For the removal of dust and dirt or when any foreign body is embedded in the eye, the lids should be gently separated and the eye flushed with boric acid or normal salt solution, followed by a couple of drops of a 10 per cent argyrol solution or a small bead of bichloride salve. The eye should then be bandaged and the man sent to a physician.

Treatment of Acid Burns

Wherever workmen are handling acids or chemicals, there should be readily available clean running water to be used for washing hands or irrigating eyes, on which the chemicals may have splashed through accident or explosion. The best first-aid treatment in such an emergency is to lay the victim on his back and thoroughly irrigate the eyes, lifting the lids and enabling the water to reach as far under them as possible. A small flexible hose, from which a moderate jet of water can be directed into the eyes, should be at hand. If no better way is evident, plunge the head into a pail of water and open the eyes so as to thoroughly cleanse them of the acid. If the works are equipped with first-aid kits, then apply bichloride salve, bandage the eyes, and send for the doctor. The important thing is to dilute the chemical as quickly and thoroughly as possible.

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CENSUS OF BRASS, BRONZE, AND COPPER INDUSTRY

The Bureau of Census of the Department of Commerce recently issued its report of the brass, bronze and copper industry for 1914, indicating that there were in that year 992 establishments employing 45,657 persons. The capital invested was about $116,000,000 and the value of the products about $162,000,000.

HOLDING PARTS FOR MILLING

BY DONALD A. HAMPSON[1]

In a continuous milling operation on some castings, a simple kink resulted in a marked saving of both time and material. Fig. 1 shows some of the castings placed on the removable platen of the fixture, ready to be clamped down and passed between the two end-mills of a duplex milling machine. One of the sides to be machined is solid, and the other is broken by the slot through the middle of the casting. Because of the shape of the piece, there is an uneven cut and the feed sets up a turning moment, with the result that the pieces, in moving, are cut a few thousandths inch under size and spoiled. Before going to the milling machine, the top and bottom faces of the pieces are roughly ground by pushing the pieces between a gage strip and an emery wheel of the ring type, which leaves them approximately square and of the same size.

If one or two pieces only were clamped, the pressure was so distributed, or rather concentrated, that they would not move under the heaviest cut; but with a dozen pieces there were always three or four that would not be tightly held. The problem was to get something that would prevent the castings from moving without an individual clamp for each piece. Various means of holding the rows of castings were tried out, all with a view of equalizing the clamping pressure on the different castings—strips of leather, fiber, and bristol board, sectional clamps of the equalizer type, knife-edges the full length of the clamp, etc.—but while they worked part of the time, none was a commercial success. At last the method shown in Fig. 2 was tried.

A steel wearing strip *C* is screwed to the platen, and the castings *A* are placed on it and clamped. The strip is spaced off and drilled at two points under each casting, and short pins of drill rod *B* are set in the holes. One end of the pins is flat and backs against the platen *D*, while the other is ground to a 90-degree point; the pin length is such that the point is a full thirty-second inch above the working surface of the strip. When the clamp is brought down, it forces the castings on the pins; and with these two holding points in every piece, there is no turning under a cut. As a result, the "wasters" are limited to the poor castings and the inaccuracies of the machine itself. The pins are hardened and drawn to a dark brown. They are then tough enough not to break, but yet are hard enough to give three month's wear before renewal. They make small indentations in the castings, which do not hurt them but have remarkable sustaining power like a lathe center. It does not require much greater effort on the clamp to force the castings on the pins than to clamp the pieces without the pins, and when clamped, the pieces have the same broad bearing and a light pressure holds them in place.

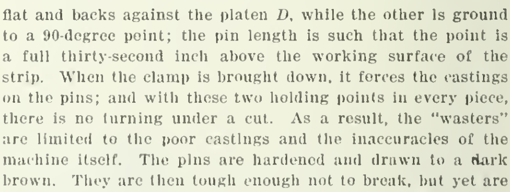

Fig. 1 Fig. 2

Figs. 1 and 2. Method of holding Parts for Continuous Milling

The question might arise as to why pins are not put in the clamp also so that the castings are held top and bottom. In this particular case, the castings are loaded off the machine and a clamp on the loading fixture sets them on the pins; also, a set-screw at the end of the platen is used to nest the castings. The pins and the set-screw hold the parts during the transfer to the machine, and it was found that pins in the clamp proved a disturbing element, because the clamp was made a loose fit and the castings had been aligned in the fixture, so the second set of pins often changed the setting, and they were unnecessary.

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INTERESTING THINGS IN METALLURGICAL CHEMISTRY

THE EUTECTIC ALLOY AND CHANGES OCCURRING IN METALS AND ALLOYS WHEN COOLING

BY C. W. STARKER [1]

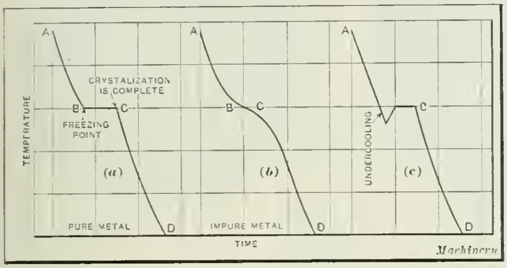

Fig. 1. Time-temperature Curves for Single Metal

WHAT happens to a metal when it is heated and melted is best understood if the conditions are reversed and a study is made of the metal as it passes from the molten into the solid state. Such a study will show, first of all, that the temperature of the molten metal does not decrease uniformly; that is, if plotted as a time-temperature curve, the temperature will not follow a straight line or even an unbroken curve. When the metal has cooled to the point where it begins to crystallize, the temperature remains constant for a time, due to energy being given up in the form of heat by the metal in passing from the liquid to the solid state; after the metal has completely solidified, the temperature again drops. This is shown graphically in the time-temperature curves in Fig. 1. At *A*, the metal is in the molten state; at *B*, the so-called "freezing point," crystallization begins and the temperature remains constant, or practically so, until at *C* the metal has become completely solidified, when the temperature decreases until the point *D* is reached. If this process is reversed and a solid metal is heated from the temperature *D*, by exposing it to a uniform source of heat, the melting point is reached and fusion begins at *C*. Energy is then required to change the state of the metal; therefore, the temperature does not increase until *B* is reached, that is, until the metal becomes completely liquid. Then the temperature increases again according to the amount of heat transmitted to the metal from the outside source.

It will be noted that the slope *CD* is steeper than the slope *AB* because the specific heat is greater for the liquid than for the solid metal; or, in other words, because with increasing temperature of the metal a relatively greater amount of heat is required to raise its temperature further. The specific heat of a metal is the ratio between the temperature necessary to raise the metal and that necessary to raise water 1 degree C. This ratio increases with the temperature attained and is particularly high near the melting point. In raising the temperature of the metal from *D* to *A*, therefore, the slope of the curve *BA* decreases as the temperature of the metal approaches that of the outside heat.

With impure metal, as shown at *b*, the line *BC* is not so pronounced. If a molten metal is cooled slowly, it may cool below the freezing point without solidifying, as shown at *c*; this is known as "undercooling." When the metal then begins to solidify, the heat liberated raises the temperature to the true freezing point. Tin has shown an undercooling of as much as 20 degrees C. In alloys, this undercooling is less; for instance, in a tin-copper alloy it is only 7 degrees.

Changes that Occur During Cooling of Alloys

If the cooling process of a two-metal alloy is studied, it being assumed that the metals do not form a chemical combination, it will be found that, compared with the pure metals, the freezing point has been lowered. This is due to the fact that as one of the metals crystallizes it separates from the other; therefore, as the cooling continues, the liquid alloy becomes enriched with the second metal until it is saturated with this metal; then both metals cool and solidify side by side.

When the point of saturation is reached, there may be said to be two quantities, the excess of one metal and the saturated combination of the two metals; the latter is called the eutectic. Fig. 2 shows the first break in the curve to occur at B_1, where one metal crystallizes; then the excess of that metal and the molten alloy, the proportions of which are changed, cool together until at B_2C_2 they solidify together. The slope of the line B_1C_1 and the rounding at C_1 should be compared with the line *BC* in Fig. 1. The amount of depression of the freezing point has been found to be directly proportional to the amount of the second metal that is added to the first. If, therefore, the two metals are combined in such proportions that from the beginning there is no excess of the first metal to crystallize out, or if there is only a saturated alloy present from the start, there will be the lowest possible freezing point (or, what is the same thing for practical purposes, melting point) of any combination of the two metals. This ideal proportion is called the eutectic ratio, and the saturated alloy is called the eutectic alloy, or the eutectic. Fig. 3 shows time-temperature curves for various proportions of the two metals from the pure metal No. 1 at the left to the pure metal No. 2 at the right. From these curves the eutectic point *F* and the eutectic line *HI* are obtained. Summing up, the characteristic features of the eutectic are that it has the lowest melting point of any proportion in which the two metals may be combined and that this proportion, and therefore the freezing point, is constant.

The two molten metals, in freezing, split up into a conglomerate of crystals of the metals. The photomicrographs shown in Figs. 4, 5, and 6 (taken from "General Metallurgy," by H. O. Hoffman) are made from copper-silver alloys, combined in different proportions. In Fig. 4, the alloy is 20 per cent copper and 80 per cent silver; the photomicrograph shows that it has crystallized in the form of large white patches of silver crystals surrounded by the eutectic alloy. On the other hand, the alloy shown in Fig. 5, which is 70 per cent copper and 30 per cent silver, has, as shown by the dark patches, an excess of copper. In Fig. 6 is shown an eutectic alloy which is 28 per cent copper and 72 per cent silver; there are neither black nor white patches, but a uniform crystalline structure of the eutectic alloy.

Importance of Understanding Transformations During Cooling

The practical importance and influence on manufacturing methods of a clear understanding of the phenomena in connection with proportions of alloys and the predetermination of their most favorable combination with regard to the melting point is apparent, when it is considered that melting means fuel and time, which, in turn, mean money. While the comparatively simple case of two-metal alloys has been described in order to make clear the principal conceptions, the same

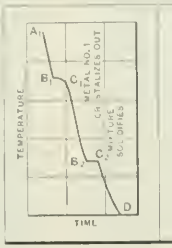

Fig. 2. Time-temperature Curves for Alloys

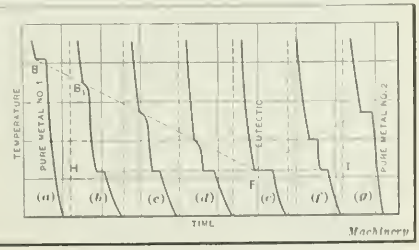

Fig. 3. Time-temperature Curves for Alloys of Different Proportions

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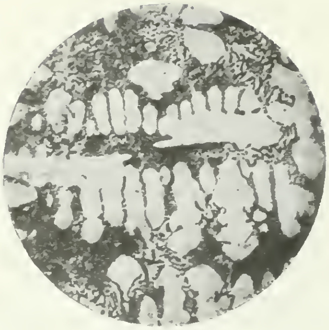

Fig. 4. Structure of Alloy containing 20 Per Cent Copper and 80 Per Cent Silver

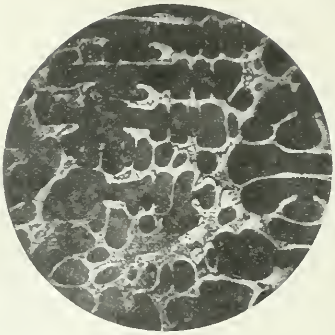

Fig. 5. Structure of Alloy containing 70 Per Cent Copper and 30 Per Cent Silver

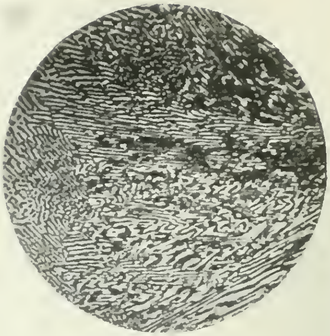

Fig. 6. Structure of Eutectic Alloy, containing 28 Per Cent Copper and 72 Per Cent Silver

methods are applied to the study of eutectics for three-metal and four-metal alloys (ternary and quarternary alloys). The graphic demonstration of these alloys becomes, of course, more complex due to the actions and reactions of the different components. The research work on quarternary alloys is still in its early stages, but it is necessary only to mention the alloy steels to show the vast practical importance of this group.

Relation between Physical Characteristics and Melting Point

It is not always desirable, of course, to combine metals in such proportions as to obtain the lowest possible melting point, for the saving in fuel may be offset by the relative cost of the component metals. For instance, in electric brazing (often called welding) the solder generally used has a melting point of about 750 degrees C. and consists of silver and brass. While the melting point may be lowered by increasing the silver content, and the electric current or the time required to perform the operation may thereby be reduced, the cost of the material will rapidly be increased. As far as the physical properties and the electric conductivity of the alloy are concerned, the different proportioning, within practical limits, will be insignificant and of no consequence in most applications. But this is not always the case. For instance, if zinc and copper are combined, the melting point may be decreased by increasing the proportion of zinc. However, an alloy high in zinc might be entirely unsuitable for a given purpose, inasmuch as with increasing zinc content the material becomes more and more brittle. A proportion of fifty parts of copper to fifty parts of zinc, for example, has a melting point of about 875 degrees C. and one of thirty-five parts of copper to sixty-five parts of zinc, a melting point about 820 degrees C., but the former has considerable ductility while the latter is brittle. Different metals act differently in this respect, and there is no definite relation between the physical characteristics and the melting point of an alloy.

If the phenomena that occur in the heating and cooling of metals are thoroughly understood, as well as the influence of the admixture of another metal or metals on the physical properties of an alloy, it is possible to develop an alloy of suitable characteristics for a given purpose. For instance, it is known that adding phosphorus to copper lowers the melting point of the mixture, even when a comparatively small percentage of phosphorus is added, and the eutectic proportion of the two, or the lowest melting point of both metals, is known. As experiments have shown that the phosphorus increases the hardness, lowers the ductility, and darkens the color of copper, the alloy may be proportioned as a hypo-eutectic or a hyper-eutectic alloy; that is, one below or above the true eutectic proportion, in order to combine such physical qualities as may be desired for the particular case on hand with a melting point desirable from a manufacturing standpoint.

That the physical characteristics of a metal or alloy are dependent not alone on the chemical composition is shown plainly by the familiar heat-treating processes of iron, steel, copper, brass, etc. It is also well known what changes are brought about by mechanical treatment, such as rolling and hammering, but it is not so generally appreciated what influence pouring temperature or the rate of melting and cooling has on a metal or alloy. At least such knowledge is frequently not applied in practice. For instance, bearing alloys, so-called "babbitts," are usually classified as tin-base and lead-base alloys. The former consists of about 90 per cent tin, 8 per cent antimony, and 2 per cent copper; the latter, of about 83.3 per cent lead, 8.3 per cent tin, and 8.3 per cent antimony. In former years the tin-base babbitt was considered the only really high-grade bearing lining, but a study of the temperature conditions in using the babbitt showed that the lead-base alloy will not only give an equally good material, but one of superior friction qualities, provided certain precautions are taken. Electric temperature-controlling devices have been developed by means of which the gas flame under the molten metal is regulated and maintained within + or — 5 degrees C. Considering the very high cost of tin, as compared with the cost of lead, it is obvious that many thousands of dollars were wasted in using tin before a study of the changes taking place in heating and cooling of metals led to the correct use of the lead-base alloy.

* * *

STELLITE AS A SUBSTITUTE FOR PLATINUM

The scarcity and high price of platinum has created a demand for a practical substitute. Evidently no single metal or alloy will ever fully replace platinum. The gold-palladium alloy is a close approximation, yet this combination is expensive. Nickel-chromium and silicon-iron alloys, also pure quartz, have given satisfactory results for certain laboratory purposes. Stellite, an alloy composed mainly of cobalt and chromium of varying proportions and malleability, is an excellent substitute for platinum. This alloy possesses the highest red-hardness of any alloy yet discovered. It resists nitric acid almost perfectly, particularly if the chromium constituent is over 15 per cent. It is forged with difficulty at temperatures varying from 750 to 1200 degrees C. In its malleable form, stellite resists chemical attacks, such as hydrochloric, sulphuric, or hydrofluoric acid. Vessels of stellite used for evaporating chemical salts and for boiling caustic alkalies can be made light of section without danger of breakage, since the tensile strength of the alloys is more than 100,000 pounds per square inch. On account of its color, hardness, and retention of luster, stellite may be substituted advantageously for platinum in jewelry. While not as pliant as platinum, it is sufficiently malleable to be worked into many forms without great difficulty.

* * *

According to a statement issued by the Department of Commerce, the imports of gold for the year ending June 30, 1917, were $977,176,026, and of silver $35,003,563; gold exports amounted to $291,921,225 and silver exports to $78,279,931. The net imports of gold during the fiscal year aggregated $685,254,801; in 1916, $403,759,753; in 1915, $25,344,607; while in 1914 there was a net export of $45,499,870.

TRAINING WOMEN MACHINISTS[1]

BY I. C. DECATUR[2] AND H. A. CHASE[3]

Having read with interest the article in the April number of MACHINERY relating to the training of women in machine shop work, it was thought that the experience of the Cummings Machine Works in the training of women as machine operators and machinists would be of interest to the readers of MACHINERY. The Cummings Machine Works in Boston are engaged in the making of ship instruments, general machine work, and experimental work. The nature of the work is such that interchangeable manufacturing methods are applicable only to a small extent, and the women employed, therefore, must be trained not to be mere operators of machines, but to become general all-around machinists. In this respect the requirements of the Cummings Machine Works, therefore, probably differ to a large extent from those of most of the shops in which women workers are now being employed. At the present time about 115 men and 42 women are employed in the shops, but it is intended to increase the working force to about 150 men and 75 women, making the total number of women employed one-third of the working force. The girls are started as apprentices and given a training similar to that of a boy or young man who enters the shop. They are started at a wage of $9 a week and are kept on trial for a period of two weeks. If after this time they show no decided inclination for the work in the shop, they are dismissed, but in case they show ability, either as machine operators or assemblers, they are retained and their pay increased.

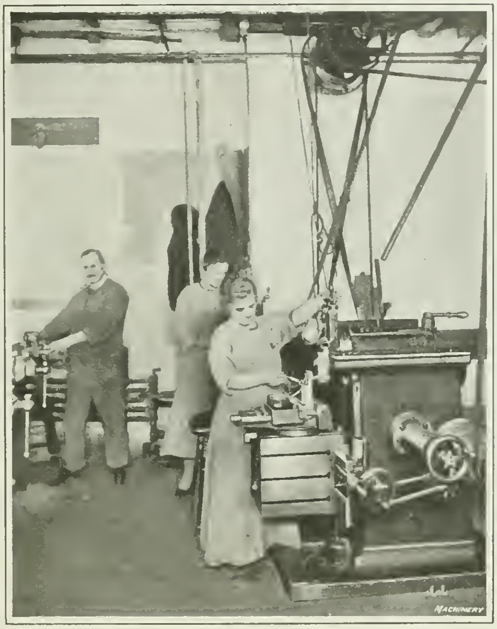

Fig. 1. Women operating Shapers in Shop of Cummings Machine Works, Boston, Mass.

It is now nine months since the company began employing women, and during this time only one has left voluntarily, while about ten have been dismissed as not fitted for this class of work. Being pioneers in Boston in the employment of women as machinists, the company has naturally acted as a guide for many other machine builders who have been employing or who are planning to employ women in the shops. The management believes that it is possible to train women to become toolmakers, and several of the girls now in the shop have shown such marked ability that in four years they will probably be as good toolmakers as most men.

At the present time, girls with from five to six months' training turn out in quality and quantity an amount of work equal to about 75 per cent of that of the average man employed, but it is confidently expected that when completely trained they will show 110 per cent efficiency as compared with the men. The principle of equal pay for equal work is being applied, and there is no distinction made in regard to compensation between men and women if they are equally efficient. The women work forty-eight hours per week. It has been found that they do not lose as much time as the men, and their record for being on time is higher than that of the men. The women leave five minutes earlier than the men at noon, as well as at night.

The women coming into the machine shop are recruited from almost all trades and conditions. Dressmakers are found to make good machinists, as well as department store girls and those who have formerly worked in laundries or at housework. Some women with previous experience in munitions work and in the making of typewriters and watches are also employed. Very strict discipline is maintained, but there has been no difficulty in maintaining proper conditions in the shop. The men have accepted the entry of the women into this work as a matter of course, and have proved willing to help and instruct newcomers. No conversation except that relating to the work is permitted during working hours, and social conversation between men and women is also forbidden on the premises during noon hours.

The most desirable age has been found to be between twenty-

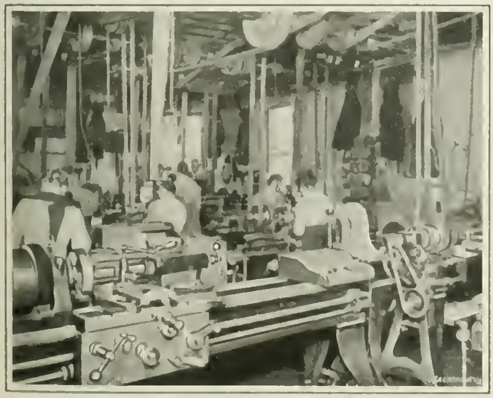

Fig. 2. Women operating Lathes in Cummings Machine Works

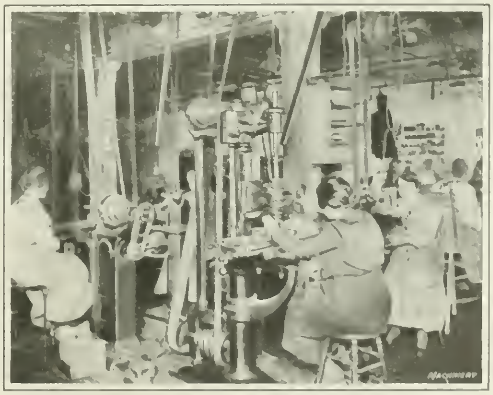

Fig. 3. Women engaged in Miscellaneous Machining Operations

two and thirty. Those that are younger are not serious-minded enough to apply themselves properly to their work, and those over thirty do not seem to have the nimbleness either in their mind or in their hands to take proper hold of the work. No difference has been found according to nationality. American and foreign-born girls are doing equally well, and on the whole it might be said that it has been found that the girls are more willing to work than the class of men which at the present time is obtainable in the labor market.

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[1] See also "War Work for Women," in MACHINERY, April, 1918; "Women Workers in Machine Shops in Great Britain," March, 1918; "Increased Employment of Women in the Industries," February, 1918; "Women Workers in the Shop," January, 1918; and "Women War Munitions Workers," June, 1917.

[2] Manager, Cummings Machine Works, 110 High St., Boston, Mass.

[3] Superintendent, Cummings Machine Works, 110 High St., Boston, Mass.

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ADVANTAGES OF STEEL OVER CAST-IRON PULLEYS

BY W. F. SCHAPHORST[1]

Many machinists believe that a cast-iron pulley is just as good as a steel pulley. However, an investigation into all the conditions will indicate that the steel pulley has many advantages. All pulleys should be strong and tough. Cast iron is strong in compression but not in tension, but steel is strong in both tension and compression, and its ultimate strength is double that of cast iron. Its resistance to shearing is also much greater. Steel is also tough, whereas cast iron is brittle. All machinists have experienced the ease with which cast iron breaks and know the result of a sharp blow on any part of a cast-iron pulley. A broken cast-iron pulley may seriously injure one or more workmen, let alone putting the machinery out of operation. The steel pulley would, therefore, seem to be the logical one from these two standpoints alone, neglecting all others. If a steel pulley is dented or bent, it is not put out of commission, but may be repaired.

Where speeds are high, centrifugal force also comes into action and the cast-iron pulley is likely to burst because of its weakness or brittleness. Steel pulleys can be run at higher speeds than any other metal pulley and are recommended for a rim speed up to 6000 feet per minute. The steel pulley also has the advantage of being 40 to 60 per cent lighter than cast iron for equal service. Unnecessary weight adds to fuel cost, loads up the shaft, increases the general friction in the hangers, and puts unnecessary stress on the hanger supports. Although for a single pulley the sum of these items may appear insignificant, the total saving where thousands of pulleys are used in a single shop will be considerable.

Since steel pulleys are generally split, whereas cast-iron pulleys are usually solid, the steel pulley has another advantage. If it is desired to place a solid cast-iron pulley on a line-shaft between several other pulleys, it is usually necessary to slip off a number of belts, remove a coupling, remove the shaft from the hangers, take off some of the pulleys, slip on the cast-iron pulley, replace the pulleys taken off, put the shaft back in the hangers, couple up, and put back the belts on all pulleys of the shaft section. The cost of doing this is often more than the first cost of a split steel pulley, which may be placed on the shaft directly without disturbing any of the other pulleys and without loss of time. Steel split pulleys also permit the use of interchangeable bushings. The bore of a pulley can be bushed down to fit any size of shaft below the size of the bore.

The set-screws generally used on cast-iron pulleys are another drawback. Much good shafting has been ruined by the ugly grooves cut in it by slipping set-screws. Shafting cannot stand much treatment of this kind and continue to give good service, because the grooves and small ridges scratched on the shafting in many cases make the removal of the pulleys very difficult. Split steel pulleys eliminate these troubles, for it is virtually impossible to cut up or seriously scratch a shaft with the bearing of a steel pulley.

The shrinkage of cast-iron pulleys at the time of casting is a source of much trouble, especially where the arms join the rim. The serious inner stresses commonly set up frequently cause cracking or weaken the pulley to such an extent that it breaks easily from slight jolts, or even from medium belt tension. It has been stated that more cast-iron pulleys are broken because of these internal stresses than from all other causes combined. Again, when a cast-iron pulley is heated by the friction of a creeping or slipping belt, the rim is bound to expand and the tension set up at the junction points may result in a fracture and the destruction of the pulley.

Tests have shown that both cast-iron and wood pulleys, when new, will hold a belt fairly well at light loads, but after use with normal or heavy loads they do not hold the belt nearly as well as pulleys with steel faces. Exhaustive tests by Prof. William M. Sawdon, of Cornell University, and by Messrs. Haven and Crosby, consulting engineers, of Boston, show that in the case of pulleys 18 inches by 12 inches, with a belt pull of 60 pounds per inch width of belt, a steel pulley slipped only 2.65 per cent, while a cast-iron pulley of the same size and operating under the same conditions had a belt slip of 5 per cent. In other words, there was a difference of 2.35 per cent in favor of the steel pulley. Another test gave the steel pulley a 2.7 per cent advantage. Where speeds are low, air resistance is of little importance, but countershaft pulleys and main drive pulleys often operate at speeds that make air resistance a factor, and in such cases the sharp steel pulley arm is another point in its favor.

On account of the uncertain characteristics of cast iron, the method of casting, and the fact that cast-iron pulleys must be machined before they can be used, it is usually necessary to balance them before they can be used on high-speed or relatively high-speed shafts. This is not necessary with the steel pulley, as steel is more homogeneous, and as the pulleys are made from sheet metal of uniform thickness, they are well balanced.

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[1] Address: American Pulley Co., 4200 Wissahickon Ave., Philadelphia, Pa.

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COMPOSITION OF HIGH-SPEED STEEL

In a paper read before the Steel Treating Research Society of Detroit, J. L. Thorne, of the Thorne Steel Treating Co., stated the following as the limits between which the various elements in high-speed steel are generally present: Carbon, 0.47 to 0.91 per cent; silicon, 0.12 to 5 per cent; manganese, 0.12 to 0.67 per cent; sulphur, 0.008 to 0.057 per cent; phosphorus, 0.006 to 0.051 per cent; chromium, 1.50 to 5.52 per cent; vanadium, 0.13 to 2.50 per cent; tungsten, 11.74 to 22.27 per cent. These figures are based upon samples analyzed in the laboratory of the Thorne Steel Treating Co.

For general purposes, the composition of high-speed steel which can be expected to give good all-around results when properly made and heat-treated is as follows: Carbon, 0.65 per cent; silicon, 0.12 per cent; manganese, 0.25 per cent; sulphur, 0.02 per cent; phosphorus, 0.02 per cent; chromium, 3.5 per cent; vanadium, 1 per cent; and tungsten, 18 per cent.

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CALORIZED IRON AS AN ELEMENT FOR THERMO-COUPLES

Various thermo-couples, with iron as one of the elements, have high electromotive forces and are fairly constant when a temperature under 500 degrees C. is required. Above this point, iron oxidizes rapidly, thus reducing the force of the couple. "Calorizing," that is, producing a coating of aluminum alloy upon the surface of the metal, will prevent oxidation below 1000 degrees C., and, at the same time, will not materially affect the electromotive forces. Under test, calorized iron wire gives substantially the same thermo-electric potentials as uncalorized wire, is practically as constant, and has much longer life. Certain grades of wire, however, may require heat-treatment before this will be found to be true. This possibility and the degree of heat required should be determined by experiment.

* * *

Before the war Germany obtained most of her copper from the United States, taking over one-third of our exports. She had a large stock at the outbreak of hostilities, but this has been depleted long ago, and supplies are now coming from other countries. The Serbian copper mines are now being intensively exploited by the Germans and Austrians, and good copper deposits are also found in Poland. Germany, herself, also produces fair quantities of copper.

Drill Grinding[1]

By Edward K. Hammond[2]

IN order to give satisfactory service, a drill must be ground so that its point is of the correct form. Efficient results cannot be expected from a drill in which the material and original workmanship are of the required standard unless the subsequent work of grinding to keep the point of the drill in working condition is handled in such a way that the proper form is maintained. It is very difficult to grind a drill by hand and secure the desired results without spending too much time on the work; men employed in factories manufacturing drills learn to do this work very rapidly as the result of their special experience, but the drilling machine operator or tool-room attendant who attempts to grind a drill by hand is likely to fail to produce a point which comes even reasonably near to meeting all requirements. It is generally conceded that the form of a drill point exerts a powerful influence upon the rate of production, accuracy of drilled holes, and the number of holes which can be drilled between successive grindings. Granting this to be the case, it at once becomes apparent that steps should be taken to provide for grinding drills in such a way as to enable them to give the maximum amount of service.

Requirements in Drill Grinding

For the average shop, the only way to be sure of attaining such a result is to have the drills ground on special drill grinding machines which are so designed that they assure producing drill points that meet all requirements. These requirements are as follows: (1) Both cutting lips of a drill must be inclined at the same angle with the axis of the drill. (2) Both cutting lips must be of exactly the same length. (3) The drill point must have the proper lip clearance or contour of the surface back of the cutting edges, and this clearance must be the same for each side of the drill. All of these factors are of the utmost importance in enabling a drill to give satisfactory service. The various undesirable conditions which it is possible to produce through improper drill grinding are shown in Fig. 1. If both lips of the drill are not inclined at the same angle a with the axis, one lip will fail to counteract the tendency of the other to spring away from the cut. Furthermore, this will result in having one lip of the drill do more work than the other, with the result that this lip will soon become dull, and an abnormal torsional strain will also be set up. When the cutting lips of the drill have the same inclination to the axis but are of different lengths, it means that the point of the drill is off center, and as a result the hole will be cut over size by an amount equal to twice the eccentricity of the drill point. It is also possible to have an error in both the angle of drill point and equality of length of the lips of the drill, and where such a condition exists there will be a combination of the undesirable results which have been mentioned.

Concerning Angles of Drill Points

An angle of 59 degrees has been adopted as the standard angle for the points of twist drills, and such a point is well suited for drills engaged on all average classes of work. There are certain cases, however, where a modification of the form of the drill point is considered advisable. For instance, where a drill is fed down onto the surface of a piece of work held at an angle to it, and where no guide bushing is provided to hold the drill in the desired position, it will be found desirable to make the drill point to an angle more acute than 59 degrees in order to facilitate penetration of the drill point without tendency for it to slide down on the surface of the work. Conversely, a drill which is used to make holes in fairly thin tubing will give better results where the point is made blunter than that of a standard drill. The reason for this is that the feed pressure of the drill tends to spring the tubing slightly until the point of the drill starts to break through; then the work springs back quickly to its original position and increases the rate of feed—the condition being similar to that explained in connection with Fig. 7, which shows the result of spring in the members of a drilling machine—and such a condition may cause the drill to be broken.

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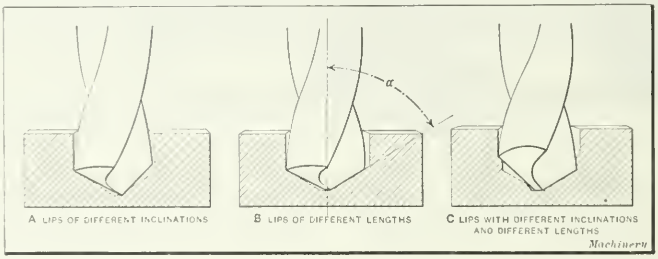
[1] For information on drilling practice previously published in MACHINERY, see "Speeds and Feeds for Drilling," in the April number.

[2] Associate Editor of MACHINERY.

The two conditions which have been cited are typical of instances where it is necessary to reduce the standard angle when grinding drills. In general, if there is marked trouble through breakage of drills, and the other conditions which are likely to result in breakage are considered satisfactory, a slight modification of the drill point may produce a drill which gives the desired results without trouble from breaking. Another case where it is necessary to modify the standard form of twist drills is when drills are used for cutting brass. Here the standard angle of rake provided for use in drilling iron or steel is such that the drill would tend to hog into the work and produce an unsatisfactory condition of operation. To overcome this difficulty, it is the practice to grind the drill so that the rake angle is reduced practically to zero. Drills ground in this way will cut quite freely and give a satisfactory rate of production.

Clearance behind Cutting Edges

In order that a drill may cut properly there must be the correct amount of clearance behind each of the cutting edges so that these edges may be forced down into the work. Where there is insufficient clearance a drill will not cut freely; and too much clearance results in weakening the tool at its cutting edges. Theoretically, the amount of clearance should be slightly in excess of that which is actually required for the rate of feed under which the drill is being operated, because any excess clearance results in a corresponding weakening of the cutting edge of the drill. As a matter of fact, drills are usually ground with an amount of clearance sufficient to take care of the maximum feed under which they are likely to be operated, and when so ground the amount that the cutting edges are weakened can safely be disregarded. In order to clearly understand the conditions which must be fulfilled in order to grind the desired amount of clearance on the point of a drill, it is necessary first to appreciate the fact that every point on each cutting edge is advanced on a spiral path as the drill is fed into the work. All of these spiral paths have the same lead—which is equal to the rate of feed per revolution—but each spiral has a different diameter.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A LIPS OF DIFFERENT INCLINATIONS
B LIPS OF DIFFERENT LENGTHS
C LIPS WITH DIFFERENT INCLINATIONS AND DIFFERENT LENGTHS
Machinery

Fig. 1. Conditions under which a Twist Drill may be forced to operate through Incorrect Drill Grinding

The clearance angle is defined as the angle which a tangent to the spiral path followed by a point on the cutting edge at the periphery of the drill makes with the axis of the drill. This fact in regard to each point following its own spiral path will be readily understood by referring to Fig. 2; a study of this illustration will also show the requirements which must be fulfilled in order to grind the proper clearance on the point of a drill. As the clearance angle at a given point is defined as the angle made by a tangent to the spiral path followed by that point with the axis of the drill, it will be apparent that the clearance must diminish from the periphery of the drill to the center. This is due to the fact that while the spirals at all points along the lip of the drill have the same lead, the diameter of each spiral is constantly growing less as we pass from the periphery of the drill to the center. Consequently the angles made by tangents to these spirals with the axis of the drill will constantly decrease. In drills made by the Cleveland Twist Drill Co., the clearance angle at the periphery is from 12 to 15 degrees, and this angle decreases uniformly from the periphery to the center in such a way that the angle made by the chisel point with each cutting edge of the drill is from 125 to 135 degrees. This is the condition indicated in Fig. 3.

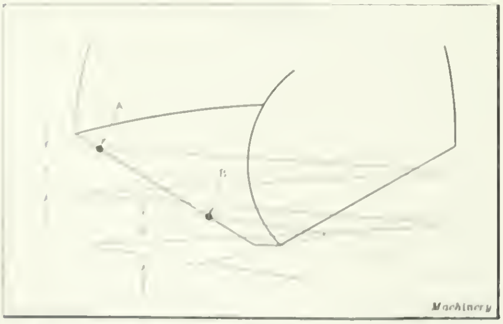


Fig. 2. Diagram showing how Feed Movement causes all Points on Cutting Edges of Drill to follow Spiral Paths of Same Pitch but of Different Diameters

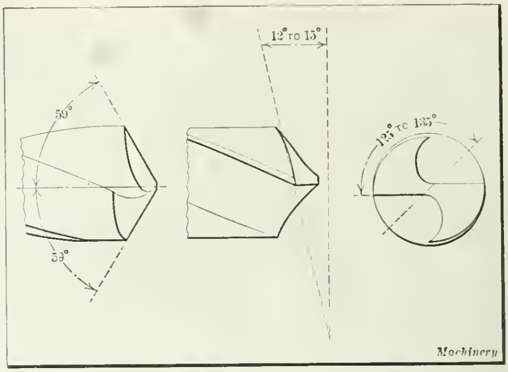


Fig. 3. Commercial Standards for Angle of Drill Point, Clearance, and Angle made by Chisel Point with Cutting Edges of Drill

In order to regulate the clearance so that it is correct for each lip of the drill all of the way from the periphery to the center, and to relieve each surface back of the cutting edges so that the proper degree of endurance and strength will be secured, it is necessary for the point of the drill to rock against the grinding wheel while it is being ground in a path similar to that which it follows while actually being fed into a piece of work. In order to secure this result, it is necessary to maintain the desired relation between the angle at which the drill is held against the grinding wheel and the axis about which it is rocked while in contact with the wheel. In Fig. 4, let *AB* in each diagram represent the axis about which the drill is rocked while being ground, and let *C* and *D* represent the radii of arcs through which different portions of the drill lip will be swung during the grinding operation. In order to have the clearance decrease from the periphery of the drill to the center, it is obvious that those portions near the center must travel on shorter paths and smaller circles than portions near the outer corner of the lip. In other words, radius *C* must be shorter than radius *D* in order to secure the desired clearance. It will be apparent that in the first two diagrams this condition is attained, while in the second two there is failure to secure the required condition.

Measuring or Gaging Drills after Grinding

In Fig. 5 are shown various methods of gaging twist drills after grinding in order to determine the accuracy of the point angle, the clearance, etc. At *A* is shown a simple gage made by the Standard Tool Co. for measuring the accuracy of the

59-degree point angle, and it will be seen that this gage is also graduated in such a way that it may be used to measure the length of the two cutting edges to see that these are equal. Used in the manner shown at *B*, this gage can also be employed to measure the center angle, i.e., the angle made by the chisel point with the cutting edges of the drill. Although the included angle of this gage is only 118 degrees and an angle of 130 degrees is required between the chisel point and cutting edges of the drill, the use of the gage in this way enables a very close estimate to be made of the accuracy of the angle of the chisel point, and it will be recalled that this angle determines the clearance provided for the cutting edges.

At *C* is shown how a protractor may be used to measure the point angle, and this illustration is self-explanatory. Another method of measuring the angle of the drill point is shown at *D*, and this method also affords a means of obtaining an idea of the accuracy of the clearance provided behind the cutting edges. The length of each cutting edge is first measured with the scale to see that they are equal; and if so, the drill is supported as shown and measurements are made at each side, as indicated in the illustration. If these measurements are equal, it shows that the point angle is the same at both sides of the drill. This method may also be used to measure the clearance provided for each cutting edge by placing the drill point beside the scale as shown, and then slowly revolving the drill. If the clearance at each side is not the same, it will be indicated by a difference in the relative positions of the drill and scale for corresponding positions of the drill. It must be borne in mind that this method indicates the clearance provided at the heel of the drill only, and while this clearance may be correct, there may still be a serious error in clearance near the drill point. At *E* and *F* are shown two types of gages made by the Morse Twist Drill & Machine Co. for testing the angle of drill point; these illustrations show clearly the method of using the gages without requiring a description.

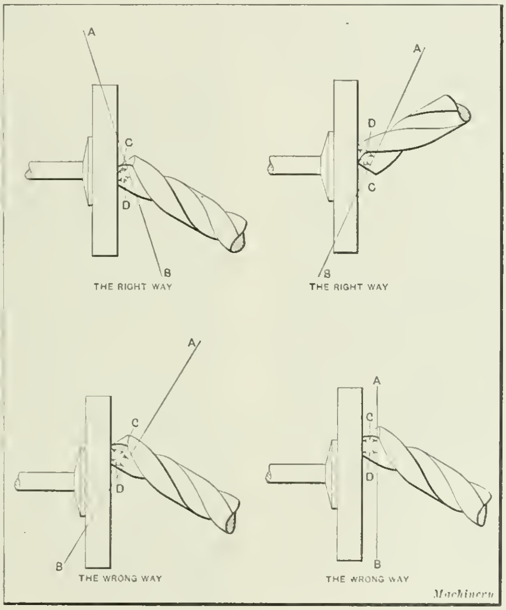


Fig. 4. Diagram showing Correct and Incorrect Methods of holding Drill Point against Wheel while grinding

Use of Drill Grinding Machines

There are a number of drill grinding machines on the market which are properly designed to provide for accurately securing the required contour for the drill point. Drills ground on such machines ought to meet all of the requirements to which attention has been called. It should scarcely be necessary to call attention to the fact that it is very important for the drill grinding machine to be kept in proper adjustment in order to produce the expected results, but we were recently told of one shop which purchased its twist drills from a well-know manufacturing firm, and an investigation made to determine the cause of breakage of drills for which a replacement claim had been made revealed the fact that the drill grinding machine used in this shop was so badly out of adjustment that it failed to produce drill points of the required form. When attention was called to the fact that the broken drills had been improperly ground, the possibility of such a condition was promptly denied, as it was asserted that "they had been sharpened on a drill grinder." Subsequently this machine was properly adjusted and a responsible mechanic was employed to do all of the drill grinding, and since that time there has been a marked falling off in the number of drills broken in the shop. Several manufacturers of twist drills who have had a great deal of experience with troubles which may result through improper grinding state that in shops using any considerable number of drills the wages of an experienced mechanic, placed in charge of all drill grinding and held responsible for the results obtained, would be more than paid by the saving in broken drills.

How to Grind a Drill by Hand

It is a difficult matter to grind a drill by hand and secure the desired results without taking altogether too much time in performing the grinding operation, as previously mentioned. Nevertheless, the mechanic who makes an intelligent study of the requirements of drill grinding can learn to grind a drill by hand after he has had enough experience to enable him to acquire the necessary degree of dexterity. One method of grinding drills by hand, which is capable of giving satisfactory results, is to hold first one lip of the drill and then the other against the grinding wheel so that a flat clearance surface is ground at the back of each cutting edge. In doing this work great care should be taken not to change the angle which the chisel point of the drill makes with the cutting edges, as it is the angle of the chisel point which determines the amount of clearance provided for the cutting edges. After these flat clearance surfaces have been ground, the mechanic very carefully swings the drill back and forth so that the flat ground surfaces are blended into the remainder of the surface back of each cutting edge. This method of grinding will not produce a drill point which appears to approximate closely the form produced on a drill grinding machine, but the results obtained with a drill ground in this way will often be far more satisfactory than those resulting from the use of a drill ground by hand, where the mechanic has attempted to secure a closer approximation of the original form of the drill point through swinging the drill back and forth on the surface of the grinding wheel.

If the mechanic attempts to grind a drill by hand and duplicate the movement secured through the use of a drill grinding machine, the proper method of procedure is as follows: The drill is held between the thumb and index finger of the left hand at a short distance back of the point, and the hand is steadied by the tool-rest of the tool grinder. The drill is held at such an angle to the grinding wheel that the surface of the drill point rests flat against the wheel, and great care must be taken to have the chisel point of the drill in a vertical position; in other words, the cutting edge of the drill is inclined upward. With the drill held in this position, the mechanic grips the shank between the thumb and index finger of his right hand and slowly oscillates the drill about an imaginary axis, between the thumb and index finger of his left hand, taking care to keep the chisel point vertical at all times. After grinding one side of the drill in this way, the drill is turned over so that the other side may be ground. This method can be used with extremely satisfactory results by men who have had a great deal of experience in drill grinding, but it is probable that the average mechanic will secure better results through the method of hand grinding referred to in the preceding paragraph. In any case, hand grinding is not recommended for the average shop, as the superior speed

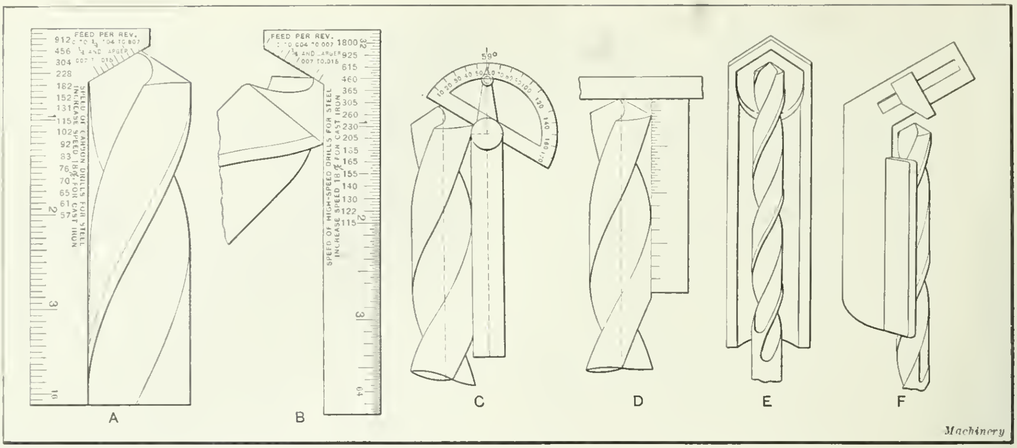


Fig. 5. Methods of measuring Angle of Drill Point, Angle made by Chisel Point with Cutting Edges and Clearance behind Cutting Edges

and quality of workmanship obtained through the use of drills ground on a drill grinding machine are quite sufficient to warrant the investment in an equipment of this kind.

Effect of Improper Drill Grinding

A better idea of the actual effect of improper drill grinding will be gathered by reference to Fig. 6, which shows various conditions of the drill point which are made possible through correct or incorrect grinding. At *A* is shown a drill ground with the proper clearance for the cutting edges, and at *B* is shown a drill on which an insufficient amount of clearance has been furnished at the center, although there is plenty of clearance at the heel of each cutting edge. It will be recalled that the angle of the chisel point, i.e., the line separating the two faces of the drill point, indicates the amount of clearance provided for the cutting edges, and at *C* is shown what is likely to happen to a drill where the angle of the chisel point and clearance of the cutting edges are insufficient. This drill had plenty of clearance at the heel, but very little clearance at the center, with the result that it was split up the center. A better idea of the way in which the angle of the chisel point indicates the amount of clearance will be gathered by referring to the two end views of the drill shown at *D* and *E*. At *D* is shown a drill in which the chisel point has been ground to make an angle of 130 degrees to the cutting edges, which gives a sufficient amount of clearance, while at *E* the angle formed is only 100 degrees, and this drill has insufficient clearance.

Most twist drills are made in such a way that the web at the center increases in thickness as the length of the drill is gradually decreased in sharpening. On account of this increase in web thickness, mechanics have acquired the practice of grinding away the web at the drill point or "thinning" the web, as the process is commonly called. A great deal of trouble is likely to result from this practice of thinning the drill point, due to the excessive amount of metal which is often ground away. Where skilled mechanics do the work and are careful to grind away only a sufficient amount of metal to maintain the web thickness equal to the original thickness of the web at the point of the drill when it was new, this practice is not detrimental; but if an excessive amount of grinding is done, it is almost sure to produce undesirable results. At *F* is shown a drill point in which the web has been properly thinned to reduce it to the original dimension, while at *G* is shown a drill point on which thinning has been carried to excess. A drill ground in this way is extremely liable to break through splitting up the center, and such a drill will also require more power to drive it, due to trouble experienced in clearing the chips. While provision of the necessary amount of clearance for the cutting edges of a drill is highly important, it is equally important not to provide too much clearance, because in such cases an insufficient amount of metal is left behind the cutting edges and trouble is likely to be experienced through chipping the drill. At *H* is shown a drill on which the proper amount of clearance has been provided, while at *I*

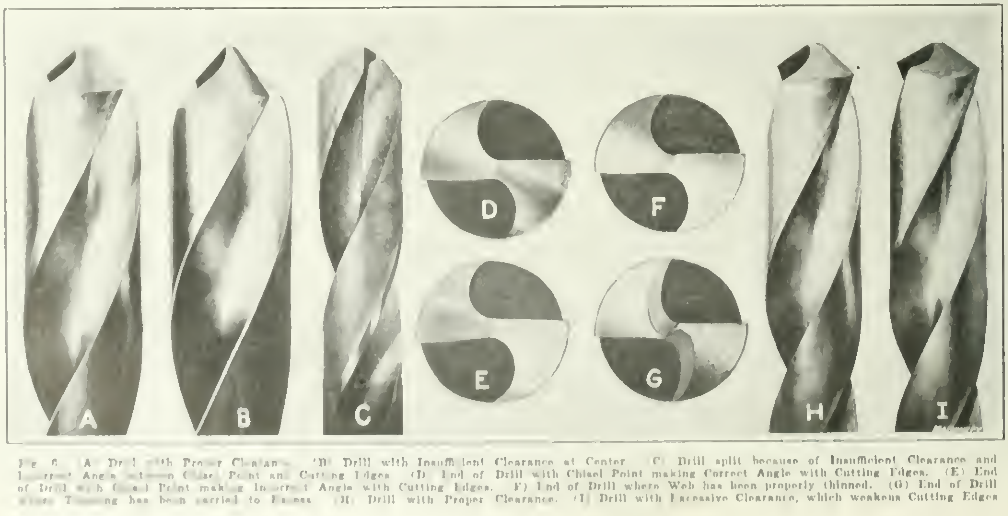


Fig. 6. (A) Drill with Proper Clearance. (B) Drill with Insufficient Clearance at Center. (C) Drill split because of Insufficient Clearance and Incorrect Angle between Chisel Point and Cutting Edges. (D) End of Drill with Chisel Point making Correct Angle with Cutting Edges. (E) End of Drill with Chisel Point making Incorrect Angle with Cutting Edges. (F) End of Drill where Web has been properly thinned. (G) End of Drill where Thinning has been carried to Excess. (H) Drill with Proper Clearance. (I) Drill with Excessive Clearance, which weakens Cutting Edges

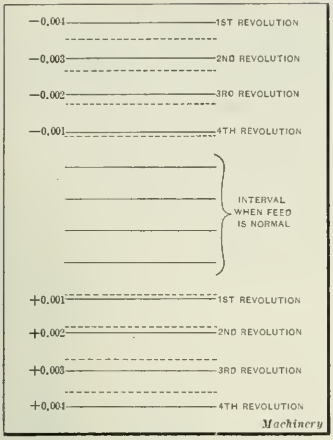


Fig. 7. Diagram showing how Spring in Drilling Machine causes Excessive Rate of Feed, which may break Drill

the drill is ground away to provide excessive clearance, which has weakened the edges so that they are liable to chip and make the drill give very unsatisfactory results in operation.

Causes of Broken Drills

The conditions of service under which a twist drill operates are more severe than those imposed upon almost any other type of cutting tool, because the drill must of necessity be of such size that it can enter the hole in which it works, while its cross-section has to be greatly reduced in order to provide the required clearance for the escape of chips. Despite this fact, it is quite probable that the average twist drill receives as little consideration as any tool used in the machine shop, there being a somewhat general impression among mechanics that a twist drill is sold ready for use and can properly be expected to continue to give satisfactory service regardless of the way in which it is handled. The fallacy of this idea is clearly shown by the tremendous wastage which occurs every year through breaking drills as a result of improper use. Reference has already been made to the conditions that must be fulfilled in order for a drill to give efficient service, and if the grinding operation is not conducted so that these conditions are fulfilled, an abnormal strain is likely to be placed upon the drill which may rapidly assume sufficient proportions to cause it to be broken.

There is another point which is likely to be responsible for breaking of drills, namely, the spring and lost motion in drilling machines due to improper design. The way in which this condition is likely to cause breakage of drills will be understood by reference to Fig. 7. For the sake of discussion, we will assume that the members of a drilling machine can be sprung 0.010 inch as a result of back-pressure exerted by the drill while in operation. During the time that this spring is being imposed upon the machine members, the rate at which the drill point is fed into the work is represented by the normal feed per revolution *minus* the amount of spring imposed upon the members of the drilling machine per revolution.

When this lost motion has been taken up, the drill will continue to operate at the normal rate of feed until such a time as the drill point breaks through the work at the bottom of the hole. When this result takes place there will be a sudden reduction of back-pressure exerted by the drill, with the result that the strained members of the drilling machine will suddenly react; now, under these conditions, the rate of feed will be the normal rate provided by the gearing in the feed-box *plus* the increase due to a sudden release of the strain on members of the drilling machine. This sudden increase in the rate of feed as the drill breaks through is the reason why so many drills are broken at just this point, and not because there is any tendency for the bottom surface of the work to catch the cutting lips of the drill according to a somewhat general impression which exists among mechanics who have given very little thought to the situation.

Now, in the case of a drilling machine where the parts have not been designed in a way which assures the required degree of rigidity, it is obvious that one of two conditions must exist: either the rate of feed must be made the maximum safe rate for the drill *minus* the amount of additional feed imposed upon the drill during the time that it is breaking through the hole at the bottom of the work, or else the risk must be run of breaking a number of drills through this sudden increase in the rate of feed while the operation is being finished. Obviously, the decision of any experienced production manager will be that neither condition will meet his requirements. He will insist upon the purchase of drilling machines of sufficiently rigid construction so that the amount of back-pressure exerted by the drill point while penetrating the work will not be sufficient to cause an appreciable amount of spring.

Determination of Magnitude of Feed Pressure and Torsion

In connection with research work conducted by engineers of the Cleveland Twist Drill Co. to determine the magnitude of strains imposed upon a twist drill due to feed pressure and torsional resistance, a special drilling machine was constructed in such a way that the table of the machine rests upon a piston-rod connected to a piston entering a cylinder filled with oil. When a drill mounted in the spindle of this machine is driven into a piece of work supported on the table, it will be obvious that pressure exerted by the drill results in introducing a corresponding amount of pressure on the piston, and hence on the oil contained in the cylinder. A recording pressure-gage connected to this cylinder makes it possible to calculate the amount of pressure exerted by the drill while penetrating the work. To prevent rotation of the table of this special drilling machine, a radial arm is carried out from the table and provided with a piston-rod connecting with a piston in a second oil cylinder. A recording pressure-gage is also connected to this cylinder, by means of which it is possible to measure the torsional stress upon the drill.

Fig. 8 shows a combined feed-pressure and torsion chart for a 1¼-inch drill operated in this machine, and this chart illustrates very clearly another important consideration in preventing broken drills as a result of spring in the drilling machine members to which reference was made in a preceding paragraph. This is the provision of a proper amount of clearance on the drill surfaces behind the cutting edges. Reference to this pressure-torque chart will make it apparent that there is a pronounced difference in feed pressure and torsion for each of the pairs of curves recorded on this chart. These differences in feed pressure and torsion are due to the fact that the drill used in making one pair of curves, where the feed pressure and torsion are greater, was ground on a machine which provides less clearance for the drill point than is the case on the drill grinding machine which ground the drill used in drawing the pair of curves where feed pressure and torsion are less. Obviously, this lays emphasis upon the importance of grinding drills on a machine which will provide the required amount of clearance to enable satisfactory operation to be secured under the maximum amount of feed that will be used under the most severe conditions of operation,

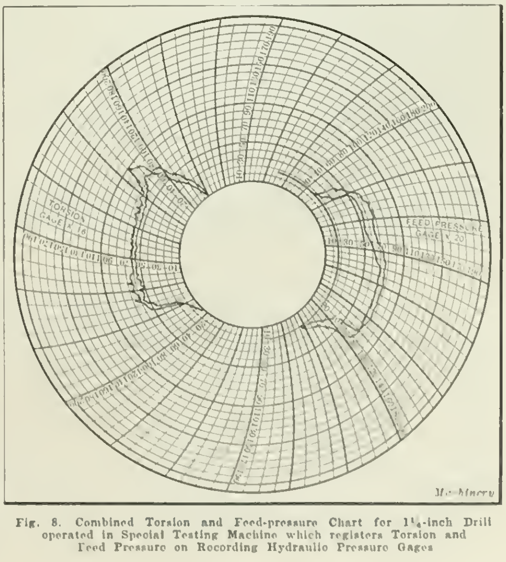


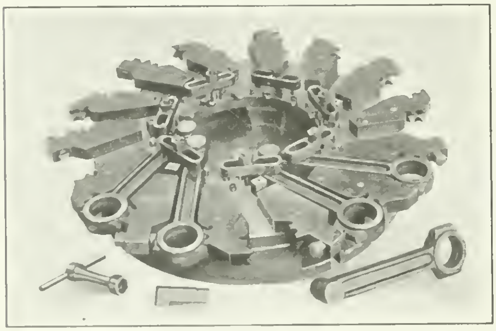
Fig. 8. Combined Torsion and Feed-pressure Chart for 1¼-inch Drill operated in Special Testing Machine which registers Torsion and Feed Pressure on Recording Hydraulic Pressure Gages

without unduly increasing the pressure and consequent spring in the drilling machine. In this connection the reader's attention is directed to the paragraph on drill grinding which explains methods of measuring the amount of clearance provided on the drill point to make sure that this conforms with the recommendations of firms specializing in the manufacture of drills. In the case of the feed-pressure curves in the chart, it will be seen that the pressure first runs up rapidly and then takes a peculiar drop before assuming the normal condition. This drop is due to the fact that near the center of the drill, the cutting edges have practically no rake; the pressure runs up while the point of the drill is entering the work, and when approaching the periphery, where there is a considerable amount of rake, this rake helps to pull the drill into the work, thus reducing the feed pressure and producing the peculiar dip seen in the feed-pressure curves.

* * *

CONTINUOUS MILLING FIXTURE

The accompanying illustration shows a continuous milling fixture made by the Becker Milling Machine Co., Hyde Park, Boston, Mass., which is employed for the milling of the connecting-rods for the Liberty motor on a double-spindle Becker vertical milling machine. Four surfaces on the rods are milled at once, the top and bottom surfaces at each end being milled simultaneously. The main spindle, which is provided with two cutters, one for the upper and one for the lower surface, mills the outer end of the rod, while the auxiliary spindle with cutters mounted in a similar manner mills the inside end of the rods. Fourteen connecting-rods are mounted in the fixture at a time, and as the fixture rotates on the table, the finished rods are taken out and new rods are inserted by the operator while the work progresses. Every other jaw for holding the connecting-rods is fixed, while every alternate jaw is pivoted at one end. By clamping against one rod with a clamping screw at the extreme end of the pivoted clamp, pressure is brought to bear upon the ends of the connecting-rods on each side of the pivoted clamp, thus making the clamping very rapid. At the inside end, one clamp also holds two rods in place. This clamp is provided with a small pin which fits into a slot in the clamping stud, so that, when tightened, the clamp must always be in one position and cannot come out far enough to interfere with the milling cutters.



Continuous Milling Fixture for Liberty Motor Connecting-rods

* * *

An agreement has been reached by representatives of the piano manufacturers and the War Industries Board by which a curtailment of 30 per cent of the output will be made. Meanwhile the War Industries Board will arrange for the transfer of war work to the musical instrument factories wherever possible. It is probable that the curtailment plan will be extended to all building activities and the industries manufacturing building materials that are needed for war work. The brewing, window glass, and boxboard industries already have made voluntary agreements to reduce production from 30 to 50 per cent, and it is understood that restrictions suggested for the automobile industry are to be enforced

CENSUS REPORT OF MACHINE TOOL INDUSTRY

According to a partial report of the 1914 Census of Manufactures, which has just been published, there were in that year, in the United States, 409 establishments making machine tools and 277 establishments making other metal-working machinery. The machine tools manufactured that year were valued at $31,446,660, and the other metal-working machinery at $17,419,526. Ohio was the leading state in the production of machine tools, with products constituting over one-fourth of the total reported for all states. Rhode Island ranked second, Connecticut third, and Massachusetts fourth. In the manufacture of other metal-working machinery, Pennsylvania was the leading state in the value of output, with New York ranking second, Ohio third, and Connecticut fourth. The four states combined contributed nearly three-fourths of the total value of products. The output, according to states, is given in the table.

VALUE OF METAL-WORKING MACHINERY MANUFACTURED IN 1914

State	Value of Machine Tools	Value of Other Metal-working Machinery
Ohio	$9,014,178	$2,909,389
Rhode Island	3,679,190	174,490
Connecticut	3,280,940	2,407,987
Massachusetts	3,042,894	859,608
Pennsylvania	2,466,198	4,069,278
Illinois	1,935,861	1,902,651
New York	1,782,494	3,160,369
New Jersey	1,558,412	546,346
Michigan	1,179,761	280,564
Wisconsin	1,004,812	209,052
All other states	2,501,920	899,792

Machinery

* * *

BRANCH GAGE LABORATORY OF THE BUREAU OF STANDARDS

The Bureau of Standards has announced that a branch gage laboratory has been established in New York City. This laboratory was opened and prepared to receive gages for test on April 15. It is located on the sixth floor of the Engineering Societies Building, 29 W. 39th St., New York City, where it is easily accessible both from the Pennsylvania and the Grand Central stations. The object of the laboratory is to take care of gage testing in the New York district, but all gages which are ordered by the War Department for test at the Bureau of Standards at Washington should be submitted directly to the Bureau of Standards in Washington.

The branch laboratory, however, has facilities for testing all types of munition limit gages, and the equipment installed is practically a duplication of the various machines and devices used by the Bureau of Standards in Washington for testing plain plug and ring gages, profile and other forms of gages, especially screw-thread gages. The facilities of this branch laboratory are available, without charge, to manufacturers carrying out government contracts for munitions of war. Gages may be submitted by mail, express, or by messenger. It is recommended that they be sent by registered or insured mail rather than by express, on account of the saving of time. Firms submitting gages for test are requested to furnish complete information as to the identification and classification of the gages, instructions for test and shipment, and information as to the drawings and specifications which establish the important dimensions of the gages submitted. If copies of the Ordnance Office drawings or other government gage drawings or part drawings are submitted with the gages, it will greatly facilitate the test and permit the sealing of the gages.

* * *

According to an estimate made by the National League of Women's Service, 1,266,000 women at the beginning of this year were employed on work directly or indirectly necessary for the carrying on of the war. Of this number, 100,000 were employed in the munitions factories.

LETTERS ON PRACTICAL SUBJECTS

WE PAY ONLY FOR ARTICLES PUBLISHED EXCLUSIVELY IN MACHINERY

CORRECTING ERRORS IN PRECISION SCREW-CUTTING LATHE

It is a well-known fact that the lead-screws on ordinary lathes, such as are used for general manufacturing operations, are not accurate enough for such work as making thread gages, and they have to be either corrected or replaced. The lead-screws are usually a little short in lead and a thread cut on an ordinary lathe is likely to be slightly "drunken" or irregular because of such inperfections as play in the spindle or inaccuracy in the gearing. While these errors may be slight, they can readily be detected by precision testing methods.

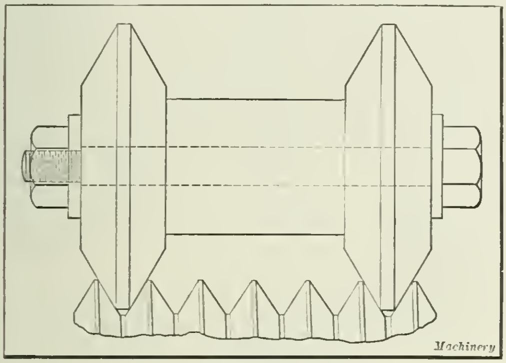


Fig. 1. Gage for testing Lead of Thread

In examining a lathe to be used for precision screw cutting, all radial and end-thrust bearings from the headstock down to the lead-screw should be carefully gone over and corrected, if necessary. Any endwise movement of the main spindle or lead-screw is, of course, particularly objectionable. It is also essential to correct any errors there may be in the gearing. For instance, the bushing that carries the intermediate gear may be from 0.005 to 0.007 inch eccentric, in which case it should be replaced by a new one. The gear teeth must also be accurate, both as regards evenness of spacing and concentricity.

After correcting the parts referred to or replacing them with new ones if necessary, the lathe must be provided with an accurate lead-screw. In order to illustrate the method of procedure, we shall assume that the screw is 0.0005 inch short per inch and the problem is to produce a new lead-screw of the correct lead. In order to do this, the taper attachment is used to compensate for the error in the original lead-screw while cutting a new one. If the lathe is intended for such work as threading plug gages, a short master screw can be used. Obviously, the length of screw that can be cut while held between the centers of the lathe in the usual manner is limited; therefore a comparatively short screw is cut and this master screw is connected to shafting as shown in the upper part of Fig. 3, so that the length will suit the lathe. It is first necessary to determine to what angle the taper attachment should be set. Since the original lead-screw on the lathe is short 0.0005 inch per inch or 0.006 inch per foot, the cosine of the angle to which the taper attachment should be set equals $\frac{11.994}{12} = 0.9995$. Referring to a table of cosines, we find that 0.9995 is the cosine of 1 degree 49 minutes, which is the amount the attachment is inclined from its parallel position. The master screw blank is next set parallel with the taper attachment by traversing an indicator along it. A follow-rest should be used even if the screw is only 30 inches long, and this should be clamped to the independent slide which connects with the taper attachment. The driving end of the dog should have a ball-shaped end and the faceplate slot should be made as square as possible on account of the rocking motion of the dog in driving the part when held at an angle. As it is difficult to make perfect gearing, there should be as few gears as possible between the lathe spindle and the lead-screw.

In order to test the accuracy of the lathe before cutting the master screw, it should be used for cutting a trial thread on a short plug. A plug about 6 inches long, 1½ inch in diameter, having 10 threads to the inch will be found convenient for measuring. Fig. 1 illustrates the type of gage used for testing the accuracy of the thread. This gage consists of two disks, a spacing collar, and a bolt for holding the parts together. In order to insure accurate angles for this gage, 60-degree male and female gages of the form shown in Fig. 2 are used. The

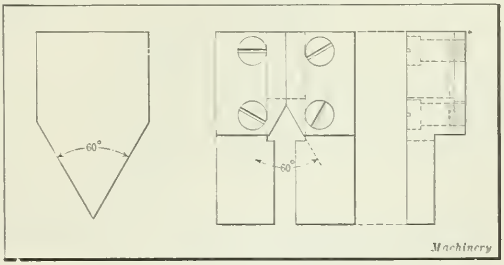


Fig. 2. Sixty-degree Angle Gages

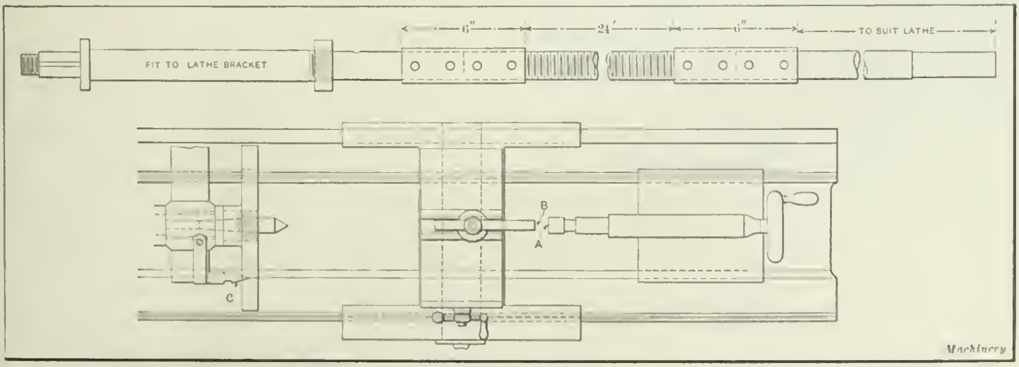


Fig. 3. (Upper Illustration) Master Lead-screw for Precision Lathe. (Lower Illustration) Method of detecting Irregularity of Motion between Spindle and Lead-screw

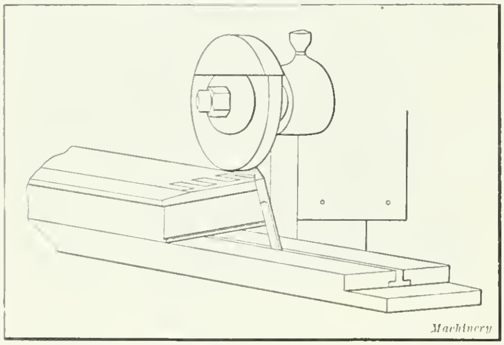
sine-bar and Johansson gages are used in connection with this work in order to reduce the error to a minimum. If the center-to-center distance between the disks of the gage shown in Fig. 1 measures exactly 1 inch as closely as can be determined, no light should be visible between the gage and the screw when applied as shown in the illustration.

The next test is to determine whether the lathe cuts an even thread or one that is irregular or "drunken." The method of making this test is illustrated in Fig. 3. A plug *A* having a smooth and true end is fitted to the tailstock spindle and a piece having a flat end *B* is clamped on the toolpost. These end surfaces *A* and *B* should be parallel. A large faceplate is mounted on the spindle, and two lines are located on it 180 degrees apart. The lathe is geared to cut, say, ten threads per inch, and the pointer at *C* is used to indicate half revolutions. Each time the spindle is turned a half revolution, the distance between surfaces *A* and *B* is measured by using Johansson gages. If the errors in the lathe have been eliminated, the movement for each half revolution should equal 0.050 inch. In manufacturing thread gages, it is advisable to use the master screw-cutting lathe only for making other lead-screws; otherwise its accuracy will soon be impaired as a result of wear.

Beloit, Wis. J. E. Lindgren

TRUING AN EMERY WHEEL QUICKLY

When truing an emery wheel on a surface grinder provided with a magnetic chuck, it is customary to clamp the diamond holder in the vise or in a special fixture. However, the vise may be in use on another machine, or the spindle of the grinder may have been lowered so that the wheel is so near the magnetic chuck that a vise could not be used to hold the diamond holder without raising and again lowering the spindle. By the following method no vise or fixture is needed to hold the diamond holder in truing a straight wheel. The holder is milled on the sides until its thickness is 1/32 inch less than the width of the bolt slot, in which it is placed so as to lean against the magnetic chuck at an angle of about 15 degrees, as illustrated. It is then held firmly to one side with the right hand. The spindle is lowered until the diamond touches the wheel, and, using the left hand to turn the handle, the diamond is traversed across the face of the wheel. This method, of course, is not recommended for large wheels.



Quick and Easy Method of truing an Emery Wheel

New York City E. J. Higgins

MILLING A RIFLE GAGE

It might be of interest to many employed in rifle factories to know the methods used by one large munitions plant in milling the gage shown in Fig. 1. The first method was to straddle-mill each lug to width and depth and then machine to the proper diameter between the lugs with a small end-mill. In this way it was possible to produce about three gages in eight hours. Later, a form cutter like that shown in Fig. 2 was made. With this, four cuts completed the gage, so that an apprentice boy could produce three gages an hour. But this output is doubled when the form cutter shown in Fig. 3 is used. The radius is backed off 6 degrees; then when the table is set at 6 degrees, which is the angle of the spiral, the cutting edge of the radius is at an angle of 90 degrees with the 0.285 inch diameter of the gage. By this method one-half of the gage is finished in one cut, as shown; the machine is indexed twenty turns, or half way around, and the gage is finished by the second cut.

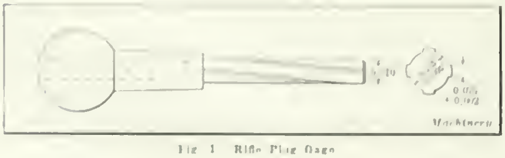
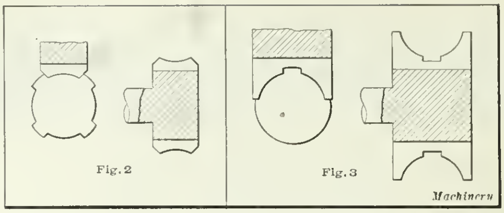


Fig. 1. Rifle Plug Gage



Figs. 2 and 3. Form Cutters for milling Rifling Gage

Bridgeport, Conn. George W. Cook

LOSS DUE TO NOT MOVING PARTS PROMPTLY

It is very important that all work in a factory or machine shop be moved promptly from place to place as the different operations, including inspection, painting, and assembling, are completed. This prompt movement prevents any possible lag between operations and encourages the operators to work as quickly as possible, for it will convince them that there is a real need for their output. Such promptness will have a better effect on the average workman than the word "Rush" marked on the order, regardless of the size of type or lettering or the color of ink or pencil used. Nothing will take real interest out of a man quicker than to have his work lie around after he has finished it. In cases where the movement between operations is dependent on the individual operators or departments, it is much better to have those finishing their parts make the deliveries rather than have those who are to do the next work go after them.

Watervliet, N. Y. Martin H. Ball

AIR-RIFLE BRACE

In Fig. 1 is shown the brace used in an air rifle, and in Fig. 2 are shown three views of the two-stage follow-die for making it in one operation. The finished piece is shown at *A*, Fig. 1, and at *B* is shown the strip from which it is made, with the legs bent down. The usual method of making a piece of this shape is to use metal the width of the piece, cut out scrap to the cut off, and form the piece on top of the die. This necessitates some waste and is slow, as the piece must drop from or be knocked off the die. Sometimes the piece is pushed through the forming die, which is a much faster process, but does not give good square bends.

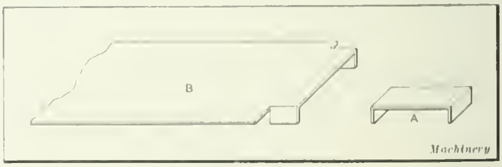


Fig. 1. Air-rifle Brace

In the die shown in Fig. 2 the piece is formed across the strip, cut off without waste, and pushed through the die, and as the motion is very short, the strip can be fed into a press making 125 to 150 strokes a minute with no trouble. As the

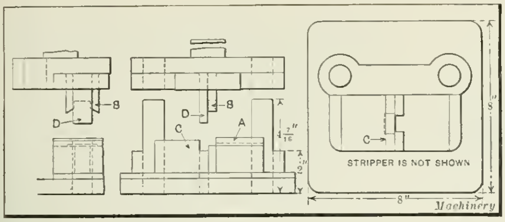


Fig. 2. Two-stage Follow-die for forming Air-rifle Brace

edges are sheared, the brace is not quite so smooth as if made the other way, but the corners are square and sharp, and tumbling smooths it. The operation is simple. The strip is fed through the stripper *A*, Fig. 2, under the punch *B*, which shears and turns down the legs. The punch bottoms the piece on the die and so squares the corners. On the up stroke, the strip is moved forward to the solid stop *C*, so that on the next down stroke the first piece is cut off and pushed through by the punch *D*, which is backed by stop *C* while punch *B* is forming the next brace.

Plymouth, Mich. W. B. Greenleaf

GEARS TO CUT THREAD OF 4.5-MILLIMETER PITCH

An operator wanted to cut a thread of 4.5-millimeter pitch on a lathe that had a lead-screw having five threads to the inch and a fixed gear on the stud having twice as many teeth as the gear on the spindle with which it meshed. As there are 25.4 millimeters in one inch, there were $25.4 \div 4.5 = 5.644$ threads to the inch to be cut. As the lead-screw has five threads to the inch and is geared 2 to 1, the ratio of the gears desired is $\frac{10}{5.64}$. Setting the slide-rule to $\frac{10}{5.64}$, it is found that among the whole numbers that coincide, the ratios $\frac{62}{35}$, $\frac{55}{31}$, and $\frac{48}{27}$ come very close to the requirements. By having several sets of numbers to choose from, gears that will fit the conditions may easily be found, and one or more gears may be on hand that can be used. J. C. S.

BROACHING SQUARE HOLES

Figs. 1 and 2 show a method the writer recently used for rough-broaching a hole 1/2 inch square in a piece of tool steel, enough stock being left to finish with a sizing broach. A piece of 1/2-inch, round, cold-drawn steel that was a little more than twice the length of the piece to be broached was used as a pilot; from this a quarter section was milled as shown. A piece *D* of Armstrong self-hardening steel, one-third longer than the work, was used for the broach; this was given a slight taper and was left from 0.004 to 0.005 inch under size at the larger end. The pilot piece *A* was then inserted in the hole, and the broach *D* was inserted in the quarter section *M* and forced through in the arbor press. Piece *A* was then turned a quarter turn, gaging by the eye, and the operation repeated on the other three corners, as shown by the dotted lines in Fig. 2. The hole was then broached to size with a multiple-tooth sizing broach. The piece to be broached by this method should be cut 1/8 or 3/16 inch longer than the finished size, as the first operation has a tendency to break out the corners on the opposite side. This can be avoided, however, by using a double-cut broach of 3/16 and 1/4 inch size or by using two pieces.

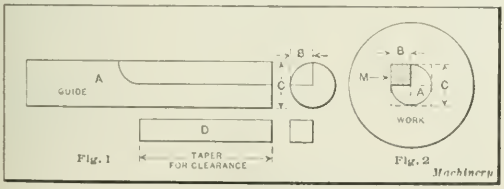


Fig. 1

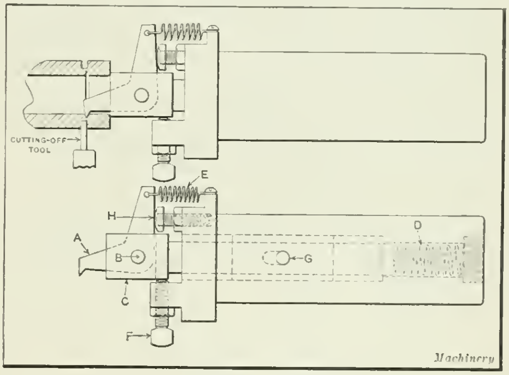
Fig. 2

Figs. 1 and 2. Broaching Square Holes

Bremerton, Wash. Stanley Edwards

CHAMFERING TOOL

When collars or similar parts are cut from bar stock or tubing, the inner edge which is left sharp is sometimes removed by a second chamfering operation. The tool shown in the accompanying illustration is designed to chamfer the inner edge of work of this class before the part is completely cut off from the bar or tube. This tool is held in the turret and it is arranged to feed the cutter inward automatically for forming a beveled surface opposite the end of the piece being severed by the cutting-off tool. The upper view shows the tool in operation, and the lower view illustrates its construction. The cutter *A* is pivoted on pin *B* which is carried by a rod or holder *C*. This rod is normally held outward by a spring *D* and the cutter *A* is also drawn backward by spring *E*, so that the end clears the work as the tool advances. The set-screw *F* bears against the end of holder *C* and serves to steady it. The pin *G*, which passes through an elongated slot in holder *C*, limits the travel of the latter. The chamfering tool is so located relative to the work that the end of holder *C* comes into contact with the end of the collar or other part that is being cut off, thus causing the holder to move backward against the tension of spring *D*. When the extension on cutter *A* comes into engagement with the adjustable screw *H*, the cutting end is forced into engagement with the work and forms a groove as indicated by the upper illustration. The groove is in such a position that it forms a beveled surface for the inner edge of the collar after the latter is cut from the bar. This tool makes it unnecessary to place collars or similar parts in a speed lathe for removing the sharp edge by using a hand scraper, which is the method that is frequently employed.

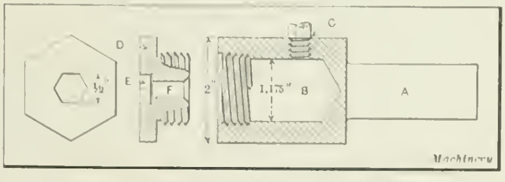


Tool used to chamfer Inner Edges of Collars before they are cut off from Bar or Tube

Flint, Mich. C. C. Spreen

TAPPING STUD NUTS IN SCREW MACHINE

Tapping nuts in a hand screw machine seems to be an odd thing to do, when tapping machines are made for just this purpose; but quite a few shops are not equipped with these machines. Some of these use drilling machines, but the writer



Fixture for Tapping Stud Nuts in a Hand Screw Machine has seen nuts tapped with the fixture shown in the accompanying illustration. This fixture is connected directly to the oil-pump, and the oil passing through the nut keeps the tap clear of chips and the tap from breaking. The fixture is made from a piece of 2-inch cold-drawn steel. The shank *A* is turned to fit the hole in the turret of the machine, and then the piece is turned around and held in a three-jaw chuck while the hole, or oil chamber *B*, is bored; at the end, a 1¼-inch, 14 U. S. thread per inch is cut for the reducer *D*. A hole *C* is then drilled in the large part of the holder, to serve as the oil inlet. This hole is tapped with a standard ¼-inch iron-pipe tap and a short nipple is inserted. A small valve attached to this nipple regulates the flow of oil, the other side of the valve being connected to the oil-pump by a flexible metal tube.

The reducer *D* is made of a piece of 2-inch hexagonal cold-drawn steel. After the recess and the thread have been cut, the small hexagonal hole *E* is broached a little larger than the outside diameter of the nut to be tapped, and the hole *F* is drilled about 1/16 inch larger than the outside diameter of the tap to be used. This tap is held in a regular spring collet in the spindle, as the operator is then able to remove the nuts already tapped from the shank of the tap without stopping the machine. When being tapped, the nuts are set in the broached hole *E* and held there with the operator's finger until they are brought into contact with the tap. If the nut is not held in this way, the oil flowing from the oil chamber will force it out. All parts, with the exception of the pipe connections, are casehardened. Care must be taken when broaching the hole *E* to see that no burrs are left to tilt the nut when tapping.

Aurora, Ill. JOHN J. BORKENHAGEN

MACHINING PANORAMIC SIGHT PARTS

When setting up a turret lathe for a job, the problem of tooling should be given careful study. The number of pieces to be made largely governs the cost of the tools provided. Standard tools should be used whenever possible, but time should not be sacrificed in order to use standard tools if the number of pieces to be made will warrant special tooling. Where there is a large variety of work in small quantities, standard tools will generally handle the work to the best advantage, and when a large number of similar pieces are to be machined, the use of special tools or a combination of standard and special tools will probably be the best and cheapest method of handling the operation. The work should be held securely, even if special jaws or fixtures are necessary.

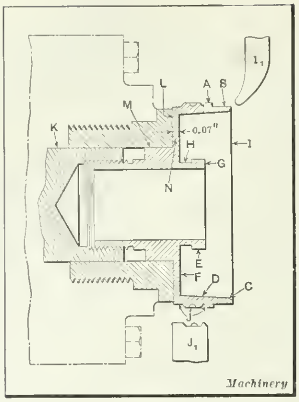


Fig. 1. Azimuth Circle of Panoramic Sight

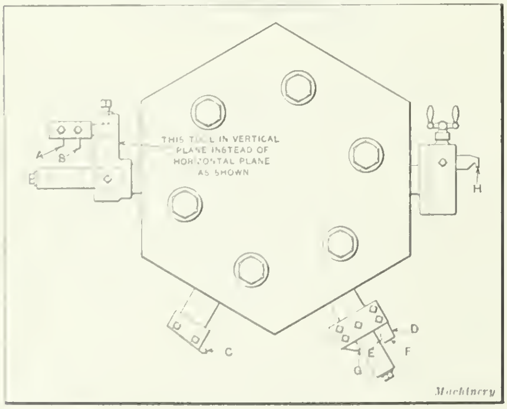

A
B
THIS TOOL IN VERTICAL PLANE INSTEAD OF HORIZONTAL PLANE AS SHOWN
H
C
D
E
F
G
Machinery

Fig. 2. Setting of Tools for machining Azimuth Circle

The azimuth circle for the panoramic sight used by the United States Army is made from a forged steel bar, roughed out to shape and annealed. The part is then mounted on a Warner & Swasey No. 4 turret lathe as shown in Fig. 1. As will be seen, it is held in an adjustable hood and a threaded draw-back adapter *L*. In order to insert the piece in the machine, the plunger *K* is pulled back and the piece is then screwed in until it bears against adapter face *L*, which gives it a good support. Bearing *M* holds the piece true. The surfaces that were finished on this machine are marked by reference letters. Surfaces *I* and *J* were finished by tools I_1 and J_1, respectively, which were held in the cross-slide.

Fig. 2 shows the setting of tools for the machining operations, the reference letters of the tools corresponding with the reference letters of the finished surfaces in Fig. 1. The face *L*, which is only 0.07 inch thick, remained straight until the tools *D*, *E*, *F* and *G* had completed their cuts, when it was found that face *L* was convex, due to the burnishing action of these tools. It may be thought that this was caused by stresses produced by roughing out the cold-rolled stock on the screw machine, but as the work was annealed previous to the finishing operations, no such stresses remained. It was decided to change the tooling to single-point tools as far as possible, and this resulted in overcoming the trouble. The new tooling is illustrated in Fig. 3. With this method of tooling it was possible to face surface *F* and bore *D* with single-point tools, thus eliminating the burnishing action of a forming tool and the tendency of the piece to screw up tight in the plunger *K*. The latter action would not interfere with the removal of the work, because the plunger is thrown forward, but it might have a tendency to spring the face *L*, although the adapter appears to give a shearing action at *N*.

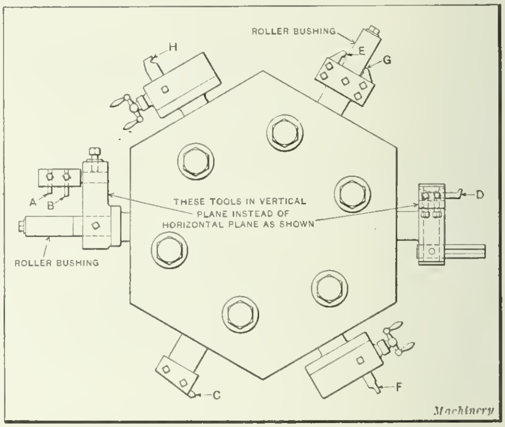

ROLLER BUSHING
H
E
G
A
B
THESE TOOLS IN VERTICAL PLANE INSTEAD OF HORIZONTAL PLANE AS SHOWN
D
ROLLER BUSHING
C
F
Machinery

Fig. 3. Improved Setting of Tools for machining Azimuth Circle

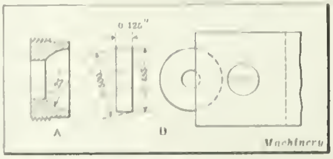


Fig. 4. Worm Bearing Cap and Tool for cutting Seat

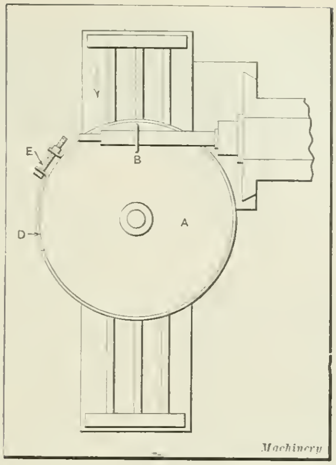
At *A*, Fig. 4, is shown a brass worm bearing cap for use in the panoramic sight, and at *B* is shown a cheap and satisfactory tool for forming the seat in piece *A*. The tool was hardened and ground all over. As it does not have much of a cutting edge, it probably would not cut steel, but it worked successfully on brass.

Cleveland, Ohio L. J. ORR

CUTTING A LONG RACK

Having a long rack to cut, the writer was obliged to resort to the following method: As shown in the accompanying illustration, the index head was placed on the milling machine table with the spindle vertical, and a large faceplate *A* was secured to the spindle. A band *D* was placed around the faceplate and drawn up snug with the bolt *E*, the band projecting above the faceplate a distance equal to the depth of the tooth. The cutter *B* was then started from the inside and cut out through the band like a crown gear. The band was afterward straightened on the anvil and several thicknesses were riveted together, making a good rack. As the index was set for a gear having a diameter equal to the diameter of the faceplate, one thickness of the band made the tooth a shade too wide on the outside and a shade too thin on the inside.

Thompson, Iowa E. E. Larson

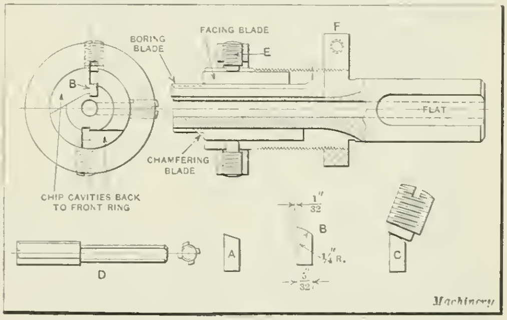


Cutting a Long Rack

BUILT-UP TOOLS FOR BRASS WORK

While the use of built-up tools in manufacturing work is quite general, there are comparatively few shops where any sort of system of interchangeable blades, collars of standard design, etc., is used. These are important points to consider in connection with this class of tools, as they save time and material in building, time in designing, and time in the shop when it becomes necessary to replace a worn-out blade. The type of tool shown in the accompanying illustration is especially suitable for use in a turret lathe for machining brass parts. The body is preferably made of tool steel, hardened, and the shank ground, as the extra cost of this material over machine steel will more than be made up in the increased length of life and freedom from repairs due to dents in the shank, battered threads, etc. The collars may be of machine steel.

Boring blades in tools of this kind usually have a straight relief, as shown at *A*, and it will be readily seen that an angle which is correct for one diameter will interfere on a smaller diameter and have insufficient backing for a larger diameter. The eccentric relief shown at *B* does not have these disadvantages. The radius given is correct for a blade 5/32 inch thick, and the radius for any other thickness of blade should be in proportion, the center from which the arc is struck being kept 1/32 inch ahead of the face of the blade in all cases. When a blade is designed for a new tool, a record should be kept and consulted whenever another built-up tool is designed. In the majority of cases, after a list of reasonable length is compiled, it will be found that a blade has already been made which can be used in the contemplated tool, by milling the slots to the correct depth. This makes it possible to carry a comparatively small stock of blades and at the same time furnish any built-up tool of this design with a new blade. Experience with these blades shows that it pays to grind the top and bottom after hardening, as they warp more or less, and the accuracy of the hole drilled depends upon the blade being the proper height and lying flat on the bottom of the slot. A special fixture is required to grind eccentric relief.

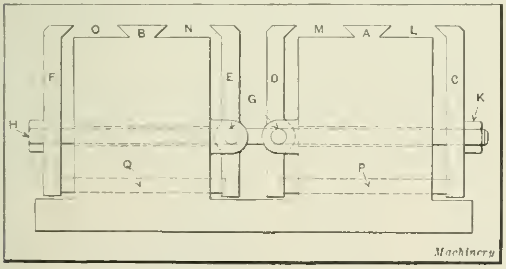


Tools for machining Brass in Turret Lathe

Most boring blades require a ring *F* behind them as shown, because the set-screw *E* in the front ring cannot always be depended upon to prevent pushing back. This will sometimes make two screw rings necessary where two boring blades are used. When the set-screws in the front ring are used to clamp directly on an eccentric relief, the screw should be set at an angle, as shown in detail at *C*, to prevent damage to the edge. Headless or hollow set-screws are preferred, as square heads

MILLING FIXTURE

The accompanying illustration shows a fixture for a milling machine with two fixed jaws *A* and *B*, and movable jaws *C*, *D*, *E*, and *F*. *D* and *E* being hinged at *G*. In operation, work is placed at *L*, *M*, *N* and *O*, and is clamped by means of a star-wheel or a nut at *K*, which through bolt *H* draws the jaws together. The bolt should have a clearance in the fixture and through the clamps *D* and *E*. The clamps *C* and *F* are supported at the lower end by the rods *P* and *Q*, which press against the lower ends of *D* and *E* when the nut *K* is tightened. The rods should be a working fit in the fixture and a tight fit in the clamps *C* and *F*. but a loose fit in the clamps *D* and *E*. Clamps *D* and *E* should be made heavy enough at the center to allow for a clearance hole for the draw-bolt and pins. The jaws may be modified to hold odd-shaped pieces of work; this particular device was used to hold four pieces six inches long, across the machine, and they were held as tight as one piece would have been.



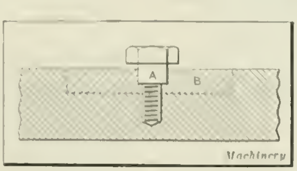
Milling Fixture for clamping Four Pieces simultaneously

Indianapolis, Ind. Robert W. Smith

KINK FOR FASTENING PATCHES SECURELY

The accompanying illustration shows an easy method of fastening patches in place. All that is necessary is to turn down the head of the cap-screw *A* to fit the counterbore of the patch *B* and then shape or file the screw flush with the patch. The cap-screw will then hold the patch securely in place.

Milwaukee, Wis. Fred Fruhner



Using Cap-screws for fastening Patches

break off frequently. A hole in the center of the body as shown is often necessary to hold the shank of a small fluted or flat drill, or in some cases a twist drill. When the smallest diameter to be bored by a blade is so small that it is impossible to mill a slot of sufficient depth with a bottom in the body of the tool, a flat may be milled on the shank of the small drill, as shown at *D*, and the blade slot milled through into the center hole, allowing the blade to rest on the small shank and act as a clamp for it. In most cases, each diameter of the body part of the tool should be 1/16 inch smaller than the corresponding boring diameter.

Dubuque, Iowa CHESTER W. HATHAWAY

BURNISHING TOOL FOR BABBITT BUSHINGS

The following article describes a burnishing tool that is used to burnish the babbitt bushings of automobile and marine engine connecting-rods, etc. The bushings are die-castings and the metal is coarse-grained and not solidly compressed, so that when the engine is in operation the continued blows of the connecting-rod would compress the metal and the result would be a loose bearing. The hole of the bushing could be made smooth and sized by the use of a reamer, straight arbor or mandrel, but these tools would not remedy the condition mentioned, and for this reason a burnishing tool is used which compresses and forces the babbitt metal into any irregular surfaces that there may be in the bore of the connecting-rod, thus giving a bearing, the only change in size of which will be due to friction.

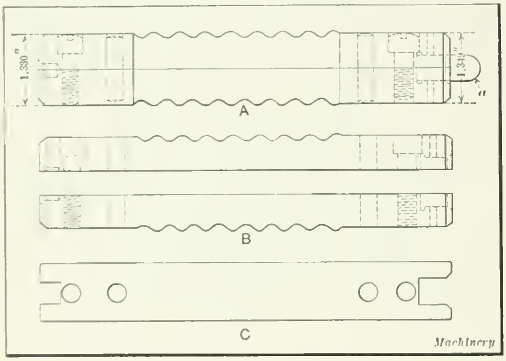


Fig. 1. Burnishing Tool for Connecting-rod Bushings

In making the burnishing tool which is shown at *A*, Fig. 1, the two pieces of material were bolted together and rough-turned as shown at *B*. Shim *C* was then placed between the two parts and the hole bored for pilot *a*. The two pieces *B* were then carburized and hardened, and the flat surfaces ground, after which they were bolted together without the shim and the outside diameters ground. The shim was again placed between the two pieces and the hole for *a* was ground.

The connecting-rod that the burnishing tool is used on is illustrated in Fig. 2. In Fig. 3 the connecting-rod is shown mounted on the machine for the burnishing operation. At *A* is a pin for locating the connecting-rod. The burnishing tool is secured at *B*, the pilot *a*, Fig. 1, fitting into the hole of the press spindle. The tool is pressed through the connecting-rod bushing, and it then drops into the pocket *C*, which is partly filled with lead so that the end of the burnishing tool will not be marred.

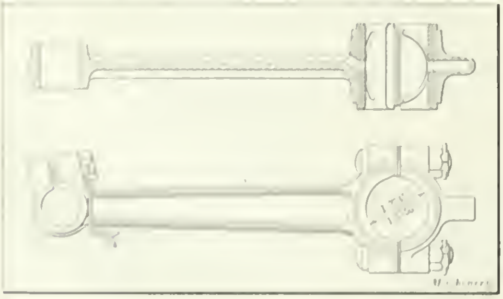


Fig. 2. Connecting-rod burnished by Method described

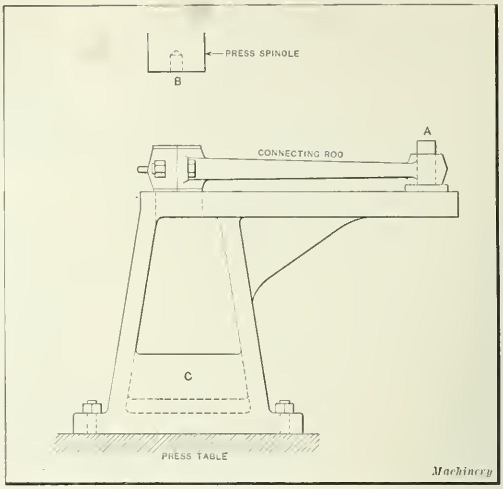
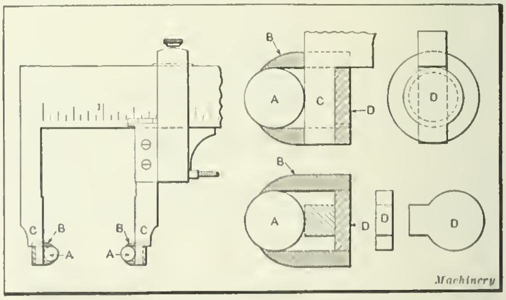


Fig. 3. Connecting-rod mounted for Burnishing Operation

Flint, Mich. C. C. SPREEN

BALL-POINT HOLDER FOR CALIPER SQUARE

Several improvised ball-point attachments for large caliper squares and vernier calipers were made some time ago in a certain shop in the Middle West, on account of inability to secure satisfactory deliveries on some measuring tools. Most of the tools were for measuring distances between large holes and other concave surfaces. The ball-point attachment illustrated served so well that it was used eventually on a wider scope of work. The steel balls *A* are ¼ inch in diameter and are a running fit in the brass sleeve *B*, which is slotted at one end to receive snugly the caliper jaw *C*. The steel section *D* at the end is soldered in place and partly closes the outer side of one slot. After this piece *D* has been soldered in place, and before the attachment has been placed on the vernier caliper jaw, a piece of steel 0.001 inch larger than the thickness of the jaw *C* is inserted. This piece is used only while assembling the ball and sleeve so as not to injure the jaw. Then the ball *A* is inserted in the sleeve and made to rest on this piece of steel. The rounded end of the sleeve is then carefully calked against the ball, using a concave punch for this operation, after which the piece of steel is removed. The attachment will be found to fit snugly when placed on the caliper jaw.



Ball-point Holder for Caliper Square

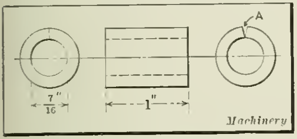
New York City E. J. HIGGINS

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

DIE FOR FORMING THIMBLE

F. M. H.—In the accompanying illustration is shown a thimble 1 inch long, made from No. 10 gage strip band iron, with a 7/16-inch hole that should be as nearly round as possible. Can a die be made to form this thimble in one operation; if not, how many operations will be required? Will some reader of MACHINERY suggest a die that will form this thimble without leaving an opening as shown at *A*?



Thimble to be formed by Die

PROBLEM IN GEOMETRY

A. B. C.—Prove that in any triangle the product of two sides is equal to the product of the diameter of the circumscribed circle and the altitude upon the third side.

Answered by Robert W. Smith, Indianapolis, Ind.

Let *ABD* be the triangle and *AE* the altitude; draw *AC* through center *O* of the circumscribed circle and connect the points *C* and *D*. Then *AEB* is a right angle by construction, and *ADC* is a right angle by being measured by an arc of 180 degrees. Also, angles *ABD* and *ACD* are similar because they are measured by the same arc *AD*; therefore, the right triangles *ABE* and *ACD* are similar. As a result, $AB : AC = AE : AD$; or $AB \times AD = AC \times AE$.

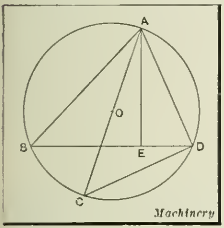
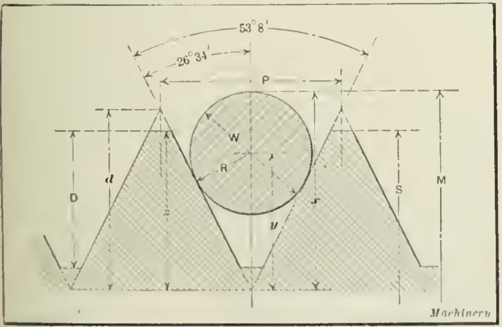


Diagram illustrating Problem in Geometry

THE LOWENHERZ THREAD

W. S.—What are the proportions of the Löwenherz thread and how can a formula be deduced for determining what the micrometer reading should be for a given screw diameter, when measuring the thread by the three-wire system?



The Lowenherz Thread

A.—The Löwenherz thread (a section of which is shown in the accompanying illustration) has flats at the top and bottom the same as the U. S. standard form, but the angle is 53 degrees 8 minutes. The depth *D* equals 0.75*P*, and the vertical distance *d* between the points where the sides at the root and top would intersect if continued (as indicated by the dotted lines) is equal to the pitch *P*. The width of the flats at the top and bottom is equal to 0.125*P*. This screw thread is based on the metric system (see table) and is used extensively for the fine threads of measuring instruments and to some extent in shell manufacture. Assuming that *M* equals the micrometer reading and *S* the outside diameter of the screw, then $M = S - 2z + 2x$; $z = 0.875P$, and $2z = 1.750P$; $x = y + R = R + \dfrac{R}{\text{sin 26 deg. 34 min.}}$, or $x = R + \dfrac{R}{0.44724}$. $2x = 2\left(R + \dfrac{R}{0.44724}\right) = 2B + \dfrac{2R}{0.44724} = \dfrac{2.89448R}{0.44724} = 6.4718R = 3.2359W.$

Hence:

$$M = S - 1.75P + 3.2359W$$

This formula, expressed as a rule, would be as follows: To determine the micrometer reading for a Löwenherz screw thread of given diameter, multiply the pitch of the thread by the constant 1.75; subtract the result from the outside diameter of the screw and add to the difference 3.2359 times the diameter of the measuring wires.

LOWENHERZ THREAD

Diameter		Pitch, Millimeters	Approximate Number of Threads per Inch	Root Diameter, Millimeters	Width of Flat, Inches
Millimeters	Inches				
1.0	0.0394	0.25	101.6	0.625	0.0012
1.2	0.0472	0.25	101.6	0.825	0.0012
1.4	0.0551	0.30	84.7	0.950	0.0015
1.7	0.0669	0.35	72.6	1.175	0.0017
2.0	0.0787	0.40	63.5	1.400	0.0020
2.3	0.0905	0.40	63.5	1.700	0.0020
2.6	0.1024	0.45	56.4	1.925	0.0022
3.0	0.1181	0.50	50.8	2.250	0.0025
3.5	0.1378	0.60	42.3	2.600	0.0029
4.0	0.1575	0.70	36.3	2.950	0.0034
4.5	0.1772	0.75	33.9	3.375	0.0037
5.0	0.1968	0.80	31.7	3.800	0.0039
5.5	0.2165	0.90	28.2	4.150	0.0044
6.0	0.2362	1.00	25.4	4.500	0.0049
7.0	0.2756	1.10	23.1	5.350	0.0054
8.0	0.3150	1.20	21.1	6.200	0.0059
9.0	0.3543	1.30	19.5	7.050	0.0064
10.0	0.3937	1.40	18.1	7.900	0.0069
12.0	0.4724	1.60	15.9	9.600	0.0079
14.0	0.5512	1.80	14.1	11.300	0.0089
16.0	0.6299	2.00	12.7	13.000	0.0098
18.0	0.7087	2.20	11.5	14.700	0.0108
20.0	0.7874	2.40	10.6	16.400	0.0118
22.0	0.8661	2.80	9.1	17.800	0.0138
24.0	0.9450	2.80	9.1	19.800	0.0138
26.0	1.0236	3.20	7.9	21.200	0.0157
28.0	1.1024	3.20	7.9	23.200	0.0157
30.0	1.1811	3.60	7.1	24.600	0.0177
32.0	1.2599	3.60	7.1	26.600	0.0177
36.0	1.4173	4.00	6.4	30.000	0.0200
40.0	1.5748	4.40	5.7	33.300	0.0219

Machinery

A TOOLMAKER'S PROBLEM

A. S.—I am a toolmaker with but slight knowledge of mathematics. The following problem came up recently in connection with my work, which I am unable to solve. Please show me how to find *x* to the nearest thousandths of an inch.

Answered by J. J. Clark, Scranton, Pa.

A.—An elementary knowledge of geometry, trigonometry, and algebra is required in order to solve this problem. Although a formula could be derived that would apply to the case, a knowledge of how to use a table of trigonometric functions is necessary, and it is also necessary to be able to solve an affected quadratic equation.

Referring to the illustration, the first step is to find the angle $A'DF = \phi$. $B'H = 1.853 + 0.200 = 2.053$, and $HD = B'H \cot \phi = 2.053 \cot \phi$. $A'B'O' = \phi$, and $O'B' = FH = 1.2 \operatorname{cosec} \phi$. Therefore $FH + HD = FD$, or $1.2 \operatorname{cosec} \phi$

$+ 2.053 \cot \phi = 2.38$. Since $\operatorname{cosec} \phi = \sqrt{1 + \cot^2\phi}$, $1.2\sqrt{1 + \cot^2\phi} + 2.053 \cot \phi = 2.38$; from which, $1.2\sqrt{1 + \cot^2\phi} = 2.38 - 2.053 \cot \phi$. Squaring both sides of this equation, $1.44 + 1.44 \cot^2\phi = 5.6644 - 9.77228 \cot \phi + 4.214809 \cot^2\phi$. Transposing and combining terms, $2.774809 \cot^2\phi - 9.77228 \cot \phi + 4.2244 = 0$. Solving this quadratic equation, $\cot \phi = 0.50458$ or 3.01721; hence, $\phi = 63$ degrees 13 minutes 32 seconds, or 18 degrees 20 minutes 13 seconds. There are evidently two values for the angle, since from a point without a circle two tangents may be drawn to the circle. In other words, the angle may be $A'DF$ or IDF. In the present case, the larger angle is the one required, and $\phi = 63$ degrees 13 minutes 32 seconds. The angle $ABO = AOC = BDE = \phi$. $ED = BE \cot \phi = 0.2 \cot \phi$. $BO = OA \operatorname{cosec} \phi = 0.2 \operatorname{cosec} \phi$. $DC = BO - ED = 0.2 \operatorname{cosec} \phi - 0.2 \cot \phi = 0.2 (\operatorname{cosec} \phi - \cot \phi)$. From a table of natural trigonometric functions, cosec 63 degrees 13 minutes 32 seconds = 1.12009, and the cotangent is 0.50458, as previously found; hence, $DC = (1.12009 - 0.50458)\ 0.2 = 0.61551 \times 0.2 = 0.1231$. Since $x = FD + DC$, $x = 2.38 + 0.1231 = 2.5031$ inches.

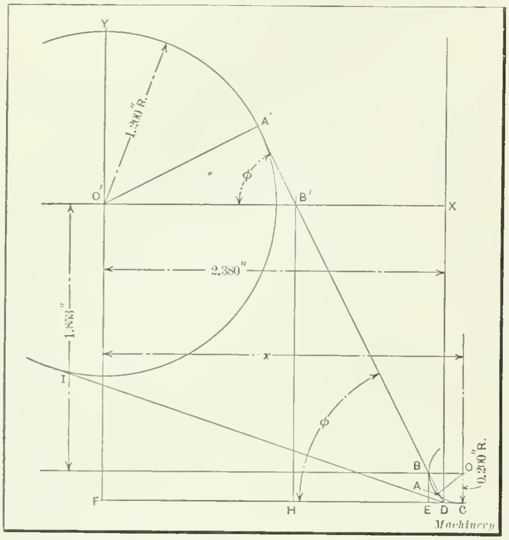


Diagram illustrating Solution of Toolmaker's Problem

Another method of determining the angle ϕ is the following: Let $O'X$ and YF be the axes of rectangular coordinates; then the equation of the large circle is $x^2 + y^2 = r^2 = 1.2^2$. The coordinates of the point D are $x_1 = 2.38$ and $y_1 = -2.053$. Let m = tangent of angle $A'DF$ or IDF. Then, it is shown in analytical geometry that $(x_1^2 - r^2)\, m^2 - 2\, x_1\, y_1\, m + y_1^2 - r^2 = 0$. Substituting the values of x_1, y_1, and r, $(2.38^2 - 1.2^2)\, m^2 - 2 \times 2.38 \times -2.053\, m + (-2.053)^2 - 1.2^2 = 0$. Expanding, collecting, and combining terms, $4.2244m^2 + 9.77228m + 2.774809 = 0$. If it is desired to obtain the cotangent instead of the tangent, all that is necessary is to substitute $\frac{1}{m}$ for m (since the cotangent is the reciprocal of the tangent), and the last equation, after reduction becomes $2.774809m^2 + 9.77228m + 4.2244 = 0$. The roots of this equation are the same as those previously found, except that they are negative, the negative sign merely indicating that the tangent lines slope from D upward to the left instead of upward to the right.

PROBLEM IN MENSURATION

J. C.—A circular cylindrical tank, shown in Fig. 1, is 5 feet in diameter and 12 feet long, and rests at an angle of 30 degrees with the horizontal; if the tank contains 400 gallons of water, what is the distance x?

Answered by J. J. Clark, Scranton, Pa.

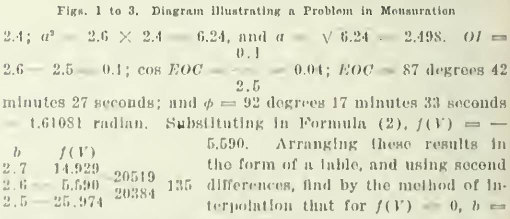
A.—Two conditions are imposed—the angle of rest and the volume of water—and both cannot be fulfilled at the same time, as a little consideration will show. According to the conditions, the tank would be represented by the outline $AEFD$, and the water level by the line KF, whereas the tank should be represented by the outline $ABCD$ and the water level by HC. In the latter case, the volume of the water is greater than one-half the volume of the tank, which is $\frac{1}{4}\pi \times 5^2 \times 12 \times 7.48052 = 1762.56$ gallons, one-half of which is 881.28 gallons, since one cubic foot contains 7.48052 gallons. It will be assumed, therefore, that it is desired to know the distance x when the tank contains 400 gallons, without regard to the angle of rest. The shape of the solid formed by the water is indicated by Fig. 2. If the water level coincides with the diameter AB of the bottom of the cylinder, the volume of the shape formed by the water is $V = \frac{2}{3}\pi r^2 h$, in which r = radius $OA = OD$ and h = height HD. In the present case, $r = 2.5$, $h = 12$, and $V = \frac{2}{3} \times 2.5^2 \times 12 = 50$ cubic feet $= 50 \times 7.48052 = 374.026$ gallons. Hence, the water level must be a little higher than AB in order that the tank may hold 400 gallons. The shape formed by the water is represented by the outline $EHDF$. The volume of a solid having this shape is expressed by the formula

$$V = \frac{h}{3b}\left[a(3r^2 - a^2) + 3r^2(b - r)\phi\right] \qquad (1)$$

in which h and r have the same values as before, b = distance DI, $a = EI$, and ϕ = angle EOD, in radians. This formula may be used also when DI is less than the radius OD. In the present case, a, b, and ϕ are not known, but by assigning a value to b, a and ϕ are readily found. Evidently, b is a little greater than the radius $r = 2.5$; assuming that it is $2.7 = DI$, Fig. 3, $CI = 5 - 2.7 = 2.3$. Since $EI = a$, $a^2 = 2.7 \times 2.3 = 6.21$, and $a = \sqrt{6.21} = 2.4920$. $OI = 2.7 - 2.5 = 0.2$, and $\cos EOC = \frac{0.2}{2.5} = 0.08$; whence, $EOC = 85$ degrees 24 minutes 41 seconds, and $\phi = 180$ degrees $-$ 85 degrees 24 minutes 41 seconds $= 94$ degrees 35 minutes 19 seconds $= 1.65088$ radian. In Formula (1), $V = 400$, when reduced to gallons, and the formula may be written

$$f(V) = \frac{h}{3b}\left[a(3r^2 - a^2) + 3r^2(b - r)\phi\right] \times 7.48052 - 400 = 0. \qquad (2)$$

Substituting the values of h, b, a, r, and ϕ, $f(V) = 14.929$. When $b = r = 2.5$, Formula (2) reduces to $f(V) = \frac{2}{3} r^2 h \times 7.48052 - 400 = -25.974$. Consequently, b lies somewhere between 2.5 and 2.7; assuming that it is 2.6, $CI = 5 - 2.6 = 2.4$; $a^2 = 2.6 \times 2.4 = 6.24$, and $a = \sqrt{6.24} = 2.498$. $OI = 2.6 - 2.5 = 0.1$; $\cos EOC = \frac{0.1}{2.5} = 0.04$; $EOC = 87$ degrees 42 minutes 27 seconds; and $\phi = 92$ degrees 17 minutes 33 seconds $= 1.61081$ radian. Substituting in Formula (2), $f(V) = -5.590$. Arranging these results in the form of a table, and using second differences, find by the method of interpolation that for $f(V) = 0$, $b = 2.6273$, which is the value of x, Fig. 1, when the tank contains 400 gallons. The angle KFD is then readily found, since $\tan KFD = 2.6273 \div 12 = 0.21894$, or $KFD = 12$ degrees 20 minutes 58 seconds. It is here assumed that the line EF represents the end of the cylinder.



Figs. 1 to 3. Diagram illustrating a Problem in Mensuration

b	$f(V)$		
2.7	14.929		
		20519	
2.6	−5.590		135
		20384	
2.5	−25.974		

OPERATING THE GRIDLEY MULTIPLE-SPINDLE SCREW MACHINE[1]

COMPLETE INSTRUCTIONS FOR TOOLING, SETTING UP, AND OPERATING

BY DOUGLAS T. HAMILTON[2]

INASMUCH as there are no cams to design in connection with the Gridley multiple-spindle automatic screw machine, and also as the time required for the longest single operation is the time necessary to make one piece, the first step in determining upon the tooling arrangement is to decide on the longest single operation. This, in some cases, cannot be done without some preliminary calculations; to arrive at a satisfactory result, it is necessary to decide on a suitable speed for the work and the correct feed for the tools. The feed, however, can be changed later by a gear-box mechanism, which is one of the important advantages of this type of machine.

A point that is of equal, if not greater, importance, especially when a large number of the same parts must be made, is to determine the best method of applying the tools to the work. The operations should be laid out so as to divide the cuts between the various tools, say on the turret-slide, so as to obtain the greatest possible production without crowding any one tool with a heavier feed than it will stand without frequent resharpening. It is also good practice, when the work is of irregular form, to cover the irregular part with a forming tool. In fact, this plan should be used with most work, whether it is plain or of irregular shape, especially when the part to be formed is not greater in length than two and one-half or three times its smallest diameter. When the forming tool is of the vertical type and covers several shoulders, provision need be made in the gage for testing only one diameter, as the forming tool automatically takes care of all the other parts covered by it.

It should also be borne in mind that on this type of multiple-spindle automatic screw machine, the threading spindle is operated independently of the turret, and consequently the cases are extremely rare when the threading operation will be the longest single operation. It is, therefore, obvious that the longest single operation will be done by a tool in either the forming slide or the turret. As all the tools on the turret are advanced toward the bars of work at the same feed, it is a comparatively simple matter, when the longest operation is to be performed from the turret, to select the tool or tools that will govern the time required to make one piece.

As an experienced operator can, with this type of machine, greatly increase production over that which can be accomplished by one not familiar with its principal features, it is evident that a careful study of the principal operating mechanisms and their functions is highly advantageous. This information can be obtained from the articles dealing with this subject that have previously appeared in MACHINERY. On some other types of automatic screw machines, it is absolutely necessary, in the majority of cases, for the operations to be laid out and cams made. With this machine, however, it is not necessary to make any cams, except in rare cases where special attachments are to be operated from the turret or forming slide. It is general practice, however, for a tool-setter to lay out the order of operations, outlining the type of tools to be used and specifying the longest single operation. If a tool-setter is not employed for this work, the operator must go ahead and set up the machine. In this case, setting up the machine is largely a cut-and-try method, but owing to certain features that this machine possesses, this method can be used with very satisfactory results.

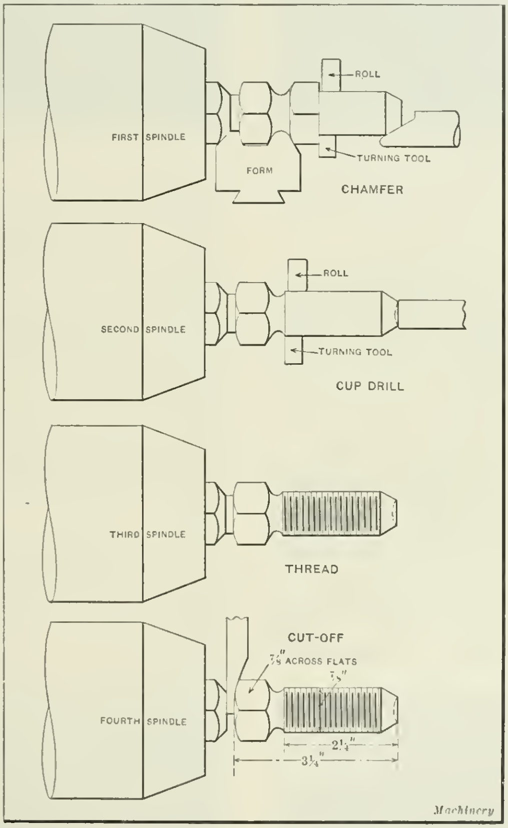


Fig. 1. Order of Operations in making Set-screw on Gridley 1¼-inch Multiple-spindle Automatic

Method of Tooling

The question of deciding what tools to use on the turret and on the forming and cutting-off slides is governed almost entirely by the character and shape of the work. If the piece to be made is a simple shoulder screw, there is no question but that the standard box-turner should be used to perform most of the work of breaking down the body and head of the screw with the forming tool. One stud-turner or box-turner, depending on the number of shoulders on the work, can be used for finishing in the second position. The threading is then done in the third position, and the piece cut off in the fourth position. As has been mentioned in a previous article, it is necessary to use a special cam on the turret drum when an end-working tool is used in the fourth position.

Preparing Machine for New Set-up

If the machine has already been set up and in operation on a certain part and it is necessary to change it over to produce another piece, the method of procedure will be somewhat as follows: If the part to be produced is not at all similar to that previously made, it is necessary to remove the spring chucks and feed-chucks, so as to insert new pads in them to accommodate the size and shape of bar to be handled. As was mentioned in the June, 1917, number of MACHINERY, the feed-chucks can be removed by withdrawing the plug from the star back-stop and rotating the latter a fraction of a turn, when the pusher-tubes can be withdrawn. The screws are then removed from the feed-chucks and pads of the proper size and shape inserted.

The next step is to remove the chucks. This is done by first taking off the nose caps with a spanner wrench, the pressure on the chucks being first relieved by the hand-lever to release the fingers from the chuck-closing spools. The spring chucks can then be removed and pads of the correct size and shape

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[1] For other articles on the Gridley multiple-spindle automatic screw machine practice, see "Screw Machine Tool Equipment," October and December, 1917 and January, 1918.

[2] Address 45 Woodson Ave., Springfield, Vt.

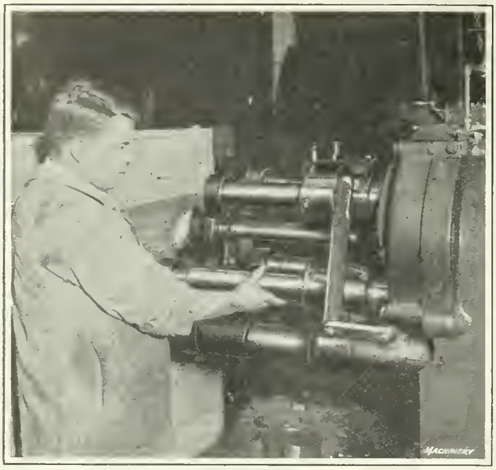

Fig. 2. Removing Feed-chuck Sleeves from Work-spindles

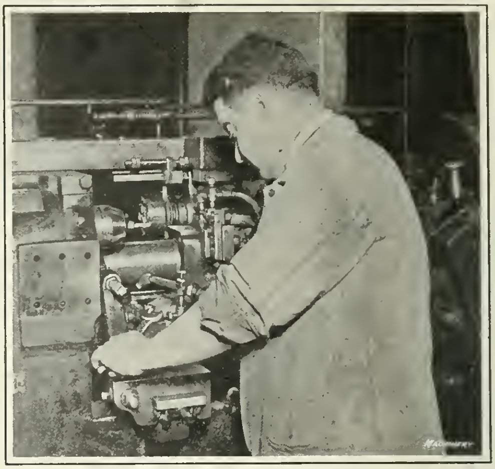

Fig. 3. Setting Forming Tool-holder

inserted. Following this, all the tools are removed from the turret and cross-slide, providing that none of them are adapted to the work to be produced.

Turret, Forming Cams, etc.

Three sets of feed-cams for operating the tool-slide, as shown in Table 1, which appeared in the July, 1917, number of MACHINERY, are provided for each size of machine. These cams cover the same section of circumference of the cam-drum, but advance the tool-slide different amounts, depending upon the rise of the cam. The feed for the tools is controlled, in connection with the cams, by a change-gear box, as shown in Fig. 5.

It is not always necessary to use a cam of exactly the right rise. For example, suppose it is necessary to turn a screw, the length of which is 1 1/2 inch, on the 3/4-inch machine. With either the 3-inch or the 4 9/16-inch cam, the desired feed may be obtained by changing the levers in the change-gear box. With the 3-inch cam, the drum will be made to rotate faster than with the 4 9/16-inch cam, and in this way the same rate of feed will be obtained. Of course, it is impossible to turn a greater distance than the rise on the cam, so that a cam should always be selected which will give a greater rise than that actually required to turn the work to the desired point.

Example of Set-up of Machine

As a practical example to show how the machine is set up, the method to follow in making the screw shown in Fig. 1 is given. This set-screw is made from square stock that measures 7/8 inch across the flats, or 1.237 inch across the corners. It will be necessary, therefore, to make this piece on a 1¼-inch machine. As shown, the operations consist of forming, turning, and chamfering; turning and cupping; threading; and cutting off.

The first step, after deciding on the order in which the operations are to be handled, is to select the proper spindle speed for the work and put on the necessary change-gears. Assuming a surface speed of 85 feet per minute, it will be seen from Table 3 in the July, 1917, number that a spindle speed of approximately 276 revolutions per minute is required. To secure this speed, it is necessary to use a 36-tooth pulley gear and a 52-tooth driving gear. The way in which these gears are put on the machine is illustrated in Fig. 17, in the June, 1917, number, where a description of the operation also appears.

The next step is to select spring chucks and feed-chucks of the proper size and shape, and insert these in the spindles. To insert the feed-chucks, it is necessary to remove the feed-tubes. This is done by removing the locking plug from the star-stop, as shown in Fig. 2, and rotating the stop a fraction of a turn, so that the feed-tube can be withdrawn. The feed-chucks are then removed and replaced by those of the proper size and shape, after which the tubes are again inserted and the star-stop brought back into its former position and locked. The spring collets are now removed by taking off the nose caps with a spanner wrench, and collets of the proper size and shape are inserted. Bars of stock can now be placed in all

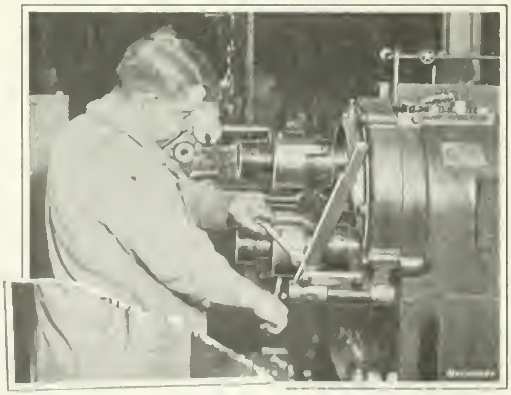

Fig. 4. Adjusting Tension of Spring Chucks to Bars so that they will be held securely

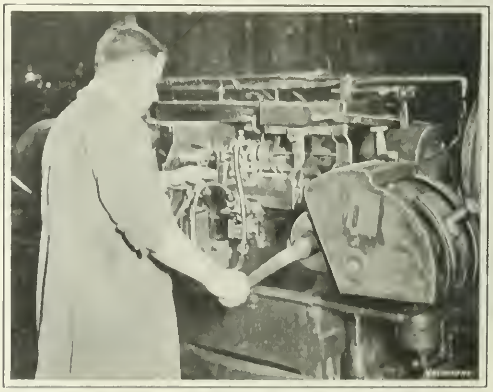

Fig. 5. Setting Box-turner—Cranking Machine by Hand to bring Roll to High Point of Tool-slide Cam

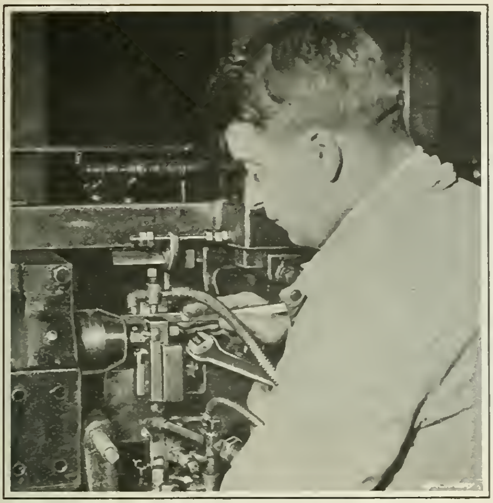

Fig. 6. Setting Box-turner Relative to Face of Chuck

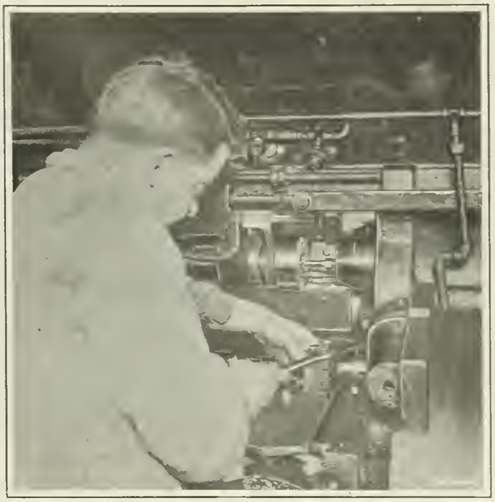

Fig. 7. Setting Cutting-off Tool

four spindles, but should not be inserted before the ends have been chamfered to remove any burrs.

Setting Forming Tool Relative to Chuck

We now select a forming tool of the desired type; this, as shown in Fig. 1, is a dovetail or vertical type of tool, which must be made special for the job. This is clamped in a suitable holder; the latter is fastened to the forming slide, as shown in Fig. 3, and then the tool is set in the correct position relative to the chuck. With the bar protruding through the chuck, the tool can be easily set to the correct height and diameter by means of a scale. The distance that it is located from the face of the chuck is governed by the shape of the work. The forming tool should always clear the face of the chuck by not less than 1/32 inch, while 1/16 inch is preferable.

Adjusting Tension of Spring Chuck

The spring chucks should be adjusted to the bars of stock so as to hold them securely against the thrusts of the cutting tools. As explained in a previous article, the spring chucks used on this type of machine are closed on the work by being forced into a nose cap, held on the front end of the spindle. In order to make this adjustment, it is necessary, as shown in Fig. 4, to index the spindle carrier and bring each successive spindle into the first stock-feeding position to make the adjustment. The collar carrying the chuck-closing fingers is held on the sleeve by means of a set-screw, which should be released and the collar adjusted, so that when the hand chuck-closing lever is operated, the grip of the chuck on the work can be tested. The collar should be so adjusted that when the chuck is forced down on the work, the chuck will prevent the work from being moved by the thrust of the cutting tools.

Setting Box-turner

After all the spring chucks have been properly adjusted, the next step is to set the box-turner. The tool-slide is advanced by cranking the machine by hand, as illustrated in Fig. 5, until the roll is on the high point of the tool-slide cam and the slide advanced to its extreme position. The box-turner is then placed on the slide and, by means of a scale, the distance from the front edge of the cutting tool to the face of the chuck is measured. This measurement is only approximate, as it may later be necessary to make a slight adjustment. The first tool is required to turn a distance of 1⅝ inch only. As shown in Fig. 6, the box-turner is adjusted along the tool-slide and, when properly located, is clamped by the T-bolt, as illustrated.

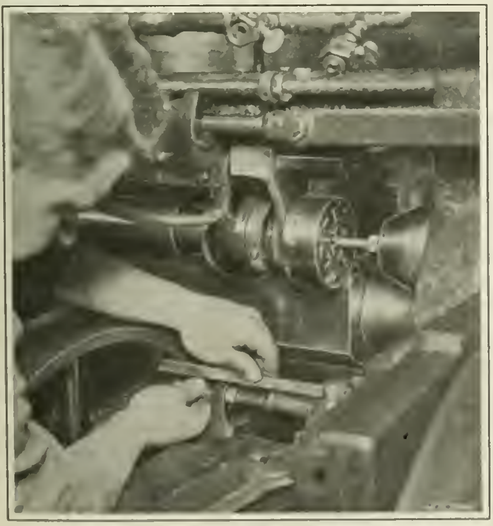

Fig. 8. Setting Swinging Stop

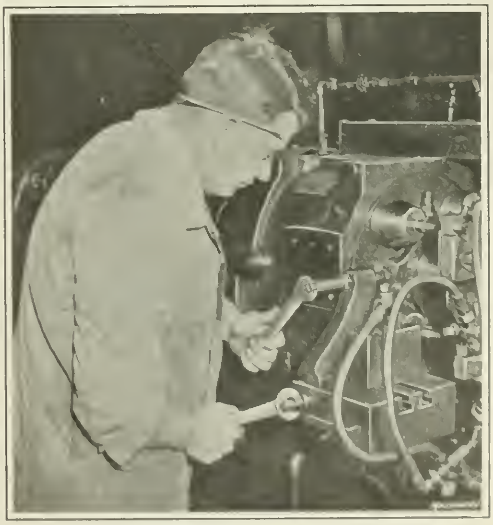

Fig. 9. Setting Forming Tool to turn to Correct Diameter

The turning tool can now be set to turn the bar to the approximate diameter. To do this, the supports are withdrawn from contact with the work and the tool-slide returned by operating the hand crank. Then the bar stock in the first-position spindle should be fed forward by hand until it projects far enough from the face of the chuck to allow the bar to be reduced for a length of about 1/2 inch. The chuck is now closed by hand and the belt shifter pulled over to start the spindles rotating. The box-turner is now advanced toward the work, by cranking the machine by hand, and the tool set to the work. When the proper diameter has been obtained, the supports are brought up into contact with the work and locked in position. The same procedure is followed in setting the box-turners in the second position, the spindle head being inclined to bring the partly turned bar into this position.

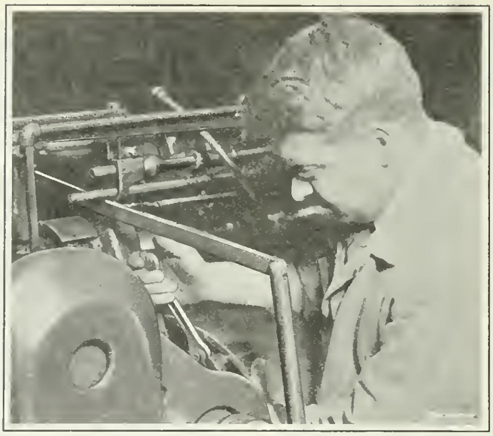

Fig. 10. Setting Tripping Dogs to change from Fast to Slow Feed

Setting Cutting-off Tool

In order to set the cutting-off tool, the stock should be pulled back from the face of the chuck in the fourth position, so that the tool can be set to the proper height and to its extreme forward position. The machine is cranked by hand until the roll operating the cutting-off slide is on the high point of the cam. The cutting-off tool is then set at the proper distance from the face of the chuck, to the proper height, and also slightly in advance of the center of the chuck, so that it will be certain to cut the stock completely off.

Setting Stop

As it is not necessary in this case to use any tool working from the tool-slide in the fourth position, the swinging stop that works in the fourth position can be used; it is set as shown in Fig. 8. The chuck is opened and the bar fed out to the total length required, taking into consideration sufficient stock for the part to be made, the amount used by the cutting-off tool, and that necessary for the cutting-off or forming tool to clear the chuck. The required amount is measured by a scale, as shown, the chuck tightened, and the stop set to the proper position.

Setting Forming Tool

The forming tool can now be set. The machine is cranked by hand to bring the stock that is in the fourth position around to the first position. Prior to this, however, the cutting tool should be set for height relative to the center of the chuck. The machine is again cranked by hand until the roll operating the forming slide is on the high point of the forming cam. By means of the adjusting screw, as shown in Fig. 9, the forming tool is fed in until it has reduced the work to the proper diameter; the spindles, of course, are running when the tool is being fed in. When the work has been reduced to the proper diameter, the stop for the forming slide, as shown in Fig. 9, is adjusted. This should be so adjusted that it will create a slight tension in the lever operating the forming slide, thus reducing the feed slightly at the end of this cut and assisting in retaining the correct diameter of the work. After the stop has been adjusted, the locking nuts should be tightened sufficiently to insure that there will be no motion.

Setting Tripping Dogs

The setting of the pointing or cupping tool is a comparatively simple matter. The next step is to set the tripping dogs, Fig. 10, for operating the machine on the slow and fast feed and indexing the spindle cams. The dogs, as has been mentioned in a previous article, are carried on the side of the main cam-drum and operate a Johnson friction clutch, which changes from the slow to the fast feed. The spindle cams are indexed by a Geneva stop mechanism, which has also been previously described. The main point to observe in setting the tripping dogs is to have the tool-slide, forming slide, and cutting-off slide operating on the fast feed as long as possible to save time on the job. For instance, in setting the tripping dog for changing from fast to slow feed for the box-turner, the tool-slide should be operated on the fast feed until the tool has almost reached the work, before it is thrown into the slow or cutting feed. Of course, it is necessary to set the dogs so that the tools will not dig into the work.

Before setting the threading die, it is advisable to have the machine work under power to see that all the tools are functioning properly, and at this time it is also possible to change the change-gear levers until the tools have been given all the feed that they will conveniently stand. In starting up on any job, it is advisable to start with the slowest possible feed and increase this feed after all the tools have been set. In this way there is less likelihood of breaking any of the tools, and the feed that is best suited to all the tools can be selected.

Setting Threading Mechanism

The setting of the threading mechanism was clearly described in the July number of MACHINERY. It should be borne in mind that in cutting threads on the Gridley multiple-spindle automatics, the working speed of the die-holder is the differ-

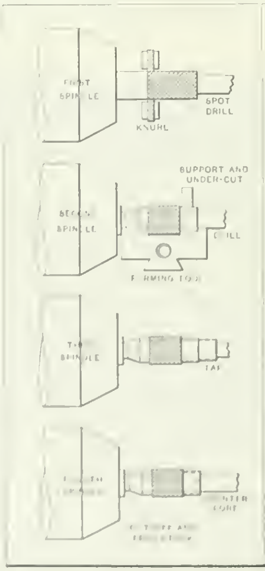

Fig. 11. Set-up for producing Knurled Sleeve on 3/4-inch Machine

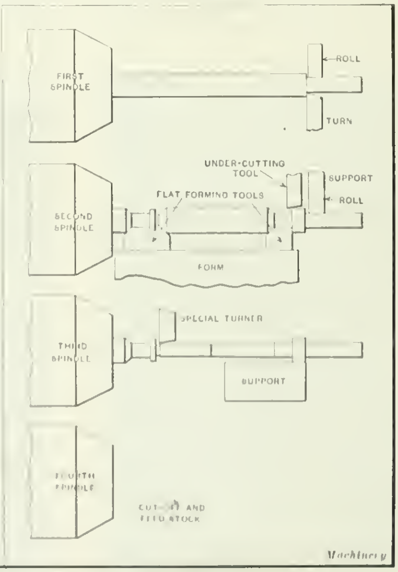

Fig. 12. Method of tooling for producing Long Slender Part

ence between its own speed and that of the work-spindles. This gives the number of effective or cutting turns made by the die or tap. In cutting right-hand threads, the die-holder always runs slower than the work-spindles. In cutting left-hand threads, the die-holder always runs faster than the work-spindles.

When the screw has been formed and turned to the desired size, the work is indexed to the third position and the die set. The die can start immediately after the work has been indexed to the third position; or if sufficient time is available to thread, the high point of the cam should be set to coincide with the time that the turning tool starts to work. The tension on the spring is then adjusted to start the die. Before the die lever starts to work, the clutch should be in slow speed, and the tripping lever in position for right-hand threading. Then the machine is started and the die allowed to run onto the work to the required length. The machine is stopped and the adjusting screws set so as to trip the lever into fast speed to run off the die. As this finishes the setting of the machine, the high-speed dog is set on the high point of the cam. The machine is indexed around and the slow-speed dog set at the point where the turning operation commences. The machine should never be cranked by hand by the high-speed dog, and the operating lever should always be removed before starting the machine into operation.

Method of Tooling for Knurled Sleeve

In order to assist the operator of the Gridley automatic in deciding on the method of tooling this machine for producing various parts, several examples are given, and the method of tooling for each part is described.

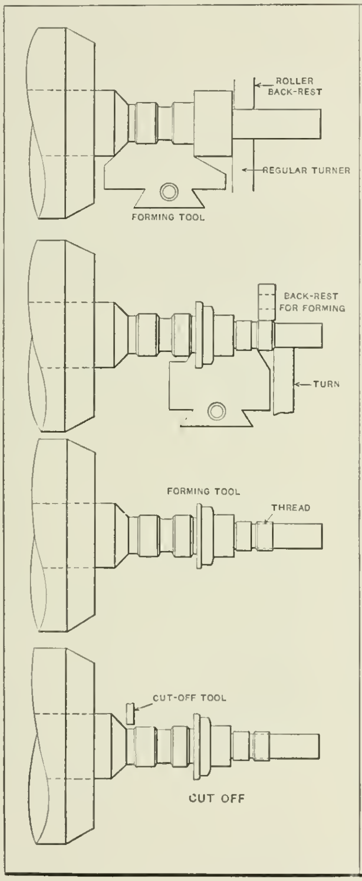

Fig. 13. Example of Work completed largely by Forming Tools

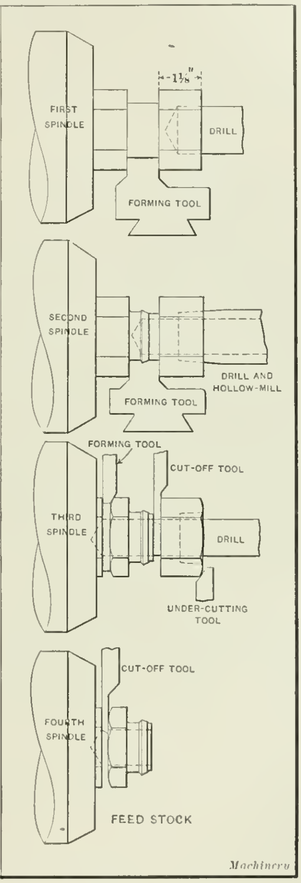

Fig. 14. Method of tooling so as to produce Two Nuts at One Time

The first example is a knurled sleeve, which is shown in Fig. 11. This piece is to be made from a bar of cold-rolled steel 5/8 inch in diameter and is 1 11/16 inch long. It can, therefore, be handled on the 3/4-inch machine. The operations consist in knurling, drilling, turning, forming, tapping, counterboring, and cutting off. The method suggested for handling the part is: drilling and knurling in the first position; turning, drilling, and forming in the second position; tapping in the third position; and counterboring, cutting off, and feeding stock in the fourth position.

As was mentioned in the July, 1917, number, and illustrated in Fig. 31, a special lead cam is necessary when operating a tool-slide tool in the fourth position. It is also necessary to employ a special stop, as shown in Figs. 11 and 12 of the June number. The counterbore must pass through a hole in this stop, and it must be elongated so that the cut-off slide can be advanced while the counterbore is working. With the exception of this one modification, the tooling can be handled in regular order. The tools used are as follows: standard knurl-holder operating from the tool-slide; spotting drill; vertical forming tool; drill and holder; support and a special under-cutting tool; tap; counterbore and floating holder; cut-off tool; special stop; and stripper to remove work from counterbore when tool-slide is returned.

Tooling for Slender Piece

The tooling for the piece shown in Fig. 12 is more difficult. This is made from a round bar of 9/16-inch cold-rolled steel, is $5\frac{3}{8}$ inches long, and is handled on the 3/4-inch machine. As shown, the operation performed in the first position is turning with a regular box-turner for a distance of $1\frac{3}{8}$ inch, reducing the bar to 3/8 inch. In the second position, the part is formed by two special flat forming tools, and the shoulder is reduced by an under-cutting tool. The forming tool-holder is of the double-deck type and carries two flat forming tools. In the third position, the center portion of the part is reduced to the desired diameter and shape by a special taper-turning tool, the work being supported by a special support. The method of operating a taper-turning tool on the Gridley automatic was previously illustrated and described in the September, 1917, number of MACHINERY. This particular part requires a special guide to conform to the shape of the work. The piece is cut off and the stock fed out to the swinging stop in the fourth position. For this particular part, the longest single operation is evidently turning the taper portion.

Tooling for Part Completed by Forming

A part in which the longest single operation is performed from the forming slide is shown in Fig. 13. In order to reduce the amount of work to be handled with the forming tool, the double-deck type of holder is used, and the part is formed in the first and second positions. In the first position, the part is turned with the regular box-turner and formed with a vertical forming tool, the turner supporting the work against the thrust of the cut of the forming tool. In the second position, the part is finish-turned with an under-cutting tool carrying a support, and is finish-formed with a vertical forming tool. In the third position it is threaded; and in the fourth position it is cut off and the stock fed out to the stop. This part is made from a bar of $1\frac{3}{4}$-inch cold-rolled steel, and is therefore handled on the $1\frac{3}{4}$-inch machine.

Tooling for Producing Two Pieces at One Time

Fig. 14 shows a method that can be employed on comparatively plain parts that are short and do not require threading. These check nuts are made from a bar of hexagonal stock cold-rolled steel, 1⅞ inch across flats, and are handled on a 2¼-inch machine. They are threaded in a second operation. Reference to Fig. 14 will show that the operations performed in the first position are drilling the first nut and rough-forming the second. A double-deck forming tool-holder is used, and in the second position, the center part of the bar is finish-formed, the first nut finish-drilled, the second nut partly drilled, and the first nut counterbored with a special form of hollow-mill. It will be noticed that the hollow-mill carries a drill.

In the third position, the second nut is finish-drilled, the first nut chamfered with an under-cutting tool, the tool-slide being returned before the first nut is cut off, and the second nut chamfered with a forming tool. A double-deck type of cutting-off tool is used on the cutting-off slide, so that in the fourth position, the second nut can be cut off. The stock is fed out to the stop in the fourth position, and the sequence of operations repeated on two more parts.

* * *

THE GISHOLT METHOD OF TRAINING INSTRUCTORS

For six years past the Gisholt Machine Co., Madison, Wis., have been developing a method for training expert operators on the Gisholt machine, which has gradually become a complete system for giving mechanics a general training in a very brief period of time, making them not only far more efficient in their own work, but also able to instruct others in the operation and care of both the machines made by the Gisholt Machine Co. and machine tools in general. The methods employed have been the result of a gradual evolution during a long period of years, and the Gisholt Machine Co. have considered these methods one of their assets in business, as they have been enabled by this means to train operators and instructors of operators more rapidly than could any of their competitors. However, the present war exigencies, which emphasize more than anything else could have done the lack of instructors for training men and women, have made it a patriotic duty of the Gisholt Machine Co. to give to other machine tool builders and to other lines of industry the principles involved in their scheme of intensified training, and this duty the company has voluntarily and freely assumed. In order to bring the information before other manufacturers at as early a date as possible, the details of the Gisholt instruction system were published in the *American Machinist* of April 18 and 25. MACHINERY is glad of the opportunity to direct attention to this matter so as to give the widest possible publicity in the mechanical field to this intensified course of instruction for mechanics. In these unprecedented times, everyone should contribute for the general good every idea, method, and principle that will aid in accomplishing the one purpose to which the nation is committed.

It is believed that manufacturers will find in the Gisholt method something upon which they can build in order to establish training departments for the intensified training of men to become instructors who can intelligently and ably convey knowledge to others. The intensified training given in the Gisholt plant to men sent to them by other firms is equivalent to the intensified training in the officers' training camps, where young men become officers in a fraction of the time usually required by a course arranged under peace-time conditions. By working intelligently and industriously, a mechanic acquires in a month of intensified training the amount of knowledge and understanding of the underlying principles of machine construction and operation that it would, even with proper ordinary instructional facilities, take him a long period of time to obtain. The Gisholt Machine Co. are to be commended upon their patriotic spirit in being willing to share with other machine manufacturers and allied lines of industry the advantages that would otherwise have accrued for years to come to them alone by the development of this system of intensified training.

EXAMINATIONS IN MACHINE SHOP PRACTICE

BY B. A. LENFEST[1]

The writer has tried, with considerable success, the plan of giving students in machine shop practice the test questions some time before the written test is to take place. By this plan all the students can treat the problems in the same manner as a shop superintendent or engineer, for all the books and notes are available and are intended to be used freely. The test period, which is forty-five minutes long, is then used largely in putting the notes and calculations in good shape on standard size paper and not for making extended computations. The only restriction is that there must be no exchange of work or communication between students. Although this plan has been tried, to a limited degree, in some colleges, the writer believes it is the first time it has been tried in a secondary school. It is realized that groups of students will probably do the work together and that some may copy the results obtained by the more industrious, but even the copying requires some work, and the records of the term's work show what students are reliable and resourceful.

The examination given last January consisted of the following questions; the value of each question is also stated:

1. Hand in notebook containing the complete mechanism of the 12-inch Reed engine lathe with calculations for all speeds (with armature running at 390 revolutions per minute), all feeds, and the thread-cutting devices. 40 per cent.

2. If an engine lathe has a lead-screw with ten threads per inch, calculate all combinations of change-gears needed to cut threads of 3-, 2½-, 2-, 1½-, 1¼-, 1-, and ¼-millimeter pitch; how many change-gears are necessary in the set? 15 per cent.

3. If an engine lathe has a nine threads per inch lead-screw, what change-gears are necessary to cut the U. S. standard threads from ¼ to 1 inch, inclusive? 15 per cent.

4. What time is needed to turn and face 100 disks, 12 inches in diameter and 4 inches thick, with one roughing and one finishing cut? The roughing cut is to be at 40 feet per minute and the finishing cut at 60 feet per minute maximum. 30 per cent.

In this test, a complete notebook must be prepared beforehand, used in the test, and then handed in for examination. The second question requires a table for metric threads for an engine lathe fitted with an English pitch lead-screw; the war and our relations to our allies brings this question to the front and warrants its discussion and solution. As the U. S. standard thread had not been studied at the date of the test, the third question was designed to require research, at least enough to find an explanation of what diameter and pitches were to be provided for, if the lathe was fitted with change-gears to cut threads of the limits stated. The fourth was a simple production problem, but impossible of solution without a finished notebook and preliminary calculation. The results that the test brought were very gratifying. About 95 per cent of the students passed the examination, the chief trouble being arranging a neat, concise, handy notebook. It was especially noticeable that the last question, though much harder than the two preceding, had as high a percentage of correct results, and subsequent discussion revealed a surprising interest in questions of production, shop management, overhead costs, advertising, and the sales force, with an intelligent appreciation of matters seldom considered in trade and secondary schools.

* * *

Wall St. measures values in dollars and believes in the magic power of money to produce anything desired. But the stress of war has brought a realizing sense to business men generally that money in itself is powerless to make even a pin. Men and materials are the essentials; with them all things are possible, but without them all the gold is worthless. Many of the early attempts to make guns and shells failed because bankers had little conception of industrial methods, requirements, and limitations. They found that the rarest commodity is brains capable of organizing mechanics, developing equipment, and planning production in large quantities, quickly and efficiently.

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HEAT-TREATMENT OF GEAR BLANKS[1]

During the past few years great advancement has been made in the heat-treating and hardening of gears. In this advancement the chemical and metallurgical laboratory have played no small part. However, the condition of the blanks given to the machine shop to be machined has not received its share of attention in the heat-treating department of many forge shops, and in many cases has been neglected or not considered by the machine shops themselves. This is especially true of shops using only the lower carbon steels.

There are two distinct types of gears, one of which may be termed "carburized" and the other "heat-treated." The difference in the composition of the steel used for the two types is entirely in the carbon content, the carbon never being higher than 0.25 per cent in the carburizing type, while in the heat-treated gears it is seldom lower than 0.35 per cent. The difference in the completed gear is in the hardness. The carburized gear is file hard on the surface, with a soft, tough, and ductile core, which withstands shocks, while the heat-treated gear has a surface that can be touched with a file, but has a core of the same hardness as the outer surface.

With the exception of some of the higher grades of alloy steels, where the percentages of special elements, such as nickel and chromium, run quite high, which causes a slight air-hardening action, the carburizing steels are soft enough for machining when air-cooled from any temperature, including the temperature at which gear blanks are finished at the hammer. This condition has led many drop-forging and manufacturing concerns to believe that the annealing of the blanks involves an unnecessary expense, and often the blanks are only heated to a low temperature, many times just until color begins to show, to relieve the so-called "hammer-strains." While this is only a compromise, it is better than no reheating at all, although it does not properly refine the grain of the blank to insure good machining conditions.

"Annealing" may be defined as the heating of steel to a temperature slightly above the highest critical point, and cooling it slowly either in the air or in the furnace. The object of annealing is twofold—to relieve mechanical strains, and to soften and produce refinement of the grain. Theoretically, annealing should be accomplished at a temperature very slightly above the critical point. In practice, however, the temperature is raised to a somewhat higher point, but temperatures exceeding the critical point by 100 degrees F. should never be used.

Annealing 0.15 to 0.25 Per Cent Carbon Steels

For annealing low-carbon steels having a carbon content of about 0.15 to 0.25 per cent carbon, the following temperatures have been found to produce uniform machining conditions:

0.15 to 0.25 straight carbon steel.—Heat to 1650 degrees F.; hold at this temperature until the work is uniformly heated; then remove from the furnace and cool in the air.

0.15 to 0.25 per cent carbon, 1½ per cent nickel, ½ per cent chromium steel.—Heat to 1600 degrees F.; hold at this temperature until the work is uniformly heated; then remove from the furnace and cool in the air.

0.15 to 0.25 per cent carbon, 3½ per cent nickel steel.—Heat to 1575 degrees F.; hold at this temperature until the work is uniformly heated; remove from the furnace and cool in the air.

In the annealing of higher grades of chrome-nickel steel, with a nickel content of about 3 per cent and a chromium content of about 1 per cent, the operation is more difficult, as rapid cooling through the upper critical range produces a hardness due to the slight air-hardening properties of steel of this composition. To produce the best machining qualities in this steel, the following practice gives satisfactory results:

Heat to a temperature about 100 degrees F. in excess of the critical point, holding at this temperature for a considerable time to allow for thorough heating; cool rapidly, either by removing from the furnace into air, or opening up the furnace doors, to a point at which the forgings show no color in daylight; reheat to a point just in excess of the highest critical point and cool slowly in the furnace. The temperatures, length of heating, time and rate of cooling are dependent on analysis, size of forging, and weight of the load of forgings in the furnace.

Proper annealing makes it possible to machine the forgings easily, and subsequent troubles in the hardening plant are also greatly reduced. The advantages in hardening begin to appear in the carburizing operation, because steel of uniform grain will carburize more uniformly; a more even hardness is produced, and there are less chances for soft spots. The bores in the gears will also close in more uniformly, thus eliminating the condition where some gears require excessive grinding, while others have just enough stock to "clean up." All strains are also removed from the forging, eliminating to a great extent the distortion in hardening and the noisy gears that result from this cause.

Annealing of Gear Blanks Having a Carbon Content Higher than 0.35 Per Cent

The steels used for heat-treated gears have so high a carbon content that annealing after forging is necessary in order to make it possible to machine them, as it would be impossible to obtain satisfactory production from unannealed forgings, especially when made from alloy steels. As there are so many different compositions of steel for heat-treated gears, it is impossible to give specific directions, but the general procedure is practically the same as that used for the casehardening steel mentioned in a preceding paragraph that has 3 per cent nickel and 1 per cent chromium. More time must be given for the heating, and the rate of cooling must be closely watched, as well as the temperature at which the forgings are removed from the furnace. For a furnace load weighing 550 pounds, of medium section forgings made from 0.50 per cent carbon, 0.60 per cent manganese, 3 per cent nickel, and 1 per cent chromium, the following treatment gives very good machining conditions, both for the turning and gear-cutting operations:

Heat to 1330 degrees F., reaching this temperature in 2 hours. Hold at this temperature for 1½ hour, and allow the steel to cool in the furnace to 1170 degrees F., 1 hour being taken for the cooling. Reheat to 1230 degrees F., consuming ¾ hour for reheating. Hold at this temperature for 1¼ hour. Cool slowly in the furnace until a temperature of 900 degrees F. is reached, the rate of cooling not being faster than 75 degrees during the first hour. After 900 degrees has been reached, cool in the air.

If steels of this quality are not properly annealed, there will be hard spots in them, which, in forming the tooth, will cause the cutter to ride over the hard metal, thus producing high spots on the face of the tooth.

Hardness Test

The simple carburizing steels do not need to be tested for hardness after annealing, but alloy steels containing high percentages of nickel or chromium, and all heat-treated steels, require a hardness test. The Brinell hardness test has been found the most accurate for this purpose, but it should never be used without the aid of a microscope. By careful control of the annealing operation and with the aid of the hardness test, it is possible continually to produce forgings that will have uniform machining qualities and that will be soft enough to make possible a satisfactory rate of production. The following hardness numerals used in the manufacture of gears have been found to insure good machining qualities: 0.20 per cent carbon steel containing 3 per cent nickel and 1.4 per cent chromium—Brinell hardness numeral, 156-170; 0.50 per cent carbon steel containing 3 per cent nickel and 1 per cent chromium—Brinell hardness numeral, 179-187; 1.50 per cent chrome-vanadium steel—Brinell hardness numeral, 170-179.

* * *

The country's foreign trade amounted to over $9,000,000,000 in 1917, the exports reaching a total of $6,226,000,000, while the imports amounted to $2,952,000,000; this is a gain of nearly $1,300,000,000 over 1916. The excess of exports over imports has nearly doubled in the last two years, amounting to $3,274,000,000 in 1917, against $1,776,000,000 in 1915.

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[1] Paper read by C. R. Poole, of the Frost Gear & Forge Co., Jackson, Mich., at the American Gear Manufacturers' Association convention, at White Sulphur Springs, W. Va., April 18 to 20, 1918.

STANDARDIZATION OF GEARING[1]

The subject of standardization as it pertains to industrial activities is receiving the attention of all the national organizations representing the various industries at the present time. The American Gear Manufacturers' Association has, therefore, considered it advisable for the advancement of the gear industry to appoint as one of its standing committees a "general standardization committee," together with a number of subcommittees, to consider and develop, from the mass of data now available in various forms, standards for use in this industry.

While the types of gearing differ from one another in many respects, there are a number of functions common to many or all of them, and an endeavor will be made in the following to outline some of the details that might be made standard for each type of gearing. Another matter of interest in this connection is that of symbols used to denote different dimensions in gearing calculations. Different text-books and handbooks use different symbols to represent the same dimensions, which makes it difficult to compare the results of different formulas. To overcome this difficulty, it might be well to have a nomenclature committee which would authorize a standard set of symbols for use in gear calculations. Working limits should also be adopted to assure standards of quality, these limits pertaining to such matters as the permissible running out in the blank and in the cutting of the teeth, the size of the hole, the width of the keyway, etc. Standard formulas for calculating the strength of all classes of gearing, with values to cover the various factors used, should also be adopted.

Bevel Gears

Within the last few years, bevel gears have been highly developed, due principally to the great advance in machinery for producing them. New formulas for calculating the dimensions of bevel gears, which differ from the usual or standard practice, have also been developed, the reference here being to the long addendum and the spiral type of gears. These formulas should be standardized, as the growing use for long addendum and spiral type gears makes it necessary that these be considered standard and not special types. Many bevel gears will continue to be cut with rotary cutters, and some consideration should be given to the proper cutters used in producing them.

Spur Gears

The spur gear is, by far, the most commonly used of all gears, and has theoretically and practically received the most consideration, both as regards design and production. Most of the theory of gearing can be studied from it, and the methods of producing it have been highly developed. For this reason, any standard adopted must be one that does not conflict with any method of production, but should be applicable to each and all of these methods.

Worm-gears

Within the last few years, worm-gears have become widely used. They are now employed for transmitting greater power at higher speeds than was thought possible in the past; but even now, with this great development, their design is not based upon complete analysis. There are so many conditions that enter into the design of worm-gears that it is almost impossible to design a drive with any certainty of success, unless the design is based upon a similar successful design. It would be well if the subcommittee on worm-gears of the American Gear Manufacturers' Association could investigate the many successful drives now in existence, and from these deduce some tangible working basis of design. There is a great lack of uniformity in calculating the dimensions of both the worm and the wheel, and also in the method of producing the worm, as well as in the selection of the material from which worms and wheels are made. It would be possible to develop standard formulas for worm and worm wheel dimensions that would permit makers to produce similar gears for regular conditions.

At the present time, multiple-threaded worms, for example, are not produced to a uniform standard. They may be either cut in a worm-thread milling machine with a straight-sided cutter, or on a lathe with either a straight-sided tool having the standard dimensions on an axial plane or a straight-sided tool having the standard dimensions in a plane normal to the helix of the thread. If these three methods are pursued, the thread of each worm would be different from the others, and a hob could be right for only one of them, the hob being made to the same system. Again, when the angle of thread with the axis becomes less than 72 degrees, it is the practice in some shops to make the hob with spiral flutes, as it works better than a straight-grooved hob of this angle, and in that case, the tooth proportions are calculated from the normal pitch. This indicates the necessity for standardization. The present length of the worm and the width of the face of the wheel might also need investigation and standardization.

Herringbone Gears

Herringbone gears have only been recently developed. The industry is highly specialized, and the only suggestion the author can make is that experience has taught him that they must be extremely well made if they are to do their work properly, and it would be desirable to determine definitely the degree of accuracy that should be demanded.

Sprockets

Chain sprockets present another highly specialized branch of gearing, and any work that the gear manufacturers would do with regard to standardization must have the sanction of the chain manufacturers. The latter hesitate to furnish chain to run on sprockets that they have not themselves cut, owing to the lack of standardization, and also to lack of knowledge on the part of many who attempt to cut sprockets as to the proper method in which they should be cut. Cooperation between the chain manufacturers and the American Gear Manufacturers' Association should be valuable in defining standard designs and methods of cutting sprockets.

Composition Gears

For several years past, gears of other materials than metal have been made to an ever-increasing extent. Until recently, these gears were usually made of rawhide or fiber, but today the two largest electrical companies in the country have developed a fabric composition that is used to probably a greater extent than any of the older materials. The working standards for any of these materials are different from those used for metal, and a different set of standard rules will be required.

Hardening and Heat-treatment

The best and most durable gears are those that are properly heat-treated or hardened, and standard methods for handling various kinds of steels used for gears should be developed. Such methods would be of inestimable value to every gear manufacturer and user. The steel manufacturers would, no doubt, willingly cooperate with the gear manufacturers in the determination of standard heat-treatment methods.

Inspection

Standard inspection methods for different kinds of gears are also required. This standardization includes the determination of working limits suitable for different kinds and sizes of gears and methods for testing and inspection.

The association has formulated plans for obtaining, from gear manufacturers and others interested in the design and production of gearing, suggestions and data relating to the subject, and the committees will digest the information thus obtained and present reports which, in turn, will be sent to the various manufacturers for suggestions and criticism. The General Standardization Committee of the American Gear Manufacturers' Association (B. F. Waterman, Brown & Sharpe Mfg. Co., Providence, R. I., chairman) will welcome any suggestions from any users of gears, as the success of the undertaking depends largely upon the cooperation of all concerned. The importance of the subject and the desirability of standardization will commend itself to all mechanical men.

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[1] Abstract of a paper read by B. F. Waterman of the Brown & Sharpe Mfg. Co., Providence, R. I., before the American Gear Manufacturers' Association convention at White Sulphur Springs, W. Va., April 18 to 20, 1918. Mr. Waterman is chairman of the Standardization Committee of the Association.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

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SPRINGFIELD GUN BORING MACHINE

This machine is adapted for boring tubes, jackets, and bands for field guns. It has a capacity for boring holes up to 7 inches in diameter by 21 feet in length. The gun parts bored on this machine are made of chrome-nickel steel, and working in this tough heat-treated material the machine has a capacity for boring at the rate of 2 to 3 inches per minute.

IN the accompanying illustrations are shown four views of a large gun boring machine made by the Springfield Machine Tool Co., 631 Southern Ave., Springfield, Ohio, for boring field gun tubes, jackets, and bands. These parts are all made from chrome-nickel steel, which is very tough when heat-treated and has a high elastic limit. Naturally a powerful machine is required to bore such material. This Springfield gun boring machine is 28 feet long, and the headstock has a hole through the spindle which is 15 inches in diameter. The machine has a capacity for boring holes up to 7 inches in diameter and up to 21 feet in length. It will be seen that the machine consists of a bed with a headstock at one end, that is driven by a thirty-five-horsepower variable-speed motor, from which power is transmitted to the rear of the headstock by means of a silent chain drive running in a bath of oil and thence through a train of gears to the spindle. These gears afford four mechanical changes of speed, and they are made of chrome-nickel steel, heat-treated and hardened, with the exception of the large gear directly back of the chuck, which is made of high-carbon vanadium steel. With the variable-speed motor having a range of speeds of from 500 to 1500 revolutions per minute, and the four mechanical changes in the headstock, spindle speeds are available covering a range of from 20 to 200 revolutions per minute.

On large drills used in this machine, the thrust is enormous, and in order to support this thrust load, there is placed directly behind the chuck a large thrust bearing containing balls one inch in diameter, on which the entire pressure of the drill is supported. To insure proper lubrication of the spindle, which is 18 inches in diameter, it was found necessary to employ a forced-feed system of lubrication to insure the delivery of a steady stream of oil over all working parts in the headstock. The carriage and apron are of special design to provide for carrying the drill forward at varying speeds. Some idea of the conditions which had to be met in building this gun boring machine will be gathered from the fact that it is sometimes necessary to apply a pressure on the drill as great as 50,000 pounds. Feed is transmitted to the carriage through a long feed-rod, which will be seen in the front view of the machine, Fig. 1, and then through a system of gearing consisting of a worm and wheel, spur gears, and a rack and pinion. The total gear reduction amounts to 2400 to 1.

A handwheel is provided in front of the carriage for use in securing a small movement forward or backward, but for longer movements a quick-return mechanism is furnished at the back of the carriage, which will be seen in the rear view of the machine, Fig. 2. In the close view of the carriage shown in Fig. 3, the center lever is the quick-return lever, while the long lever at the front of the apron is a power feed lever. The handle to the right, pointing vertically, is the interlocking lever which prevents the quick-return mechanism from

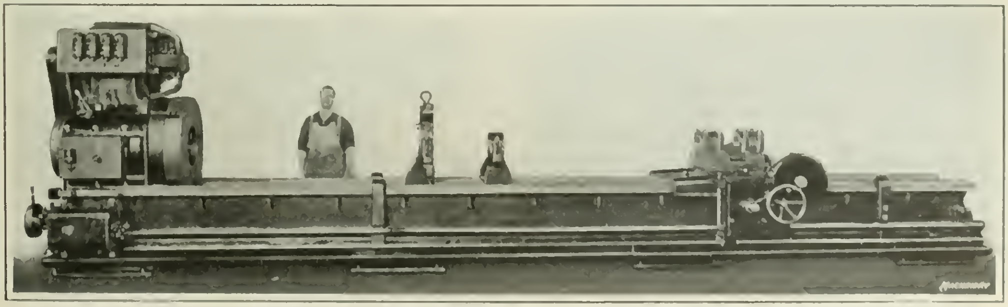


Fig. 1. Large Gun Boring Machine built by Springfield Machine Tool Co. for Use in boring Field Gun Tubes, Jackets, and Bands

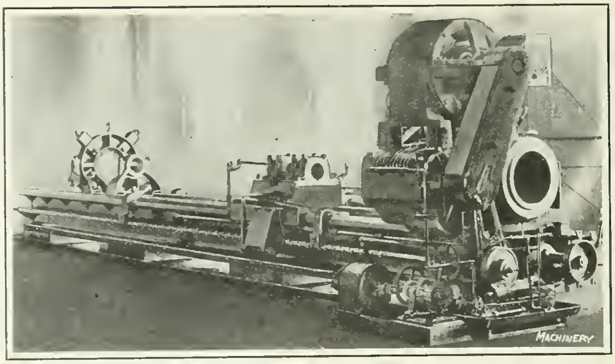


Fig. 2. Opposite Side of Springfield Gun Boring Machine, showing Arrangement of Quick-return Mechanism

being engaged while the feed mechanism is in operation. The handle to the left, which will be seen pointing vertically, is for operating the electrical mechanism that controls the motor, and is used for starting and stopping the main driving motor. In this illustration there will also be seen a large saddle which carries the drill. In the rear view of the machine shown in Fig. 2, a better idea is given of the arrangement of the quick-return mechanism and the means for furnishing cutting lubricant to the drill.

At the rear of the carriage there is a feed mechanism which causes the carriage to travel along the bed at a rate of 35 feet per minute, this result being accomplished by means of a double-threaded lead-screw which has a lead of 4½ inches. The box arrangement at the back of the carriage supports two nuts, one of which has a right-hand and the other a left-hand thread, so that by engaging either one of these nuts with the screw, the carriage is caused to travel in one direction or the other, according to whether the right- or left-hand nut is engaged. Owing to the great length of the machine, it was found necessary to furnish the screw and rod with additional supports, the arrangement of which is clearly illustrated. The quick-return screw is driven by a three-horsepower motor, which will be seen at the rear of the machine, power being transmitted from this motor to a jack-shaft, which, in turn, drives the quick-return screw. This jack-shaft also transmits power to a large rotary pump capable of delivering 26 gallons of cutting compound per minute under a pressure of 100 pounds per square inch. One of the worst conditions to contend with in drilling especially deep holes is the necessity of carrying away the chips, which is accomplished by delivering a light liquid, such as a water cutting solution, to the point of the drill. This serves to keep the drill cool and in its backward flow carries the chips out of the hole in the work. As the carriage travels along the bed, it requires a constantly increasing or decreasing length of tubing to conduct this lubricant to the rear of the drill, and this is accomplished by a system of telescopic brass tubes, each of which has packed joints, so that provision is made for carrying the lubricant without leakage. In the rear view of the machine shown in Fig. 2, there will also be seen the provision made for forced lubrication of the various journals.

Power for driving the feed mechanism is transmitted from an intermediate shaft in the headstock to a two-step cone pulley by means of a silent chain drive, and from this point it is carried to the front of the machine to a gear-box located directly behind the controller on the front left-hand corner of the machine. This gear-box is furnished with gears that provide five rates of feed, and these are doubled by the two-step cone to give a total of ten available feed changes for the carriage, covering a range from 0.0015 to 0.016 inch per revolution. It will be seen that the entire machine stands in a steel pan, which catches all the chips and drilling compound and returns the compound to the reservoir ready to be delivered again to the drill point. To provide for handling the heavy work for which this machine is intended, it has to be heavily constructed. Exclusive of the electrical equipment, the weight is 28,000 pounds, and with the electrical apparatus added, the weight is brought up to 31,000 pounds. It will be of interest to note that the largest casting in the machine is the bed casting, which weighs 14,000 pounds, and also that all castings were made at the plant of the Springfield Machine Tool Co. In operation, the machine is capable of drilling large holes at the rate of from 2 to 3 inches per minute.

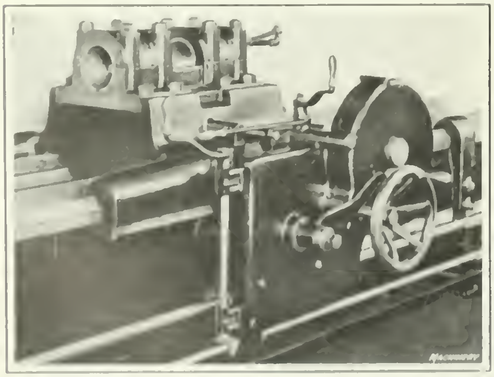


Fig. 3. Close View of Carriage of Springfield Gun Boring Machine

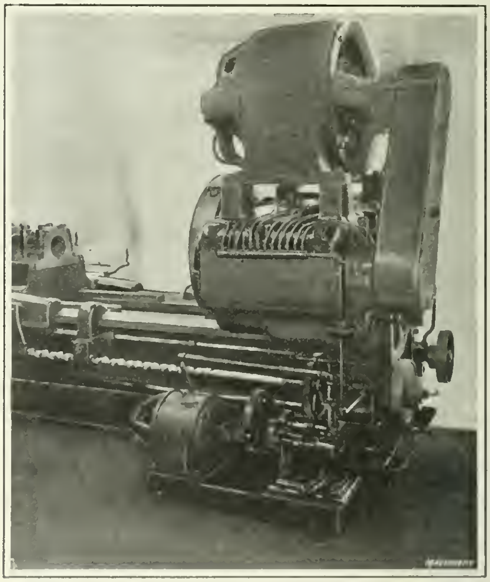
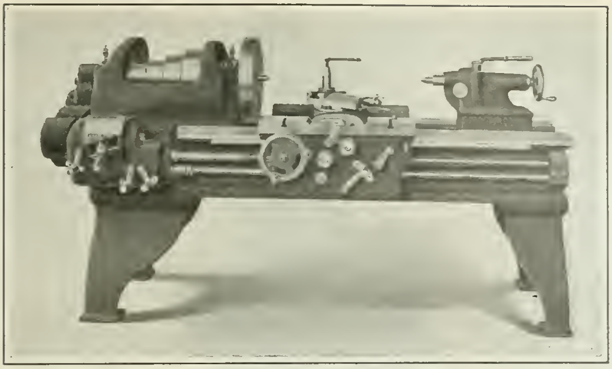


Fig. 4. Close View of Headstock of Springfield Gun Boring Machine

HAMILTON ENGINE LATHE

The 16-inch engine lathe with a cone head and quick-change gear, which forms the subject of this description, is one of the recent products of the Hamilton Machine Tool Co., Hamilton, Ohio. The bed is made of semi steel, and the side walls are reinforced and secured by cross braces at frequent intervals. One vee and one flat way are provided at the front of the bed and two vees at the back, the outer one being of extra width and extending well out from the front in order to afford plenty



Sixteen-inch Engine Lathe built by Hamilton Machine Tool Co.

of support for the carriage when the lathe is machining work of large diameter. The headstock is of box construction, with the sides extending up to the center line of the spindle; in this way, the front and rear bearings are tied together, causing the spindle thrust to be taken by both bearings and practically eliminating spring and vibration. The usual equipment of the headstock consists of a four-step cone pulley and single back-gears. An improved locking device permits the cone pulley and face gear to be instantly connected or disconnected without requiring the use of a wrench. The hollow spindle is made of chrome-nickel steel and the spindle bearings are lined with phosphor-bronze. These bearings are scraped to fit the spindle accurately and they are provided with sight-feed oil-cups. End thrust of the spindle is taken on a special ball bearing supported against the inside of the rear spindle box.

The tailstock is secured by two clamping bolts extending to the top, where they may be conveniently reached by the operator. The tailstock spindle is graduated in eighths of an inch and it is also provided with a micrometer dial which permits fine adjustments to be made. Provision is made for setting over the tailstock for the performance of taper-turning operations, and graduations indicate both the central position and the amount of set-over. A flat surface is provided on top of the carriage, which is furnished with T-slots so that work can be clamped to the carriage if so desired. The compound rest is furnished with taper gibs in both the top and bottom slide. A chasing dial is provided which facilitates the performance of thread-cutting operations. This dial is set flush with the carriage at the right-hand side and is so arranged that it may easily be disengaged when not in use, thus avoiding unnecessary wear. The apron is of box construction, the double walls supporting all shafts at both ends. Bronze bushings are provided for the shaft bearings and all gears in the apron are made of steel. Provision is made to prevent the feed and screw-cutting mechanisms from being engaged simultaneously. Both the longitudinal and cross feeds are friction driven and they may be easily engaged or disengaged.

All of the gears in the quick-change mechanism are made of steel and they are hardened and ground from the pitch line. This gear-box is a compact self-contained unit with provision for easily obtaining any desired rate of feed. Forty-eight changes of feed are available with regular set-ups, and the open-end lead-screw enables provision to be made for cutting any thread by the use of extra gears. In working out the design of this lathe, particular care has been taken to provide for convenience of operation. Quick-action handles are provided on the tailstock screw, the apron handwheel, and the cross-feed screw; and central oiling devices are provided on the apron and the quick-change gear-box, thus facilitating lubrication and assisting in keeping the bearings free from dirt. All oil-holes are protected by suitable covers and all gears are enclosed. The regular equipment furnished with the lathe includes a compound rest, double friction countershaft, large and small faceplates, a steadyrest, centers, and wrenches. Double back-gears, taper attachment, relieving attachment, cabinet legs, turret, oil-pan, etc., may be furnished as special equipment.

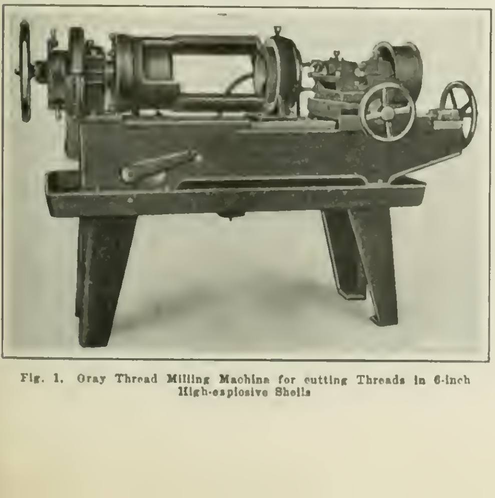


Fig. 1. Gray Thread Milling Machine for cutting Threads in 6-inch High-explosive Shells

The principal dimensions of this lathe are as follows: swing over ways, 18¼ inches; swing over compound rest, 11¾ inches; capacity between centers for 6-foot bed, 36 inches; dimensions of front spindle bearing, 3⅛ by 5¼ inches; dimensions of rear spindle bearing, 2½ by 3¾ inches; diameter of hole through spindle 1½ inch; ratio of back-gear, 10 to 1; maximum traverse of tailstock spindle, 10 inches; diameter of tailstock spindle, 2 1/16 inches; range of spindle speeds, 6½ to 450 revolutions per minute; capacity for thread cutting, 2 to 112 threads per inch, including the 11½ per inch pipe thread; length of carriage bearing on ways, 27 inches; size of tools, 5/8 by 1 inch; capacity of steadyrest, 5½ inches; dimensions of countershaft friction pulleys, 12 by 4⅜ inches; speeds of countershaft, 154 and 190 revolutions per minute; and weight of machine with 6-foot bed, 3480 pounds.

GRAY SHELL MACHINERY

In the accompanying illustrations are shown machines built by the Gray Machine Tool Co., Inc., 2665 Main St., Buffalo, N. Y., for use in the performance of various operations involved in the manufacture of shells. In Fig. 1 is shown a machine designed for use in milling the threads in the nose or base of 6-inch high-explosive shells, and this machine provides for trimming the fuse seat or plug recess at the same setting of the work, thus making these surfaces perfectly true with the threaded hole. On 6-inch shells it is stated that the actual threading time is 1¼ minute for the 2-inch fuse hole, and 2½ minutes for the base plug recess. The work and cutter are rotated by separate belts from a countershaft. In performing a thread-milling operation on this machine, the lead of the thread is governed by moving the work-spindle endwise as it revolves. For this purpose, a threaded sleeve on the spindle runs in a nut which is held in a stationary position. During the facing operation this nut is locked to the spindle and revolves with it. To traverse the spindle endwise the nut is revolved in the reverse direc-

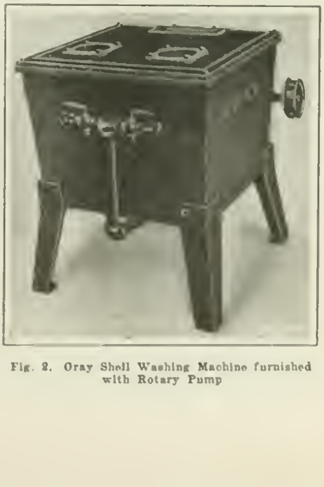


Fig. 2. Gray Shell Washing Machine furnished with Rotary Pump

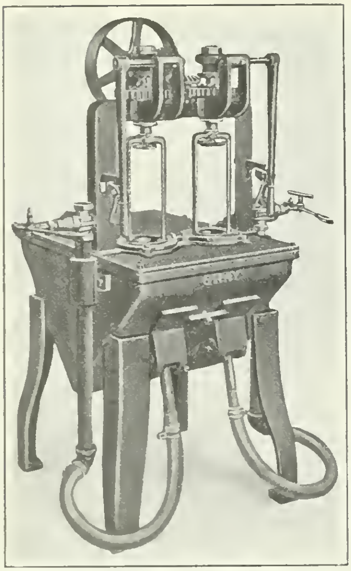


Fig. 3. Gray Shell Blast for alternately loading and cleaning Inside of 75-millimeter Shells

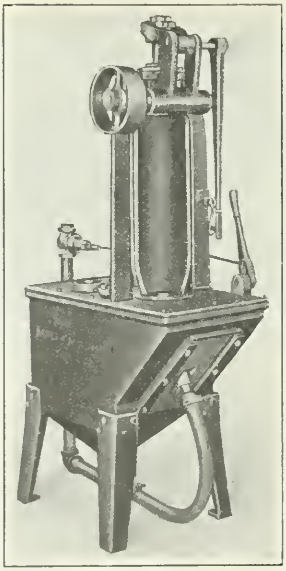


Fig. 4. Gray Shell Blast for cleaning Inside of 4.5-, 5-, 6-, and 8-inch Shells

tion, the work-spindle bearings are extended to allow a traverse of 2½ inches, and the direction of rotation of the work-spindle is such that the work travels away from the cutter.

In Figs. 3 and 4 are shown two forms of shell blasting machines which are especially adapted for cleaning the inside of shells with steel grit or steel shot. This treatment removes any signs of scale or boring-tool marks from the inside of nosed-in shells. The method of operation of both machines is essentially the same, so that the following description will give a good idea of the way in which either one operates. A shell is placed in the holder with its nose downward in a cup, after which the long lever handle is released to let the shell and holder drop down so that the blast nozzle is inside the mouth of the shell. This results in automatically engaging a clutch which causes the shell-holder to be slowly revolved. Then by pulling the short lever, a quick-opening gate valve on the air-line is opened, with the result that a specially arranged injector draws up the steel shot from the hopper and discharges them into the shell. After a few revolutions, the air is shut off and the long lever is pushed down, thus raising the shell and disengaging the clutch drive. The machine is said to be practically dustproof and the production from thirty to fifty shells per hour. The machine shown in Fig. 4 is suitable for cleaning 4.5-, 5-, 6-, and 8-inch shells and could easily be arranged for other sizes.

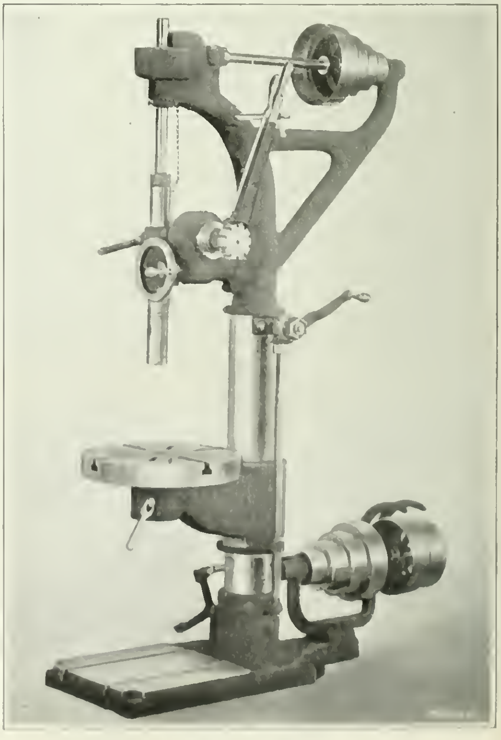
The machine shown in Fig. 3 is designed with a large hopper and two shell-holders and nozzle arrangements to provide for rapidly removing scale and tool-marks from the inside of 75 millimeter shells. A shell is placed in one holder and dropped into position to start the blasting operation. Then a shell is placed in the second holder and by the time that the operation has been started on the second shell the first one has revolved a few times and is ready to have the air shut off and be removed from the machine. The two shell-holders are run independently of each other. On this machine the production is said to be sixty or more shells per hour.

The shell washing machine shown in Fig. 2 is a cast iron tank furnished with a rotary pump bolted to the back of the tank and piped to the two shell cups in the cover. When desired, the shell manufacturer can put a steam coil into the tank for heating the washing liquid. The capacity of the tank is approximately forty gallons, and it is divided into two compartments, so that only water can get back to the pump, the dirt and chips remaining in the first compartment. This machine handles shells up to 6 inches in size.

WEIGEL VERTICAL DRILLING MACHINE

The 20-inch wheel and lever feed vertical drilling machine illustrated is a product of the Weigel Machine Tool Co., Peru, Ind. It will be seen that this machine is built with a square base, which is of ample size and well ribbed underneath. It will also be noticed that the base is planed and furnished with T-slots to provide for bolting work in place. Split bearings are used for the upper driving shaft to afford means of taking up wear, and it will be seen that the head is fixed to the column. The feed rack and pinion, as well as all other gearing, are cut from solid blanks, and means are provided for taking up any wear of the spindle. This spindle is made of steel and finished to size by grinding. It has a drift slot through the nose, and quick approach and return movements are imparted to the spindle by means of the rack and pinion operated by a short lever at the left-hand side of the spindle. Ball bearings are employed to take the end thrust. The spindle sleeve is accurately finished by grinding, and it is graduated and fitted with bronze bushings.

The table arm has an enlarged circular support for the table, and it is raised and lowered by means of a screw and pair of miter gears, as illustrated. The table can be swung around the column when it is necessary to set up large pieces of work on the base. To enable the operator to start or stop the machine instantly with his foot, and leave both of his hands free for handling the work, the belt-shifter is located at the base of the machine. All shafts, racks, and pinions used in this drilling machine are made of steel, and all gears are cut from solid blanks. To



Vertical Drilling Machine with Wheel and Lever Feed built by Weigel Machine Tool Co.

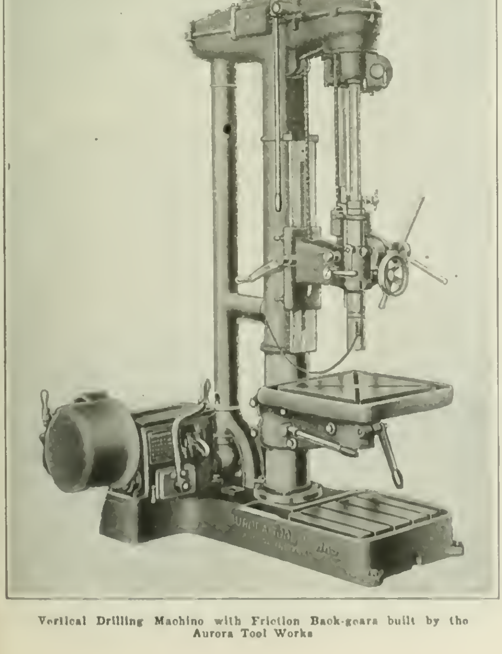
avoid accidents, all gears are covered by guards. Accurate alignment between the table and spindle is assured by having the hole in the table arm bored by the drilling machine after it has been assembled.

The principal dimensions of this machine are as follows: total height with spindle extended, 6 feet 3¾ inches; height to top of cone pulley, 5 feet 10¾ inches; maximum capacity between spindle and base, 37½ inches; maximum capacity between spindle and table, 19⅜ inches; maximum traverse of spindle, 8 inches; maximum traverse of table on column, 17 inches; diameter of spindle, 1 5/16 inch; diameter of spindle in sleeve, 1 7/16 inch; diameter of sleeve, 2¼ inches; diameter of column, 5½ inches; diameter of table, 16½ inches; diameter of large step on cone pulley, 9 inches; diameter of small step on cone pulley, 4 inches; face width of cone pulley steps, 2¼ inches; dimensions of tight and loose pulleys, 9 inches in diameter by 3¼ inches face width; speed of lower shaft, 600 revolutions per minute; and approximate weight of machine on skids, 750 pounds.

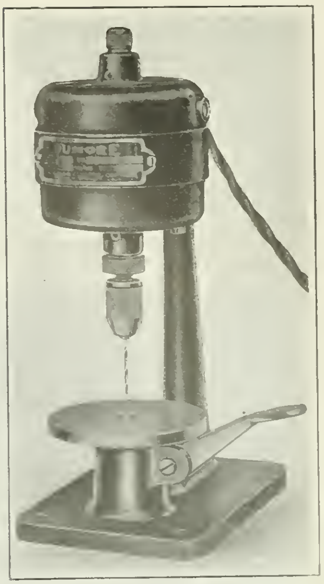
AURORA TOOL WORKS VERTICAL DRILLING MACHINE

An important feature of the design of the 28-inch friction back-geared drilling machine which has recently been placed on the market by the Aurora Tool Works, Aurora, Ind., is that it has been designed with a thoroughly built-in construction. Every moving part, with the exception of the spindle and feed-rod, is enclosed, thus effectually excluding all foreign matter from moving parts of the mechanism and avoiding the possibility of injury to the operator. All bearings and gears are submerged in oil, and gage glasses show the oil level at all times, thus avoiding danger of the bearings or gears running dry. Ball bearings are used throughout the machine except in the quill. Another feature is the centralizing of all control levers and wheels, so that the operator is able to start or stop any movement, including clamping of the table and table arm, without leaving his position at the front of the machine. Every speed and feed is plainly marked and may be obtained for any size of drill without guesswork and without having to stop the machine.

All spur gears are made of nickel alloy steel and heat-treated. They are of the cut spiral stub-tooth type, with a 20-degree pressure angle, and run without vibration or noise. All bevel gears are of the spiral type. Both tight and loose pulleys on the speed-box are fully enclosed, and the loose pulley is equipped with an oilless bearing; this pulley is made considerably smaller than the tight pulley in order to slacken the belt tension when the machine is not running. Through this speed-box and the back-gears sixteen changes of speed are obtainable. The spindle is machined from a high-carbon steel forging; it is double-splined and furnished with ball thrust bearings. A large reservoir is provided from which a copious flow of cutting compound is delivered to the tool carried by the spindle. This reservoir is cast integral with the base of the machine, and the base is furnished with a deep oil-groove extending all the way around the T-slots, thus permitting bolts to be entered into the T-slots from either end and allowing a free passage through which the cutting compound can flow back to the reservoir. The vertical driving shaft passes up through the tubular back-brace, where it is effectually guarded. An Aurora improved friction tapping attachment can be furnished with this machine.



Vertical Drilling Machine with Friction Back-gears built by the Aurora Tool Works



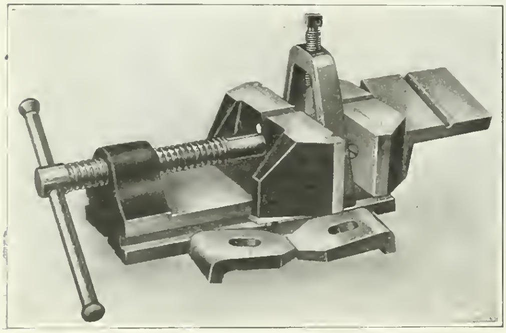
Type A "Dumore" Drilling Machine built by Wisconsin Electric Co.

"DUMORE" ELECTRIC DRILLING MACHINE

The Wisconsin Electric Co., 1429 Dumore Bldg., Racine, Wis., are now building a "Dumore" Type A electric drilling machine which is suitable for the use of manufacturers and jewelers who require a sensitive drilling machine for handling light work. It will be seen that the machine is equipped with a direct-connected motor, which is of the variable-speed type. The machine is adapted for handling a wide range of drilling operations in steel, cast iron, brass, aluminum, fiber, hard rubber, etc. It is equipped with a No. 1 Jacobs chuck and a six-speed controlling unit which affords speed variations from 500 to 10,000 revolutions per minute, the available speeds being approximately 500, 2000, 4000, 6000, 8000 and 10,000 revolutions per minute. The controller is mounted on the floor and regulated by a foot-pedal. On this drilling machine the table is adjustable and gives the drill a stroke of ½ inch, the capacity of the machine being for drilling holes up to 1/16 inch in diameter in steel and 1/8 inch in diameter in soft alloys. Holes can be drilled to the center of a 5-inch circle. By carefully bringing the motor and drill chuck into accurate dynamic balance, smoothness of operation is assured.

G-S COMBINATION DRILL VISE

The Germanow-Simon Machine Works, 58 Mill St., Rochester, N. Y., are now building a combination drill vise which performs three distinct functions in that it combines a vise, V-blocks, and angle-plate in a single tool. The vise is of simple construction with the screw set above the center of the sliding jaw to prevent wear on the bearings. This screw is of the square-thread type. The vees, cut across the top of the jaws and on the face of the sliding jaw, are always ready for work, and the work may be rigidly held in position in them. A special steel clamp provides for holding the work in the upper vees without the necessity of using straps and bolts. The angle-plate at the left-hand end of the vise can be set to any degree and held in place by tightening a single nut. The G-S combination vise is manufactured in two sizes, known as Nos. 1 and 2. The No. 1 vise has a base 12½ inches in length by 5 inches in width, and an extreme height of 5 inches. The size of jaws is 2½ inches in depth by 8 inches in width, and the jaws open 5 inches. The No. 2 vise is of similar design, but of larger capacity and heavier construction. The base is 15½ inches in length by 7 inches in width, and the extreme height of the vise is 6 inches. The jaws are 3 inches in depth by 9 inches in width, and have a maximum opening of 7 inches.



Combination Drill Vise made by the Germanow-Simon Machine Works

TAFT-PEIRCE SQUARES AND V-BLOCKS

Knife-edge squares and V-blocks of the forms shown in the accompanying illustrations are recent additions to the line of tools made by the Taft-Peirce Mfg. Co., Woonsocket, R. I. It will be apparent that the squares are intended for use on work requiring a high degree of accuracy, and in order to fulfill this requirement each square is carefully hardened, ground, and lapped. It will be seen that the surplus stock is removed from the center of the tool to provide for inserting an insulation which affords a convenient grip and also decreases the weight of the square. These tools are made in two sizes, namely, 2 by 2½ by 1/2, and 2½ by 3 by 9/16 inches, and each size is packed in a morocco leather case.

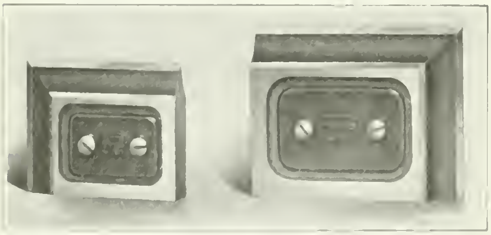


Fig. 1. Knife-edge Precision Squares made by Taft-Peirce Mfg. Co.

In Fig. 2 is shown the new Taft-Peirce V-block which is designed for holding cylindrical work for the performance of drilling and milling operations, etc. These blocks are made with a 3/4-inch hole through them, central with the sides and vee and square with the bottom surface. The hole is finished so that the block may be readily trued up on the faceplate, maintaining the vee central with the axis. Each side of the vee has three tapped holes for clamping screws, and as these holes extend entirely through the block, they can also be used for clamping it to a faceplate. Two clamps and four clamping screws are supplied with each block, and in the illustration one of these clamps is shown in position while the other clamp and its screws are shown lying beside the block. These clamps are so designed that they may be loosened or removed by one or two turns of each screw. A groove is milled all the way around the block to provide for strapping it in position, and each block is finished on all surfaces.

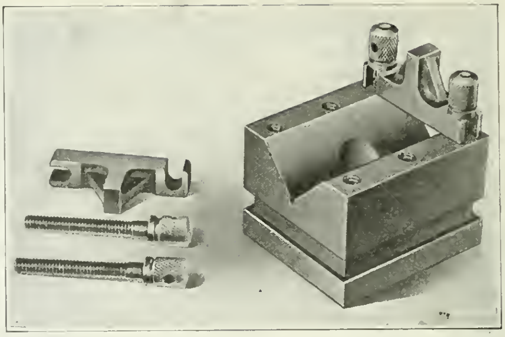
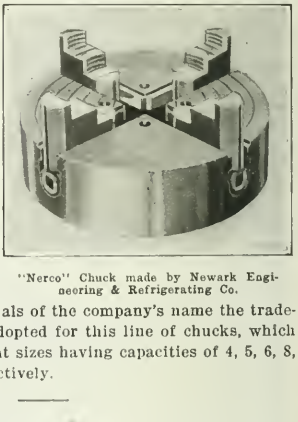


Fig. 2. Type of V-block now being made by Taft-Peirce Mfg. Co.

"NERCO" FOUR-JAW CHUCK

The Newark Engineering & Refrigerating Co., Newark, N. J., are now manufacturing a line of independent four-jaw chucks with iron bodies, the general design of which is shown in the illustration which accompanies this description. The jaws furnished in these chucks are reversible to provide for holding work from either the outside or the inside, and for use in those shops where a three-jaw chuck is preferred, independent three-jaw chucks can be furnished. From the initials of the company's name the trade-mark "Nerco" has been adopted for this line of chucks, which are made in seven different sizes having capacities of 4, 5, 6, 8, 9, 10, and 12 inches, respectively.



"Nerco" Chuck made by Newark Engineering & Refrigerating Co.

H. P. WHEEL-TRUING TOOLS

The H. P. Co., 45 Fort St. E., Detroit, Mich., are now manufacturing the Nos. 1, 2, and 3 grinding-wheel truing tools which are shown in the accompanying illustrations. The No. 1 truer is equipped for precision grinding machines and has interchangeable shanks which fit any make of machine. This tool is intended to true wheels for performing all classes of rough and semi-finished grinding operations. It will be seen that a grease cup is provided, which affords forced lubrication,

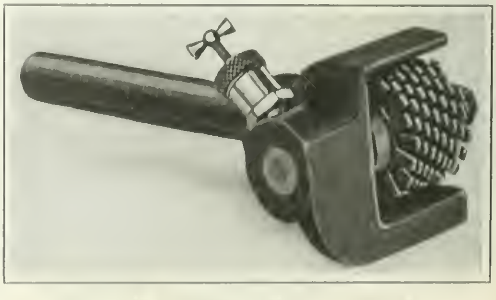


Fig. 1. No. 1 Wheel-truing Tool made by H. P. Co.

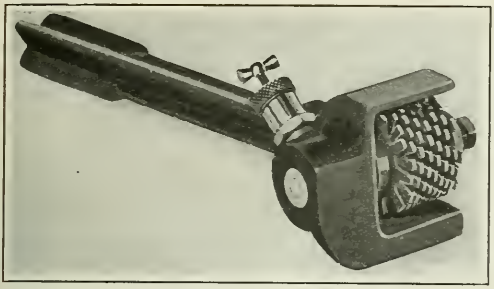


Fig. 2. No. 2 Wheel-truing Tool made by H. P. Co.

and the bearings are designed in such a way that dust and particles of abrasive are effectually excluded. The H. P. No. 1 truing device is being used successfully for truing grinding wheels used for rough-grinding crankshafts and camshafts, axle shafts, and other classes of lighter work.

In Fig. 2 is shown the No. 2 truing device which is intended for hand use only. It is furnished with the same form of cutter as the tool shown in the preceding illustration and either new or partially worn cutters may be employed in this tool. The head is of identically the same design as that of the No. 1 tool, the only difference being in the shank, which is so formed that it may be conveniently held in the hand. This shank is furnished with thoroughly lubricated bearings which are dust-proof and waterproof. It is stated that when this tool is equipped with a new set of cutters, it will give 1500 dressings before being worn out.

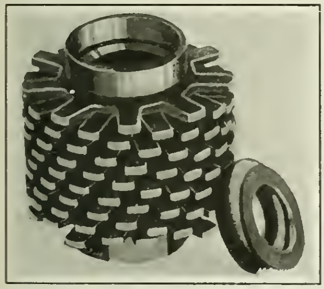


Fig. 3. Improved Abrasive Wheel Cutter used on H. P. Truing Tools

The improved abrasive wheel cutter used on both of these tools is 1⅝ inch in diameter by 1 inch face width. It consists of individual cutters mounted on a hub with the teeth so arranged that they form spirals. Each tooth is separate, so that it provides a distinct cutting point, and each cutter is mounted on a shaft which fits into the bearing in the shank. The cutters are hardened and ground to fit the hub. When the cutter is worn out, the shaft is withdrawn from the holder and each new cutter is equipped with a new shaft on which it is assembled and tested before being shipped. The only assembling necessary in the user's shop is to pull out the old shaft and substitute the one carrying a new set of cutting points. Guards are provided to protect the operator from possible breakage of cutters or from being struck by particles of the wheel.

On the No. 3 H. P. abrasive wheel-truing tool which is shown in Fig. 4, double adjustable bearings are provided and the truing tool is equipped with a set of cutters made of thin metal, which have been specially treated. The teeth are sharp and close together to give a smooth sharp surface to the wheel.

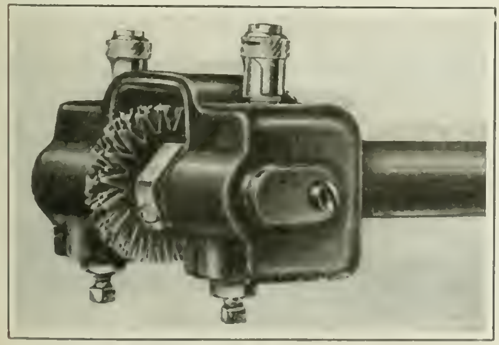
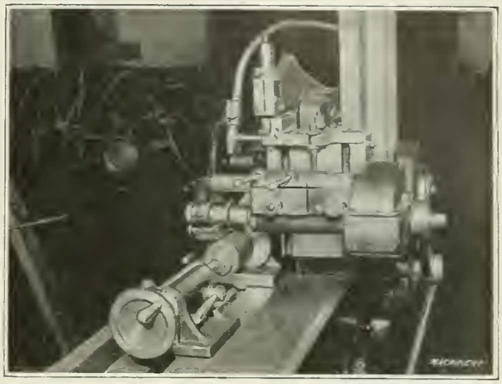


Fig. 4. No. 3 Wheel-truing Tool made by H. P. Co.

ATTACHMENT FOR BILTON MILLING MACHINE

The Bilton Machine Tool Co., Bridgeport, Conn., have added an attachment to their milling machines whereby the work feed is dependent upon the movement of the cutter. They have experienced considerable trouble in the past with work of the nature which requires the use of a fine saw. In the old-style Bilton milling machine a single-belt drive is used; and if by chance the cutter becomes broken or caught in the work, the table continues to feed and causes no end of trouble. To overcome this difficulty the belts that drive the feeding mechanism have been placed on the same shaft as the belt which drives the cutter-spindle. Having the feed belt connected with the belt that drives the cutter-spindle causes the feed to stop when the cutter-spindle gets stuck.



Attachment for Bilton Milling Machine which makes Feed Movement Dependent upon Cutter Rotation

WETMORE TAPS AND REAMERS

Since the first contracts for munitions were let in this country, there have been a great many developments in such special tools as taps, reamers, thread-milling hobs, and gages required in the production of munitions of war. In the accompanying illustrations are shown two forms of taps and an expanding reamer of the floating type for finish-sizing the fuse holes in shells. These tools represent additions to the line of products of the Wetmore Mechanical Laboratory Co., Milwaukee, Wis. In designing these special taps, shown in Fig. 1, advantage has been taken of experience gained in making taps to meet the requirements of a variety of different shell manufacturers, and thread forms have been chosen which have given the longest life and the greatest degree of accuracy. They are made of a special alloy steel.

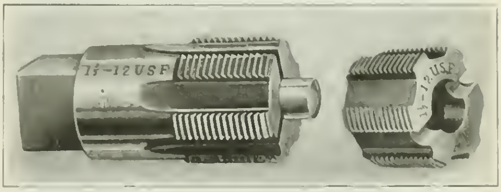


Fig. 1. Solid Hand Sizing Taps made by Wetmore Mechanical Laboratory Co. for Use in Fuse Holes of Shells

The expanding reamers are of the floating type, and the one shown in Fig. 2 is made to fit a 3-inch turret hole and is used for finish-sizing fuse holes of 155-millimeter United States Army shells. This reamer floats freely in its socket, is self-

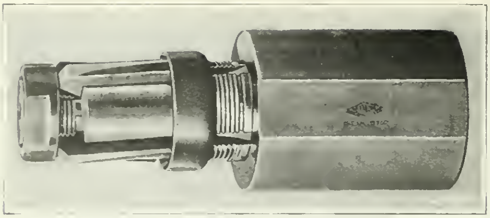
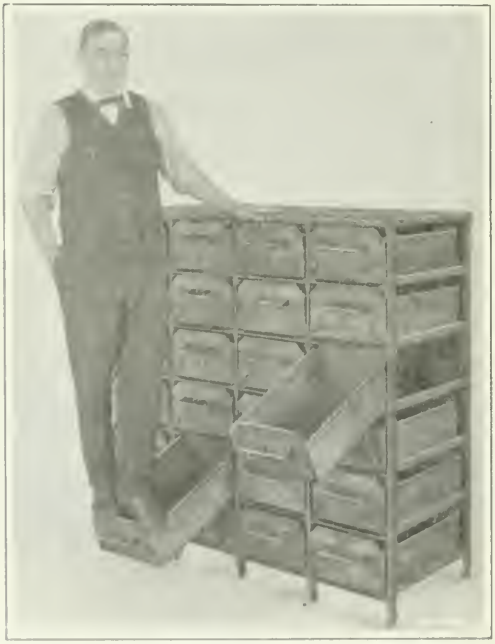


Fig. 2. Wetmore Expanding Reamer for finish-sizing Fuse Hole and Shoulder

centering, and assures the reaming of a true round hole. The blades are set at an angle to facilitate smooth cutting action and to eliminate the liability of chatter. In order to take up wear of the blades, they are expanded by means of two ground nuts and the design of the reamer is such that the blades may be removed or replaced without taking the tool apart. A true center in the end of the reamer makes it possible to grind the blades in place if so desired. These reamers are shipped with the blades ground to the dimension required by the user.

NEW BRITAIN TOTE-BOX RACK

To meet the requirements of users of New Britain tote boxes who would find it convenient to store these boxes in a rack, the New Britain Machine Co., New Britain, Conn., have recently placed on the market racks of the form shown in the accompanying illustration. Based upon their experience with the uses which are made of tote boxes, the builders of this rack are of the opinion that it is universally adaptable to all requirements for small-parts storage. Although especially suitable for use in stock and assembling rooms, there are many other places in the factory where racks of this kind should be the means of saving time and money. The rack is of simple design and light weight, although it is so constructed that ample stiffness is provided to withstand practically any load that is likely to be placed upon it. The front uprights are made of flat steel and those at the rear are made of angles; angle runners upon which the boxes slide are electrically welded to each pair of uprights and these welded members are connected by cross-ties at the front, while the back is closed in and is stiffened by sheets bolted to the angle-iron uprights.

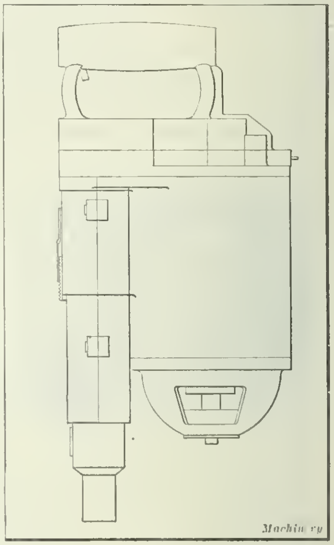


Rack for Tote Boxes made by New Britain Machine Co.

Racks of this type are commonly furnished in standard units as illustrated, although they may be expanded horizontally to any extent. Special racks may also be built to accommodate more than six boxes in each tier. Units are frequently placed back to back with a single sheet of metal between them. Particular attention is drawn to the safety feature which is clearly brought out in the illustration. When a box is pulled out, if the forward end is permitted to drop slightly, the raised rear end of the box will come into contact with the front cross-tie, thus permitting the box to be loaded or unloaded in this exposed position without any danger of its sliding out. A complete description of the New Britain tote boxes used in this rack was published in MACHINERY, November, 1916.

PAYNE & WILES ELECTRIC HAMMER AND DRILL

The Payne & Wiles Machine Co., 302-308 S. Ninth St., Lincoln, Neb., are now manufacturing a combination electric hammer and drilling tool. In working out the design, care has been taken to simplify the mechanism as far as possible and reduce the number of parts to a minimum. The tool is adapted for the use of machinists, electricians, and in garages, etc. It is suitable for chipping castings, cutting holes through concrete floors, calking boiler seams, beading flues in boilers, drilling metal, etc. The weight of the tool is 11 pounds and it will drive drills up to 1/2 inch in diameter in steel or cast iron; chisels up to 1/2 inch may be driven by the hammer for key-seating, and chisels up to 1 inch can be driven for chipping iron and steel castings.



Payne & Wiles Combination Electric Hammer and Drill

A universal motor is used to drive the tool, which is adapted for connection to 110-volt alternating- or direct-current circuits, attachment being made to any lamp socket. Tools of this type can be made in different sizes ranging in weight from 3 to 100 pounds. The hammer and drilling spindle can be operated independently of each other, or the drill and the hammer can be run simultaneously. Patents have been granted on features of this tool to W. S. Payne of the Payne & Wiles Machine Co.

GLENZER COUNTERBORE AND SPOT-FACER

The "Utility" interchangeable piloted counterbore and spot-facer is a recent product of the J. C. Glenzer Co., Fort St., W., corner Fourteenth, Detroit, Mich. The manufacturers claim that the design of these interchangeable counterbores and spot-facers has been developed with a careful consideration of the

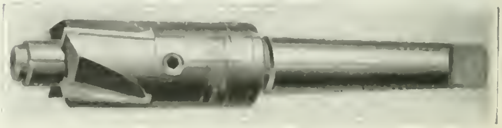


Fig. 1. "Utility" Piloted Interchangeable Counterbore and Spot-facer made by J. C. Glenzer Co.

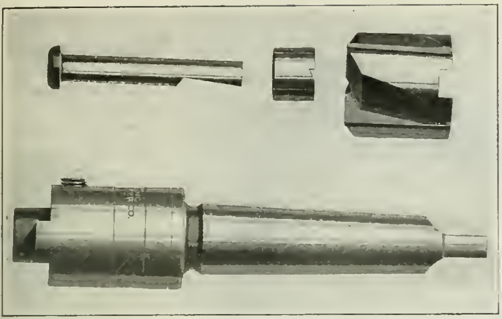


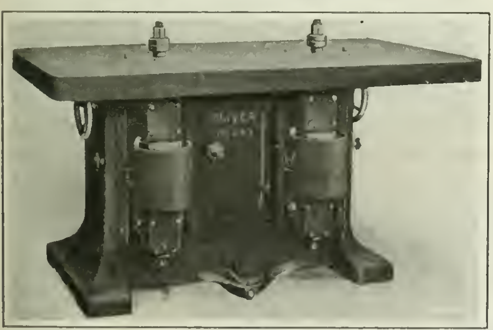
Fig. 2. Parts of "Utility" Counterbore and Spot-facer

actual requirements which tools of these types must fulfill under severe conditions of service. The cutter drive is of simple though powerful construction, and the cutters can always be quickly and easily removed. By having the pilot made in the form of a bushing and positively driven by the cutting edges of the cutter, all strain is relieved from the pilot pin.

These interchangeable counterbores and spot-facers are made with four different sizes of holders which have capacities for holding cutters from 3/8 to 3/4 inch, 3/4 to 1¼ inch, 1¼ to 2 inches, and 2 to 3 inches in diameter, respectively. The holders are heat-treated and accurately ground to size, and the cutters are made of high-speed steel. Pilot bushings are of standard 1/64-inch sizes, and they are made 0.008 inch under size. Cutters are made in 1/16-inch sizes, and holders with special tapered shanks or straight shanks can be made to special order.

OLIVER DOUBLE SHAPER

A No. 483 high-speed double shaper has recently been added to the line of woodworking machines built by the Oliver Machinery Co., 7 Coldbrook St., Grand Rapids, Mich. This machine is adapted for the performance of rabbetting, grooving, fluting, routing, or shaping operations. It is furnished with a large table which is planed and then ground to an accurate finish. The spindles are made of high-carbon crucible machinery steel and are finished by grinding. They are supported in bronze conical-shaped bearings furnished with oil-chambers which lubricate the spindles for the entire length of the bearings. At the bottom of each spindle there is a copper adjustable step which is constantly washed with oil. Adjustments of the bearings are easily and rapidly made. As this machine runs at high speed, it is important to have the pulleys carefully balanced; they fit the spindles perfectly and are held in place by tapered pins.

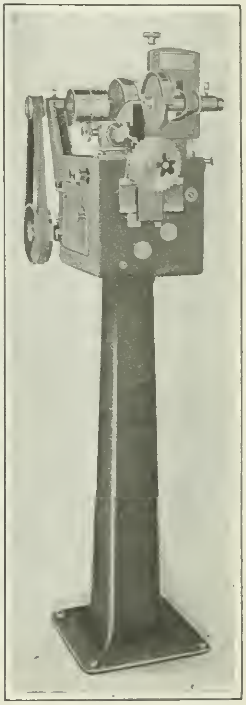


No. 483 High-speed Double Shaper built by Oliver Machinery Co.

A quick-adjusting shaper guard is furnished with each machine and additional guards may be obtained, as each table is drilled and tapped for two guards. These guards are adjustable in all directions, so that they do not interfere with the operation of the machine. When motor drive is used any of the following methods may be employed: Two separate motors may be furnished, one for driving each spindle; one motor may be direct-connected to the end of the countershaft by means of a coupling; or one motor may be employed with the shaft sufficiently extended to carry a suitable pulley at each end. An improved column type of countershaft fitted with independent belt tighteners and a ring type shifting device is furnished with each machine. The main pulleys are of the ring-oiling type and the loose pulley is bronze bushed and has an oil-chamber of ample size to insure efficient lubrication.

AUTOMATIC SLITTING SAW SHARPENER

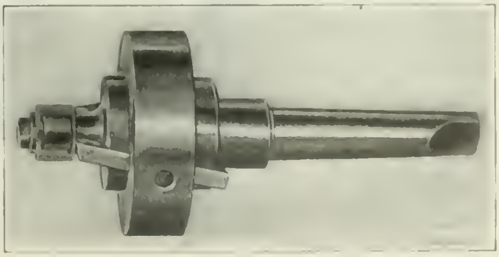
The Machinery Co. of America, 505 Sixth St., Grand Rapids, Mich., are now building a No. 10 automatic slitting or milling saw sharpening machine which will resharpen or recut saws with very little loss of time. It is stated that this machine will grind circular saws with the teeth all uniformly spaced and the circumference of the saw perfectly round. With the saw ground in this way, strains on the blade and danger of breaking the teeth are practically eliminated. The machine is adapted for sharpening or recutting saws from 2 to 10 inches in diameter with the usual spacing of teeth, and it is especially suitable for use in reclaiming very thin slitting saws with fine tooth spacing. The operation of the machine is fully automatic, requiring very little attention on the part of the operator after the work has been set up and the machine started. The machine is rigidly constructed and supported on a pedestal of substantial design, which brings the mechanism to a convenient height for the operator. All essential parts of the mechanism are enclosed in the body of the machine, where they are fully protected from abrasive dust and other foreign matter. Ample adjustment is provided for taking up wear in all moving parts. On this machine any standard shape or spacing of teeth may be readily obtained by means of handwheel adjustments, conveniently located for the operator.



No. 10 Automatic Slitting Saw Sharpening Machine built by the Machinery Co. of America

GENESEE FACING TOOL

For use in the performance of counterboring, facing, forming and similar operations, the Genesee Mfg. Co., Rochester,



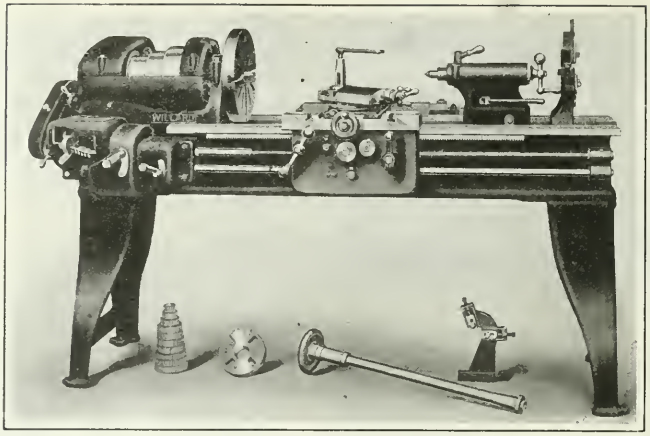
Facing Tool made by Genesee Mfg. Co.

N. Y., are now making the facing tool which is illustrated and described herewith. The blades can be sharpened without requiring the use of a special holder, and these blades are supported in such a way that the tool is adapted for securing the full productive capacity from high-speed steel. The design has been worked out along such lines that the chip clearance remains the same, regardless of the number of times the blades have been ground, so that their cutting efficiency remains uniform throughout the life of the blades. When it is required to use this tool in close corners, the heavy-duty ring is removed.

When grinding the blades it is simply necessary to remove them from the holder and grind in such a way that they will test up to a square. The tool is never removed from the machine, so that after the blades have been ground the only thing required is to slide them back against the bushing which locates each cutting edge in line and in the same position that the blades occupied before grinding. This method of grinding makes it unnecessary to readjust the machine each time the blades have to be sharpened. For cutting steel, malleable iron, etc., the blades are placed at an angle of 12 degrees, while for machining brass and other soft materials, they are placed in a radial position. The body of the tool is made of machine steel, casehardened, and is of ample strength to stand up under the full capacity of the power feed of any drilling machine. These tools are made in styles A and B with two and three blades, respectively, and each style is made in four different sizes.

WILLARD TOOL-ROOM LATHE

The Willard Machine Tool Co., of Cincinnati, Ohio, are now building the tool-room lathe which is illustrated and described herewith. The quick-change feed-box on this machine is a separate unit which is secured to the bed by means of four bolts, its alignment being assured by means of tongues planed to fit corresponding grooves in the bed of the machine. One lever on this box manipulates the tumbler gear and affords forty changes in connection with only one other lever, which engages one of three ratios in the gear trains and reverses the two gears at the end of the bed. In addition to the range of threads which the gear box provides for cutting, the machine may be set up for cutting other pitches by changing the gears on the end of the bed. The third lever at the right-hand side of the feed-box is only to provide for disconnecting the lead-screw when turning operations are being performed on this lathe. All gears in the feed-box are made of steel, the only cast-iron gears being the two reversible driving gears at the end of the bed. All gears are supported at both ends and there are no overhanging studs. All shafts are made of 50-point carbon steel and they are ground to an accurate finish.

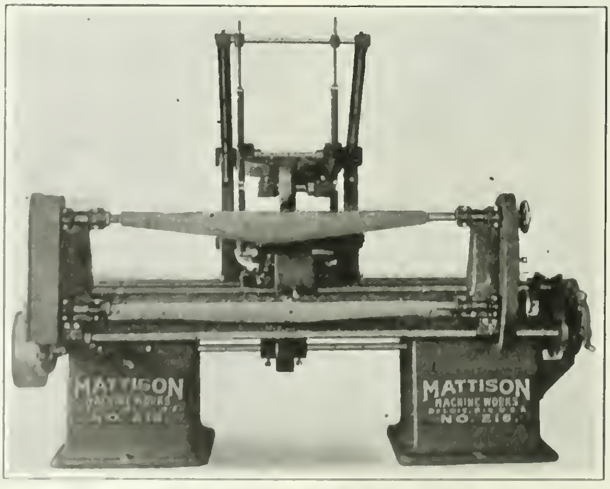


Tool-room Lathe built by Willard Machine Tool Co.

Since the Willard Machine Tool Co. took over the Willard Machine & Tool Co., the new management has been working on the improvement of the Willard lathe. The sides of the headstock have been brought up level with the center line of the spindle at both the front and rear, which assures greater strength and rigidity by tying the two spindle bearings together. The headstock has a bearing 21½ inches long on the bed of the machine, and it is furnished with a spindle made of 65-point carbon crucible steel, which is finished by grinding. The reverse gears are made of steel and the idler gears are bronze bushed. A bearing 18 inches in length is provided for the carriage on the vees of the bed, and this carriage is furnished with a bridge 7½ inches in width. All sliding surfaces are taper gibbed to provide a convenient means of compensating for wear, and all dials are of ample size to facilitate accurate reading. The vees on the bed of the machine are chilled to insure durability.

MATTISON AIRPLANE STRUT TURNING MACHINE

The copying lathe which forms the subject of this description is built by the C. Mattison Machine Works, Beloit, Wis., for use in turning airplane struts. Special attention is called to the double-end drive which is of exceptional importance when long slender stock, such as an airplane strut, is being turned. Driving from both ends avoids much of the tendency to twist the work and revolve it with a jerky motion. This double drive is also said to do away with trouble experienced from putting a "wind" in the work and producing a poor finish. The carriage is of the double rocker type, and the rocker arms which support the cutter-head and model wheel work without friction, thus insuring great sensitiveness and accuracy in operation.



Copying Lathe built by the C. Mattison Machine Works for turning Airplane Struts

Travel of the main carriage is backward or forward along the bed of the machine, so that no time is lost in shifting the carriage back to the starting point between successive operations. Quick-change gears are provided which give three rates of feed, any of which may be instantly obtained while the machine is running. A special cutter-head has been developed for use on this copying lathe, which is adapted for rapidly and smoothly cutting spruce wood. The rate of feed may be varied from 7½ to 30 inches per minute, depending upon the shape of the stock which is being worked. The standard lathe takes stock up to 6 feet in length, but special machines may be built to take longer pieces. The machine is entirely self-contained and may be driven either from an individual electric motor or from a countershaft. It occupies a floor space of 4 by 11 feet and weighs 4500 pounds.

MASON HIGH-SPEED DRILLING MACHINE

The A. C. Mason Co., Inc., Paterson, N. J., are now building a quick-change high-speed drilling machine of the bench type. In the accompanying illustrations is shown a single-spindle machine, but multiple-spindle drilling machines of this type are also being built. This machine is built on the unit plan with all parts of the mechanism readily accessible to facilitate making adjustments. Ball bearings are used throughout, and all exposed parts of the mechanism are guarded in a way which avoids danger of damage to the mechanism or injury to the operator. The mechanism and method of operation have been simplified as far as possible, thus making the machine well adapted for use by women employed in machine shops. On this machine, the design has been worked out in such a way that all changes of speed may be made without requiring the machine to be stopped. The cone pulley is made of a special fabric composition to reduce belt slippage and to make it unnecessary to maintain the belt under excessive tension.

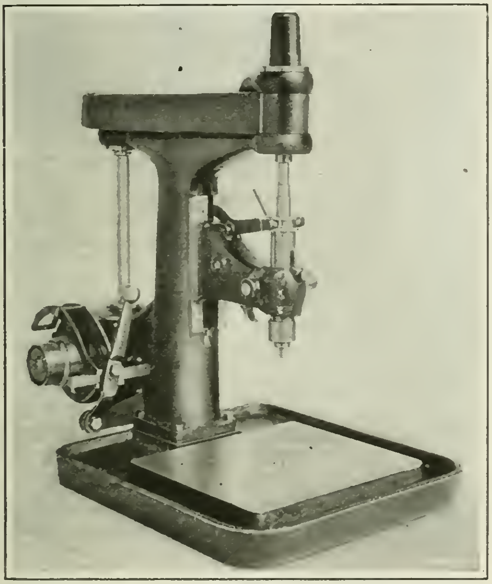


Fig. 1. High-speed Bench Drilling Machine built by A. C. Mason Co., Inc.

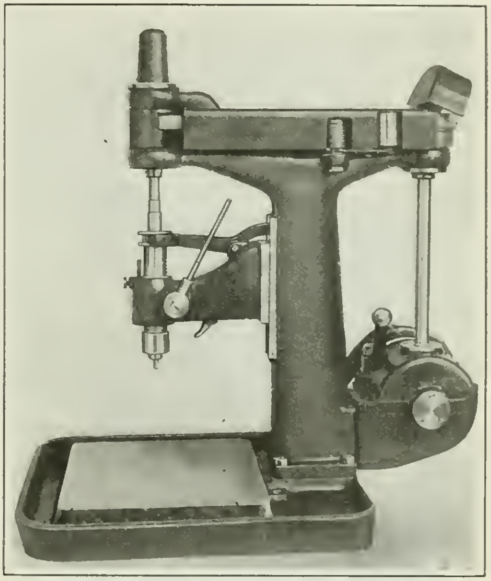


Fig. 2. Opposite Side of A. C. Mason Bench Drilling Machine

A uniform belt tension is maintained by a spring idler pulley which also compensates for differences in length of the belt track. The rear vertical shaft is fully enclosed and driven by a two-speed geared drive. Either of the two available speeds is obtained by a semi-automatic clutch operated by a convenient handle. Power to drive the machine is carried by a belt which runs over a tight or loose pulley on the gear-box, the pulleys being fully enclosed. There is a total of four available spindle speeds ranging in geometrical progression from 3000 to 10,000 revolutions per minute. The back-shaft speed is 1800 revolutions per minute. The horizontal back-shaft is a unit with the gears and so is the vertical shaft, each one being removable without the necessity of disturbing adjacent parts.

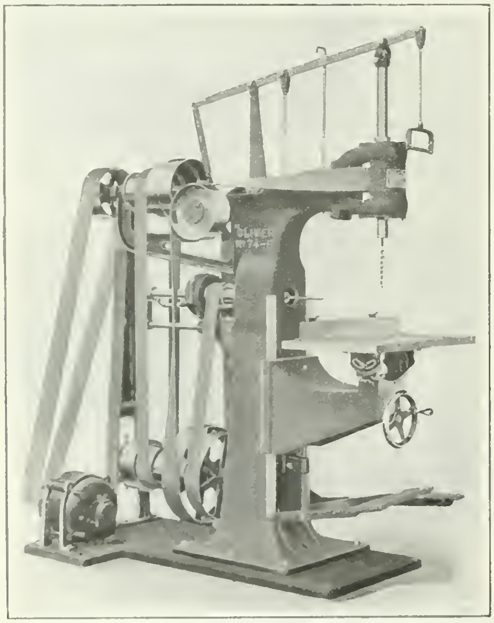
The spindle pulley, together with its upper and lower bearings, is a complete unit which can be removed without requiring any other part to be disassembled. The design has been so arranged that the spindle is relieved of all belt pull. Semi-hardened steel of high elasticity is used in making the spindle, this material being capable of resisting blows resulting from jigs being slammed against the chuck, without danger of bending the spindle. The spindle and its bearings are a complete unit which may be removed from the sleeve without taking the sleeve or spindle pulley from their fastenings. A positive depth gage is provided for the spindle to facilitate drilling holes to a specified point. Continuous lubrication to all bearings connected with the spindle and the spindle bracket is accomplished by means of a simple oiling device which furnishes a continuous flow of lubricant. A balanced chuck suitable for holding drills up to 1/4 inch in diameter is provided with the machine, and the spindle has a maximum feed movement of 6½ inches. The pinion which governs the feed movement of the spindle may be operated from any position and is quickly adjusted to take up backlash between the pinion and the rack teeth cut in the spindle sleeve. A table of liberal proportions is furnished on the machine and it has a large channel running around its periphery to carry away lubricant or cutting compound.

OLIVER WOOD-BORING MACHINE

One of the recent products of the Oliver Machinery Co., 7 Coldbrook St., Grand Rapids, Mich., is the No. 74 universal vertical and horizontal wood-boring machine which is shown in the accompanying illustration. This machine is adapted for all kinds of boring and it also operates efficiently in drilling holes in metal and in doing the work of a router, shaper, buzz-planer, or sanding machine. Both the vertical and horizontal spindles are mounted in ball bearings, and they can be fitted with a three-jaw chuck and a variety of bits, fly cutters, and such special cutters as little patternmakers, etc. Both spindles have a capacity for boring holes up to 3 inches in diameter; the vertical spindle will bore to a depth of 12 inches at the center of a circle 36 inches in diameter, and the horizontal spindle will bore to a depth of 7 inches at a height of 16 inches from the top of the table. This machine is built in two types known as the Nos. 74A and 74B, the first of which has only a single-speed self-contained countershaft. Either type of machine may be furnished with motor drive.

On these machines the vertical spindle is usually bored to take 1/2-inch straight shanks, but when so ordered, it may be threaded to receive a three-jaw chuck. The spindle is 1⅞ inch in diameter and slides in a sleeve formed by the driving pulley, which has extended ends carried by ball bearings. The vertical travel of this spindle is 12 inches and on the No. 74A machine the speed is 3000 revolutions per minute, while on the No. 74B machine the four available speeds cover a range of from 968 to 3450 revolutions per minute. The horizontal spindle is also ordinarily bored to take tools with straight shanks, 1/2 inch in diameter, but this spindle may also be specially equipped. It slides in a sleeve formed by the pulley, which is mounted in ball bearings. The horizontal travel of this spindle is 7 inches, this movement being accomplished by a foot-treadle, while return of the spindle is effected through pressure applied by a coiled spring. On both types of machines, the horizontal spindle speeds are the same as the speeds for the vertical spindle, which have already been given.

The table is 18 by 30 inches in size and has a vertical adjustment of 17 inches, which is obtained by means of a screw and handwheel. Angular settings of the table may be made up to 40 degrees toward or away from the column and 30 degrees to the right or left. Graduated scales are furnished to facilitate making the angular settings of the table. When motor drive is employed, either a 900 revolutions per minute constant-speed motor or a suitable adjustable-speed motor is employed on the No. 74A machine, and this motor is mounted on the baseplate in place of a countershaft. With the No. 74B machine, either an 1800 revolutions per minute constant-speed motor or a suitable adjustable-speed motor is mounted on an extension of the baseplate and belted to the upper driving shaft. The motors used must be from three to five horsepower, according to the service for which the machine is to be employed. The floor space occupied by the No. 74A machine is 70 by 38 inches, and the No. 74B machine occupies a floor space of 73 by 38 inches.


No. 74 Universal Vertical and Horizontal Wood-boring Machine built by Oliver Machinery Co.

"CRESCO" DRILL CHUCK

The Chicago Recording Scale Co., Waukegan, Ill., are now building a quick-change drill chuck which is illustrated and described herewith. Features claimed for the design of this chuck are that no screws are employed to hold the parts together and that the chuck is ground on all surfaces; the chuck is said to be perfectly balanced, so that it will run without any tendency toward vibration. This chuck is of the quick-change type which is used in cases where different tools are required for the performance of a sequence of machining operations. Different tools to be held and driven by the chuck are carried in collets which have two tangential grooves cut on opposite sides so that hardened steel balls in the chuck can enter these grooves. It is unnecessary to stop the drilling machine spindle rotating in order to change tools; the operator simply takes hold of the collar on the chuck body and lifts it to release the two hardened steel balls so that they may drop back out of the grooves in the collet. This collet is then withdrawn from the chuck and another collet carrying the next tool is pushed up into the chuck, after which the collar is dropped. Dropping of the collar forces the hardened steel balls inward, so that they engage the grooves in the collet, thus serving the double purpose of holding it up in the chuck and affording a positive drive for the tool.

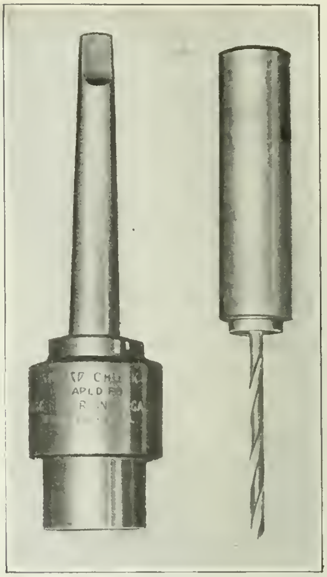


Fig. 1. "Cresco" Quick-acting Drill Chuck made by Chicago Recording Scale Co.

CUTLER-HAMMER DRUM TYPE STARTING SWITCHES

Purchasers of equipment for the modern factory are now giving special consideration to methods of drive and control which offer the greatest protection to the operator and the motive power; this has been especially true in those factories

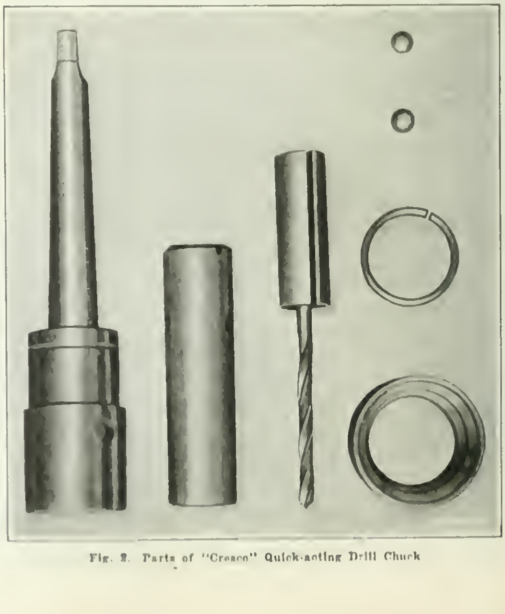
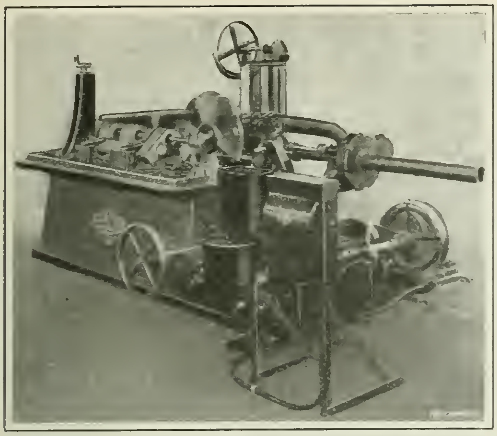


Fig. 2. Parts of "Cresco" Quick-acting Drill Chuck



Rockford Horizontal Drilling and Milling Machine equipped with Cutler-Hammer Drum Type Starting Switches for Individual Motor Drive

which have been built to meet the immediate demand for guns, ammunition and other war necessities. The accompanying illustration shows one of four oil-immersed starting switches controlling a five-horsepower squirrel-cage alternating-current motor, driving one of the Rockford Drilling Machine Co.'s horizontal drilling and milling machines in a gun factory in Wisconsin. These drum type switches are especially adapted for this and other machine shop installations because it is impossible for the workman to come into contact with any live part, and, furthermore, they offer a degree of protection to the motor not obtainable with knife switches and some other form of starting devices. These switches are built by the Cutler-Hammer Mfg. Co., Milwaukee, Wis., and follow the design of the well-known C-H drum type controller. Copper segments mounted vertically on a thermoplax cylinder carried on a square steel shaft engage three sets of contact fingers which have hard drawn copper tips that are renewable and non-snubbing. No moving leads are used, a terminal board being conveniently located in the top of the cover casting, the connections to which can be made very easily. This arrangement prevents the leakage of oil due to syphoning or capillary action. The switch shown in the illustration is furnished with enclosed fuses, although in some cases two inverse time element overload relays are substituted. All are provided with no voltage release.

When the handle is thrown to the "start" position the motor is connected to the line ahead of the fuses, and then connects the fuses in the circuit when thrown to the "run" position. Besides being smaller than many forms of starting switch, they are provided with large mounting lugs, permitting the switch to be secured to a machine or wall. This arrangement also permits the oil tank to be removed without disturbing the mounting or connections. The terminal board is provided with control circuit terminals, so that with the addition of a two-wire circuit and push-buttons the motor can be stopped from any desired position. This feature is especially desirable when the motor drives a large machine tool, conveyor or other machinery, where the danger of workmen being injured must be reduced to a minimum. On failure of voltage, overload, or when purposely released, the switch is returned to the "off" position by a strong coiled spring and the motor is entirely disconnected from the line. These switches are made for 110, 220, 440, and 550 volts, and can be used with any polyphase motor up to twenty horsepower. A similar switch is made for use with three-phase squirrel-cage motors.

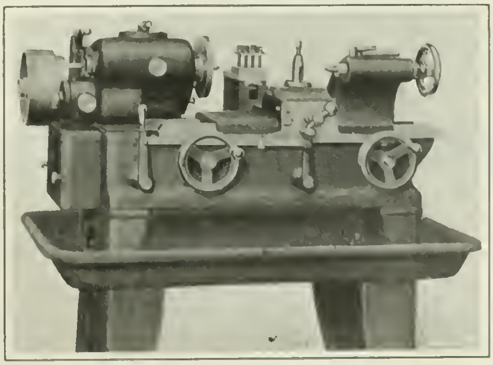
"SUNDSTRAND" MANUFACTURING LATHE

To meet the requirements of plants engaged in the production of large quantities of duplicate parts, the Rockford Tool Co., Harrison Ave. and 11th St., Rockford, Ill., have recently placed on the market the "Sundstrand" manufacturing lathe which is adapted for rapid production. This machine is simply designed throughout, so that the operation has been simplified; and ample power is provided to enable machining operations to be performed under the maximum conditions of speed and feed. As there are a great many lathe jobs performed on a strictly manufacturing basis, which consist of machining short pieces of comparatively small diameters, a compactly built lathe of this type effects a saving of approximately 50 per cent in floor space without in any way affecting the efficiency with which work can be handled that comes within the capacity of the machine.

The bed is of a new design, having separate ways for the tool carriage and the tailstock, the arrangement being such that the carriage can travel to the end of the bed in front of the tailstock. It will be apparent that this allows the tailstock to be set up close to the work, eliminating the overhang of the tailstock center. The bed is of deep section and ribbed to afford the necessary rigidity. An all-geared type of headstock is employed, which is operated by a sensitive friction clutch upon which the driving pulley is mounted. This clutch is manipulated by a conveniently located lever and the same movement that disengages the clutch automatically applies a friction brake which stops the spindle almost instantly. This permits quick removal of finished pieces and setting up of blanks, and it also permits the spindle to be instantly stopped for measuring the work, etc. The spindle bearings and all the other principle bearings in the headstock are fitted with SKF self-aligning bearings.

Three spindle speeds are instantly obtainable by means of a shifting lever, and additional speeds are obtained in series of three by changing two auxiliary gears on the end of the headstock. Four auxiliary gears are furnished by means of which twelve spindle speeds are obtainable. Gears in the headstock run in a bath of oil which assures adequate lubrication. The design of the spindle has been worked out to adapt it for the use of draw-in collets. Movement of the carriage is effected by a screw located between the ways, directly under the tools; this position reduces torsional strains to a minimum. Automatic adjustable stops are provided for the carriage. A special plain rest is furnished as a regular equipment for the carriage. Rear tool-holders of the multiple-tool type for use in the performance of facing and grooving operations, etc., can also be easily mounted on the rear ways where they are entirely independent of the carriage. Cross-feed to the rear tool-holders is operated by a handwheel at the front of the bed and both the front and back tools are equipped with positive stops. A back-rest, taper attachment, draw-in attachment and collets, oil-pump, etc., can be furnished as special equipment whenever required.

The principal dimensions of this lathe are as follows: swing over bed, 9 inches; swing over plain rest, 7 inches; distance between centers, 12 inches; diameter of hole through spindle, 1¾ inch; maximum collet capacity, 1 inch; diameter of spindle nose, 2⅛ inches; threads per inch on spindle nose, ten; size of cutting tool, 5/8 by 1⅜ inch; length of carriage on bed, 18 inches; diameter of driving pulley, 8½ inches; width of driv-

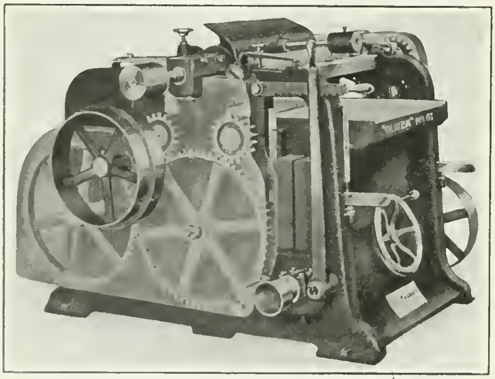


"Sundstrand" Manufacturing Lathe built by Rockford Tool Co.

ing belt, 2¾ inches; regular speed of driving pulley, 350 revolutions per minute; number of available spindle speeds, 12; number of available feed changes, 4; floor space occupied by machine, 45 by 24 inches; and weight of machine crated for shipment, 1050 pounds.

OLIVER SINGLE-CYLINDER SURFACER

The Oliver Machinery Co., 7 Coldbrook St., Grand Rapids, Mich., are now building a single-cylinder four-roll cabinet surfacer which forms the subject of the following description. This machine is adapted for handling a wide range of work in both soft and hard woods. It is suitable for use in pattern shops and factories engaged in the manufacture of furniture, pianos, organs, boats, interior finish, etc. The machine is made in two sizes with capacities for planing work up to 24 and 30 inches in width, and adjustment of the bed is provided so that it may be dropped sufficiently to plane material up to 8 inches in thickness. The available rates of feed are 14, 18, 24, and 31 feet per minute. The cylinder is made of a crucible steel forging which is belted at both ends. It carries two thin high-speed air-hardened steel knives, which are securely clamped against hard steel chip breakers whose lips are shaped to throw off shavings and chips. The cylinder pulleys are carefully balanced and their faces are grooved spirally to prevent air pockets forming under the belts.



Single-cylinder, Four-roll Surfacer built by Oliver Machinery Co.

Self-oiling bearings support the cylinder; these bearings are of the side clamping type and readily adjustable to hold the cylinder firmly in place to assure smooth running. Power for the feed motion is transmitted through belts from the cutting cylinder, and the feed is under instant and positive control by the operator. Ample power and positive operation are assured, and there are four rates of feed which have already been given. There are four feed-rolls, one pair being located back of the cylinder to feed the material free from the knives and assist in carrying it through the machine. These rolls are made of hammered steel and suppored in self-oiling bearings. The upper "feed-in" roll is corrugated to enable it to secure a firm grip on the work. All rolls are driven by a train of heavy gearing, the teeth of which are cut to insure smooth operation of the feed mechanism.

NEW MACHINERY AND TOOLS NOTES

Friction Clutch Countershaft: Foster Machine Co., Elkhart, Ind. A line which comprises six sizes of double-friction countershafts and six sizes of triple-friction countershafts. These are of the expanding friction ring type and Hyatt roller bearings are used on all loose pulleys.

Elevating Truck: Cowan Truck Co., 88 Canal St., Holyoke, Mass. A Type H transveyor equipped with a hydraulic lifting mechanism. This truck is intended for heavy service and is adapted for carrying loads up to 5000 pounds. Provision is made for elevating the platform 3 inches by means of a hydraulic ram which is operated by a few strokes of the handle.

Filing Machine: W. F. Davis Machine Tool Co., Inc., 85 Liberty St., New York City. This is known as the "20th Century" filing machine It is of the bench type and may be arranged for either belt drive or individual motor drive. The stroke of the machine is adjustable from 0 to 2 inches, and the table may be quickly set and locked at any desired angle.

Multiple-spindle Valve Grinding Machine: Defiance Machine Works, Defiance, Ohio. A line of machines designed for the purpose of grinding valves in internal combustion engine cylinders. These valve grinding machines are built in three different sizes with four, six, and eight spindles, respectively. Adjustment is provided to take care of different distances between valve centers.

Drinking Fountain: D. A. Ebinger Sanitary Mfg. Co., Columbus, Ohio. This is known as the "Ebco" fountain, and it is mounted in a cooler in such a way that the stream of water flows up at an angle from beneath a guard, making it impossible for anyone to place his mouth on the nozzle. This form of jet also makes it possible to fill a glass or drinking cup at the fountain.

Sanding Machine: Carter & Bucholz Co., Inc., 1234 S. State St., Syracuse, N. Y. An oscillating spindle sanding machine adapted for use by pattern-shops and wood-working plants. It is equipped throughout with New Departure ball bearings and is driven by a 1/2-horsepower enclosed ball bearing motor. The table is 20 inches in diameter and it tilts 45 degrees downward or 15 degrees upward.

Grinding Stand: Luther Grinder Mfg. Co., 285-289 S. Water St., Milwaukee, Wis. An improved No. 271 "Hummer" grinding stand, which is known as a "Model F." It is provided with a worm-gear drive instead of cast bevel gears, and ball bearings have been incorporated to insure easy operation. This grinding stand is intended to be driven by foot-pedals and is adapted for use where power is not available.

Tool-holders: Right and Left Tool-holder Co., Jasper and E. Willard Sts., Philadelphia, Pa. A tool-holder intended for using up short bits of high-grade steel. A short tool bit is held between the body of the holder and a cap which is clamped down by means of a square-headed screw. These holders are made of high-carbon steel and can be furnished in straight, right-hand offset or left-hand offset types as desired. They are made in eight different sizes.

Scrap Metal Baling Press: Galland-Henning Mfg. Co., Milwaukee, Wis. A hydraulic baling press which automatically ejects the baled sheet metal scrap so that the bundle may be carried out on a conveyor leading to the scrap pile, or into a car or charging hopper. A grooved liner plate is provided in the charging box, and guides on the plunger fit into these grooves to guard against wedging of scrap metal between the plunger head and the sides of the box.

Geared-head Lathe: Springfield Machine Tool Co., 631 Southern Ave., Springfield, Ohio. A geared-head lathe built in 14-, 16-, 18-, and 20-inch sizes and furnished with individual motor drive or belt drive. All journals except the main spindle bearing are furnished with ball bearings and speed changes are arranged in geometrical progression, any desired speed being available without having to pass through any series of speeds to reach the one which is desired.

Attachment for Brinell Test: Pittsburg Instrument & Machine Co., Pittsburg, Pa. An attachment for use in measuring the depth of impressions made in conducting the Brinell hardness test. It is claimed that the depth of impression can be measured with greater accuracy than the diameter, and with this attachment the claim is made that the depth can be determined to 0.01 millimeter. One complete turn of the needle of the dial indicator represents a depth of 1 millimeter.

Metal Product Washing Machine: Ideal Concrete Machinery Co., Cincinnati, Ohio. A machine for cleaning and rinsing metal products by the batch process. This equipment is particularly adapted for removing grease from stampings and drawn work of steel or brass. Work can be held in the drum, passing continuously through the cleaning solution until thoroughly cleaned, after which it enters the rinsing drum and then passes on to draining and drying screens.

Bench Lathe: DeMant Tool & Machine Co., 79 E. 130th St., New York City. A precision bench lathe furnished with headstock and tailstock spindles which are hardened and ground, and supported in bearings furnished with means of compensating for wear. A compound rest and a three-speed countershaft form part of the regular equipment of this machine, and the compound rest is designed with large graduated dials which facilitate making accurate settings.

Stock Support: A. F. Way Co., Inc., Hartford, Conn. An adjustable stock support which is intended for use in connection with hacksaw machines, screw machines, band and circular sawing machines, bolt cutters, threading machines, pipe machines, etc. It will be found convenient wherever long bar stock or tubing has to be handled in a machine. The support is furnished with a base of ample size to prevent it from being turned over, and the height of the column may be quickly adjusted.

Planing Machine: Liberty Machine Tool Co., Hamilton, Ohio. A 36-inch planing machine designed to meet the requirements of modern shop practice, and equipped with all necessary safety appliances and conveniences to safeguard the operator and provide efficient operation of the machine. A patented feed mechanism is furnished which is independently adjustable on either the cross-rail or the side head, so that the operator may change the rate of feed while the machine is running.

Chord Plates: R. W. Beckman Co., 920 Hume-Mansur Bldg., Indianapolis, Ind. A device particularly intended for use in grinding tapers, although it may be used for other classes of work. This chord plate is made in 3- and 6-inch sizes, and in two styles, namely, horizontal and vertical. It consists of a baseplate carrying a revolving upper plate upon which the work is mounted by any suitable means. The angular setting is determined by measuring the chord of the arc by means of a micrometer used over two measuring points.

Proportional Mixer: Eclipse Fuel Engineering Co., Rockford, Ill. A device known as the "McKee" proportional mixer which may be used in connection with practically any furnace installation where gas is used as a fuel. This device provides for delivering gas and air mixed in any predetermined proportions, and is claimed to save fuel and also provide for obtaining any desired type of flame; that is to say, a reducing, oxidizing, or neutral flame. This device is made in three sizes with outlets 1½, 2 and 3 inches in diameter, with gas capacities per hour of 600, 1000 and 2000 cubic feet.

Engine Lathe: Sidney Tool Co., Sidney, Ohio. A heavy-duty engine lathe built in 30- and 36-inch sizes. The vees on the bed are cast with a 25 per cent steel mixture which affords a close grained metal with high resistance against wear. The spindle is made of 50-point carbon steel and is carried in liberally proportioned bearings which are lined with phosphor-bronze. The lead-screw is 1 11/16 inch in diameter and is made of 40-point carbon steel. The machine is said to be especially adapted for the extremely heavy-duty service found in car shops, rolling mills, shipbuilding yards, etc.

Shell Calking Hammer and Rivet Header: High-Speed Hammer Co., Inc., Rochester, N. Y. A hammer especially adapted for calking or peening the gas check plugs on 155-millimeter shells. The shell is placed in the machine and a burring tool is applied in such a way that one or two revolutions of this tool by the handles, when under slight pressure, will remove any burrs from the dovetail base. The plug is then inserted and a lead gasket is dropped into position, after which the hammer peens it into place. The rivet heading machine is suitable for upsetting the heads of copper rivets used in harness, etc.

Drill Head and Gear Chuck: Garrison Machine Works, Dayton, Ohio. This company is now manufacturing a line of multiple-spindle drilling heads for use on a single-spindle drilling machine to provide for simultaneously drilling a number of holes. The line includes a variety of different heads to meet the requirements of various classes of work. The gear chuck is so designed that provision is made for holding a variety of different forms of work which have gear teeth cut on them. It is claimed that this chuck will hold gears with sufficient accuracy to provide for machining holes concentric with the pitch circle within 0.001 inch.

Boring, Milling, Drilling, and Tapping Machine: Defiance Machine Works, Defiance, Ohio. A No. 6 horizontal machine for the performance of these four operations, on which the maximum distance from the faceplate to the back-rest is seven feet, and the maximum distance from the top of the platen to the center of the spindle is 37 inches. A spindle 4½ inches in diameter provides ample driving power, and the table is 36 inches square with a maximum cross travel of 64 inches. Ten changes of speed are available, ranging from 7½ to 157 R.P.M., and there are twelve available rates of feed changes to all actuating screws covering a range from 0.004 to 0.500 inch per revolution.

* * *

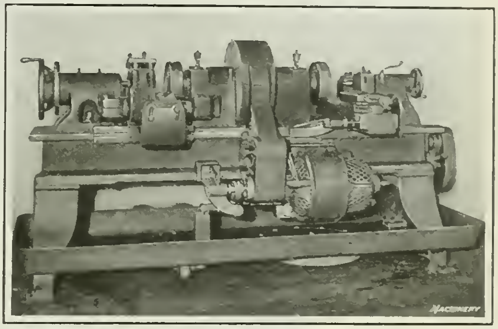
PERMANENT EXHIBITION OF MACHINERY IN NEW YORK CITY

A permanent display and salesroom for machinery and mechanical appliances is being planned in New York City, to be operated by what is known as the Merchants and Manufacturers Exchange of New York, the display and salesroom being located in the Grand Central Palace, Lexington Ave. and 46th St. The machinery exhibition will occupy an entire floor of the building, having an area of 50,000 square feet of floor space. For the convenience of the buyer, a general information bureau and reading room will also be maintained where important trade and technical journals and catalogues will be kept on file. All communications should be addressed to the Machinery Sales Department, Grand Central Palace, New York City.

CENTER-DRIVE LATHE

The center-drive lathe shown in the accompanying illustration was originally designed for the Ford Motor Co. for turning both ends of an automobile driving shaft simultaneously. The work is passed through an opening in the left-hand tailstock, which is brought into position by indexing the barrel of the tailstock 180 degrees, at which position the work passes directly into the spindle in the headstock. After the work has been passed through the tailstock, the tailstock barrel is again indexed 180 degrees, to bring the center into position. The work is then mounted on the centers, after which the chucks (which are of the floating type) are bound or clamped to the work. The chucks are then secured to the driving plate. When the machine is started, the two carriages feed toward the center headstock, thereby turning the various diameters at each end of the work, as well as the outer portion.

While this turning is in process, the back-arm tools are simultaneously squaring down the shoulders which are necessary on the shaft. The action of the carriage transmits radial motion to the back-arm tool-block. This motion is obtained through the medium of a cam which is secured to the bracket fastened to the rear of the carriage. An extension arm with a roller, which comes in contact with the cam, is secured to the back-arm bar. The cam, in its longitudinal travel along the bed, must necessarily transmit a rocking or radial action to the back-arm block and tools, thereby performing the squaring operation. This machine is driven by a five-horsepower Westinghouse Type SK motor, which runs at 1100 revolutions per minute, and the stopping and starting of the spindle are effected through the medium of an internal expanding clutch provided on an extension of the motor shaft. The drive from the motor to the head spindle is through a set of sprockets and a Morse silent chain, and an idler pulley is provided to take up the slack. These machines were designed and manufactured by the Reed-Prentice Co., Worcester, Mass.



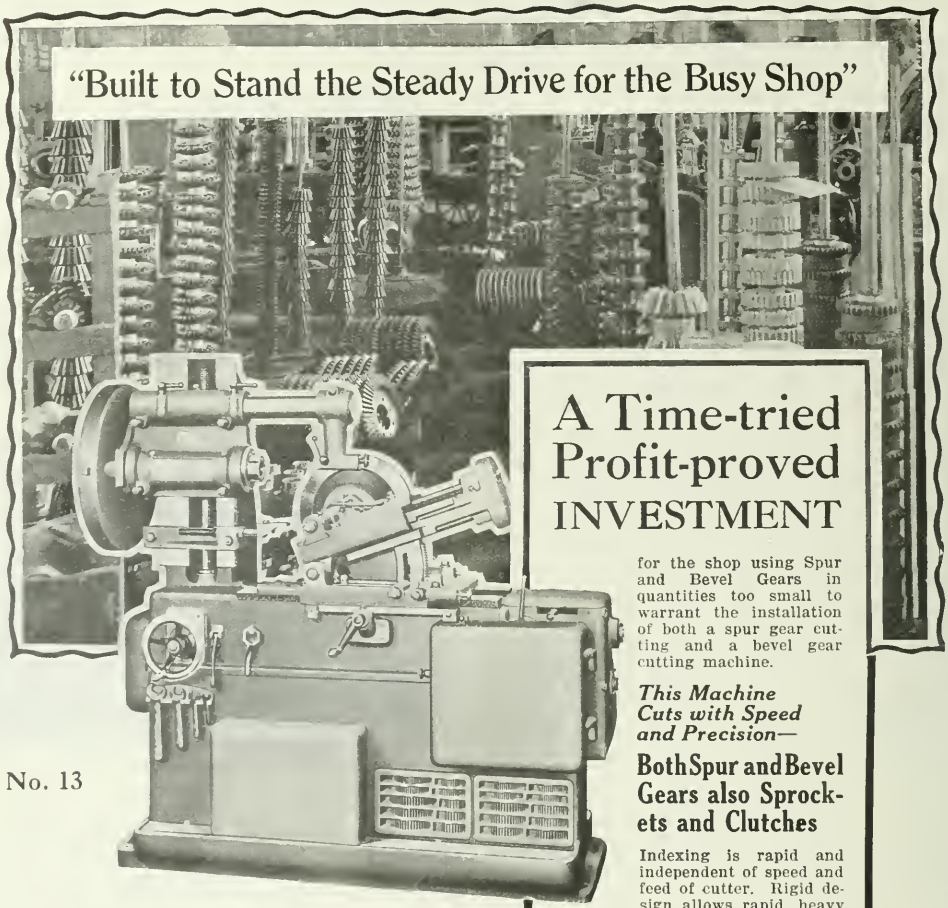
Center-drive Lathe

* * *

APRIL MEETING OF AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The April meeting of the New York Section of the American Society of Mechanical Engineers, held in the Engineering Societies Building, 29 W. 39th St., New York City, Tuesday, April 9, was attended by about four hundred members. The feature of the meeting was to bring together the members of the New York Section and the Metropolitan Student Branches of the society. Many addresses were made by prominent speakers relating to the important features of how engineers are helping to win the war. Sessions were held both in the afternoon and in the evening. At the latter session, Ira N. Hollis, president of the Worcester Polytechnic Institute and past president of the society, gave an inspiring address, and B. F. Hart, Jr., lieutenant in the United States Naval Reserve Force, dealt with the accomplishments of the United States Navy in the war. The event of the evening was an interesting lecture and motion picture on the war in the air, by G. Douglas Wardrop, editor of *Aerial Age*.

"Built to Stand the Steady Drive for the Busy Shop"



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Spur and bevel gears to 18 inch diameter, 4 inch face. Cast iron, 4 diametral pitch. Steel, 5 diametral pitch.

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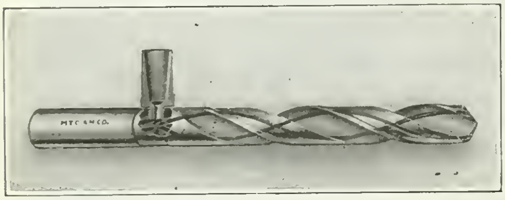
HISTORICAL NOTE ON OIL-DRILL DEVELOPMENT

At the World's Fair in Chicago, in 1893, the Morse Twist Drill & Machine Co., of New Bedford, Mass., exhibited tools in which provision was made for conveying lubricant directly to the point of a drill or cutting tool. The drills exhibited at that time were duplicates of some made during the two previous years under patents granted to the T. & B. Tool Co., and subsequently acquired by the Morse Twist Drill & Machine Co. Various devices have been used for conveying lubricant to the cutting point of a twist drill or other tool, the early method being to insert a tube, although this practice has subsequently been replaced by cutting holes through the solid metal. All Morse oil drills 2½ inches in diameter and smaller have holes drilled through the solid metal, while drills larger than 2½ inches in diameter have oil channels milled in them, which are covered in order to make closed passages through which the lubricant is delivered. In the case of taper shank drills, the oil-hole may extend right through to the end of the shank, it may connect with a cross-hole drilled midway between the large and small ends of the shank or connection may be similar to that shown in the accompanying illustration. Straight-shank oil drills are also made with the oil-hole extending through to the end of the shank.


Morse Oil Twist Drill

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GEAR MANUFACTURERS' CONVENTION

The second annual convention of the American Gear Manufacturers' Association was held at White Sulphur Springs, W. Va., April 18 to 20. Several papers were presented, two of which are abstracted elsewhere in this number. The papers of particular mechanical interest were "Gear Standardization," by B. F. Waterman, of the Brown & Sharpe Mfg. Co., Providence, R. I.; "Heat-treatment of Gears," by C. R. Poole, of the Frost Gear & Forge Co., Jackson, Mich.; and "Hobs and Hobbing Machines," by F. G. Hoffman and John Edgar, of the Barber-Colman Co., Rockford, Ill. The following officers were elected: President, F. W. Sinram, Cleveland, Ohio; vice-president, H. E. Eberhardt, Newark, N. J.; secretary and treasurer, Frank D. Hamlin, Philadelphia, Pa. The executive committee consists of the three officers mentioned, elected for three years, and, in addition, Frank Burgess, Boston, Mass., George L. Markland, Jr., Philadelphia, Pa., Milton Rupert, Pittsburg, Pa., elected for two years; and William Ganschow, Chicago, Ill., E. J. Frost, Jackson, Mich., and H. W. Chapin, Syracuse, N. Y., elected for one year. About fifty members were present.

* * *

NATIONAL METAL TRADES' ASSOCIATION CONVENTION

The twentieth annual convention of the National Metal Trades' Association, held at the Hotel Astor, New York City, April 24 and 25, formed the occasion for the presentation of many addresses and papers, national in their scope and value. Among others, that by W. A. Viall, of the Brown & Sharpe Mfg. Co., Providence, R. I., on "The Employment of Women in an Industry" was of great interest and value at this time when so many manufacturers are considering the solution of this problem. F. A. Halsey, commissioner of the American Institute of Weights and Measures, presented a resume of the work of the Institute, and several addresses of a patriotic character, bearing upon the relation of the industries to the national welfare, were also presented.

HELPING UNCLE SAM

The branch office of the Inspection Division, Ordnance Department, 600 W. Jackson Blvd., Chicago, Ill., has immediate need for 250 to 300 inspectors. At present the positions of inspector of field artillery ammunition and inspector of carriage division are open, which pay a salary of $3.50 to $5 for an eight-hour day. These positions are in the vicinity of Chicago. It is anticipated that many more examinations will be opened up immediately. Women applicants between the ages of twenty-one and fifty and men between the ages of thirty-one and fifty will be considered. Applicants are especially needed who have had artillery ammunition, carriage, motor, small arms, or small arms ammunition experience. There is immediate need for the services of these inspectors and applicants are expected to report to Mr. Becker, 600 W. Jackson Blvd., Chicago, Ill., for interview and application blank.

The Bureau of Mines Experiment Station, at Washington, D. C., requires the services of trained men of the following qualifications in the engineering trades: Draftsmen, electrical engineers, instrument makers, machinists, plumbers, steamfitters, as well as chemists and chemical engineers. Men whose training fits them for any of these occupations should address the Bureau of Mines, American University Experiment Station, Washington, D. C. Blank forms will then be sent to the applicant for filling in information relating to his experience and qualifications. These blanks will be placed on file and the applicant will be notified as soon as his services are required. Those who have registered for the draft but have not yet been ordered to camp may enter immediately into this service, while those who are not in the draft, but feel that they wish to serve their country in the present crisis, may either enlist or serve as civilians.

Most of the younger technical men in the Government's Reclamation Service, the Bureau of Standards, and the Geological Survey have been detailed for special war service either at home or abroad, and the draft has cut off from these branches their usual supply of new men; hence, the personnel of these departments is so depleted that it is almost impossible for them to do their regular work. In this emergency, therefore, the Government calls upon technical students of the country. From May 1 to October 1, there is much work in these departments that can be performed by undergraduates of technical training. Those particularly desired are young men of good physique who are below the draft age. The requirements for work in the Bureau of Standards are not less than one year of college work in physics and mathematics; in addition, special mechanical and testing skill is desirable. For the Reclamation Service, not less than one year of college work in civil engineering and surveying is required, and for the Geological Survey, not less than one year of college work in civil engineering. Men with drafting experience are particularly desired. The qualifications mentioned are the minimum requirements; additional qualifications will lead to better paid positions. Further information may be obtained by writing to the following department heads: Dr. W. S. Stratton, director of the Bureau of Standards, Washington, D. C.; Dr. George Otis Smith, director of the Geological Survey, Department of the Interior, Washington, D. C.; or A. P. Davis, director of the Reclamation Service, 8th and E Sts., Washington, D. C.

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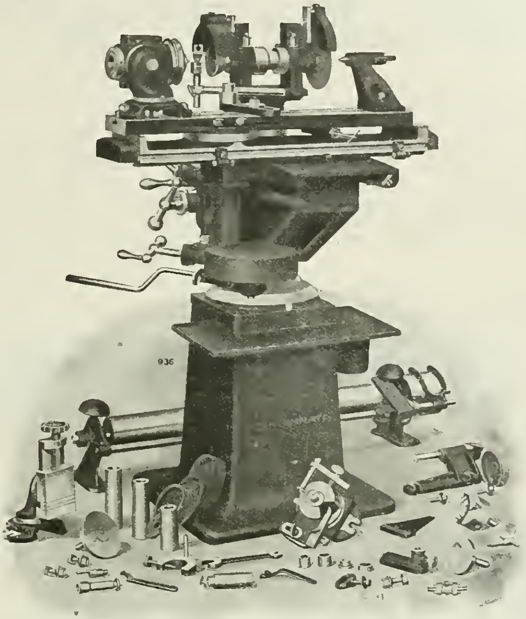
CORRECTION

In the New Machinery and Tools note on page 759, in the April number of MACHINERY, the statement was made in describing the reclaiming tang placed on the market by the Mallometer Co., Detroit, Mich., that the tool to be reclaimed can be ground to fit the shoulder provided on the new tang of which the device consists. The statement should have been as follows: When the tang breaks, it is hacksawed off to fit the driving shoulder on the new tang, the special advantage being that the hacksaw is the only tool required by means of which the drill is fitted for use with the tang.

CLEARANCE



The No. 1½ Cincinnati Universal Cutter and Tool Grinder

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You wouldn't think of using lathe tools with the wrong clearance. On milling cutters correct clearance is even more important.

Incorrect cutter clearance will reduce the output of your milling machines as much as twenty per cent.

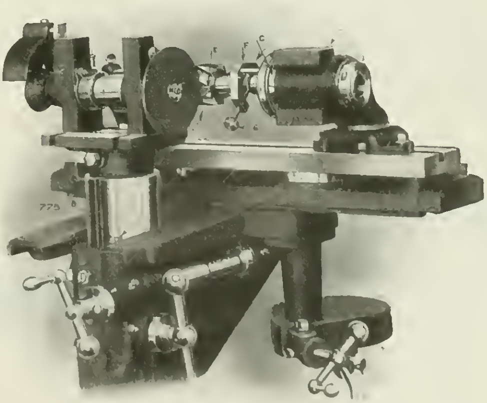
Clearance depends upon certain mathematical relations between the cutter and the grinding wheel.

To obtain these on the ordinary grinder requires several measurements and reference to diagrams, tables or charts.

The average operator doesn't understand these and after a couple of trials grinds until the clearance looks right—and your milling department suffers.

Compare the Cincinnati method. After a simple preliminary setting the swivel head is revolved the desired amount, the clearance angle being read direct from the dial—the cutters are ground with the correct clearance—and your milling department profits.

This is only one of our *exclusive features.*



Method of setting for clearance

Catalog tells them all

Cincinnati Milling Machine Company

CINCINNATI **OHIO, U. S. A.**

OBITUARIES

Adolphe Janssens, formerly one of the largest dealers in machine tools in Paris, France, died on March 8 last, at the age of sixty-five. Mr. Janssens retired from business some years ago.

Colonel George Pope, president of the National Association of Manufacturers and formerly prominently connected with the Pope Mfg. Co., Hartford, Conn., died April 19, at his home in Hartford, aged seventy-four years. Colonel Pope was a national figure in the automobile industry and was, at one time, chairman of the Automobile Board of Trade. He was born in Boston, Mass., January 9, 1844, and was a veteran of the Civil War.

Richard Ward Baker, superintendent of Outside Construction with the Watson-Stillman Co., New York City, died March 24 from apoplexy at his home in Roselle, N. J., aged sixty-eight years. Mr. Baker spent his entire business life in the service of the Watson-Stillman Co., having entered the company's employ at the age of fourteen, finally becoming superintendent, which position he held for many years. Upon the completion of fifty years' service in 1914, the Board of Directors presented Mr. Baker with a check and a copy of a resolution setting forth the company's appreciation. Mr. Baker is survived by his wife and one son.

Rufus Franklin Emery, secretary and treasurer of the Westinghouse Airbrake Co., Pittsburg, Pa., died April 11 from heart failure, aged forty-eight years. Mr. Emery was born near Boston, and, coming to the Pittsburg district in 1891, became affiliated with the Westinghouse interests, in whose upbuilding he played an important part. He was also assistant secretary of the American Brake Co., assistant secretary and a director of the National Brake & Electric Co., a director of the Vulcan Crucible Steel Co., secretary and treasurer and a director of the Westinghouse Friction Draft Gear Co. and treasurer and a director of the Westinghouse Traction Brake Co. He was a public-spirited citizen and took an active interest in various religious, social, civic, and patriotic movements.

PERSONALS

D. B. Clark, formerly superintendent of the Shell Department of the American Brake Shoe & Foundry Co., Erie, Pa., is now general superintendent of the Watervliet Arsenal, Watervliet, N. Y.

D. F. Noble, for the past four years connected with the Sales Department of the E. L. Essley Machinery Co., Chicago, Ill., has resigned and is now in the Sales Department of the Marshall & Huschart Machinery Co., Chicago, Ill.

A. H. Willey, for some time connected with Hermann Boker & Co., has joined the selling force of the Reliance Steel & Tool Co., 30 Church St., New York City, and will have charge of the Pennsylvania territory, with headquarters in Philadelphia.

Laura G. Edwards, for more than ten years connected with the National Tube Co., Pittsburg, Pa., writing advertising and other copy for publication, is now in the Publicity Department of the A. M. Byers Co., of Pittsburg, manufacturers of wrought-iron pipe.

F. S. Cole, formerly with the Imperial Belting Co., Chicago, Ill., is now with the Industrial Bearings Division of the Hyatt Roller Bearing Co., Metropolitan Tower, New York City. Mr. Cole will specialize on the sale of Hyatt roller bearings for lineshafting.

August Mertes, for some years superintendent of the Pittsburg Machine Tool Works, Pittsburg, Pa., has resigned to take a similar position with the Bradney Machine Co. of Middletown, N. Y., builders of locomotive cranes, elevating machinery, and machine shop tools.

Fred B. Crosby has resigned his position in the Power and Mining Engineering Department of the General Electric Co., Schenectady, N. Y., to become electrical engineer with the Morgan Construction Co., Worcester, Mass. Mr. Crosby has specialized in electrical equipment for steel works.

A. E. Ward, formerly with the Prest-O-Lite Co. and for many years associated with the compressed gas industries, has been appointed sales manager of the International Oxygen Co., 115 Broadway, New York City. Through his long experience Mr. Ward has gained recognition as an expert in the industrial applications of oxygen, hydrogen, and acetylene.

Vilhelm Christensen, of the firm of V. Lowener, with offices in New York, Copenhagen, Stockholm, Christiania, and Moscow, sailed for Copenhagen in the early part of April. Mr. Christensen has been studying the use of modern small tools and appliances for several years in this country. He will join the Tool Department of the main office of V. Lowener in Copenhagen in order to stimulate the use of American tools in the Scandinavian countries.

C. R. Dooley, manager of the Educational Department of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has been granted a leave of absence to accept an appointment by the Government as director of the Vocational Educational Project for Army Needs, now being developed by the War Department Committee on Educational and Special Training. He will be located in the War Department at Washington, D. C. During Mr. Dooley's absence, his duties will be assumed by C. S. Coler, who has been appointed acting manager of the Educational Department.

Colonel Henry P. Bope has resigned his position as vice-president and general manager of sales with the Carnegie Steel Co., Pittsburg, Pa., to devote his time to private interests. Colonel Bope became connected with Carnegie Bros. & Co. in 1879, and has remained continuously in the sales work of that company and its successors up to the present time. He has been succeeded by William G. Clyde, whose connection with the U. S. Steel Corporation and its subsidiaries dates from 1894, when he became superintendent of the plate mills of the Illinois Steel Co. at South Chicago. Charles L. Wood, who has been assistant to Mr. Clyde, has been made assistant general manager of sales in charge of the Bureau of Bars and Hoops.

Charles Philip Coleman has been elected president of the Worthington Pump & Machinery Corporation, 115 Broadway, New York City. Mr. Coleman has been vice-president of the corporation since May, 1916, and prior to that date was the receiver of the International Steam Pump Co. and associate companies, which have now been reorganized into the present corporation. Mr. Coleman is a graduate in mechanical engineering of the Lehigh University and was afterward employed by the Lehigh Valley Railroad in various positions as car agent, chemist, engineer of tests, assistant to the general superintendent, general storekeeper, and general purchasing agent, until 1903. Later he became secretary and treasurer of the Singer Sewing Machine Co., and president of the Saurer Motor Co. and of the International Motor Co. He came to the International Steam Pump Co. in 1913 as vice-president.

COMING EVENTS

May 15-17—Joint convention of the National Supply and Machinery Dealers' Association, Southern Supply and Machinery Dealers' Association and the American Supply and Machinery Manufacturers' Association at Hotel Hollenden, Cleveland, Ohio. Secretary of the American Supply and Machinery Manufacturers' Association, F. D. Mitchell, Woolworth Bldg., New York City.

May 16-17—Spring meeting of the National Machine Tool Builders' Association at the Marlborough-Blenheim Hotel, Atlantic City, N. J. Charles E. Hildreth, care of Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass., general manager.

May 20-22—Twenty-third annual convention of the National Association of Manufacturers in New York City. Secretary, George [illegible] Boudinot, 30 Church St., New York City.

May 30—Monthly meeting of the Rochester Society of Technical Draftsmen in Rooms 131-137, Sibley Block, [illegible] Main St., [illegible] Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

June 20-22—Fifth annual convention of the American Drop Forge Association held at the Iroquois Hotel, Buffalo, N. Y. [illegible] Horne, "The American Drop Forger," 108 Smithfield St., Pittsburg, Pa., secretary.

October 7-12—Joint convention of the American Foundrymen's Association and the American Institute of Metals in Milwaukee, Wis. Concurrent with these meetings there will be an exhibition of foundry equipment, machine tools, and accessories.

SOCIETIES, SCHOOLS AND COLLEGES

Columbia University, Morningside Heights, New York City. Bulletin of the day and evening courses for the 1918 summer session, beginning June 5 and ending August 16.

Rochester Athenaeum and Mechanics Institute, Rochester, N. Y. Bulletin of the Departments of Mechanics, Electricity, and Chemistry of the School of Industrial Arts, for 1918-1919.

NEW BOOKS AND PAMPHLETS

Comparative Tests of Six Sizes of Illinois Coal on a Mikado Locomotive. By Edward C. Schmidt, John M. Snodgrass, and Otto S. Beyer, Jr. 101 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the University of Illinois, Urbana, Ill., as Bulletin No. 101.

Stabilized Platform Weighing Scale of Novel Design. By Frederick J. Schlink, associate physicist of the Bureau of Standards. 28 pages, 7 by 10 inches; illustrated. Published by the Department of Commerce, Washington, D. C., as Bulletin No. 106 of the Bureau of Standards. Price, 5 cents.

Essentials of Drafting. By Carl L. Svensen. 181 pages, 6 by 9 inches; 150 illustrations. Published by D. Van Nostrand Co., 25 Park Place, New York City. Price, $1.50.

In his capacity of assistant professor of engineering drawing at the Ohio State University, the author of this book has had an excellent opportunity to adapt it to instruction purposes in engineering and trade schools. The book is specifically intended for the evening technical school, and has been prepared with a view to making it a part of the technical course at the Ohio Technical Drawing School. One of the main features of the work is the great number of examples of drawings shown and the practical nature of these examples, the majority of the sketches being from various kinds of machine parts. The book is divided into twenty chapters, the last of which contains questions and problems for the students, while each of the other nineteen takes up some particular phase of mechanical drawing. The chapters are headed as follows: Drawing Instruments and Materials, Lettering, Constructions; Projections, Materials and Stresses; Screw Threads; Bolts and Screws, Riveting, Working Drawings; Sections, Dimensioning; Machine Construction; Sketching, Estimation of Weights; Piping; Intersections, Developments, Picture Drawing, Shade Line Drawings, Drawing Questions, Problems, and Studies.

The LUCAS

(OF CLEVELAND)

"PRECISION"

BORING, DRILLING AND

MILLING MACHINE

ALWAYS GOOD

and as time goes on

ALWAYS BETTER

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF CLEVELAND, O., U.S.A.

NEW CATALOGUES AND CIRCULARS

H. P. Maughlin Co., Columbus, Ohio. Circular giving price lists of numbering tacks and pattern letters and figures.

Genesee Mfg. Co., Rochester, N. Y. Circular descriptive of the Genesee facing tool for counterboring, facing, and forming.

Link-Belt Co., Chicago, Ill. Book 358, containing information on Link-Belt roller chain and giving tables of dimensions, strength, etc.

Buckeye Twist Drill Co., Alliance, Ohio. Catalogue giving tables of dimensions and prices of twist drills, sockets, shanks, reamers, taps, etc.

Kales Stamping Co., 441 Lafayette Blvd., Detroit, Mich. List of sizes of special steel, brass, lead, and fiber washers in stock ready for immediate shipment.

Smith-Serrell Co., Inc., 144 Cedar St., New York City. Catalogue of Francke flexible coupling installations and revised list prices of Francke flexible couplings.

West Haven Mfg. Co., 30 Church St., New York City. Catalogue 15 of hacksaws, hand saws, nail sets, center-punches, tap and reamer wrenches, jack-screws, etc.

Taylor Welder Co., Warren, Ohio. Catalogue of the Taylor process of electric welding, illustrated with diagrams and halftones, showing Taylor electric spot-welding machines.

Driver-Harris Co., Harrison, N. J. Circular of "Nichrome" wire mesh containers for pickling, hardening, and heat-treating, containing testimonial letters from a number of users.

Electric Controller & Mfg. Co., Cleveland, Ohio. Net price sheets for electric controllers, brakes, push-buttons, starters, rheostats, switches, and other electric apparatus made by the company.

Greenfield Tap & Die Corporation, Greenfield, Mass. Catalogue 38 of pipe tools, showing the complete line of pipe tools manufactured by this company, and giving tables of dimensions and prices.

DeVilbiss Mfg. Co., Toledo, Ohio. Catalogue illustrating and describing finishing room equipment, including "Aerons," exhausting equipment, air-lift turntables and wheel jacks, air compressors, etc.

Norma Co. of America, 1790 Broadway, New York City. Circular of Norma ball bearings for fractional horsepower motors, which require anti-friction bearings that will reduce friction losses to a minimum.

Cleveland Milling Machine Co., Cleveland, Ohio. Stock list of plain, side, and angular milling cutters, end-mills, T-slotting cutters, hollow-mills, slitting saws, bevel gear-cutters, involute gear-cutters, etc.

Fitchburg Machine Works, Fitchburg, Mass. Catalogue of the 8-inch "Lo-swing" lathe illustrating this size machine, its parts and attachments, and showing the set-up for turning various types of work.

Landau Machine & Drill Press Co., Inc., 368 Broome St., New York City. Circular illustrating and describing the Landau sensitive drilling machine, equipped with a multiple drilling head which can also be used for tapping.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Circular 7174, dealing with electrical equipment for cement mills and giving the advantages of motor drive for this work, together with the characteristics of motors for this service.

Winfield Electric Welding Machine Co., Warren, Ohio. Catalogue entitled "Electric Welding by the Winfield Way," illustrating and describing Winfield spot-welding machines and giving data on the design, comparative cost of the process, etc.

Transmission Ball Bearing Co., Inc., Military Road, Buffalo, N. Y. Pamphlet entitled "It Takes a Load to Show the Friction," giving dimensions of Transmission ball bearings, which it is claimed effect a saving of 15 per cent of the total power consumption.

Aluminum Castings Co., 6205 Carnegie Ave., Cleveland, Ohio. Circular entitled "Small Parts and Big Points," telling of the care with which "Lynux" bronzes are made by bushing and bearing specialists to insure the production of long-wearing, high-speed, heavy-duty bearing bronzes.

Aluminum Castings Co., Cleveland, Ohio, are issuing a circular containing a letter which they term "A Printed Salesman." The letter gives information concerning "Lynux" bronze, and is intended to take the place of a part of the regular traveling force, as about 50 per cent has been lost because of the war.

Nielsen-Barton Chuck Co., 106 S. Jefferson St., Chicago, Ill. Catalogue of the Eclipse roller-bearing drill chuck, giving a concise description of the chuck, together with illustrations showing its simplicity and the convenience of its operation. The company also makes ground arbors for all kinds of drill chucks.

Driver-Harris Co., Harrison, N. J. Circular of 99 per cent pure nickel sheet, outlining the characteristics and advantages and giving a list of products in which nickel sheet is now being used to advantage. A table of the physical properties of Grade A cold rolled sheet nickel for drawing, stamping, and spinning is included.

Fitchburg Machine Works, Fitchburg, Mass. Catalogue of the "Lo-swing" 8½-inch lathe, containing illustrations of the machine and its various parts and attachments. A number of line drawings show different types of work set up on the "Lo-swing" lathe, and directions are included for setting up the machine.

Powell Machine Co., 243 Stafford St., Worcester, Mass. Circulars descriptive of 24- by 24-inch "Hy-speed-cut" planers; 30- by 30-inch "Hy-speed-cut" planer; 36- by 30-inch "Hy-speed-cut" planer; 36- by 36-inch "Hy-speed-cut" planers; 24- by 24-inch standard planer; 30- by 30-inch standard planer; 36- by 36-inch standard planer.

Mossberg Wrench Co., 25 Charles St., Providence, R. I. Circular descriptive of "Sim-pull" countershafts and "Sim-plex" belt shifters of the "pull-auto-lock" type. The "Sim-pull" belt shifters are made in three sizes for 1½-, 2- and 2½-inch belts, and the "Sim-plex" belt shifters are made in three sizes for 3-, 3½-, and 4-inch belts.

E. F. Houghton & Co., Philadelphia, Pa. A treatise on the handling of steel, entitled "Steel and Its Treatment," dealing with the composition of steel, its hardening, tempering, and annealing. The subject is presented in regular book form, with a complete index, and covers 165 pages, 5½ by 8 inches, substantially bound in cloth binding.

J. C. Glenzer Co., 3 Fourteenth St., Detroit, Mich. Circular illustrating and describing the "Utility" interchangeable counterbore and spot-facer, the advantage of which is that the pilot cannot be twisted off. The circular contains dimensions of the cutters and pilots, the number of Morse taper with which the counterbores are provided, and price list.

Gisholt Machine Co., Madison, Wis. Circular entitled "How to Save Money on High-speed Steel," describing Gisholt tool-holders by means of which it is possible to utilize high-speed steel tools that have been worn too short to be used without holders. These tool-holders are especially designed for use in turret lathes and engine lathes equipped with turret toolposts.

Cooper-Hewitt Electric Co., Eighth and Grand Sts., Hoboken, N. J. Pamphlet entitled "Lighting for Production and Safety," by William A. D. Evans, comprising the study and selection of a system of illumination with a view to ultimate efficiency of the plant. The halftone illustrations in the book are made from photographs taken under Cooper-Hewitt lamps.

Oliver Machinery Co., 7 Coldbrook St., Grand Rapids, Mich. Circular illustrating and describing the Oliver No. 15-R combination band resaw and scroll saw with 38-inch wheel. Circular of Oliver No. 61 single-cylinder, four-roll, double-belted cabinet surfacer with capacity up to 24 and 30 inches in width and 8 inches in thickness. Circular of Oliver No. 483 high-speed double shaper with a 60- by 36-inch table.

TRADE NOTES

Hyatt Roller Bearing Co. announce that their Industrial Bearings Division is now located in the Metropolitan Tower, New York City.

Oesterlein Machine Co., Cincinnati, Ohio, manufacturers of Ohio milling machines and grinders, are now located in their new plant at 3301 Colerain Ave.

Lyon Metallic Mfg. Co., Aurora, Ill., manufacturers of all-steel equipment, including bins, shelving, lockers, etc., are erecting a large addition to their plant.

Bullard Machine Tool Co., Bridgeport, Conn., have made a 100 per cent record on the Liberty Loan, every one of their employes, numbering over 1200, having subscribed.

Diamond Chain & Mfg. Co., Indianapolis, Ind., manufacturers of chain for machine tools, are now located in their new building, which is considered one of the finest factories in Indianapolis.

Chicago Recording Scale Co., Waukegan, Ill., have opened a new department for the manufacture of dies, tools, jigs, fixtures, stampings, screw machine work, and contract work in general.

Hendey Machine Co., Torrington, Conn., have opened a branch office at 521 Chamber of Commerce Bldg., Rochester, N. Y., for the purpose of covering the northern and western parts of the state direct.

Diamant Tool & Mfg. Co., 164 Emmett St., Newark, N. J., are continuing the tool and manufacturing business of Sidney Diamant, who was formerly an owner of the DeMnot Tool & Machine Co. of New York City.

Westinghouse Electric Products Co., Mansfield, Ohio, will manufacture the heating appliances previously made by the Copeman Electric Stove Co. The general manager of the company is W. K. Dunlap, who is assistant to the vice-president of the Westinghouse Electric & Mfg. Co.

Reliance Die & Stamping Co., 515 N. LaSalle St., Chicago, Ill., makers of dies, tools, gages, fixtures, and special machinery, as well as manufacturers of stampings, have enlarged their plant by adding to it a five-story building. This addition will practically double the floor space and capacity.

Rockford Tool Co., Rockford, Ill., manufacturers of lathes, have acquired the patent rights and plant of the Sundstrand Mfg. Co., who have been building a small 9-inch manufacturing lathe for some time. The Rockford Tool Co. will continue the manufacture of this lathe, in addition to their regular line.

J. R. Stone Tool & Supply Co., Detroit, Mich., dealers in machinery, tools, and machine tool accessories, moved to their new quarters at 197 Woodward Ave., May 1, where they carry a stock of new and second-hand machinery and tools of all kinds to meet the needs of the metal working industries.

Victor R. Browning & Co., College Point, N. Y., manufacturers of hoisting and conveying machinery, are now making 5-inch naval gun mounts for the U. S. Navy Yard, and would like to obtain catalogues from manufacturers of the various parts that enter into the production of gun mounts and of factory equipment.

E. J. Flather Mfg. Co., Nashua, N. H., at a recent meeting of the stockholders, changed the name of the corporation to The Flather Mfg. Co. E. J. Flather is retiring from the active management but will continue with the company as consulting engineer. H. E. Flather is president and Edwin Morey, treasurer.

Aborn Steel Co., Inc., 26 Clarke St., New York City, have been appointed sales agents for the Century Steel Co. of America, Inc., Poughkeepsie, N. Y., manufacturers of crucible steels. The Century Steel Co. of America have given up their New York office and warehouse and the Aborn Steel Co. will carry Century products in stock.

Union Switch & Signal Co., Swissvale, Pa., have recently placed orders for additional equipment consisting of two 3000-pound steam drop-hammers, one 8000-pound steam drop-hammer, and presses which, added to their present equipment, will place them in a position to handle additional orders for forgings for automobiles, war trucks and airplane parts.

Alfred Box & Co., Front and Poplar Sts., Philadelphia, Pa., manufacturers of cranes and hoists, were sold by the estate of Alfred Box, on March 1, 1918, to Herman L. Winterer and Ambrose G. Warren, the sale covering the firm name, machinery, good will, and fixtures in the crane and hoist business conducted by the company. The business will be carried on by the purchasers under the old name of Alfred Box & Co.

Buhr-Buiwitt Co., 1662 Dubois St., Detroit, Mich., have taken over the exclusive sales of the Detroit Pneumatic Chuck Co., Flat Rock, Mich., for the United States and Europe. The Detroit Pneumatic Chuck Co. have been under the management of the Buhr-Buiwitt Co. since April 1. The chuck manufactured by the company is especially suitable for shell work, but is also applicable to all kinds of manufacturing work.

Ott Grinder Co., Indianapolis, Ind., state that Albert J. Ott and his son Conrad have sold their controlling interest in the company, and the purchasers will continue the manufacture of small, plain, and universal cylindrical grinders, under the management of Russell Fortune. Messrs. Ott have agreed not to manufacture small cylindrical grinders for five years, but are privileged to build large-swing machines, which they probably will do in the near future.

Brown Instrument Co., Philadelphia, Pa., have recently let a contract to R. C. Ballinger & Co. for an addition to their factory, which will cost approximately $50,000. The addition will be erected at Wayne and Roberts Aves., adjoining the present building. The company is manufacturing pyrometers used in the heat-treatment of munitions for the United States Government. The officers are Richard P. Brown, president; C. Stanley Hurlbut, vice-president; George W. Cornman, secretary; and John P. Goheen, assistant treasurer.

Foster Machine Co., Elkhart, Ind., manufacturers of turret lathes, have acquired the sole rights for the manufacture and sale of Holden-Morgan thread millers in the United States and all foreign countries. The machines, which will be built under the patent rights of the Holden-Morgan Co., are now designed and built for all classes of munitions, including the largest sizes of shells, and all component parts, such as time fuses, graze fuses, detonators, sockets, and primers, as well as gun parts and many parts of airplanes, including turnbuckles.

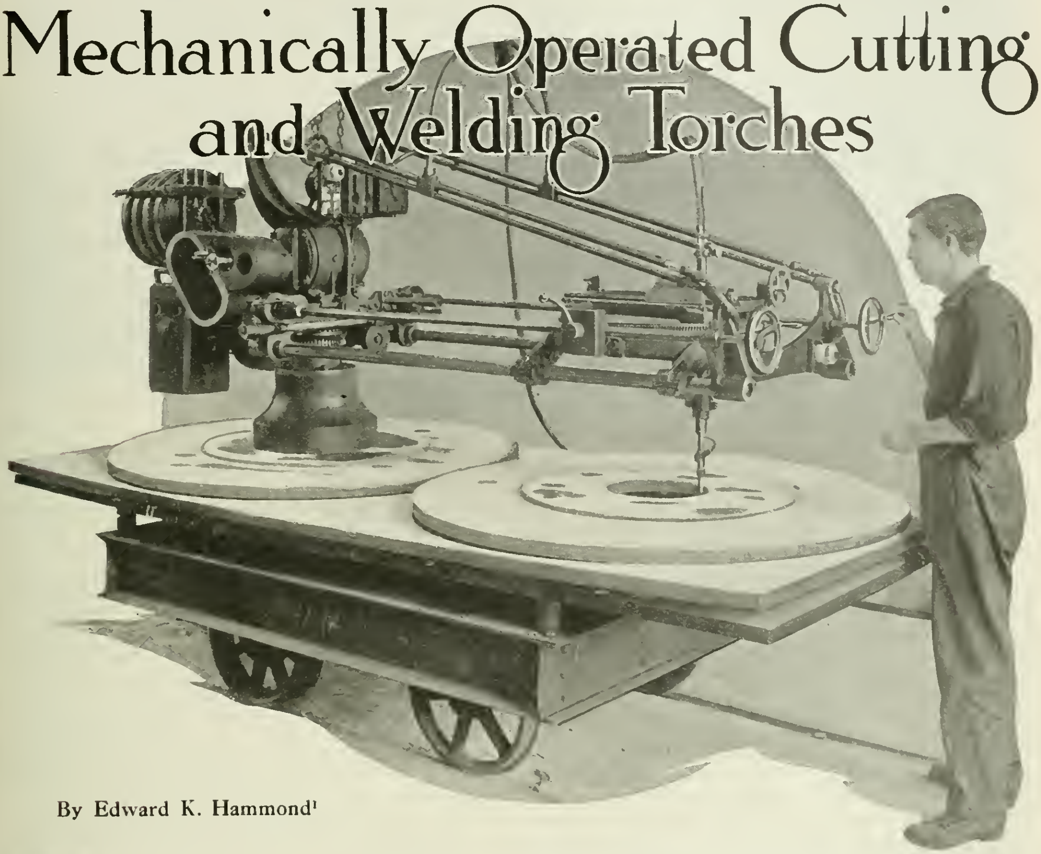
H. L. Hopwood, industrial lawyer, New First National Bank Bldg., Columbus, Ohio, is making a specialty of dealing in factory plants, foundries, and mills that are privately offered for sale, and thereby provides an opportunity to industrial enterprises which seek to acquire plants already constructed rather than to build their own plants. Confidential relations with owners of such properties have made it possible to list a number of well-equipped plants capable of being easily converted for the manufacture of various industrial products.

Akerlund & Semmes, Inc., consulting engineers, 17 Battery Place, New York City, have been appointed representatives of the Gibbs Gas Engine Co., Jacksonville, Fla., and of the Western Pipe & Steel Co., San Francisco, Cal., in connection with contracts held by these companies for the Navy Department and the United States Shipping Board Emergency Fleet Corporation, respectively. The Gibbs Gas Engine Co. have a contract for thirty-five submarine chasers, while the Western Pipe & Steel Co. have a contract for twenty-eight 8800-ton steel vessels.

Mount Vernon Die Casting Corporation., Mount Vernon, N. Y., have been incorporated under the cooperative plan by twenty-nine skilled mechanics to take over the business of C. J. Moberg, Inc., maker of die-castings. Mr. Moberg wished to retire from the die-casting field, and as difficulty had been experienced in employing this kind of labor the cooperative plan was tried. George H. Lane, secretary and treasurer of C. J. Moberg, Inc., is secretary, treasurer, and general manager of the Mount Vernon Die Casting Corporation. The president of the new company is Edward L. Smith.

Ohio Electric & Controller Co., 5900 Maurice Ave., Cleveland, Ohio, has been incorporated with a capital stock of $200,000 for the purpose of manufacturing lifting magnets and electrical controlling devices. Lifting magnets will be built at once and controlling devices later. The officers of the new company are F. W. Jessop, president; W. H. Greene, vice-president; and A. D. Walter, secretary and treasurer. Mr. Jessop was formerly works manager of the Electric Controller & Mfg. Co., Cleveland, Ohio. He has had an extensive experience in the manufacture of lifting magnets and electrical apparatus for the control of motors.

Mechanically Operated Cutting and Welding Torches



By Edward K. Hammond[1]

For the performance of manufacturing operations where cutting or welding torches are used, and for handling certain miscellaneous classes of work where the oxy-acetylene torch finds application, higher rates of production and greater uniformity in the work are secured through operating the torch by some suitable mechanism than is the case when it is moved over the work by hand. The substitution of a uniform mechanically controlled movement in place of operating a torch by hand enables the torch to be moved over the work at a rate which has been carefully predetermined after consideration has been given to the thickness of the metal and other variable conditions which are involved in any welding or cutting operation. This article explains a variety of different methods of using mechanically controlled cutting and welding torches, and these applications will doubtless suggest other ways in which readers of MACHINERY can apply mechanical control for torches used in their own shops.

Manufacturers who have use for oxy-acetylene cutting or welding torches will find that several important advantages are secured through operating the torches mechanically, when such a method of procedure is practicable. Most important among the benefits secured from mechanical control are increased production from the torches and greater uniformity in the work. Experience is required to enable the operator of a cutting or welding torch, working by hand, to produce uniform cuts or strong welds of good appearance, although such results are readily obtained by an intelligent mechanic who is given the necessary amount of time to acquire dexterity in handling a torch. But this skill can only be obtained by experience, and in plants where there is not a great amount of cutting or welding to be done, it often happens that inexperienced men are expected to use a torch and produce work which is comparable with that turned out by experts. Quite naturally, this is not often possible in practice. In such shops, the use of mechanically operated torches eliminates the personal equation and greatly improves the quality of the work; mechanical control is also the means of increasing production, as the torches are moved by power at the correct rate, which is predetermined by the design of the feed mechanism. Thus, the elimination of the personal equation increases both the quantity and quality of the work produced; even in shops where experienced cutters and welders are employed, these men are likely to become tired during the latter part of the day, with the inevitable result that they will produce less work and work of inferior quality.

For performing the miscellaneous cutting and welding operations that are met with in many different shops, manufacturers of oxy-acetylene torches have made mechanically operated equipments which are well adapted for general requirements. On the other hand, there are many specialized manufacturing operations for which mechanically operated cutting and welding torches can be used to extremely good advantage, where the peculiar requirements of the work make it necessary to design special machines to fulfill existing conditions. In such cases, it will generally be found possible to employ standard oxy-acetylene torches in connection with these special machines; in fact, this is almost invariably the method of procedure which is followed, because the standard torches are designed along lines which have been found satisfactory in practice. Owing to the highly explosive character of acetylene, hydrogen, and other combustible gases which are used in torches, it is, of course, absolutely imperative either to use standard torches or else to be sure that special torches are so

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[1] Associate Editor of MACHINERY.

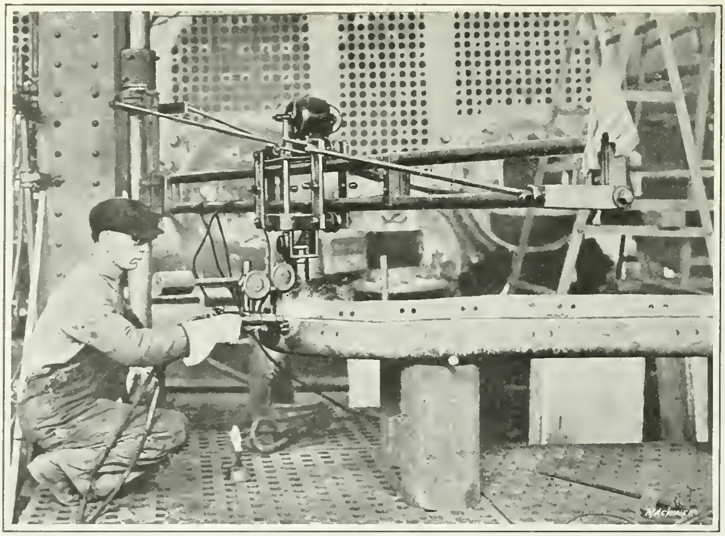

Fig. 1. Practice of New York Shipbuilding Corporation in cutting off Ragged Edge of a Boiler Head or Similar Shaped Piece which has a Flange turned up around its Circumference

designed that the proper precautions have been taken to avoid danger of explosions caused by flash-backs, etc.

Mechanically Controlled Cutting Torches

Provision can be made for the mechanical control of cutting torches that are adapted for working on parts of a variety of different shapes and sizes, which will be clearly demonstrated by reference to Figs. 1 to 13. An inspection of these illustrations will show that, in addition to making straight cuts on flat plates, it is quite feasible to follow irregular outlines on flat plates or to make cuts on cylindrical shaped pieces. With many of these mechanically controlled equipments, the torches are guided in such a way that they follow the line along which it is desired to make a cut, without calling for special attention from the operator, and, as previously mentioned, provision of power drive sets the pace for the torch, so that it is fed to the work at a predetermined speed which is suitable for the thickness of the metal that is being cut.

Figs. 1 and 2 show two methods used at the plant of the New York Shipbuilding Corporation in Camden, N. J., for cutting off the ragged edges of such pieces as boiler heads, which have a flange drawn up around the circumference. In Fig. 1 the torch is shown trimming off the flange of a boiler front, which is made of a steel plate 1¼ inch in thickness. It will be apparent from this illustration that the torch is supported by a head carried on the radial arm of a machine which is so designed that the torch head can be traversed in either direction on the radial arm, and this arm can be swung around the column of the machine. This combination of movements enables the torch to be fed around the edge of cylindrical shaped pieces, as shown. The torch head is furnished with wheels which engage both the inside and outside of the work to provide for holding the point of the torch in the proper relation to the plate which it is cutting. An electric motor, which will be seen above the radial arm, transmits power to these wheels on the head, so that they serve the double purpose of holding the torch in the proper relation to the work and feeding it over the work at the proper rate. In cutting this 1¼-inch steel plate with carbo-hydrogen gas, using a Davis-Bournonville torch with a No. 3 cutting tip, it is found possible to cut at a rate of 1 foot per minute and leave a sufficiently good finish, so that no subsequent machining operation is required.

Fig. 2 shows another method used by the New York Shipbuilding Corporation for cutting away the ragged edge of a cylindrical shaped flange, where the size of the work is too great to enable it to be handled by the radial cutting machine shown in Fig. 1. The steel is of the same thickness as in the preceding case and the rate of cutting is also the same. In this illustration it will be seen that the cutting torch is swung around a center *A;* and extending from this center to the torch there is a radial arm *B* which holds the torch point in the proper relation to the work. In this case, use is made of one of the "radiagraph" machines built by the Davis-Bournonville Co., of Jersey City, N. J., which is used in conjunction with the radial arm and center for performing cylindrical cutting operations of this kind with very satisfactory results. Radiagraph machines are also shown in operation in Figs. 3 to 6, and the description of the mechanism will be best understood by referring to these illustrations.

This machine consists of a carriage that holds the cutting torch with its tip at a suitable distance from the work and feeds the torch over the work in making the cut. Where the radiagraph is used for making straight cuts on flat plates, it is usually the practice to provide a small double track for the wheels of the torch carriage. On top of the carriage, in Fig. 3, there will be seen a small electric motor *A* that transmits power to the wheels through a suitable arrangement of gearing, thus providing for feeding the torch to the work at a speed suitable for the thickness of metal that is being cut.

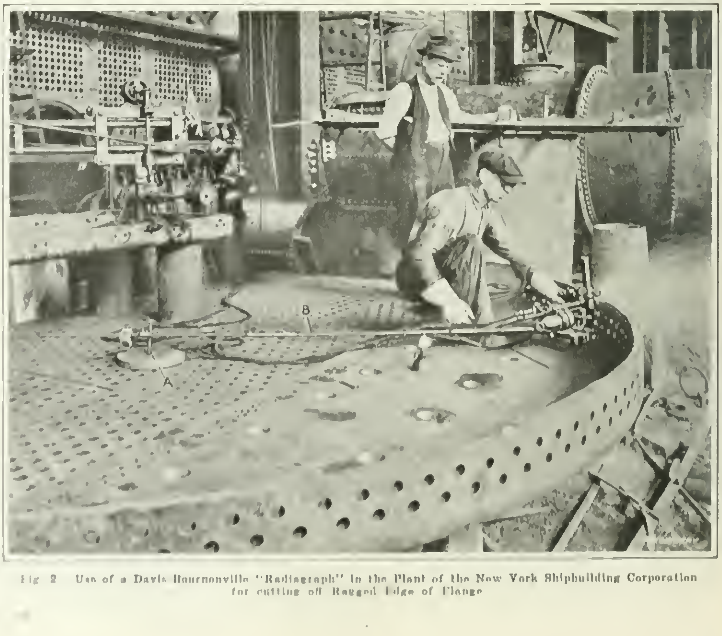

Fig. 2. Use of a Davis-Bournonville "Radiagraph" in the Plant of the New York Shipbuilding Corporation for cutting off Ragged Edge of Flange

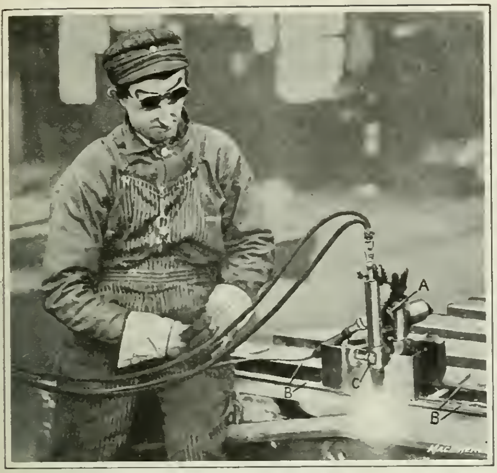

Fig. 3. Using "Radiagraph" to make a Longitudinal Cut on Flange of I-beam in Plant of Marion Steam Shovel Co.

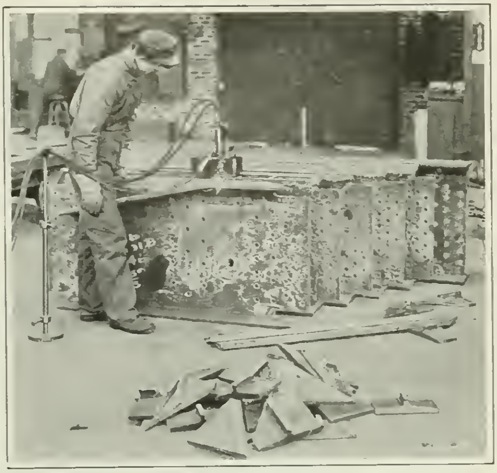

Fig. 4. Same Work illustrated in Fig. 3, showing All the Cutting Operations which are performed

The track that carries the wheels of the radiagraph is shown at *B*, and at *C* it will be seen that a rack and pinion are provided to regulate the position of the torch tip so that it is located at a suitable distance from the surface of the work.

Figs. 3 and 4 show two views of a radiagraph machine engaged on the operation of cutting I-beams in the plant of the Marion Steam Shovel Co., in Marion, Ohio. The work consists of Bethlehem 30-inch I-beams with 10½-inch flanges. Eight of these beams are put through the plant at a time, this being the number required in a unit for one large Marion shovel. Each end of the flange at the top and bottom of the beam is coped off, two ends being cut diagonally and two straight across; a longitudinal cut is also made along one flange, as shown in Figs. 3 and 4. Formerly the coping operation was performed with a swivel saw, but this naturally necessitated a great deal of handling of the work, which has now been eliminated. For making the longitudinal cut, it was formerly the practice to set the work up on a planer, two beams being set up and operated upon simultaneously. It required about from thirty to forty-five minutes to set up these two beams, and then about an hour to make the required cut in each beam. This involved a total time of one and three-fourths hour for cutting two beams, or seven hours for cutting eight beams. Doing this work with a mechanically operated oxy-acetylene cutting torch, one longitudinal cut is made in six minutes, the length of cut being 4 feet 3 inches by 1½ inch in thickness. Instead of taking from fifteen to twenty hours for sawing the ends of the beams and seven hours for planing, the whole operation of coping and longitudinal cutting is done with the mechanically operated cutting torch in five hours, which includes all the time spent in setting up, etc.

Fig. 5 shows how the New York Shipbuilding Corporation employs the radiagraph machine for cutting flat plates. This is one of the simplest applications, the machine being carried on a track which guides it over the surface of the steel plate being cut. This illustration shows the cutting of a plate 2½ inches thick, and the torch is fed at the rate of 13 inches per minute, leaving a good finish on the cut surface. In Fig. 2 is shown the way in which the radiagraph is employed for trimming the rough edges from a boiler head. Fig. 6 shows another application of the radiagraph for circular cutting in the New York Shipbuilding Corporation's plant, which is based on essentially the same principle, although in this case the diameter of the circular cut is very much less. The operation consists of cutting a number of circular openings in a plate 1½ inch in thickness, and for handling this operation the radiagraph is furnished with a radial arm *A*, which is attached to a fixed center *B*. The torch is fed over the work at the rate of one foot per minute. An interesting feature of this particular application of the mechanically operated cutting torch is the manner in which a track is provided for the carriage wheels. It will be seen that there is a break in the surface of the work left by a previous cut, which would interfere with the carriage travel; to overcome this difficulty, a thin plate is placed on top of the work to be cut, this plate having an opening sufficiently large to allow the point of the torch to make the desired cut and still furnish a bearing for the carriage wheels.

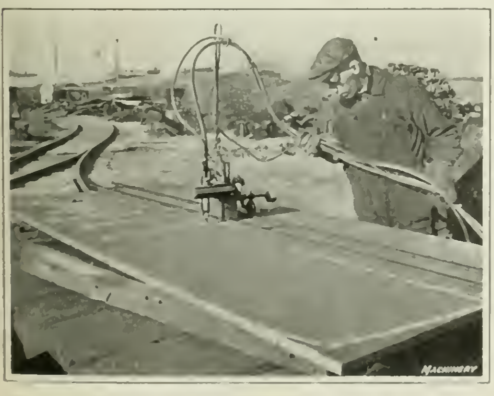

Fig. 5. Using Davis-Bournonville "Radiagraph" at Plant of New York Shipbuilding Corporation for making Longitudinal Cut on Large Steel Plate

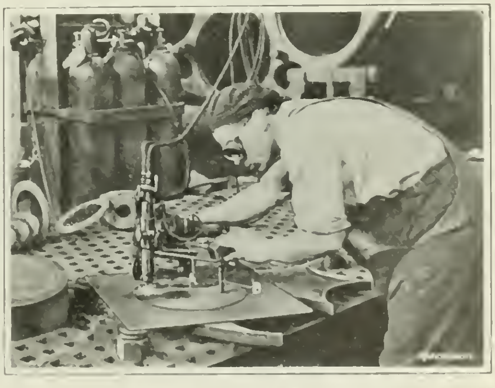

Fig. 6. Application of "Radiagraph" by New York Shipbuilding Corporation for cutting Circular Disks from Steel Plate. Note Method of carrying Wheels over Holes

Cutting Torch Used as Lathe Tool

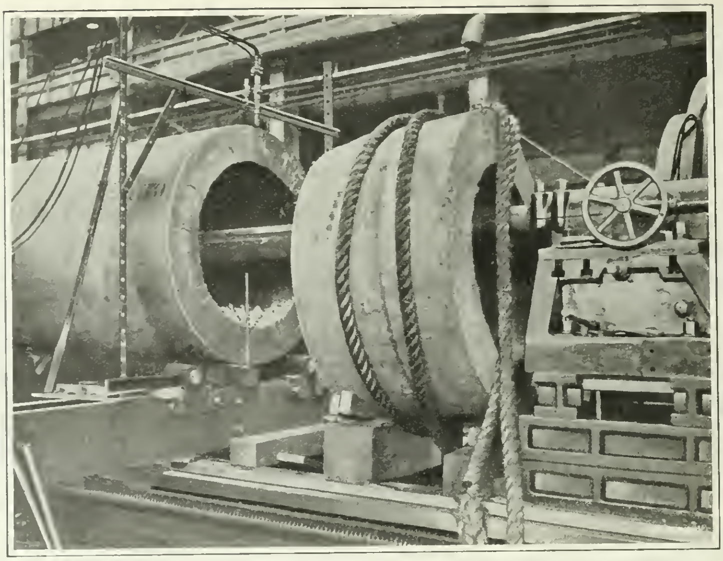

Fig. 7. New York Shipbuilding Corporation makes Body of Steam Turbine Rotors of Cast Steel, and the Ends of These Castings are cut off by rotating Work on Lathe to feed it to Flame of Davis-Bournonville Cutting Torch

In making rotors for steam turbines, it is the practice of the New York Shipbuilding Corporation to pour the molten steel into a mold which is made so that the rotor casting stands on end. The reason for this arrangement is that, by making the mold higher than is necessary to produce a casting of the required length, the excess amount of molten steel forms a riser that applies pressure and assists in producing a solid casting. Obviously, it is necessary to cut off the surplus metal during the process of machining this steel casting to convert it into a finished turbine rotor, and for this purpose it is the practice to set the casting up on a large engine lathe as shown in Fig. 7. Supported in this way, it is an easy matter to rotate the casting at a suitable speed, so that a cutting torch, supported in the proper relation to the work, will have the steel fed to the torch at the proper rate for making the cut. This rotor casting is 9½ inches thick by 16 feet 6 inches in circumference, and the cut was completed by the oxy-hydric torch in the remarkably short time of thirty-five and one-half minutes. A good idea of the quality of the finished surface left by the torch will be gathered from the illustration.

Combustible Gases Used for Cutting in New York Shipbuilding Plant

In the plant of the New York Shipbuilding Corporation, three different combustible gases are used in cutting torches, namely, carbo-hydrogen, acetylene, and hydrogen. The combustible gas selected for different classes of work depends upon the thickness of the plates which have to be cut. The range of thicknesses handled by the different gases is as follows: up to 3 inches, carbo-hydrogen; 3 inches to 6 inches, acetylene; and over 6 inches, hydrogen. It will, of course, be understood that either of these gases is mixed with oxygen to provide for its combustion, the ratio of oxygen to the combustible gas being regulated in accordance with standard practice, which has been explained in other articles published in MACHINERY.

Users of cutting and welding torches are certainly familiar with the properties of both hydrogen and acetylene, but it may be that there are some readers who have not had occasion to investigate the properties of carbo-hydrogen. This gas contains from 85 to 88 per cent hydrogen and 15 to 12 per cent light hydro-carbons of the higher heating series. It is claimed that less oxygen is required for the combustion of this mixed gas than for either acetylene or hydrogen; and that the temperature of the carbo-hydrogen flame is approximately 4800 degrees F. In referring to the properties of combustible gases which make them suitable for use in cutting and welding torches, confusion frequently arises through a misconception of the relation which exists between the number of heat units per cubic foot of a gas and the temperature which can be developed by the combustion of that gas. For the performance of cutting or welding operations, the number of heat units per cubic foot of gas is a matter of minor importance in determining its ability to give efficient service; it is the rapidity with which this heat is liberated to develop a high temperature which determines the suitability of the gas for use in a torch. This fact is well brought out by comparing the heat value of carbo-hydrogen with that of ordinary illuminating gas, the former having approximately 480 British thermal units of heat per cubic foot, while the latter has approximately 600 heat units per cubic foot. Despite this fact, illuminating gas is unsuitable for use in a torch because, although it has 25 per cent more available heat per unit volume of gas, this heat is not liberated rapidly enough to generate a temperature suitable for the cutting or welding of metals.

It is claimed by the Carbo-Hydrogen Co. that this gas has readily cut armor plate up to 24 inches in thickness, using standard apparatus, and that open-hearth steel pit castings 36 inches thick at the center by 17 inches thick at the edges, and 10 inches across, have been cut in half by special apparatus, using carbo-hydrogen as the combustible gas. For this work a number of oxygen cylinders were manifolded together and a preheating flame was used, which was provided by a torch fitted with a ¼-inch gas pipe taking oxygen directly from the manifold oxygen supply. Of course, this was an unusual operation, and the cut was

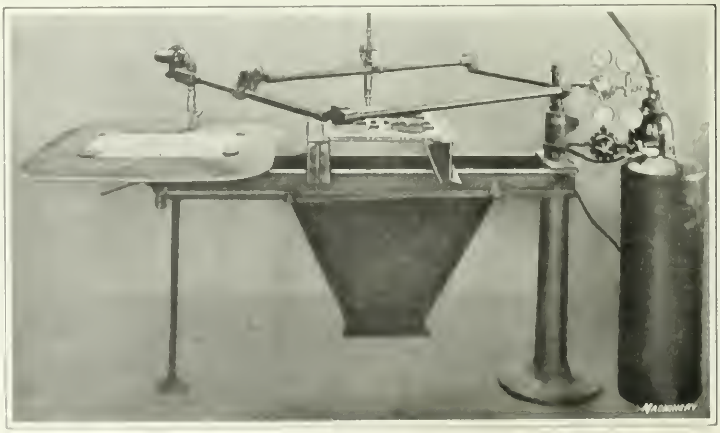

Fig. 8. Davis-Bournonville "Oxygraph" equipped with Single Torch which follows Same Outline as that over which Tracing Point is guided on Copy Table

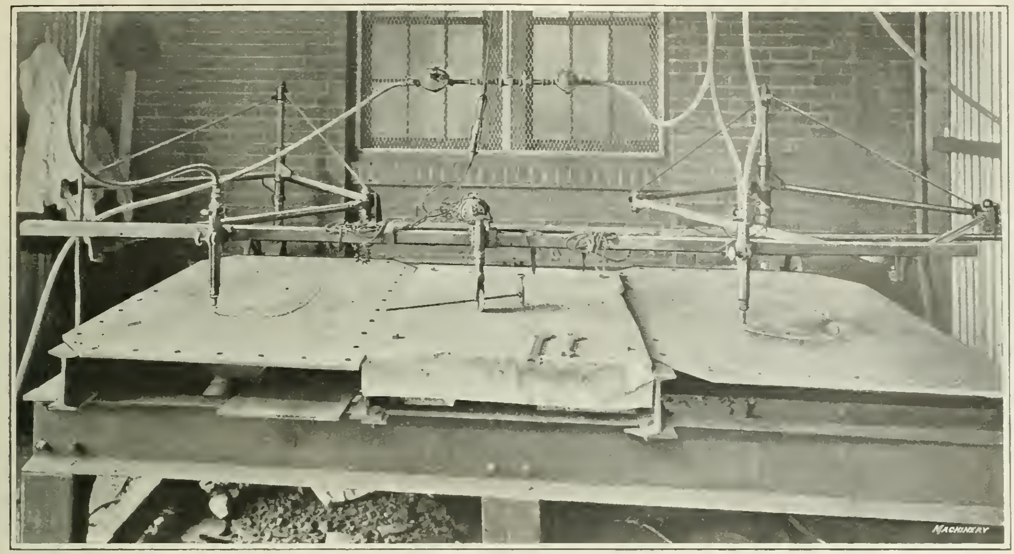

Fig. 9. Davis-Bournonville "Oxygraph" Machine equipped with One Tracing Point which runs over "Copy" and guides Two Cutting Torches over Similar Paths on Work

not made by one continuous traverse of the torch. In the case of the 24-inch armor plate, to which reference was made, the cut was finished at one operation. The composition of carbohydrogen gas is such that an accurate, clean cut is made, and the slag produced is almost pure oxide of iron, there being little pure iron in it. This indicates that cutting is accomplished by a complete process of oxidation, which is the ideal method, and not by melting the iron. Where metal is severed by melting, it is almost inevitable that a ragged surface will be left in making a cut, so that it is necessary to employ some subsequent process of finishing before the work is ready for use.

Machines Designed for Cutting Irregular Outlines

To facilitate the work of following irregular outlines with a cutting torch employed for working on flat metal plates, the Davis-Bournonville Co. has developed a machine known as the "oxygraph," which is made in two types, one of which is illustrated in Fig. 8, while the other is shown in operation in Fig. 9. So far as the principle of operation is concerned, both machines are the same, but it will be apparent from the illustrations that in one case provision is made for using a single torch for cutting one piece of work, while on the other machine the use of two torches enables two cuts to be made simultaneously. These machines work on the pantograph principle, and in preparing for their use it is first necessary to make a drawing of the outline which is to be followed by the cutting torch. This drawing is laid on a copy table on the machine and is followed by a tracing point carried by the pantograph, with the result that one or both torches—according to the type of oxygraph machine that is being used—follow a similar outline on the work.

Reference to the illustrations will show that the tracing point used on machines of this type consists of a wheel which is serrated to give it a firm grip on the surface of the paper on which the design is laid out, and this wheel is driven by a small electric motor, which relieves the operator of the machine from the necessity of pushing the tracing point around. As a result, it is merely necessary for this man to guide the tracing point so that it follows the required outline, thus adding greatly to the sensitiveness of the machine, because the operator is relieved of the necessity of pushing the tracing point and overcoming friction and inertia of the pantograph mechanism. Fig. 8 shows an example of quite an irregular outline which one of the single-torch type of machines was recently engaged in cutting, and this illustration gives a good idea of the irregularity of outlines which may readily be followed with a machine of this type. In Fig. 9 is shown one of the double-torch machines engaged in cutting a hole in steel ship plates at the plant of the Philadelphia Navy Yard. In this case the outline to be followed is fairly regular, but the use of a double-torch machine enables two plates to be cut simultaneously, which, combined with the superior rate of production of the mechanically operated torch over a cutting torch manipulated by hand, greatly increases the rate at which the cutting operation can be performed.

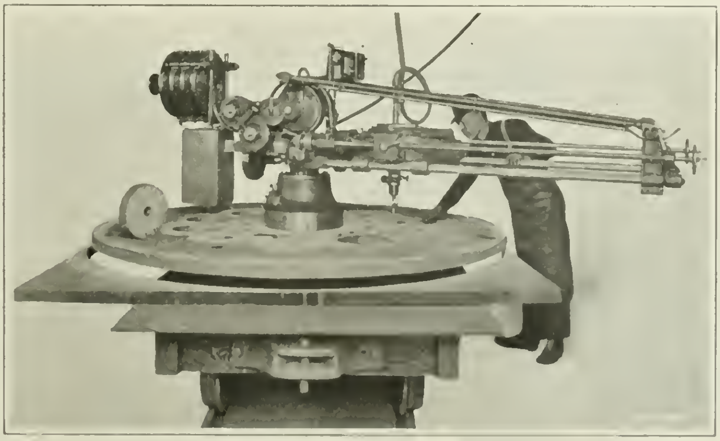

Fig. 10. Automatic Universal Cutting Machine developed for Use in Schenectady Plant of General Electric Co.

Special Cutting Machine Developed by General Electric Co.

In Figs. 10 and 11 are shown automatic universal cutting machines developed for use in the plant of the General Electric Co., in Schenectady, N. Y., which employ either an oxy-acetylene or an oxy-hydric flame. The machine shown in Fig. 10 can be set for automatically making circular, spiral, radial, or tangential cuts, with a rate of feed ranging from 1 inch to 72 inches per minute, depending upon the character and thickness of the material to be cut. It has been successfully employed for cutting steel up to 16 inches thick, the limit in this direction being imposed by the capacity of the flame rather than by any limiting features of the machine. On this machine it will be seen that a revolving head is provided that can be adjusted for automatically feeding the torch in every direction, provision being made for reaching any point on a circle up to 20 inches in diameter, while cuts over larger surfaces are made by revolving the entire cutting machine or by reciprocal movement of the revolving head along the horizontal bars; in some cases a combination of these movements is required to obtain the desired result. Revolving the entire cutting machine or reciprocal movement of the revolving head along the main arms is accomplished by gearing connected to a driving motor, which will be seen mounted above the pedestal. This motor is a 250-volt, direct-current machine of 1/2-horsepower capacity, which happened to be available at the time the machine was built. As a matter of fact, a considerably smaller motor would give ample power for operating the machine.

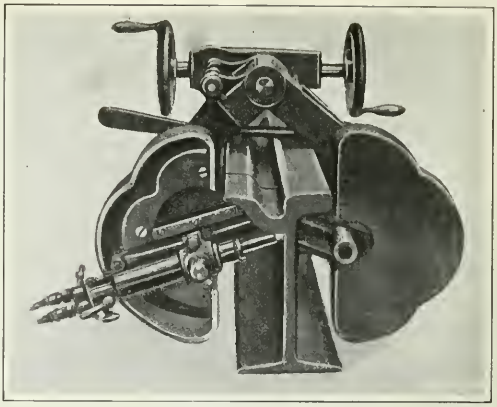

Fig. 13. "Railograph" Machine built by Davis-Bournonville Co. for cutting Rails in Place on Roadbed

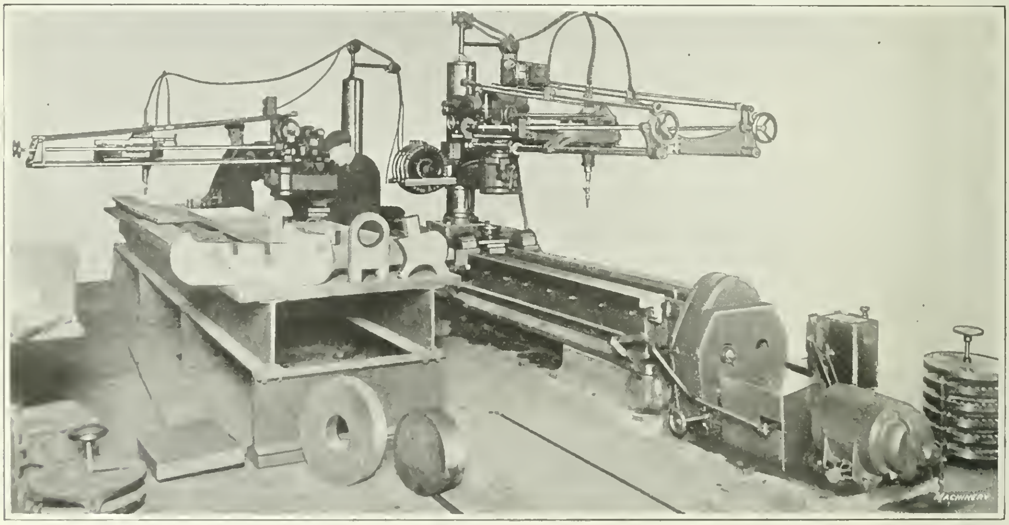

Fig. 11. Double-head Automatic Universal Cutting Machine mounted on Bed which affords Traverse Movement in Addition to Movements Available on Machine shown in Fig. 10

Two rheostats are provided for obtaining speed control, and attention is called to the fact that the long radial arm is balanced by a counterweight. The base is provided with a powerful electromagnet, which is used if the machine is placed on a rough or uneven surface, and also to hold it in position when it is necessary to perform cutting operations on work held in a vertical plane. Under normal conditions of service with the machine working on a horizontal plane, the magnet is not required, as the weight of the machine is sufficient to hold it in place. It will be apparent from the fact that the machine is shown in place on a truck that it is adapted for portable service, it being an easy matter to transport the machine around the shop, as it only weighs approximately 1900 pounds. The outfit shown in Fig. 11 is of similar design to the one which has just been described; it consists essentially of two of the machine units shown in Fig. 10 mounted on beds to provide a traverse movement. This double machine is ordinarily employed for work which is too large to be handled on a single machine.

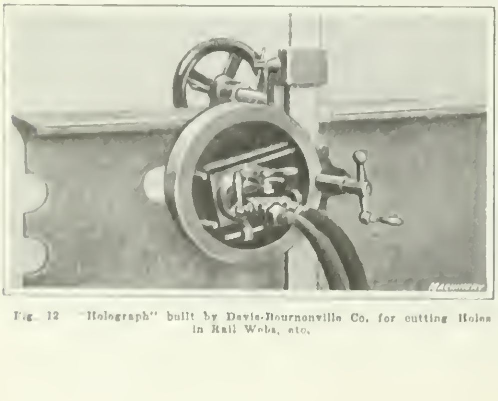

Fig. 12. "Holograph" built by Davis-Bournonville Co. for cutting Holes in Rail Webs, etc.

Special-purpose Mechanically Operated Cutting Torches

In the case of the mechanically operated cutting torches which have already been described, the design has been worked out in such a way that the machines are adapted for the performance of miscellaneous cutting operations. Such work, however, by no means represents the range of possibilities of the mechanically operated cutting torch. For instance, consider the case of equipments shown in Figs. 12 and 13, which show, respectively, the "holograph" and the "railograph" developed by the Davis-Bournonville Co. These machines were made for performing the special operations of cutting holes in the webs of structural steel rails, etc., and for cutting T-head rails. They give excellent results in performing these special operations for which they are intended, but are not suitable for other classes of work.

Referring to the illustration of the holograph shown in Fig. 12, it will be seen that this machine is provided with a circular head which holds the cutting torch so that it can be rotated through movement transmitted by bevel gearing from a crank handle at the side of the machine. The capacity is for cutting work up to 3/4 inch in thickness, and round holes can be made with this machine without previous drilling. Smooth round holes from 1/2 to 2 inches in diameter can be cut in from thirty to sixty seconds, and the diameter of the hole is varied by simply shifting the torch holder toward or away from the center of the rotating head. This machine is especially adapted for railroad work and for enlarging existing holes or cutting new ones in structural steel.

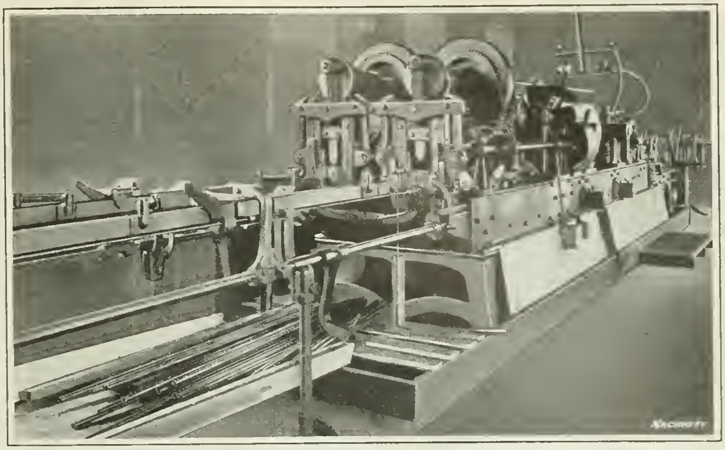

Fig. 18. Opposite End of Automatic Tube-making Machine shown in Fig. 17; Flat Stock is fed into Machine at End shown in Fig. 17 and Finished Welded Tubing is withdrawn from End of Machine shown in This Illustration

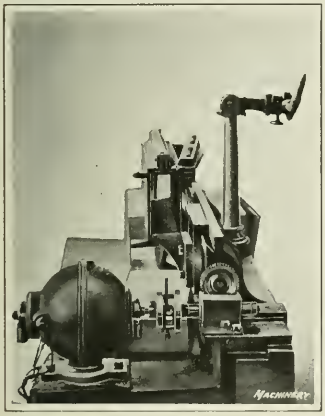

Fig. 14. Special Machine developed by Edison Storage Battery Co. for Use in welding Side Seams of Battery Containers

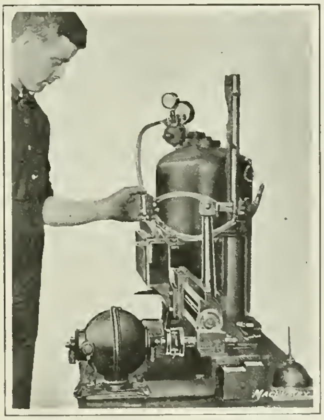

Fig. 15. Machine shown in Fig. 14 with Clamps closed to hold Work Ready for welding

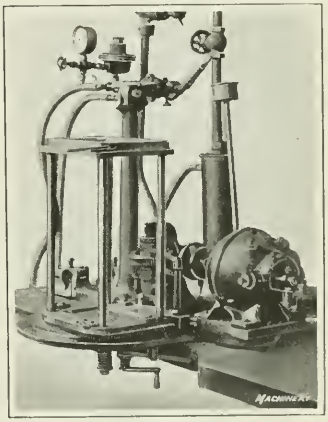

Fig. 16. Special Machine developed by Edison Storage Battery Co. for welding Top and Bottom into Battery Containers

In the case of the railograph illustrated in Fig. 13, it will be seen that provision is made for clamping this machine to the web of a rail. It can be used for cutting a rail while in position in the roadbed. At each side of the machine there is a bracket in which a cutting torch can be mounted. This bracket is carried by a slide, and attached to each bracket there is a roller which runs in contact with a cam formed in such a way that it provides for maintaining the tip of the cutting torch at a uniform distance of about 1/8 inch from the surface of the work as the torch is fed over the work to provide for cutting the rail. Feeding of the torches is accomplished by two handwheels which transmit motion through a set of suitable gearing. In operation, the torch is first applied at one side of the rail and fed over the line on which the cut is to be made, one half of the base and head of the rail and the web being cut in this way. The torch is next removed from the holder and mounted at the opposite side of the rail, where it is again passed over the line of cut, with the result that the remaining half of the base and head of the rail is severed. An idea of the rapidity with which cutting can be accomplished with this machine will be gathered from the fact that at a recent exhibition a 9-inch trac-

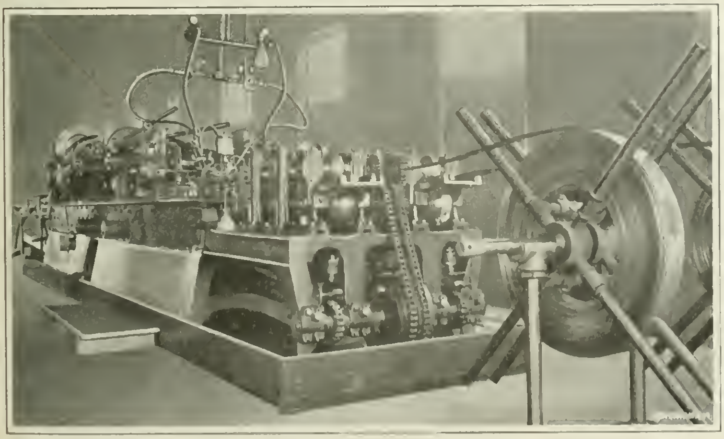

Fig. 17. Machine used by Elyria Iron & Steel Co., of Cleveland, Ohio, for Use in automatically converting Flat Steel Ribbon Stock into Welded Steel Tubing

tion rail was cut off in a few seconds over three minutes with the consumption of 2 cubic feet of acetylene and 5½ cubic feet of oxygen. A standard Davis-Bournonville cutting torch is used on this machine.

Special Welding Machines Used for Manufacturing Operations

In manufacturing sheet-steel battery containers, the Edison Storage Battery Co., of Orange, N. J., has designed special machines for welding the seams. It will be recalled that in connection with the discussion of special cutting machines, mention was made of the fact that it is usually found desirable to employ torches of standard design, and the same is true of machines built to meet the requirements of welding operations that must be performed on special classes of work. In the case of the battery container welding machines shown in Figs. 14, 15, and 16, Davis-Bournonville welding torches are employed. Figs. 14 and 15 show the machine employed for welding the side seam, and Fig. 16 shows a machine developed for welding the head into the container. An interesting feature of the application of welding torches in connection with these machines is that the welding is accomplished without the addition of metal from a "welding stick" according to the usual practice. To avoid the necessity for making such an addition of metal, the sheet-steel stampings which are welded together to make these battery containers are drawn up with flanges along the two edges that are to be welded together. By having these flanges raised above the surface of the steel, sufficient metal is provided to make the weld without the necessity of using a Swedish iron wire to add metal along the line where the weld is to be made.

For welding the side seam of battery containers, use is made of the machine shown in Figs. 14 and 15, which is somewhat similar to a bench lathe. The work to be welded is clamped over a form supported by a carriage, which is traversed along ways on the bed of the machine by means of a feed-screw driven by an individual electric motor. Welding of the side seam is the first operation, and the body of the container comes to the machine with neither the top nor the bottom in place. It is slipped over the form and two swinging clamps grip the work at each side of the longitudinal seam, so that the flanges are pressed close together. After this has been done, the pivoted bracket supporting the welding torch is swung over so that it causes the oxy-acetylene flame to impinge upon the top of the abutting flanges at one end of the container, and the drive is then connected to start feeding the carriage along the ways on the machine bed. The feed movement is regulated so that the work is passed under the torch at a suitable rate to provide for welding the side seam as rapidly as possible. These battery containers are made of cold-rolled sheet steel 0.025 inch in thickness.

After the side seam has been welded, the containers are taken to the machine shown in Fig. 16, where the bottom is welded into place. The bottom consists of a steel stamping with the flange turned up around the edge. It is pressed into place in the battery container body until the top of the flange is at the same level as the edge of the body, after which the work is set up in the machine. As in the case of the equipment for welding the side seam, the torch is mounted on a swinging support, so that it can be dropped into place to cause the flame to impinge upon the edges of the steel which are to be welded together. The machine is driven by an electric motor which transmits power through a suitable train of gearing to a pinion carried by a vertical shaft. This pinion meshes with a rack, which will be seen running all of the way around the base of the frame in which the work is supported while the welding operation is being performed.

From the illustration it will be apparent that this rack runs along the sides and around the corners of the base of the work holder, so that provision is made for giving this holder a combined traverse and rotary movement that causes the work to be fed around under the welding torch, keeping the two edges that are to be welded together constantly in place under the tip of the torch. In the top of the battery container there are three fittings that have to be secured in holes provided in the steel stamping for that purpose. In making the stamping for the top of the container, flanges are drawn up around the holes to receive these three fittings which are made on screw machines. In making the fittings, the screw machines are tooled up to produce a flange on each fitting which is of such form that the fittings can be pressed into place in the holes in the top of the battery container, with these flanges on the fittings abutting against the flanges around the holes in the container top, so that the edges are at the same height. A machine of somewhat similar design to the one shown in Fig. 16 is then employed to weld the edges of the flanges on the battery top and fittings together so that the fittings are secured in place. These welds are made on the under side of the top of the battery container, after which the entire top is pushed into position in the body of the container and welded to hold it permanently in place.

Application of Welding Torches in Tube Manufacture

At the plant of the Elyria Iron & Steel Co., in Cleveland, Ohio, welded tubing is manufactured in automatic machines which take flat ribbon stock of either hot- or cold-rolled steel from a reel placed at one end of the machine and deliver finished tubing at the opposite end of the machine. This result is accomplished by passing the stock through a series of forming rolls which convert the flat stock into a cylindrical form with the edges abutting against each other. The work is next fed under an autogenous welding torch which joins the seam, after which the welded tubing passes through straightening and polishing apparatus, so that it leaves the machine in a finished form. Fig. 17 shows the end of the machine at which flat ribbon stock is fed in, and in Fig. 18 finished tubing is shown leaving the machine.

Adaptability of Mechanical Control for Cutting and Welding Torches

In this article we have presented information concerning miscellaneous applications which have been made of mechanically operated cutting and welding torches, and attention has been called to the benefits that are secured through the substitution of mechanical control for hand operation. Despite the increased production and higher quality of workmanship that are secured through mechanical operation, many manufacturers are continuing to use torches which are moved over the work by hand. There is no denying that the latter method is capable of producing highly satisfactory results when torches are placed in the hands of skilled operators, but the average mechanic will frequently fail to produce good work until he has had a considerable amount of experience. For this reason, and also because higher rates of production are secured through mechanical operation than can be produced by the most skillful operators using torches by hand, it is well worth while for the manufacturer who has use for the oxy-acetylene torch to carefully investigate the requirements of his work with the idea of determining whether it could not be handled by one of the standard cutting or welding machines. If investigation shows that the work could not be handled on any of the available commercial equipments, the next step is to ascertain whether a special machine using standard torches could not be developed at a reasonable expense. If so, development of such an equipment will usually prove a highly profitable investment, both from the standpoint of direct earnings and also by making an improvement in the quality of workmanship where cutting or welding operations have to be performed.

* * *

A maker of hollow-frame micrometer calipers designed for measuring large dimensions tried in vain for several years to introduce them to United States Government navy yards and arsenals. He was unable to secure recognition, but foreign governments were not so conservative in their views of measuring instruments, and some were sold abroad. These came to the attention of our military experts in France, and the result was that the maker has received orders for his large micrometers for use in government plants here. It seemed necessary for the bureaucratic mind to go far afield to get indorsement of a home product before it could see the manifest advantages of the instruments for our own government work.

PURPOSE AND METHODS OF USING MANUFACTURING ORDERS

BY FRED H. KORFF[1]

There always has been misunderstanding among factory executives and the clerical force relative to the manner in which orders are to be handled, especially when the items on the orders are in standard crates or containers. They do not seem to realize that an order entering the factory represents dollars and cents in raw material and should be treated as such. The greatest difficulty generally is for them to realize that the amount of material called for on the order, whether in pounds, feet, or pieces, is constantly changing. For instance, one hundred feet of bar stock is delivered to an automatic screw machine to have certain operations performed that will produce one thousand pieces; but some of the pieces will be rejected by the inspectors and others will be spoiled in the machine, so that, perhaps, only seven hundred good pieces will be made. The foreman of the department should immediately bring this fact to the attention of the chief cost clerk in order that the amount on the factory order and the office records may be changed to show seven hundred pieces instead of one thousand. If this is not done, the cost department will assume that one thousand pieces are in production throughout the succeeding departments and all labor costs per piece will be figured 30 per cent too low, due to the loss of the three hundred pieces on the first operation. Factory executives should realize that while production is an essential factor, the proper recording, checking, and transferring of both material and orders is as important a factor, and one that cannot be overlooked if accurate records are to be obtained. The argument may be advanced that factory executives are not supposed to be bookkeepers; but that does not signify that during the time that orders and material are in a department they cannot be properly taken care of; unfortunately, however, shop orders are generally treated as something of small consequence.

Use of Order

A shop order is used for the following purposes: First, checking advancement of work, as shown by the planning board; second, requesting orders from order department; third, checking material on hand and called for by previous shop orders; fourth, issuing material to cover the needs of respective departments. When the planning board shows that the work, in its progress through the various departments, is reaching the shortage danger point, requests for orders are issued by the planning office. The order division, upon receiving this request, checks the material called for against the stock on hand and on the different order lists, to determine whether or not the order can be filled; if it can, the material is sent to the department to which it is routed. It will be assumed that the order request calls for one hundred camshafts. As the order department finds that it has sufficient rough camshafts to fill the shortage called for, it immediately issues triplicate orders, which are sent to the planning office. At the proper time, as shown by the shop schedule list compiled from the trial records, the planning office sends one copy to the materials department and one to the cost department, and keeps the other for its own files. The materials department, on receiving the factory order, delivers the material with the order to the department called for by the routing shown on the order. The cost and dispatching departments enter their copies in their files preparatory to receiving data from the factory relative to the work that is being done.

Checking Material

When the material, with the order, enters a department, the clerk should immediately enter a full description of it upon the departmental progress or receipt report. All finished pieces and outgoing deliveries from the department should also be recorded upon this report, which at the end of each day should be given to the planning department and entered upon its records. As it is from these records that all shortage lists are made, it is important that they be accurately kept, so that correct records of shortages may be obtained.

The clerk should also see that all incoming material corresponds to the amount shown on the order; if it does not, he should return the material to the department from which it came. The amount of material in the containers should be that shown on the face of the order, and all bar stock received should be measured. All outgoing material also must correspond to the amount shown on the order. If the amounts do not agree, the orders should be given to the planning department so that the necessary changes may be made. Clerks should not permit an order to leave the department until it has been signed by an inspector, who will specify the number of pieces accepted, rejected, and held for correction.

Use of Containers

As far as possible, all material should be sent into the factory from the materials department in crates of a standard size, and the work should remain in these crates as it progresses from one department to another. While in some cases this cannot be done, every effort should be made, if possible, to provide ways and means to prevent the moving of material by separate pieces. In order that the manufacturing orders shall be kept correctly, each container should bear a tag showing the order or job number, piece, part number and name, total amount on order, and the amount in the container to which the tags are attached. Cards specifying the job number, operation, piece number, and name of part should also be placed at each machine. This card should correspond to the tag attached to the container that holds the work being machined.

There should never be more than two orders at any one machine—one order in process of machining and the other waiting to be machined. Suppose, for example, that there are two orders of camshafts, composed of five crates each, at the machine performing the first operation. As the operator finishes a camshaft he replaces it in the crate from which he obtained it and proceeds with another until all in that crate have been machined. If necessary, this crate can then be passed on to the succeeding operation, but separate pieces should never be taken from a container and placed into operation on another machine; in fact, it is preferable that only a complete order be moved from one operation to another.

If, during the different machining operations, a piece is rejected by an inspector, it should be properly tagged by him and set aside, but should not proceed with the container from which it was taken; neither should the spaces thus left vacant in the containers be filled with good parts. When a part has been rejected by an inspector, he should make the necessary notations on the back of the order representing the part, and as the container proceeds from one operation to another he should note on the order the number of good and bad pieces obtained. After the final operation, prior to transferring from the department, the clerk should bring the order and the parts to the inspector for his approval.

* * *

IRON ORE PRODUCTION IN 1917

From figures compiled by the United States geological survey, it is estimated that the iron ore mined in this country last year amounted to 75,324,000 gross tons, as compared with 75,167,672 tons in 1916. The shipments from mines in 1917 are estimated at 75,649,000 gross tons, valued at $236,178,000, as compared with 77,870,553 tons, valued at $181,902,277, the previous year. The percentage lost in quantity last year was 2.9, but the increase in value was 29.8 per cent. The general average value of the ore per ton at the mines was $3.12 in 1917, as compared with $2.34 in 1916. About 85 per cent of the ore mined last year was received from the Lake Superior district. The South mined and shipped more than 8,100,000 tons of iron ore, the bulk of which was produced in the Birmingham district of Alabama. The northeastern states, including New Jersey, New York, and Pennsylvania, increased their production slightly as compared with 1916, and shipped to blast furnaces approximately 2,446,000 tons. The imports for the year are estimated at 988,500 tons, as compared with 1,325,736 tons in 1916.

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EXAMPLE OF PRECISION GAGE MAKING

METHODS OF MAKING AND TESTING A GAGE REQUIRING UNUSUAL ACCURACY

THE manufacturers of precision gaging tools and fixtures are constantly being reminded of the fact that it is easy to specify extremely close limits on drawings, but often very difficult to transfer those exact dimensions to a piece of steel. The gear-testing fixture or gage illustrated in Fig. 1 is an example of gage making which required an unusual degree of accuracy throughout and made it necessary to provide special tools and methods. This gage is one of a number of special designs recently made by the Nelson Tool Co., Inc., 781 E. 142nd St., New York City. Some of the more important parts of the work will be referred to, but first it should be explained that this gage is used for testing the accuracy of the bevel gears *A* and *B*. As the axes of these gears are located at right angles, the body *C* of the fixture is in the form of an angle-plate in which there are horizontal and vertical holes. Gear *A* is supported in close-fitting bushings *D* by its shaft, and gear *B* is held in place by plug *E*, which enters bushing *F*. The gaging members consist of two blocks *G* and *H*, which are held in position by the bolts shown and are free to revolve. Each of these gaging blocks has two arms which project outward at an angle. If the gears are correctly made, one of these arms will just clear the top of a gear tooth when the gage is turned about its pivot, whereas the other will strike the tooth. In other words, these are "Go" and "Not Go" arms; they are both finished, of course, to the same angle, but one gaging surface is about 0.006 inch higher than the other one.

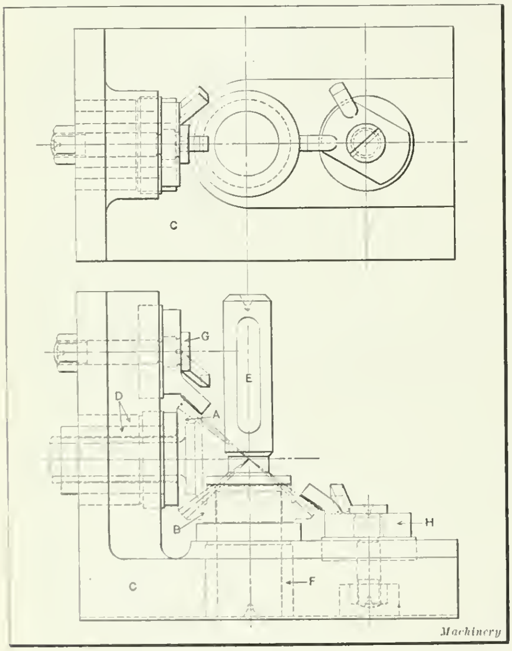

Fig. 1. Elevation and Plan of Gear-testing Fixture

The angle specified on the drawing for the gaging surfaces of the arms of part *H* is 36 degrees 8 minutes 33 seconds, and for part *G* 46 degrees 31 minutes 53 seconds. Of course, there is no gage or toolmaking equipment obtainable that will enable one to finish angular surfaces to the extreme degree of accuracy indicated by these figures; that is, to a given angle within one second or even several seconds, especially when the length of the finished surface is comparatively short and its accuracy must be tested by direct measurements and without employing some method of magnifying the error. To detect an error of one second in a length of one-half inch, which is approximately the length of the gaging arms, would involve a measurement of about 0.0000025 inch. It is not necessary to comment on the impracticability of taking such a measurement, but even though it is not possible to work to such close specifications, if the error is so slight that it cannot be measured by ordinary means, the work is sure to pass inspection and to serve its intended purpose satisfactorily, which is all that is required. In addition to the extreme accuracy in regard to the angles, it was necessary to finish the body of the fixture previously referred to so that the horizontal and vertical sides were as near square as it was possible to make them, and the tolerances specified for a number of the more important dimensions were only 0.0001 and 0.0002 inch.

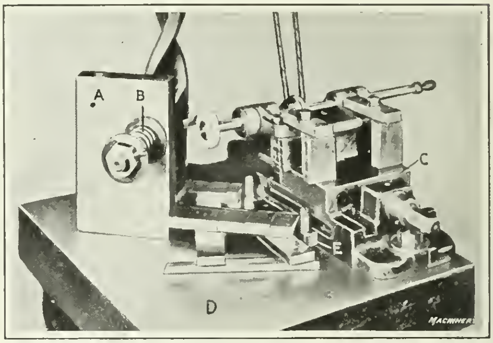

Fig. 2. Method of using Johansson Gages and Sine Bar for setting Grinding Attachment

The most interesting and important part of the work is grinding the angular arms of the gaging blocks. The general method of doing this part of the work is illustrated in Figs. 2 and 3. The block to be ground is mounted on an angle-plate *A*, Fig. 2, and it is held in position by a bolt and a spring *B*. The object of using the spring is to hold the work securely against the face of the angle-plate and at the same time permit it to be revolved easily while grinding. The grinding attachment, which is of the push-spindle type, is mounted upon a horizontal slide *C*, and both the angle-plate and slide are mounted on the faceplate *D*.

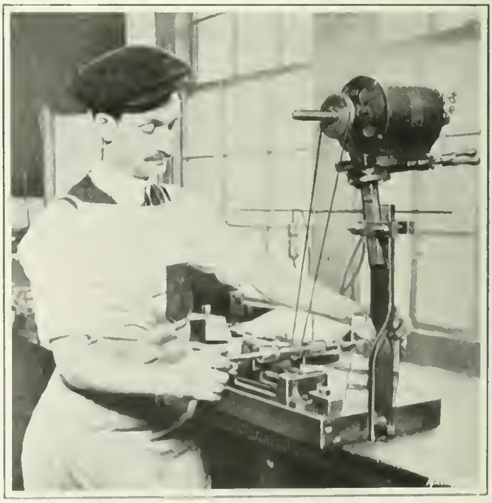

Fig. 3. Simple Method of grinding Gaging Blocks which proved Effective

The grinding of this gaging block involved first setting the horizontal slide and the angle-plate with reference to the angle required on the work; then it was necessary to adopt an accurate method of testing the inclination and location of this ground surface. Fig. 2 shows clearly how the slide and angle-plate were set relative to each other by using the sine bar *E* and the Johansson gages. The sine bar bears directly against the side of the horizontal slide upon which the grinding attachment is mounted, and the gages are used to measure the distance from the buttons on the sine bar over to the side of the angle-plate. The method of manipulating the grinding attachment and work is indicated in Fig. 3. As the gage-maker pushes the grinding wheel spindle back and forth with the right hand, he gives the work an oscillating movement, so that the entire gaging surface is ground and is finished to a convex form. The motor for driving the spindle is held in place by the vertical arm shown, and the entire arrangement is very simple, especially in view of the complicated nature of the operation.

The method of testing the angle and location of these ground surfaces is illustrated in Fig. 4. This test is made without removing the gage from the grinding fixture. The particular gage arm to be tested is simply turned around so that it is at the lowest position, as Fig. 3 indicates. Johansson gage-blocks are then inserted at *A* and *B*, and an accurate plug is pushed in between the horizontal and vertical surfaces of these blocks and the angular surface of the gage being tested. When this test has been made with the plug bearing close to the outer end of the angular arm, a different combination of gage-blocks is used and the same test is repeated at the inner end of the arm. Before this test could be made, it was necessary, of course, to calculate what the horizontal and vertical distances, as obtained by the Johansson gages, should be for a plug of given diameter.

Since the accuracy of the gear-testing fixture referred to depends largely upon the accuracy of the body of the fixture, it was necessary to adopt some method of testing the squareness of the horizontal and vertical faces, which were required to be as close as possible to 90 degrees. The ingenious form of "square" used for this purpose is illustrated in Fig. 5. This is simply a very accurate cylinder, having bearing surfaces at the ends which are exactly perpendicular to the axis of the cylinder. This "cylindrical square" is made of machine steel and is pack-hardened. It is bored out to decrease the weight somewhat, although a fairly heavy cylinder is preferable, so that it will not move or change its position easily when measurements are being taken from the cylindrical surface to an angle-plate, as is sometimes desirable. Each end of the "square" is recessed so that the bearing surface is only about 1/4 inch wide. This bearing surface is also ground slightly concave so that the bearing is around the outer edge or circumference. When this "cylindrical square" is placed in contact with a surface as shown in the illustration, even a slight deviation from the vertical will be indicated by the passage of light. F. D. J.

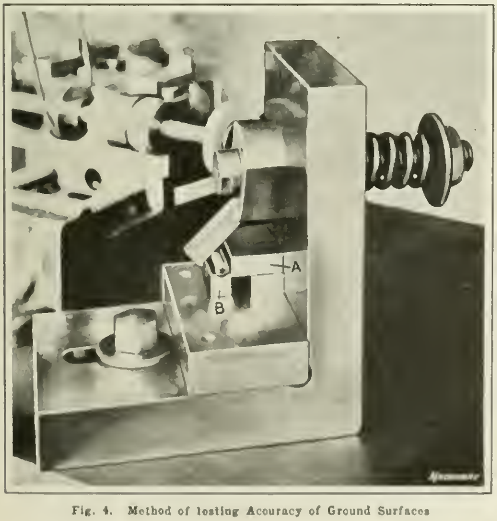

Fig. 4. Method of testing Accuracy of Ground Surfaces

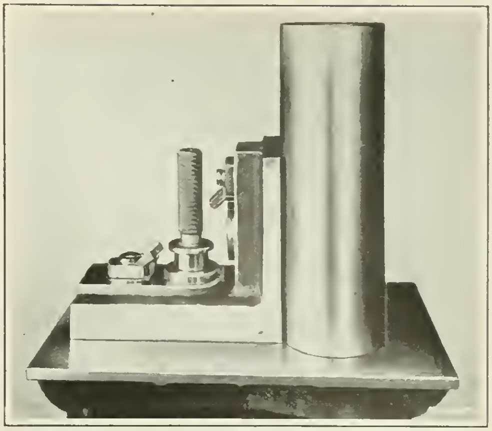

Fig. 5. Cylindrical Type of Precision "Square" used for testing Squareness of Fixture Body

* * *

STANDARDIZATION OF SCREW THREADS

The complete standardization of screw threads necessary to meet the requirements of the War and Navy Departments is proposed in a bill recently introduced in the House of Representatives by Hon. John Q. Tilson, of Connecticut. This bill provides for the appointment of a commission of seven members, which is to include a commissioned officer of the Army, a commissioned officer of the Navy, the director of the Bureau of Standards, two members nominated by the American Society of Mechanical Engineers, and two members nominated by the Society of Automotive Engineers, the last four being appointed by the Secretary of Commerce. This commission will ascertain and establish standards for screw threads, which will be submitted to the Secretaries of War, Navy, and Commerce. When approved by them, such standards will be used on work done by the War and Navy Departments, and the Secretary of Commerce will cause them to be published as a public document.

In urging the passage of this bill, Chairman Bachman of the Standards Committee of the Society of Automotive Engineers mentioned that if such standards had been established prior to the entry of the United States in the present war, an untold saving in time and material would have resulted; much confusion now existing would never have occurred, and instead of each department of the Government employing screw threads made under as many different systems, all would be working to one standard. A large duplication of effort would thus be eliminated and the production of tools and gages necessary to manufacture and inspect properly parts containing screw threads would be considerably conserved.

* * *

At a joint meeting of the Institute of Bankers and the Association of Chambers of Commerce in Great Britain, a resolution was passed with relation to decimal coinage, favoring the retention of the pound sterling as the monetary unit, but dividing the pound into one thousand parts or mils. This arrangement would make unnecessary any sudden change in the existing silver and gold coins, as all coins down to sixpence could be retained without any alteration in their respective values. A sixpence coin would equal twenty-five mils and a shilling would be fifty mils. In regard to coins of lower denomination, it was unanimously agreed to recommend that they should consist of one-, two-, three- and four-mil pieces made from copper, and five- and ten-mil pieces made from nickel.

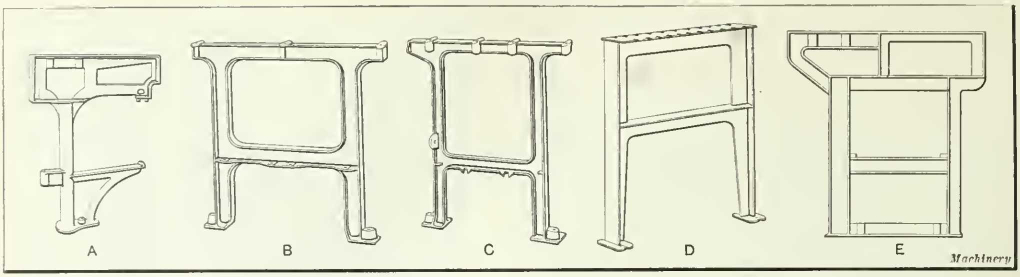

Fig. 1. Various Designs of Commercial Cast-iron Bench Legs

DESIGN AND CONSTRUCTION OF WORK-BENCHES

BENCH LEGS AND TOPS—LOCATION OF BENCHES—PORTABLE WORK-BENCHES

BY FRANK H. MAYOH[1]

BENCHES made in a workmanlike manner for the proper performance of hand and machine operations are a necessity in the modern shop. This fact will be realized when we consider the miles of benches that are strung along the walls and throughout our factories for use in conjunction with such work as filing and scraping, assembling, inspection, and numerous other jobs of machine shop practice that must be performed by hand. The purpose of a work-bench is to provide suitable means for performing hand or machine operations at a convenient height, this height depending upon such conditions as the nature of the work, the height of the man (and lately of the woman) using it, the kind and size of the machine placed upon it, in case the bench is intended for machines, and whether the work operated upon is to be held in a vise. These and many other conditions—some of which will be referred to later—have been taken into consideration in developing work-shop benches.

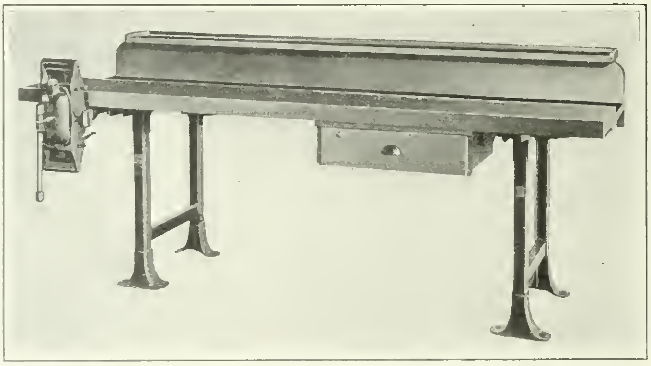

Fig. 2. Bench for Patternmakers built by New Britain Machine Co.

In the selection of a suitable bench for any particular purpose there is considerable latitude, but of recent years haphazard methods of selecting machine shop material, in general, have come to be looked upon with disfavor; consequently we find that in selecting suitable benches, light weight with rigidity, strength but not bulk, the proper kind of planking, sanitation, and movability without destruction are all points which are worth considering, while, of course, the construction of the top of the bench has much to do with its durability.

Bench Legs or Supports

In some shops wooden posts are to be found as supports for work-benches, but the modern cast-iron and pressed steel legs are preferable. It is not the intention of the writer to place one kind of metal support before the other, as there are good and bad designs of both, while the lines of construction are closely allied. An example of good design is shown in Fig. 2. This illustration shows a complete unit supported on two legs for patternmakers' use. In this case, the legs are of pressed steel, the formed sections being electrically welded together. The top and back-board are made of wood, and a patternmaker's vise is shown at the left-hand end of the bench. This bench may be made in a unit, as shown, or it may be extended indefinitely. It will be noticed that the back-board is constructed with a shelf on top.

A group of cast-iron bench legs of varied design is illustrated in Fig. 1. These are typical of the general line of cast-iron legs. Some are cast in I-section and some in T-section.

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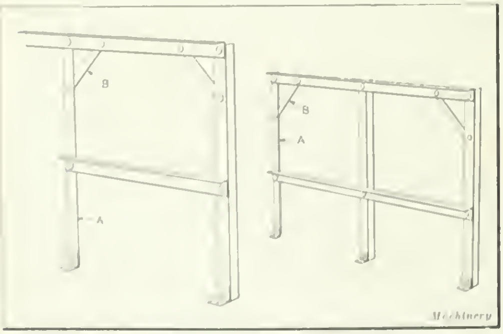


Fig. 3. Bench Legs in Single and Double Types made of Angle-iron

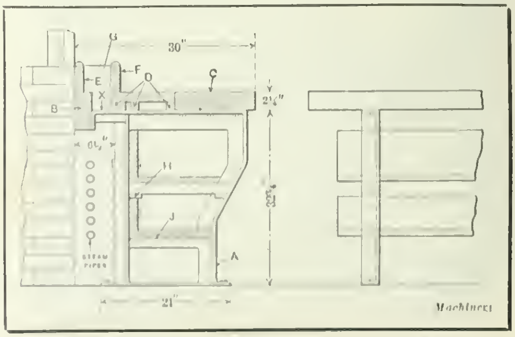


Fig. 4. Method of holding Bench shown in Fig. 6 in Position

The one shown at *A* is of the tubular stand or pedestal type. The one illustrated at *B* is a double-width type and is similar in construction to that shown at *C*. The design illustrated at *D* has a number of bolt holes through the flange, while the other legs shown have bosses through which the bolts go. Bench legs built of angle-iron are illustrated in Fig. 3. The one shown to the left is of the single-width type, while that to the right is a double-width design. There are two angle-iron supports *A* in the single-width leg and three in the double-width type. A cross-piece is bolted on the top, and there is another piece (or two in some cases) part way down the leg, which act as braces and also serve for holding shelves. Additional strips *B* are bolted across the corners for increasing the stiffness.

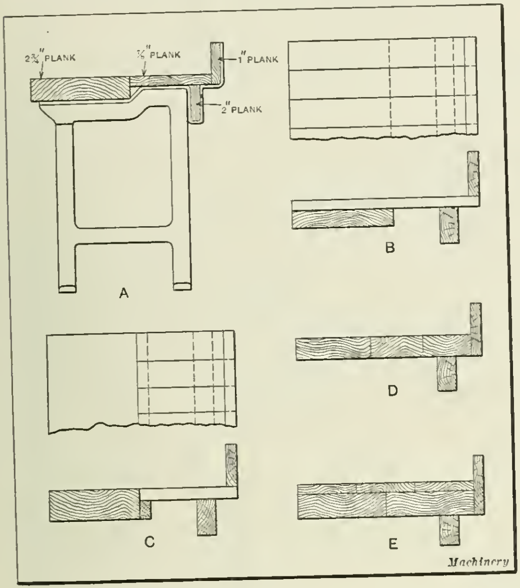


Fig. 5. Different Methods of constructing Tops of Work-benches

In regard to wooden bench legs, apart from being bulky and combustible, it is almost impossible to make them so they will hold their shape, owing to the difficulty of getting wood that is well seasoned or dry enough, as even when carefully jointed it will shrink and leave the bench shaky; besides, good wooden joints are expensive to make.

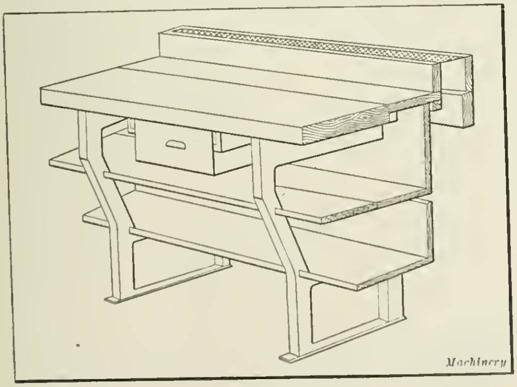


Fig. 6. Perspective View, showing Section of Work-bench with Air Space at Rear

The Bench Top

Metal tops for benches have been used to some extent, but in the handling of tools on a metal bench these are often injured by contact with the hard surface and wood is generally used. A wooden bench top should be laid close to avoid cracks through which small parts might drop, with proper regard for shrinkage of the planks, and should be so laid as to avoid splintering when sliding work on and off. In Fig. 5, five forms of bench top construction are illustrated. In the upper view at *A* a bench with heavy 2¾-inch plank at the front and ⅞-inch plank in the rear is shown; both of these planks run lengthwise of the bench. At *B* is shown a construction in which it is planned to have the grain of the wood run from front to back. The bench top at *C* has a thick plank at the front running lengthwise of the bench, with short cross-boards at the back. In these three examples the expense entailed by having heavy planking throughout is avoided, which is an important consideration in view of the present prices of lumber. For some classes of work a heavy bench top is necessary. The bench top illustrated at *D* is built up with 2¾-inch planks running the full length and width. Where heavy, rough work is being continually dragged over a bench, the expense of keeping an ordinary top in repair becomes an im-

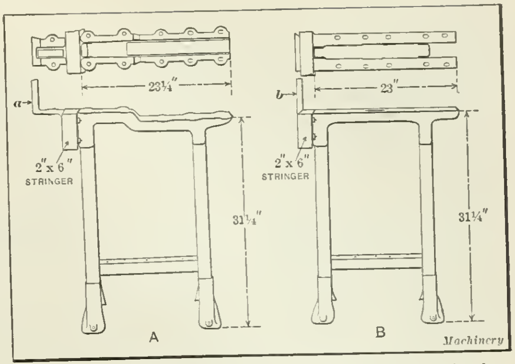


Fig. 7. Steel Bench Legs with (A) Angle Bracket for Back-board and (B) Straight Bracket for Back-board

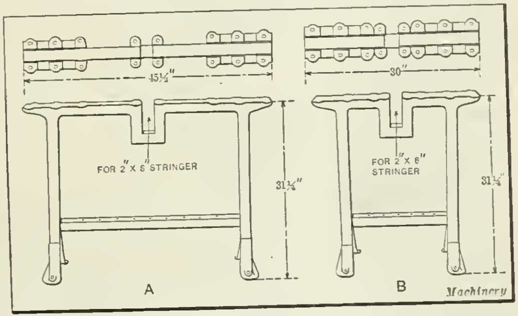


Fig. 8. (A) Wide Double Type of Pressed Steel Bench Leg. (B) Narrow Double Type

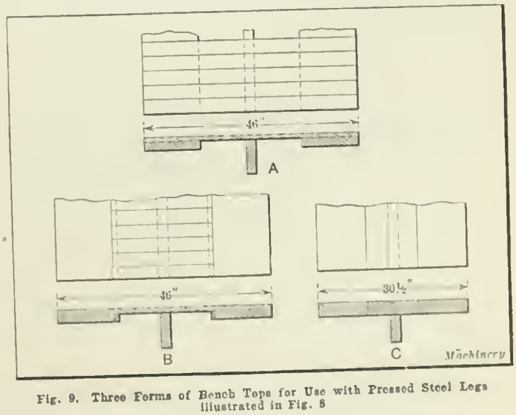


Fig. 9. Three Forms of Bench Tops for Use with Pressed Steel Legs illustrated in Fig. 8

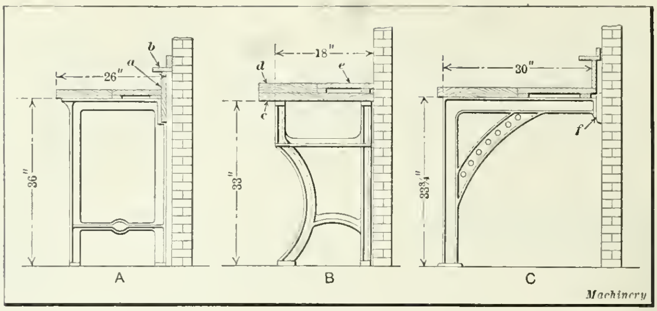


Fig. 11. (A) Bench of Straight-leg Type. (B) Curved-leg Type. (C) Angle-iron Type

portant item, and this expense can be considerably reduced by constructing it as shown at *E*, although the first cost is greater. In this construction, two heavy planks extend lengthwise of the bench, and on top of these, running either lengthwise or crosswise, ⅞-inch planks are placed. This ⅞-inch top can be planed down when it becomes rough, or it may be taken up and replaced at small cost as compared with the heavy planking. When the bench top is constructed in this way it can be made quite free from cracks, as the thin boards are usually more thoroughly seasoned than the planks; therefore, the planks will shrink more than the top boards and draw the latter together. When the top boards are placed crosswise of the bench with the end grain showing there is the objection that they may be readily chipped; nevertheless, where local wear occurs, the boards when set in this way are most easily replaced. In regard to lumber used for the bench, maple or ash has been found to be suitable for the thick front plank, with ⅞-inch pine stock at the back and for the shelves. Spruce or hemlock is suitable for the back-board and other incidentals.

Location of Benches and General Features

The best method of locating a bench is to set it away from the wall, so that, in case of fire, water from the sprinklers can get around it; this location also allows the heat from the steam pipes to rise, and leaves a convenient space where gas and air pipes may be placed. Fig. 6 illustrates a bench set up in this manner. Thick plank is used at the front and ⅞-inch plank at the back. There are two shelves beneath the bench and a drawer. An extension *X*, Fig. 4, holds it away from the wall, and the bench leg *A* is bolted to the floor. A plank *B* extends along the wall or suitable blocks are bolted in place where the legs come, the latter usually being about six feet apart with this type of leg. To plank *B* the back of the bench leg is bolted. Three bolts securely hold the legs in position (two in the floor and one in the wall), and after leveling all the legs in a row, the heavy plank *C* is bolted in position. The three strips *D* are next put in place and the back plank is placed on top of these, wire nails and screws being used for holding it in place. This completes the top of the bench. The board *E* is now placed in position on the wall and the back-board *F* attached. The wire mesh *G* is next stretched over the two boards *E* and *F* and is securely held in place by nails. This prevents things from being thrown or dropped down back of the bench, but it does not interfere in any way with proper ventilation or lessen the fire protection. Two sets of lugs *H* and *J* are cast on the legs and may be used for building either one or two shelves under the bench by placing boards on them in the manner shown. If the back-boards used in connection with the shelves on these legs are made to drive between the lugs, they provide additional stiffness for the entire bench.

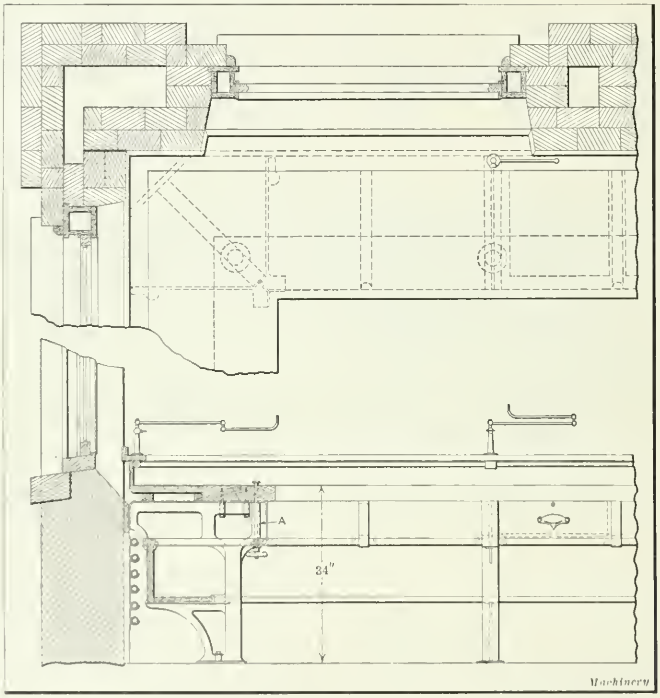


Fig. 12. Elevation and Plan illustrating Corner Construction of Work-bench

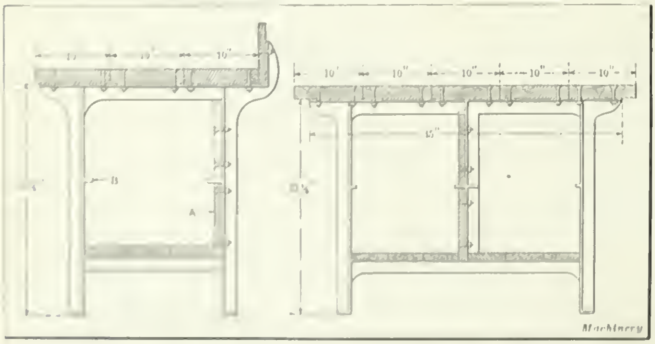


Fig. 10. Sections of Single- and Double-width Benches equipped with Cast Iron Legs

The foregoing remarks concerning bench tops apply whether using bench legs made of cast iron or of steel. Examples of the latter type, made by the New Britain Machine Co., are illustrated in Fig. 7. The leg shown at *A* has a step of 1½ inch at the top to allow a thick plank to be used in front with a thin one at the back without building up the back plank as shown in Fig. 6. An angle iron *a*, Fig. 7, is bolted to a 2- by

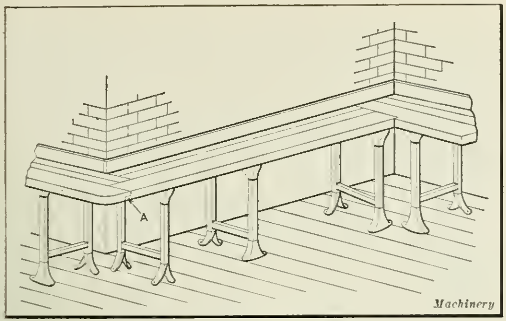


Fig. 13. Another Method of constructing a Work-bench at Corners

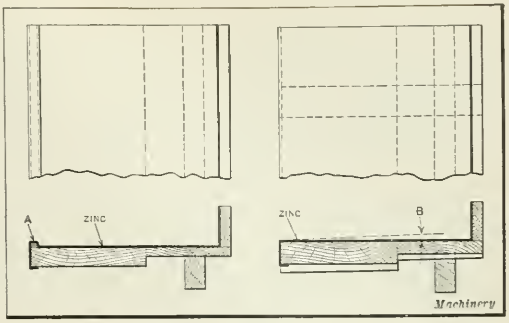


Fig. 14. Two Methods of covering Tops of Benches with Sheet Metal

6-inch stringer which runs the length of the bench. The leg with a flat top shown at *B* may be used with plank of uniform thickness, or by building up, two thicknesses of plank may be used. With this leg, a straight piece *b* bolted to the stringer is used for holding the back-board.

A leg suitable for constructing a double-width bench is shown at *A*, Fig. 8, while the design illustrated at *B* is intended for a single-width bench of the same type. Three forms of bench tops for use with these legs are illustrated in Fig. 9. The upper view *A* shows a cross-plank construction, *B* shows heavy front planks at both sides with thin cross-pieces in the center, while *C* shows the heavy type of construction throughout. In these illustrations it will be noticed that in each case the 2-inch by 6-inch stringer has been run lengthwise of the bench. This adds considerably to the rigidity of the bench and also helps to prevent end sway. With this construction it is not necessary to bolt the legs to the wall.

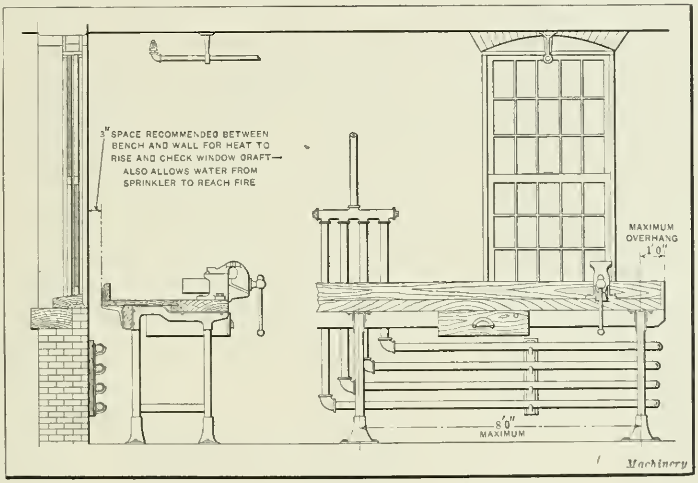

3" SPACE RECOMMENDED BETWEEN BENCH AND WALL FOR HEAT TO RISE AND CHECK WINDOW DRAFT— ALSO ALLOWS WATER FROM SPRINKLER TO REACH FIRE
MAXIMUM OVERHANG 1'0"
8'0" MAXIMUM
Machinery

Fig. 15. General Method of arranging a New Britain Work-bench

Two types of bench legs made from cast iron are illustrated in Fig. 10. These views show end sections of both a single- and double-width bench. The construction is obvious from the illustration, the benches being built up from one thickness of planking with one shelf beneath the bench and a back-board. When constructing this bench the back-board *A* should be wedged between the shelf and the lug to provide additional stiffness for the bench, while if a board similar to the back-board is placed between the shelf and the lug *B* a bin is made under the bench. This is sometimes desirable, and also applies to the double-width bench at the right.

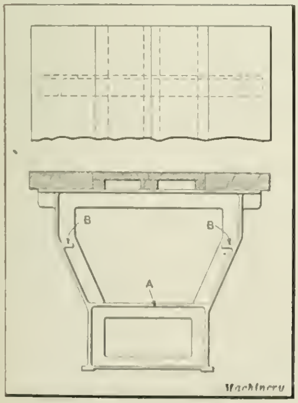


Fig. 16. Double-width Bench with all Planks extending Lengthwise

Three end sections of benches that are set up close to the wall are shown in Fig. 11. The one at *A* is a straight-leg type, while the design shown at *B* has a curved leg. With the straight-leg type, heavy planking is used in front and light boards in the rear. A stringer *a* also is used as a back-board. On top of this stringer a small shelf *b* is provided. The curved bench leg is set against the wall and is built with a cross-piece *c* on top of the leg. A heavy front plank *d* with a light board *e* in the rear are used. The curved shape of this leg enables a man to sit down in the front of the bench with less interference to his knees than in the case of some types of straight legs. The angle-iron type of leg illustrated at *C* must be securely bolted to the wall at *f* and is not very suitable for heavy work. The arrangement of the planking on top of these legs is similar to some of the examples previously shown, and may, of course, be varied to suit conditions.

A construction drawing of the pedestal type of leg is illustrated by Fig. 12. This shows a corner construction and the method of bolting the bench to the wall. The draw-bolt *A* is

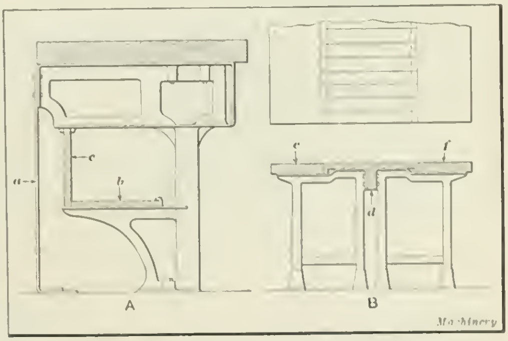


Fig. 17. (A) Method of supporting Pedestal Type of Bench Leg set away from Wall. (B) Two Single-width Bench Legs bolted together

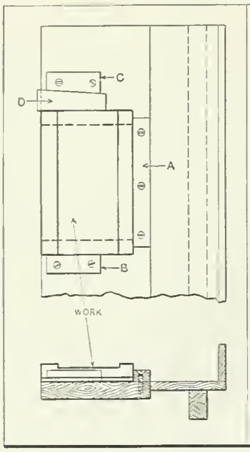


Fig. 18. Simple Method of holding Flat Plates while scraping

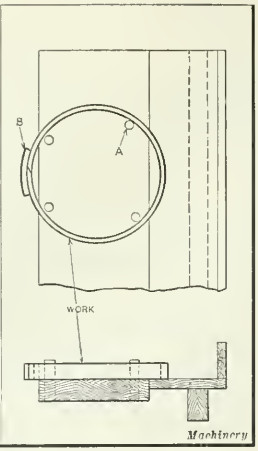


Fig. 19. Use of Pins on Bench for holding Rings

used for holding a vise, thus bringing the vise directly over the bench leg. The gas brackets are placed on a shelf with the supply pipe under it. Another view of a bench showing the corner construction is illustrated in Fig. 13. The arrangement differs from that shown in Fig. 12, as two legs are used at each corner. The construction is obvious from the illustration, which shows both types of corners. This illustration also shows how the planking is laid at the corners to obtain stiffness. Attention is called to the method of rabbeting the corner at *A*. It is sometimes advisable to rabbet the back-plank for its entire length, thus supporting the front edge of the back-plank. This is more desirable where no stringer is provided, as the back-plank is then likely to spring down under heavy loads. The bolts used in bench construction for holding the planks should be placed well to the front of the elongated holes in the legs, so that as the planks shrink the bolts will be drawn back with them, thereby lessening the chance of the planks splitting.

Fig. 15 illustrates some of the features which are recommended in connection with the installation of the New Britain bench. It will be noted that a three-inch space is recommended between the bench and the wall. For ordinary work a distance of eight feet between the legs has been found satisfactory for this type of bench, although for heavy work or where great stiffness is desired, this distance should be less, often being five or six feet. In erecting this bench, it is recommended that the front plank be twelve or fourteen inches wide and three inches thick (planed 2¾ inches). These planks may be obtained in sixteen-foot lengths, which allows the ends of abutting planks to come over every other leg; this eliminates lap joints, which would be necessary were the joints to come between the legs. A convenient method of locating the bench is to set up the two end legs; then by drawing a line tight between these legs all the intermediate legs may be set up to this line.

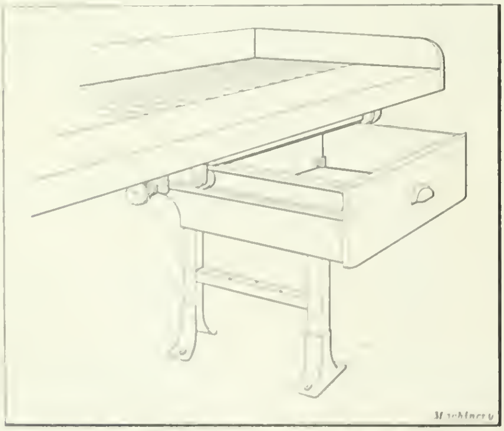


Fig. 20. Bench Drawer supported by Rollers

A double-width bench is illustrated in Fig. 16. With this construction, the planks lie lengthwise and provision is made for hanging shelves on lugs *A* and *B*. When a bench must be set away from the wall, the pedestal type of leg is somewhat at a disadvantage, as it will not stand alone like many of the others which are suitably balanced. This may be remedied by using a brace *a* made of steel as at *A* in Fig. 17. With this addition, this type of bench may be readily erected and is very satisfactory. This illustration shows heavy planking over the entire top, while a shelf *b* and back-board *c* are provided.

Benches of double width with wide legs, while economical when set in the middle of the floor, cannot be taken down and used to good advantage against the wall; therefore, two single-width bench legs, bolted together to form one double-width bench, as shown at *B*, Fig. 17, are sometimes more economical than a double-width leg, when the construction is not likely to be permanent. In this construction, two legs are bolted back to back against a stringer *d*. Heavy planking *e* and *f* is placed at the front of each leg, and narrow pieces laid crosswise complete the construction. These cross-pieces may be hard-wood flooring, tongued and grooved, or plain boards, as desired.

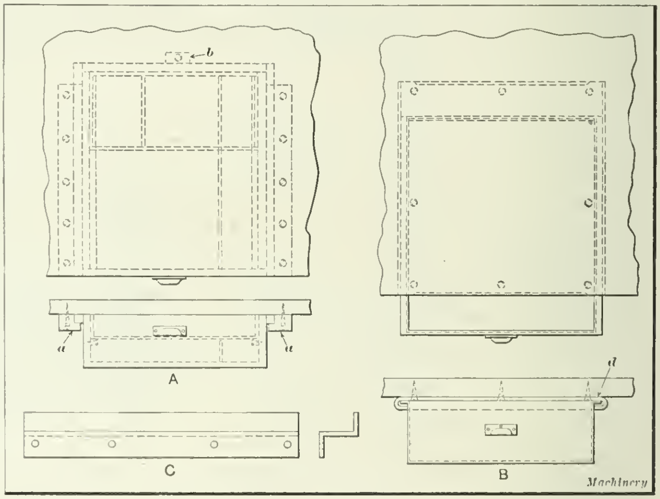


Fig. 21. (A) Wooden Type of Drawer. (B) Sheet-metal Drawer. (C) Steel Drawer Slide for replacing Wooden Strips

Where a lot of small work is handled on a bench, it is often a good plan to cover the top with sheet metal. In this connection the two views in Fig. 14 are of interest. The view to the left shows a zinc-covered bench top, and it will be noticed that a beading *A* is placed at the front of the bench to prevent the work from rolling off. Another method of constructing a bench top which is covered with zinc is shown by the right-hand view. The bench is tapered back as indicated at *B*. Hard paper is sometimes used for bench covering where delicate work is handled. In some instances, bench tops are built up from small blocks with the end grain on top; these blocks are wedged between stringers and are sometimes glued together, after which they are surfaced with a planer. This makes a fine wear-resisting bench and is similar to the wooden paving block constructions often used on streets which have considerable traffic on them.

For handling small castings, etc., it is often found convenient to have a bin under the bench. Fig. 22 shows how this can be arranged without wasting floor space. The bin *A* is placed part way under the bench while the workman stands at the opposite side. A suitable hole is cut through the bin where the bench legs interfere. In fitting up a bench for efficient work, many appliances may be used which will greatly facilitate the handling of work which is to be made in quantities. These often take the form of shelves, stops, holes, etc. To illustrate in a general way what some of these conveniences are, reference is made to Fig. 18, which shows a method of holding work while scraping it. Three blocks *A*, *B* and *C* are attached to the bench and a wedge *D* is used to hold the work securely between these blocks. With this arrangement the scraping may be done much more conveniently than would be the case if some means of holding the work in position were not provided. Fig. 19 shows a method of holding a ring on the bench. Steel pins *A* merely keep the ring in position while screwing the plate *B* in place on the ring.

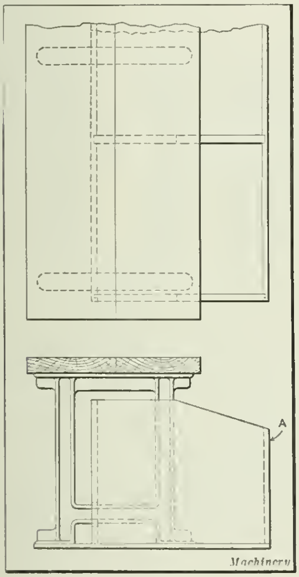


Fig. 22. Work-bench provided with Bin which is located Part Way under Bench to economize in Floor Space

Drawers for Work-benches

The hanging of drawers to the bench is receiving more consideration of late than would be thought by looking at some bench constructions. This refers particularly to the use of metal drawers and covers for them. Referring to Fig. 21, a wooden bench drawer is shown at *A*. This is a common type and is hung on wooden slides. It has a till in it divided into sections for keeping small tools and a block *b* is bolted to the under side of the bench to act as a stop when pushing the drawer in. To prevent the drawer from being accidentally pulled out too far, thus throwing the contents on the floor, a block is sometimes placed under the bench to limit the travel. The view *B* at the right shows a sheet-metal drawer. The drawer proper is hung in the support *d* which is also made of sheet metal and is held by screws to the under side of the bench so that the drawer slides in it. This support acts as a cover for the drawer and assists in keeping out dust. Steel slides, such as are shown at *C* are sometimes used for hanging drawers where something better than wood is desired.

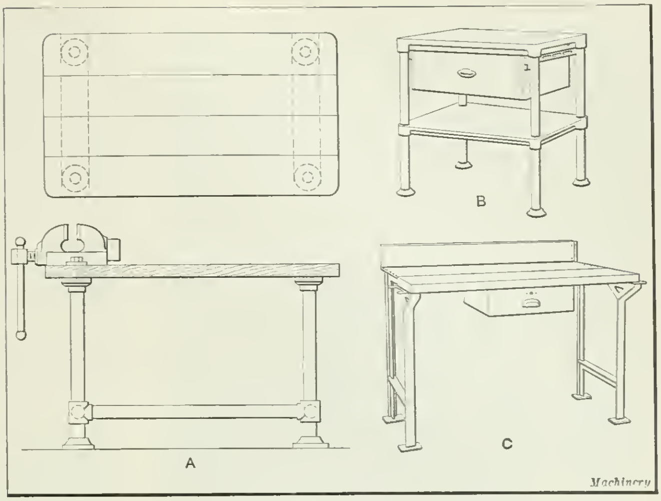


Fig. 23. Examples of Portable Work-bench Construction

A bench drawer hung on rolls is illustrated in Fig. 20. This drawer is made of wood at the bottom, front, and back, while the remainder is of steel; with this construction fine tools are not damaged when thrown carelessly into it. A metal plate is placed over the top of the drawer and is screwed to the bench, thus covering the drawer entirely when closed and preventing dust from entering. The rolls on which the drawer operates prevent sticking or cramping.

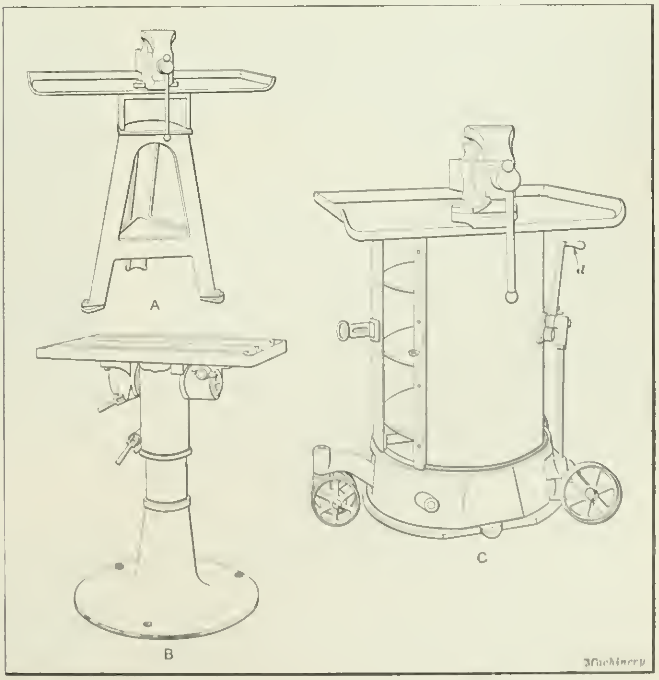


Fig. 24. Portable Stands for Chipping, Filing, and Scraping

Portable Work-benches

Many single-purpose benches that are a complete unit and capable of being moved almost anywhere quite readily are used in many shops and factories. Perhaps the most familiar bench of this type is shown at *A* in Fig. 23. This is used by steam fitters, plumbers, etc., and usually consists of a plank top mounted on four legs made of pipe and stiffened with a cross-piece. Another type of bench carrying a drawer and shelf which is compact and handy is illustrated at *B*. This consists of a wooden top held to a suitable frame and mounted on pipe legs. A work-bench made of sheet metal and constructed in five-foot sections is shown at *C*. Each section is a complete unit which may be used independently or may be bolted to other sections, thus making a long bench. This bench is made by the Manufacturing Equipment & Engineering Co. and is shown with a drawer in position. Where one section is bolted to another, one leg on one of the sections is eliminated. This makes three legs in every ten-foot section throughout the length of the bench.

For filing and chipping on the floor and doing other assembling operations, a bench which is conveniently located and has a vise is greatly appreciated and saves considerable running back and forth. Such a bench is shown at *A* in Fig. 24. This consists of a tray mounted on a three-legged stand. This construction requires no shimming up on the floor as it will take a three-point bearing on an unequal floor. The tray provides for holding a number of small parts, and a vise completes the outfit. Another stand which is used for the same purpose but which is a little more elaborate is illustrated at *C*. This stand is mounted on wheels although when in use it rests on the floor. To move it from one part of the shop to another the wheels are lowered or the stand is raised by means of the lever *d*. This stand is made in cylindrical form with a tray. Inside the cylinder are placed a number of shelves which can be used for holding tools. Another stand which is simple in construction is illustrated at *B*. This stand is for holding work while scraping. It consists of a pedestal and a table which may be tilted to a convenient scraping angle and may also be elevated to suit the workman.

While not all of the benches that are in general use have been illustrated and only a few bench accessories have been shown in connection with this article, it is believed that enough have been described to indicate that the trend of general engineering practice is in the direction of something better than plain wood for work-benches. The bench as an item of shop equipment permits of considerable freak design or construction if one is so inclined, but the writer believes that good benches, properly constructed, mean much more to a shop than is generally supposed.

• • •

It is stated in *Industritidningen Norden* that the latest German submarines are, in fact, small cruisers of 6500 tons, capable of making thirty knots on the surface and having forty torpedo tubes and twelve guns. The total length is said to be 450 feet, and the width, 36 feet. The engines for driving the boat on the surface develop 20,000 horsepower, and the motors for driving them under water, 5000 horsepower, giving the boats a speed under the surface of fifteen knots. Seventy-six 18-inch torpedoes are carried for each cruise. The submarines also have provisions for mine-laying, and can for this purpose carry 150 mines. Six of the guns are of 5-inch caliber. The vessel is protected by armor plate of from two- to three-inch thickness, and has two telescoping turrets or observation towers. It is stated that these new vessels require about five minutes for entirely submerging.

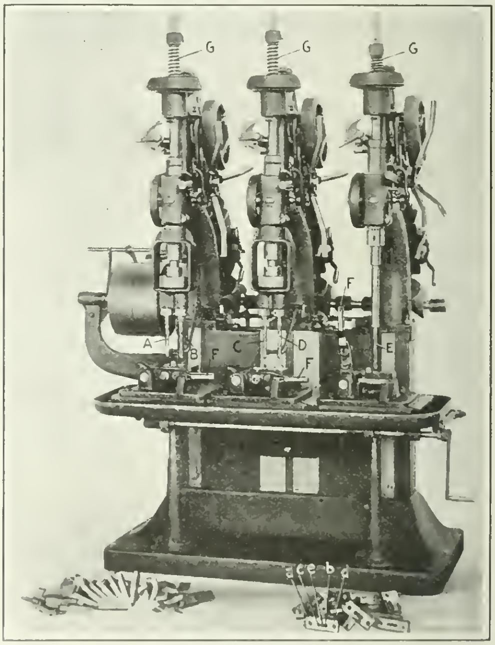
• • •

Today, the Government is the biggest employer of labor in the United States. Besides the millions in the Army and Navy, it employs over 600,000 civilians, not counting railway employes, and expects soon to increase this number to 700,000. The two next largest employers are the United States Steel Corporation, which has 300,000 men, and the Pennsylvania Railroad, which has 250,000 men.

DRILLING CLOSELY SPACED HOLES

When it is required to drill holes which are so closely spaced that the work cannot be handled at a single operation by a multiple-spindle drilling machine or by a single-spindle machine equipped with a multiple auxiliary head, it is sometimes possible to provide for drilling two or more holes at a time, so that the number of operations required to complete drilling all of the holes in the work is materially reduced. At the left-hand side of the drilling machine shown in the illustration which accompanies this description, there are shown a number of die blanks in which it is required to drill five holes as shown in the finished work at the right-hand side of the machine. To facilitate handling this work, a 20-inch drilling machine built by the Barnes Drill Co., of Rockford, Ill., was equipped with two-spindle multiple heads on two of the spindles, while the third spindle was furnished with a single drill. A quick-acting jig was provided under each spindle. In operation, holes *a* and *b* are drilled by twist drills *A* and *B* carried by the head in the first spindle of the machine, after which the work is transferred to the fixture under the second spindle, where holes *c* and *d* are drilled by drills *C* and *D*. Then by transferring the piece to the third spindle, hole *e* is drilled by drill *E*, thus completing the sequence of operations. All of the fixtures are operated by simply manipulating hand-levers *F*, and it will, of course, be understood that the operator goes from fixture to fixture, removing the finished part and substituting a fresh die blank so that each spindle of the machine is kept in practically continuous operation. Attention is called to the fact that coiled springs *G* are provided to furnish automatic return for the spindles of the drilling machine.

E. K. H.



Barnes Three-spindle Drilling Machine tooled up for drilling Five Closely Spaced Holes

• • •

A committee of the American Society of Civil Engineers has decided that it is unwise to assume a higher working stress than 12,000 pounds per square inch for columns in which the ordinary grade of structural steel is specified. Its report also emphasizes that, as the physical characteristics and strength of structural steel are affected by the amount of working received, heavier material, of the same chemical composition, is weaker

SOME FACTS ABOUT WASTE

The waste found in machine shops, engine rooms, or wherever machinery is used is generally regarded simply as a mass of cotton threads and fiber not mixed according to any plan, but thrown together promiscuously and just as the material happened to be when discarded by the cotton mill. Much waste of this kind has been and still is used, although waste which has been subjected to manufacturing processes to secure a standardized product is different in both appearance and in effectiveness from the kind of waste first referred to. The former is simply raw material from which waste of good quality may be made. Owing to the universal use of waste, some of the more essential facts regarding different kinds that are in use and methods of producing them will doubtless be of general interest.

There are two principal classes of waste. One class is intended for cleaning purposes and the other for holding a lubricant, as, for example, when used as a packing material in the journal boxes of railway cars or in some classes of motor bearings. The various grades of cotton waste comprise the first class, whereas wool waste comprises the second class, which is used as packing. The cotton or cleaning waste is by far the most important commercially, if judged by the extent of its use. The most essential property of waste is its oil-absorbing quality. Poor waste is soon saturated with oil or grease, whereas good waste will absorb much more oil and may be turned inside out and used again. A high absorbing quality is desirable both in cotton and wool waste, but the importance of this feature might easily be overlooked, especially in the case of waste used exclusively for cleaning purposes.

To obtain a waste capable of absorbing the greatest amount of oil and grease, it is essential, in the first place, to use the right kinds of raw materials and, second, to mix these materials thoroughly and separate the various threads or fibers completely, so that there are no solid masses or large thick strands extending through the waste. At the plant of the Royal Mfg. Co., Rahway, N. J., twelve standard grades of cotton waste are made, in addition to the wool waste made for packing journal boxes. There are about forty different kinds of raw materials used in producing the different grades of waste mentioned. These raw materials vary considerably, and the kind of waste obtained depends upon the mixture. The general method of mixing the different materials is indicated by the illustration Fig. 1. To begin with, a bale of waste is spread out over a surface about 15 feet wide and 40 or 50 feet long. Another bale of different material is next spread out in the same way upon the first one, and this is continued until there is a pile of these horizontal layers of mixed waste 5 or 6 feet in height. The particular materials used have been determined previously by experiment and are standardized, so that any one of the different grades referred to is obtained by varying the mixture.

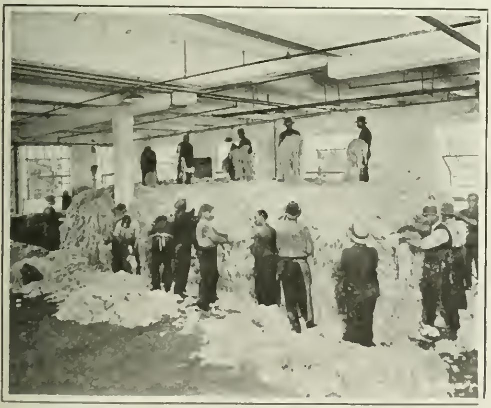


Fig. 1. Method of mixing Ingredients used in Manufacture of Waste to insure Correct Proportions

The next step in the process is known as "pulling," and this is shown in Fig. 1. This is another hand operation, and consists in pulling out handfuls of the waste from the sides of the pile. The object is to thoroughly mix the horizontal layers, and in order to do this, the pulling is done by removing vertical layers so that about the same amount of each ingredient is obtained in the mixture that is removed from the pile. This pulled material is next passed through machines, Fig. 2, which completes the mixing and also separates any thick masses or strands so that the waste comes out light or fluffy and evenly divided. This machine has a large cylindrical drum covered with thousands of teeth, and it is partly surrounded by a series of smaller rollers having intermeshing teeth. As the waste passes between these various rows of teeth, it is torn apart and shredded so that an even, homogeneous mixture is obtained. All waste passes through two of these machines to insure thorough treatment, and the rolls or "laps" which emerge from the second machine represent the finished product, which is put up into bales of different size or weight. In order to remove all extraneous matter, such as splinters, pieces of wire, needles, etc., the raw material is sorted and hand-picked before mixing, and the waste is also screened after mixing and before feeding it to the machines. F. D. J.

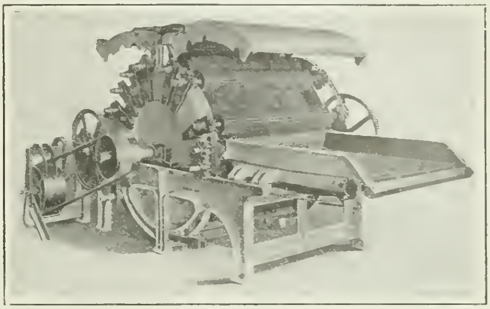


Fig. 2. Type of Machine for combing Waste to secure Homogeneous Mixture

* * *

WOMEN IN BRITISH INDUSTRIES

According to the British *Labor Gazette*, about 1,413,000 women, excluding casual agricultural laborers, are directly replacing men in Great Britain, the largest number being in industrial and commercial occupations. The proportion of women to the total numbers of employes increased from under a quarter in July, 1914, to over a third in October, 1917, although it has not appreciably altered since July, 1917. In addition, woman labor equivalent to 43,000 full-time workers is employed in military, naval, and Red Cross hospitals. About 400,000 of these women have been taken from small workshops and domestic service, but there is still a net increase of about 1,070,000 women employed in occupations outside their own homes. It must be borne in mind, also, that much of the work previously done by domestic servants is now done by unpaid labor.

In the industrial occupations the greatest gain is found in the metal trades, in which the number of women employed increased from 170,000 to 549,000. In the clothing trades, on the other hand, the number decreased 44,000, and in the printing trades, 5000. In the chemical trades, there was an increase of 53,000 women employes; in the food trades, an increase of 28,000; and in the wood trades, an increase of 29,000. The statistics of the Ministry of Labor show, however, that the demand for woman labor is now arrested, if not declining. As a result, many of the leading manufacturers and government officials are beginning to plan for the demobilization period.

* * *

According to a bulletin issued by the American Railway Engineering Association of Chicago, on curves of 8 or 9 degrees, the abrasion of manganese rails is only one-fifth that of Bessemer steel rails and one-third that of open-hearth rails.

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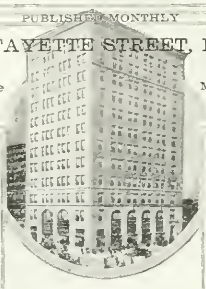

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THE DANGER FROM WITHIN

Beyond the shadow of a doubt we shall, in time, overcome the enemy outside our gates; the real danger to us is from the enemy within—the German propaganda which works in mysterious ways and never sleeps. Not always does it appear openly as propaganda; sometimes, hiding under apparently patriotic motives, it takes the form of criticism of governmental activities, the ultimate purpose of which is to cause discouragement and apathy. This sort of propaganda is the mother of all the rumors of calamity that beset us daily. It caused the Italian reverse last fall; it is at work in this country just as it was in Italy—in factories, mills, and offices.

The Government can best combat this insidious propaganda by full and frank publicity. Why not tell people exactly how matters stand? German spies in this country probably know already and take advantage of the fact that the rest of us *do not know.* Let the Government give us the facts, good or bad, and thus confound the German propagandists. This is particularly applicable to the machine industries, because most of the discouraging rumors—many, no doubt, emanating from enemy sources—have to do with our delay in manufacturing war material. The Germans have known all along that we were not prepared for war; to say so need not worry us now. But if the people are told also how rapidly we are going ahead with our preparations, much will be done toward counteracting the aid secrecy has given to German propaganda.

* * *

MUST A MACHINE BE RUNNING ALL THE TIME TO PROVE ECONOMICAL?

Manufacturers of specialized labor-saving machinery often find difficulty in selling their machines because, in some shops, the machines cannot be kept busy all the time. Many managers of machine shops, instead of calculating how much work a machine will do when working, seem to worry because a machine may be idle part of the time. They prefer, therefore, to buy a cheaper machine of lower production because it can be kept working continuously. Such a course, as a general rule, is a mistake. Unless a high-production machine costs a great deal more than a low-production machine, it will certainly prove the more economical of the two, because of the labor saved in its operation. And even if the investment on a high-production machine is greater, it is fair to assume that the factory purchasing it will eventually grow and be enabled to utilize the machine all the time. When this point is reached, additional machinery need not be installed and the cost of labor will be reduced—a very important saving of expense. The question is not: "Will this or that machine be idle part of the time?" The question is: "How much does it cost to produce a unit amount of work?" The machine that reduces the unit cost is the cheaper machine, even if it does not run more than half the time.

* * *

STANDARDIZATION—THE KEYNOTE OF EFFICIENCY

Though we have prided ourselves for years on our standardized methods in many lines of manufacture, nevertheless, as a nation, we have only just begun to scratch the surface in so far as economy due to standardization is concerned. Here, as in so many other directions, the war has taught us a lesson. Instead of building locomotives of numerous different designs, varying only slightly from each other in efficiency and adaptability, the large locomotive companies now seek to standardize their types, so that, by reducing the number of designs, they may decrease the cost of manufacture. The same idea is being applied to shipbuilding. There is no reason why many ships of similar tonnage should not be built exactly alike; yet, in the past, nearly every vessel turned out has been different from others.

In the machine tool industry, the possibilities for standardization are by no means exhausted—many firms still build dozens of different types of machines and many sizes of the same type. The manager of a large machine-tool building plant stated that it actually furnished three hundred different machines—that is, machines which differed more or less in their details. Yet many of these different types could perform practically the same work with the same average efficiency. A saving might be made by reducing the number of different kinds of machines if only customers could be brought to appreciate the saving in first cost that would result if they did not insist on so many types and sizes.

Standardization is a big problem, one that will tax many minds before it is solved; yet its underlying principle is easily grasped. The application of this principle, as a means toward economizing both in the manufacture and use of machine tools, is the next step toward national efficiency.

* * *

PATRIOTISM AND PRODUCTION OF MUNITIONS

Winning the war depends as much upon the workers in our factories as upon our soldiers at the front; but few of our workers seem to realize it. "Production could be tremendously accelerated," said the production engineer of one of the largest war munition factories in the United States recently, "if only the fires of enthusiasm could be kindled in our workers; if only they could be made to understand that, to bring the war to a victorious end, they must put the same enthusiasm into their labors as is shown by the men who have gallantly volunteered to serve in the trenches. American workers do not seem to realize as yet that they are fighters in the war; that *production* is the way in which they can most conclusively prove their patriotism. Liberty Bonds are necessary; so are Red Cross contributions, and there is no denying that all classes in the country have bought bonds and contributed to the Red Cross in a fine spirit. But, if each worker increased his production 10 per cent, he would be doing more toward ending the war quickly than he could possibly do in any other way; because, after all, war is fought, not with money, but with materials. No matter how much money liberal subscriptions to the Liberty Loan may bring the Government, little will have been gained unless our producers of munitions and other war materials put their very heart into producing these as rapidly as possible."

"Production!" That must be the watchword of every American mechanic, be he engineer or toolmaker, superintendent, foreman, or machine operator.

THE FUTURE STATUS OF THE APPRENTICE

RESULTS OF PRESENT TRAINING METHODS AND SUGGESTIONS FOR AN IMPROVED COURSE

BY C. C. HERMANN[1]

Some time ago the writer's attention was attracted by an article in MACHINERY entitled "Who Blundered—the Draftsman or the Machinist?" Articles on the same topic that followed were also read with interest, but it seems to the writer that the solution of the problem lies much deeper than appears from perusal of these articles. In the first place, the machinist, toolmaker, or patternmaker must, under present conditions, serve an apprenticeship of four years before he can call himself a member of the craft. During the first year of apprenticeship a boy must often do odd jobs about the shop—sweep the floors, wipe machines, etc. In the second year he is allowed to run a drilling machine, set up work in the lathe, and do some bench work. In the third year he does bench, vise, and floor work, is taught how to make precision measurements, and has a chance to become acquainted with milling machines, setting up automatics and checking set-ups. His fourth year is practically a review of the first three years—the finishing touch upon his apprenticeship. During those four years he sees blueprints of various parts and gets some instruction in reading drawings. Yet, despite all this, he finds himself at the end of that time with the essentials of his education still lacking. He has no firm foundation upon which to build.

Machinists should have a well-grounded knowledge of drawing—a fact which employers have ignored to their sorrow. The writer is personally acquainted with men holding positions as foremen and superintendents of machine shops who are unable to make a mechanical drawing. They left school early and served apprenticeships in various shops, where they became expert in the work done in the shop, but they have not acquired the foundation upon which to expand. The reverse is true in other cases. Many times men of splendid education have failed in responsible positions because of a lack of practical knowledge. A happy medium must be sought—a middle point between the professions of machinist and draftsman.

For the past two years, the writer has taught a night school for shop men, the total enrollment of which in the mechanical drawing class, for the two years, was thirty-two. All those enrolled were practical men, ranging in age from twenty-two to forty-four years. Eight were laborers, seventeen were machinists, five were apprentice machinists, and two were toolmakers. Two had spent two years in high school, twenty-two had finished their eighth grade studies, three had finished the fifth grade, two had finished the fourth grade, and two had never been to school. The two students who had spent two years in high school were apprentice machinists and excelled the rest of the class in every way. Moreover, they were far in advance of the average apprentice in their work, and, but for the ruling regarding ages, would have finished their apprenticeship in two and a half or three years. For the rest of the class, plain mathematics was the stumbling block; fractions, especially, seemed to dumbfound them. To add and subtract fractions was as complex to them as problems in combined torsion and bending stresses are to the average designer. Yet some of these men, who had been machinists ten years and more and had studied fractions in the grade schools, had forgotten all about them!

The men of this class seemed to measure up to about the average of men working in shops, so that what was learned regarding them may be taken as typical of their class. It appears, then, that about 4 per cent of our machinists, toolmakers, and patternmakers have had part of a high school education, 70 per cent leave school without going on to high school, 4 per cent have never been inside of a school, and 22 per cent have had about four years of schooling. In view of this, an employer should consider it lucky that more mistakes do not occur in his shop. Much can be done to improve these conditions. That the evening classes held by the Y. M. C. A. throughout the country are a real asset to employers can be proved by these typical instances: One Y. M. C. A. pupil, who had been a machinist for two years, is now foreman in a shell-producing plant; another is foreman in a railroad machine shop; six others have done such good work that they are in line for advancement.

An Improved Apprenticeship Course

The writer believes that the following program for the apprentice will eliminate many of the shortcomings which handicap machinists who have served their apprenticeship under present conditions: The first year should be spent by the apprentice alternately, in three-month periods, in the tool-designing department and the machine shop. In the tool-designing department he should do tracing the first three months and learn how to handle drafting tools and the meaning of the various lines, as well as how to read a working drawing. The second three months should be spent in the drafting-room in actually making drawings, simple parts to begin with, the more complex assembly drawings to be reserved for the latter part of the term.

In the machine shop, the apprentice should not be placed at once on a machine, but at the bench, where he should be taught how to handle the various hammers, such as the ball and peen—both the straight-peen and the cross-peen—and how to use center-punches, chisels, and files. The shop foreman should lay out the apprentice's work at first. In addition, the apprentice should be taught how to sharpen his tools, after which he should be expected to keep them in good order and in logical arrangement in the drawers and on the shelves. He should be taught the use of scribers, surface gages, calipers, and the various methods of laying out tools. His work should be at first such as admits of wide variations; work to the finer allowances should be reserved till later. The employer should bear in mind that the value of his apprentice will depend on how he is started at the work; a bad start can bring only failure. Some maintain that the shop is not a school. They are in error. The shop is the best schoolhouse on earth; it is the school of experience. What a man learns at his bench he never forgets, and it is for this reason that the apprentice should be placed under the best mechanic in the shop.

If some system of reading working drawings were practiced in the machine shop, it would lessen the chance of error, and the machinist would be able to make himself more familiar with the work in hand. The fact that educated workmen are essential has been recognized by some of the leading manufacturers in the country; some even go so far as to pay for the tuition and buy books for any of their employes who wish to study at night. The writer was informed by a chaplain of the Regular Army not long ago that, of the men in his regiment, 191 could not write their own names—and these 191 were of American parentage. Before enlisting, these men had been working at various trades. Many of them were desirous to get an education and were delighted to enroll in the classes formed by the chaplain, where they are now learning to read and write English. Right now is the time for the manufacturer to give serious consideration to this phase of his business. Educated men mean greater efficiency, and greater efficiency is necessary at a time when there is a limited number of workers available.

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The locomotive and railroad car builders of the United States did a gross business in 1917 of $575,000,000, an increase of approximately $55,000,000 over the preceding year. The number of locomotives ordered, up to December 31, was 5585, compared with 5016 the year before. Of these, 3413 were for the United States and her allies, with a small number for neutral countries and the remainder for domestic railroads. But only 125,330 freight cars were ordered, against 190,663 the year before. Foreign orders, including cars for the railroads in France operated by the American Army, totalled 66,667, while the home railroads ordered only 58,553. Only 558 passenger cars were ordered, as compared with 1854 in 1916 and 1839 in 1915.

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Forging the U. S. 75-Millimeter Shell

Fourth of a Series of Articles Describing Approved Methods Employed in the Forging and Machining of the U. S. 75-millimeter Shell — By Erik Oberg[1]

THE machining and the inspection of the U. S. 75-millimeter high-explosive shell have been described in a series of articles in the March, April, and May numbers of MACHINERY, the practice dealt with being that of the American Shell Co., Paterson, N. J. In the present article, the methods and tools used in the forging of this shell will be described. The forgings for the shells made by the American Shell Co. are furnished by the Hydraulic Pressed Steel Co., Cleveland, Ohio, and the practice of the latter company will, therefore, be described. The plant of the Hydraulic Pressed Steel Co. has a capacity for forging 20,000 shells daily, and is now being increased so that the ultimate capacity will be about 65,000 shells per day.

Nicking and Breaking

The steel from which the forgings are made comes from the steel plants in long bars, 82 millimeters (about 3¼ inches) in diameter and 10 feet long. The length of the bars varies slightly. The steel is open-hearth, Class B steel for common shells. This classification refers to that adopted by the United States Ordnance Department, in the revised specifications of December 31, 1917. The maximum phosphorus and sulphur content of Class B open-hearth steel, when made by the basic open-hearth process, must not exceed 0.06 per cent. The steel bars when received are marked on the end with a "heat number" stamped on them at the steel mill. This heat number is retained through all the operations and is stamped on the forgings before they are sent to the shops where the machining is done. When the bars arrive from the steel plant, they are stored in stock piles in the yards until the total number of bars in a complete heat have been received. A complete heat usually contains from 350 to 400 bars.

When ready to be used, the bars are taken from the stock pile in the yards and rolled into the shop on a conveyor provided with plain grooved rollers. The first operation is to break up the bars into units about 9 inches long, which are known as "billets," from which shells are afterward forged. The breaking up is done by first nicking the bar by means of an oxy-acetylene torch, and then breaking it off under an alligator shear. While nicking the bars by the torch, the operator of the torch is guided by a gage frame which has cross-bars 9 inches apart, so that, as the bar is pushed beneath the gage frame, it can be nicked at the exact points where it should be broken off, to provide proper lengths for the shell-forging blanks. After nicking, the bar is passed to the alligator shear, which breaks it up into pieces. It should be understood that there is no cutting action, but purely a breaking action.

After the bars have been broken as described, the billets are inspected for structural and surface defects by rolling them down a slight incline, the inspector observing the cylindrical surface as well as the end of the billet as it rolls along. The billets from one heat are all kept together and are stacked in piles, which are not used until the entire heat has been broken up. The piles are identified by the same marking as the bars. When the complete heat has been broken up, the billets are ready for the forging operations.

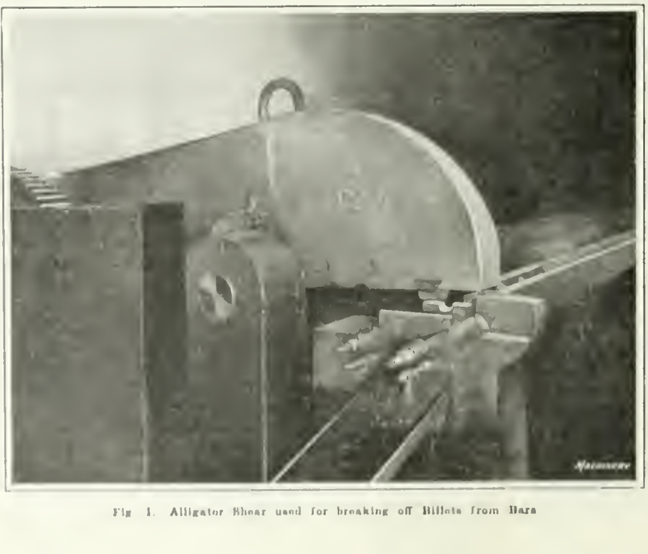

Fig. 1. Alligator Shear used for breaking off Billets from Bars

Forging the Shell

The billets are carried from the piles to the furnaces in large steel boxes by an overhead crane, and are then placed in the heating furnaces preparatory to forging. These furnaces are oil-fired.

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[1] Editor of MACHINERY.

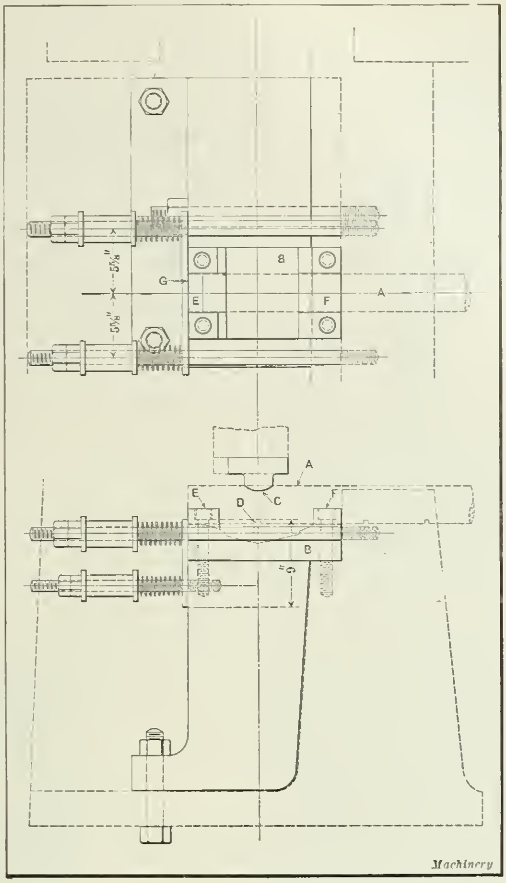

Fig. 2. Tools for breaking off Billets from Nicked Bars

The temperature in the furnace is maintained at from 2200 to 2400 degrees F., and the billets are heated to a temperature of from 1800 to 2200 degrees F. The billets remain in the furnace for forty-five minutes in order to be thoroughly "soaked" through. Sixty billets can be heated at once in one furnace, and four furnaces are used to each one of the hydraulic forging presses which perform the first forging operation. The press for the first forging operation, which is of the hydraulic type built by the Southwark Foundry & Machine Co., Philadelphia, Pa., has an average capacity for forging 220 shells per hour. After the first forging operation, the shells are immediately taken to the second-operation forging press without being heated again between the operations. There are two first-operation presses to each one of the second-operation presses. The presses are arranged so that one first-operation press is located on each side of a second-operation press, there being three presses to one unit. In this way, the shells can be readily passed from either one of the two first-operation presses to the second-operation press between them.

The first-operation press is provided with only one die and plunger, but the second-operation press has four dies and plungers, although only two are operated at a time, each set of two plungers being operated alternately, so that the other set has a chance to cool off. In the first-operation presses, the plunger and die are cooled by circulating water inside of the tools, but in the second-operation press, the plungers are immersed in a deep cup filled with water between each active stroke, and the water overflowing from the cup when the plunger is immersed in it runs over the die and cools it also. In the second-operation presses, the partly forged shells are subjected to two separate forging operations; the first makes the bottom of the correct thickness, and the second draws the walls to the right length.

Testing and Inspection

After the forging is completed, the shells are inspected while hot by an inspector who measures the length and the thickness of the bottom and tests the concentricity. The forgings are then piled on a truck especially designed for carrying them to the cooling bed. This truck consists of a plate bent up at the ends to a semicircular form, so that the shells, when piled in it, cannot roll off. These trucks are moved by a small electric locomotive to the cooling bed, where the forgings are placed on top of cinders to cool off slowly. When the shells are cold, they are again inspected for length and thickness of bottom and concentricity. At this time the inspector also notes any flaws in the forgings, and inspects the inside finish. The gages used for this work will be dealt with later.

Test pieces are cut from two shells in every heat, in order that tensile tests may be made. As one heat consists of from 3600 to 4000 shells, this means that one shell in every 1800 or 2000 is tested for tensile strength. In order that the shells may pass, the test piece must have an ultimate tensile strength of 90,000 pounds per square inch, an elastic limit of 45,000 pounds, and an elongation of 12 per cent in two inches.

The preceding paragraphs review briefly the complete processes to which the shell is subjected in forging. In the following, the details of the various operations will be dealt with, and descriptions and illustrations of the most important tools, dies, and gages will be given.

The Nicking Operation

When the bars pass into the shop from the yard for nicking, one end comes up against a stop-plate which is used in connection with the gage frame for the oxy-acetylene torches. In this way, all nicks will be uniformly gaged from one end of the bar. The gaging device is hinged, so that, when the bar has been placed in position, the gage can be brought down over it. It consists briefly of a rod long enough to accommodate the longest length of bar to be nicked, the rod having welded to it, at intervals corresponding to the unit lengths to be cut, short arms which act as guides and gages for the cutting torches. The rod is supported in bearings at each end, and when in use is rotated in these bearings, so that the short transverse arms rest on the bar to be nicked. Four torch operators are employed for a ten-foot bar, and as there are about twelve nicks or cuts to be made in a bar of this length, each operator nicks the bar on an average at three places.

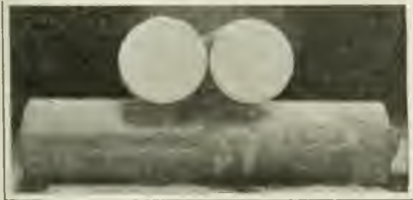

Fig. 3. View showing End of Billets broken off in Alligator Shear, indicating Character of Clean, Smooth Break

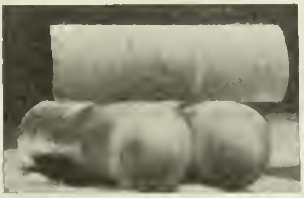

Fig. 4. Side View of Billet shown to Left in Fig. 3, showing comparatively Even Break

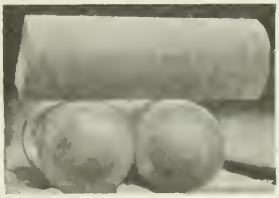

Fig. 5. Side View of Billet shown to Right in Fig. 3, showing Appearance of Break

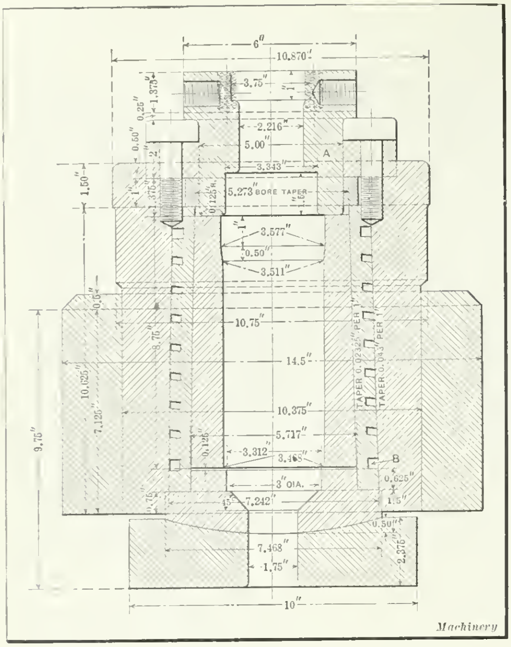

Fig. 6. Details of Die used for First Forging Operation

As soon as the nick is made with the torch, the nick or cut is chilled with a stream of water from a hose suspended from above the nicking table. For the nicking, a Davis-Bournonville Style C, No. 149, tip No. 4, torch is used. While only four torches are employed simultaneously, it would be possible, if the operation had to be speeded up, to use a greater number.

The acetylene for the torches is generated in a 200-pound carbide generator placed in a different part of the building, from which the gas is conveyed by piping to the nicking table. The oxygen is obtained from standard "Prest-O-Lite" cylinders, ten of which are connected through regulating valves to a header in the generator house, and from this header the gas is piped to the cutting table and distributed to the torches through a manifold. The water for chilling the nicks is carried by an overhead pipe and distributed to each torch operator by an individual flexible hose. All the piping is carried over the heads of the operators so as to be out of the way as far as possible.

The bars are nicked on one side only, to a depth of from 1/8 to 1/4 inch, the nick being in a plane normal to the axis of the bar. After the bar has been nicked over its whole length at given distances apart, the gage is rotated out of the way and the bar is rolled off the table onto a skid, from which it passes to the alligator shear which is used for breaking up the bar into billets.

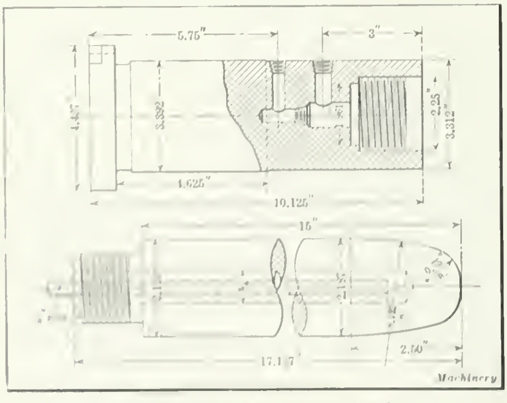

Fig 7. Punch used in First Forging Operation

The Breaking Tools

A detail of the tool equipment for the alligator shear for breaking off the nicked bar into billets is shown in Fig. 2, where the bar is indicated at *A*, the die, or lower part of the breaking tool, at *B*, and the punch, or upper part of the breaking tool, at *C*. As indicated, the nick in the bar at *D* comes directly underneath punch *C*, so that when the punch is brought down upon the bar, the latter is broken off by the pressure of the punch, the bar resting at *E* and *F* on supports in the die. A stop is provided so that when the end of the bar is pushed up against it, the bar will always be in a position where a nick will come directly beneath the punch. The plan view of the die shows the bar in place pushed up against the stop at *G*. Springs are provided bearing against the stop-plate so that there is a slight give to it, which is necessary on account of the motion imparted to the broken off part of the bar when the punch descends.

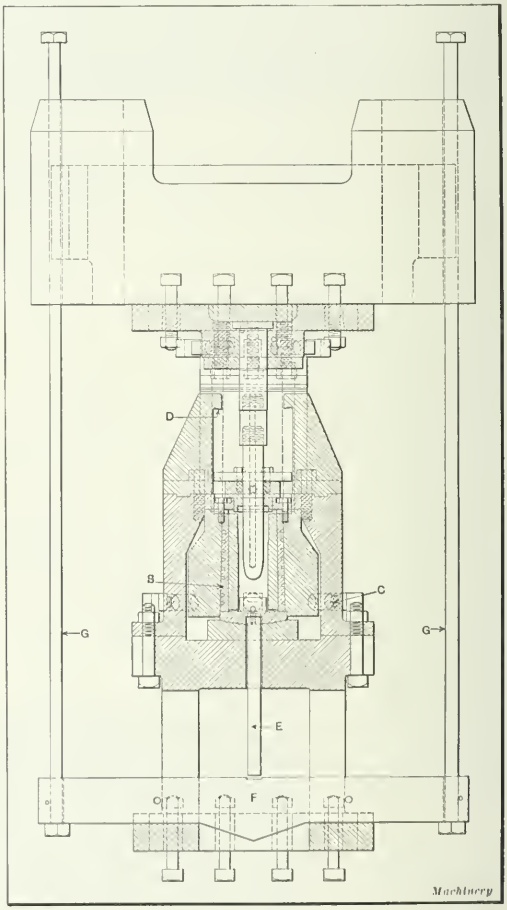

Fig. 8. Assembly View of Punch and Die used for First Forging Operation

The die consists of a hardened block with two projections, which is fastened to the built-up base of the shear. It should be noted that, when the bar rests in these blocks, the nick should always be downward. It is evident that as the upper block or punch *C* comes downward it tends to bend the part of the bar between the two lower blocks, but, as the material is fairly brittle, and also as the nick on the lower side has already started a break, the bar breaks off with fairly even ends. An illustration of the alligator shear and the conveyor in which the bar passes to it is shown in Fig. 1.

Theory of Setting the Blocks

A point relating to the breaking off of the bars into billets, which was discovered by experiments, should be mentioned at this time. If a bar consisting of only two unit lengths were placed nick down on *E* and *F*, Fig. 2, so that the nick registered with a plane normal to the axis of the bar and was located centrally between *E* and *F*, and if *C* were set to strike the bar on the top directly over the nick, then the bending moments about *C* would be equal and opposite. Assuming that there are no serious internal strains or lack of uniformity in the material of the bar, the break would be square and even from the nick to the side of the bar which is in contact with *C*. Now, however, except when the last two pieces of a bar are broken apart, one end of the bar extends beyond block *F*, and the weight of this end may be as much as 250 pounds. This additional weight causes an unbalancing of the forces at the breaking point, so that the fracture is not straight, but slightly offset toward the side of the smaller piece which is broken off. By experiment, it was found that, by shifting the blocks *E* and *F* in the direction of the overhang, but maintaining the original distance between them, it was possible to determine, by trial, a point for each heat of steel where the breaks would be square across the end of the bar. As it was difficult to make this adjustment in the lower die, provision was made for this instead in the upper block or punch, which can be moved crosswise in the face of the upper jaw of the alligator shear.

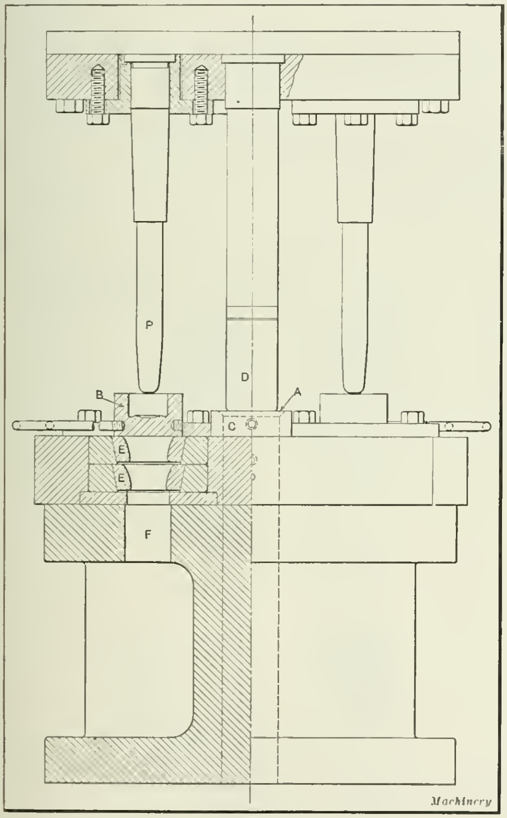

Fig. 9. General Arrangement of Punches and Dies for Second Forging Operation

This method of cutting off the bars has been found advantageous from many points of view. It is rapid in operation and very simple, and the capacity of a plant may be easily increased, due to the simple means required for the operation.

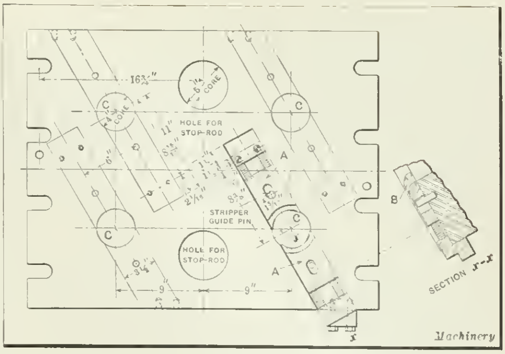

Fig. 10. Plan View showing Arrangement of Strippers for Second Forging Operation

Fig. 3 shows the ends of two billets after they have been broken apart, indicating the smoothness of the fracture beneath the nick. Figs. 4 and 5 show the sidewise appearance of the broken-off billets, indicating the fairly square surface at the break.

Tools for First Forging Operation

Fig. 8 shows a section of the complete assembly of the plunger and die for the first forging operation. The billet, as mentioned, is about 9 inches long, but the cup produced in this operation is about 12 inches long, the metal having been extruded past the punch, to some extent. A detail view of the die is shown in Fig. 6, where the stripper is indicated at *A*. The cooling water passes around the die in the spiral groove *B*, Fig. 8; it enters at the top of the spiral and passes out at the bottom, into the space between the die and the hood, and then flows out through a hole in the hood. The water is taken directly from the city mains and is not circulated, but permitted to flow off through the sewer. The pressure of the water is the regular city pressure.

The pilot at the top of Fig. 6 is entirely hand operated. At the beginning of the stroke the heated billet is put into the die, which is enough larger in diameter than the billet to permit it to enter the hole in the die. The plunger is in its upper position and the pilot is moved out of the way. When the billet is in the die, the operator lifts up the pilot, puts it on top of the billet, and operates the press, so that the plunger passes down through the hole in the pilot and into the billet.

The most important thing to be accomplished in piercing the billet is to provide a hole concentric with the outside of the cup. An attachment called a "spring yoke," shown in detail in Fig. 12, assists materially in accomplishing this result. One spring yoke is passed over each end of the stripper bar *F*, Fig. 8, but is not shown in this illustration; it is located just inside of the rods *G* and held in place by pins passed through the stripper bar; the bar passes through hole *A*, Fig. 12, in the spring yoke *B*. These spring yokes are so arranged that when the spring tension is properly adjusted by means

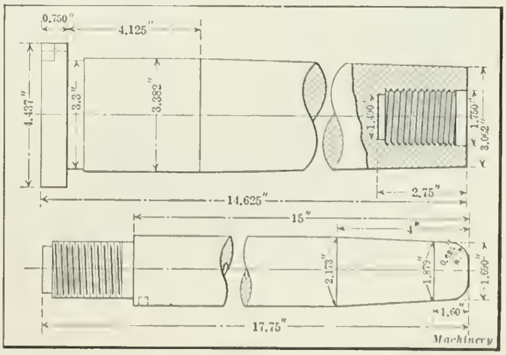

Fig. 11. Punch used for Second Forging Operation

of the nuts *C*, and the ram of the press is up with the billet in the die, and with the pilot in position, the billet is held up from the bottom of the die by pin *E*, Fig. 8, so that it extends above the top of the die into the recess provided for it in the pilot. When the plunger comes down, it enters the billet while the latter is still held centered in the pilot, and in this way the hole is started almost perfectly in the center at the top. As the plunger comes down, it forces the billet down into the bottom of the die, pushing the pin *E* down ahead of it against the spring tension, until the head of the pin seats in the recess provided for it in the bottom of the die. From this point on, the process is just the same as if a solid die were used.

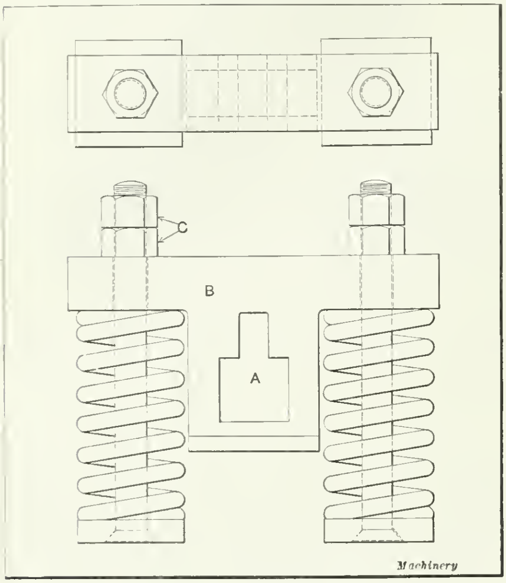

Fig. 12. Spring Yoke for obtaining Concentricity in Piercing

Another feature of this tool which allows of considerable accuracy in piercing the hole in the cup concentric with the outside is the alignment which is made possible by shifting the bottom of the die, if required, by means of three radial set-screws at *C*, Fig. 8, which extend through the hood that holds the die in place. These set-screws are set 120 degrees apart. By adjusting the die in the direction of the side of the cup that comes thin, while the top of the die is held in its original position, the alignment can be made nearly perfect.

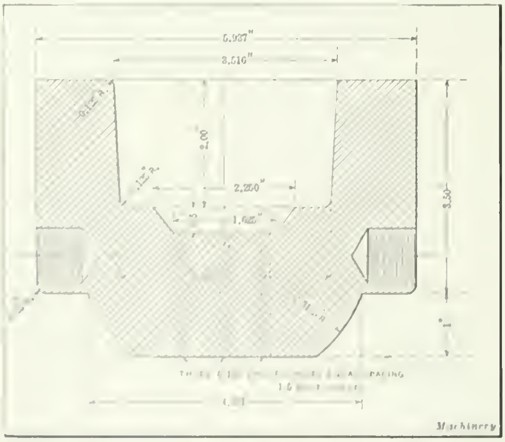

Fig. 13. Die used in Second Forging Operation

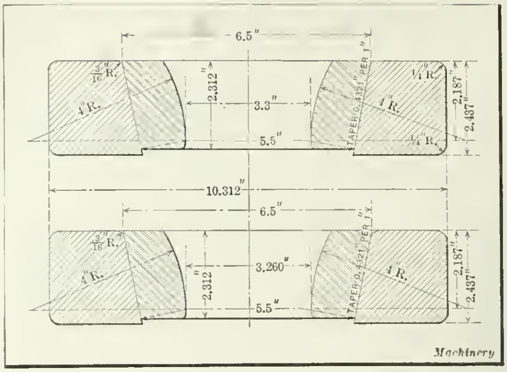

Fig. 14. Dies used for Final Drawing Operation

The valve operating the plunger is controlled by a handle. As the plunger recedes, the pilot and shell are carried up with it until the stripper strikes the stripper jaws *D*, Fig. 8, thus loosening the shell from the plunger. At this time, the shell is gripped by tongs and transferred to the second-operation press. If the shell should stick in the die, the knock-out *E*, actuated through a cross-bar *F* and tie-rods *G*, as indicated, will operate, and will force the shell out of the die.

The plunger, as well as the die, is water-cooled. In the case of the plunger, Fig. 7, a 1/8-inch gas pipe is inserted in the 3/4 inch hole shown. This gas pipe reaches to within 1/2 inch of the bottom of the hole. Water is forced in through the gas pipe and then passes out of the plunger on the outside of the gas pipe, thus cooling it effectively. Suitable stops are provided for the ram to which the plunger is attached, so that it cannot enter the shell forging to more than a predetermined depth, assuring the proper thickness of the bottom of the shell.

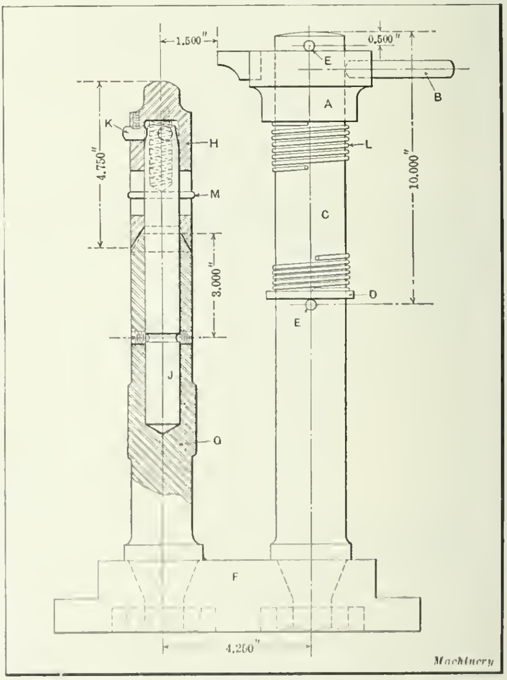

Fig. 15. Gage used for testing Concentricity of Shell Forging

Tools for Second Forging Operation

The second forging operation, as already mentioned, is divided into two parts. In the first part, the cup from the

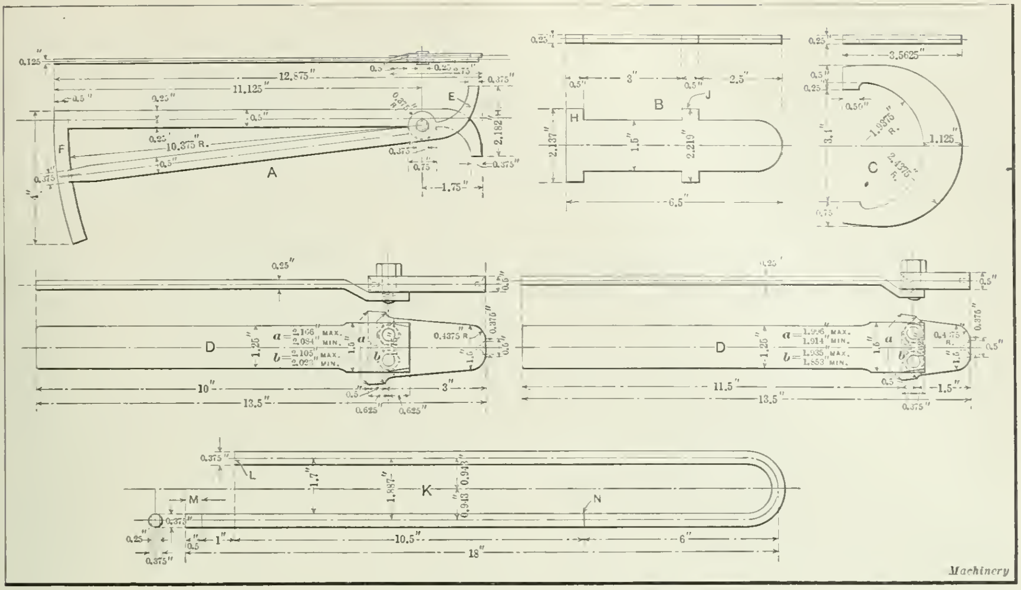

Fig. 16. Gages used for Inspection of Forgings

first operation is placed in die *B*, Fig. 9, and plunger *P* is brought down, providing for the proper inside shape and the proper thickness at the bottom of the shell. A stop-block at *A* determines the depth to which plunger *P* enters into the die, and hence insures the proper thickness of the shell base. As indicated, there are two plungers acting at once. The other two plungers, arranged along a plane parallel to those shown, but about eighteen inches behind them, are not in use at this time, but will be used for the next set of two shells. They are given an opportunity to cool off while the other two are in use. The reason why the plungers in the second-operation press are not water-cooled is that, on account of their small size, the drilling of a hole inside of them would weaken them too much.

The second part of the second forging operation consists in forcing the whole shell through the dies *E*. In order to do this, the plunger, after the first part of the operation is completed, is pulled back with the shell sticking to it; die *B*, to which a handle is attached, is then removed, and slide *C*, which constituted the stop for the plunger *D*, is pulled lengthwise until a hole in the slide coincides with the plunger *D*, so that this plunger does not prevent the ram with the punches at-

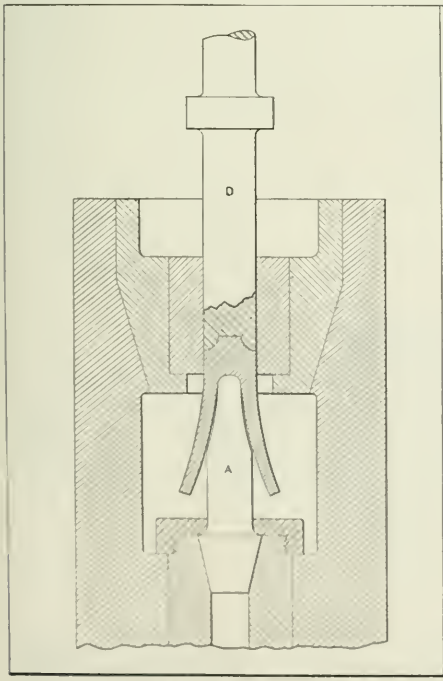

Fig. 17. First or Piercing Operation in French Method of forging Shells

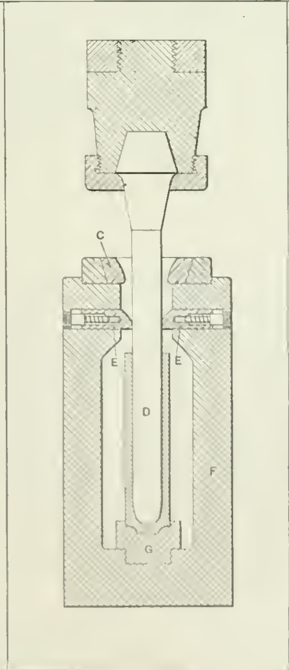

Fig. 18. Second or Hot-drawing Operation in French Method of forging Shells

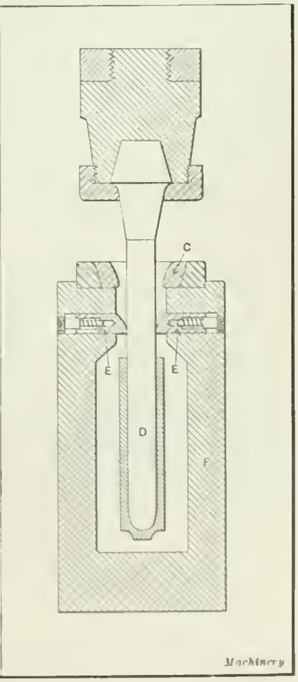

Fig. 19. Third or Cold-drawing Operation in French Method of forging Shells

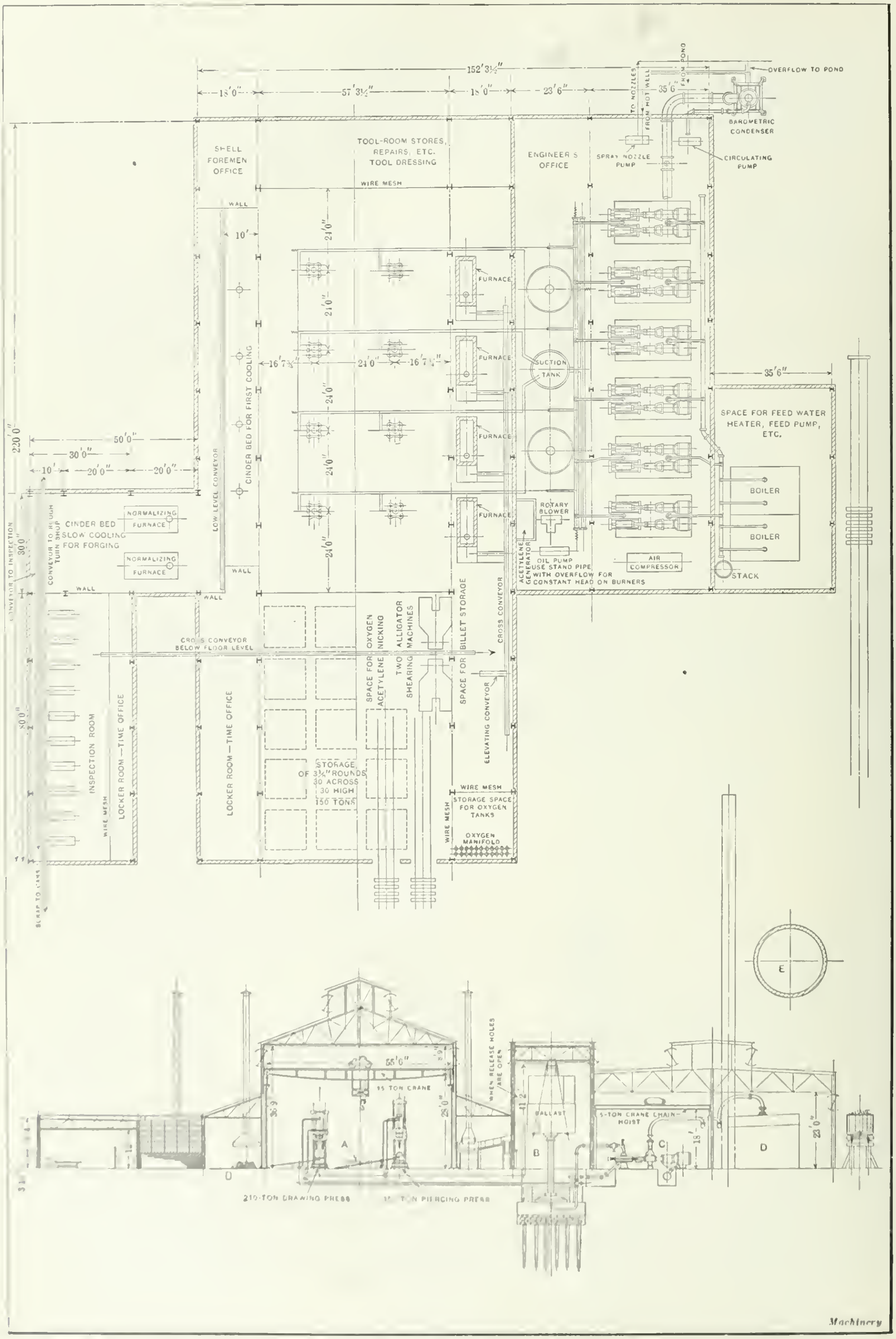

Fig. 20. Plan of a Model Forging Plant for producing Fifteen Thousand 75-millimeter Shells in Twenty-four Hours

tached from descending. The plunger then comes down with the shell and pushes it through the two dies at *E*. The shell forging is drawn to a smaller diameter in each of the two dies. The full length of the shell after having been drawn through these dies is about 14 inches. When the plunger returns on its upward stroke, the shell is removed from it by strippers *A*, shown in Fig. 10, which is a plan view of the stripper plate; holes *C* are the holes for the forgings and plungers. These strippers are backed up by springs. When the plunger and the shell descend, the strippers are pushed back, owing to the slanting shape of their face, as indicated at *B*. When the plunger again ascends, however, the lower edge of the end of the stripper catches against the edge of the shell and strips it off, the shell falling through the hole *F*, Fig. 9. As soon as the plunger has ascended after the second part of the second operation, a cup, filled with water and shaped similarly to the shell, is passed up so that the plunger is immersed in it for cooling. The water that runs over the sides of the cup as the plunger is immersed cools the sides of the dies beneath. Die *B*, Fig. 9, is shown in detail in Fig. 13, and dies *E*, in Fig. 14.

Gages Used for Inspecting Shell Forging

The gages used for inspecting the shell forging when cold are shown in Fig. 16. Gage *A* is a direct-reading gage for inspecting the inside of the shell. The end *E* is inserted in the shell, and the readings on the graduations on wing *F* are compared with the drawing of the shell. This gage is especially useful for finding pockets on the inside of the shell.

Gage *B* is a maximum and minimum gage for the inside diameter of the shell mouth. It is made from a flat piece of stock, as shown. The end at *H* must pass into the shell, while end *J* must not pass. Gage *C* is a "Go" or maximum gage for the outside diameter of the shell. In order to limit the amount of machining to be done, the shells must not be larger in diameter than is determined by this gage. Gages *D* are intended for testing the inside taper of the shell. The end of the gage must not touch the bottom of the shell. Two gages are provided for different parts of the inside taper of the shell.

The gage used for testing the thickness of the base or the bottom of the shell, as well as the total length, is shown at *K*. Here *L* bottoms on the inside of the shell, while the other leg passes along the side outside the shell. When the shell base is of the right thickness and the shell of the right length, the base surface of the shell must come within the limits indicated at *M* and the length must not pass beyond the line *N*.

One more gage is used for testing the concentricity of the shell. This consists of a mandrel *G*, Fig. 15, provided with a movable head *H*, which is supported on rod *J*. This head contains three radial pins *K*, which are forced out by the taper on rod *J*, thus centering the shell at the top. On the mandrel *G* is turned a collar which centers the shell at the mouth. The shell is placed on the assembled mandrel with the mouth or open end down. In the base *F*, into which the mandrel is set, is a post or arbor on which the gage collar *A* is assembled, so that it is free to turn in a horizontal plane and also is movable up and down on the arbor. This up and down movement is controlled by the spiral spring *L*, which is supported on the lower end by collar *D*. The pins *E* keep the parts together. The shell is rotated on the mandrel, and collar *A* is pushed down into contact with the base of the shell. While the shell is given one complete rotation, the gage point on the collar *A* must, at no position, slip down off the base of the shell. In other words, the gage point on *A* determines the maximum radius of the shell.

The preparation of the preceding article was made possible through the courtesies of G. C. Brainard, general manager, and J. D. Corcoran, factory manager, of the Hydraulic Pressed Steel Co., Cleveland, Ohio, as well as by the assistance of S. S. Daykin, engineer of tests, who aided in compiling the information given.

French Method of Forging 75-millimeter Shells

In this connection, it may be of interest to outline briefly the method used in France for the forging of 75-millimeter shells, as this method differs from that used by the Hydraulic Pressed Steel Co. This process is of especial interest to American readers on account of the fact that its application is being considered by several manufacturers of forgings in this country; among others, by the American Shell Co., Paterson, N. J. Should the latter company decide to build a forging plant to produce its own forgings, a matter which is contemplated, use would be made of a modification of the French process.

This process consists briefly of three operations—a piercing operation, a hot-drawing operation, and a cold-drawing operation. By these processes, shells can be produced having so good an internal finish and such accurate inside dimensions that no further machining is required on the inside. Furthermore, only a finish-turning operation is required on the outside, the rough-turning operation being eliminated. It is possible to obtain the required results by simply using the piercing and hot-drawing operations, but an improved shell is produced by adding the cold-drawing operation.

Diagrammatical views of the piercing, hot-drawing, and cold-drawing tools are shown in Figs. 17, 18, and 19. In the first or piercing operation, Fig. 17, no outside die is used; the punch *A*, mounted at the bottom, is stationary, while the punch *D* comes down from the top, pressing the forging downward against the punch *A* and forcing out the sides in an umbrella shape. The forging is then taken to the hot-drawing dies in Fig. 18, where it is drawn through die *C*, which forces it onto the plunger *D* so that the inside of the shell will conform exactly to the shape of the plunger. In passing downward, the shell pushes the strippers *E* outward against the spring pressure. As soon as the shell has passed, the strippers close in upon the plunger, and when the latter returns, they strip the shell from it. The shell is taken out through an opening in the side of the die frame *F*. After the completion of the second operation, the shell is sand-blasted and cleaned from all scale. The best results are then obtained by subjecting the shell to a cold-drawing operation in the die shown in Fig. 19. This differs from that in Fig. 18 only in that there is no bottom die *G*. While it is possible to obtain a satisfactory shell forging by simply using the first two operations, the adding of the cold-drawing operation is recommended; however, only the first two operations were generally used in France until recently, when the cold-drawing operation was added. After the cold-drawing operation, the outside is only slightly over size, so that a finish-turning operation only is required. Furthermore, the cold-drawing process improves the surface of the metal considerably, making it firmer and stronger.

Lay-out of Forging Plant

Fig. 20 shows a lay-out of a forging plant which may be considered a model design. This is a forging plant planned and arranged by the American Shell Co., for its contemplated extension, the capacity of the plant being fifteen thousand 75-millimeter shell forgings per day of twenty-four hours. This plant includes conveyors for mechanically handling the material and the shell forgings, and an equipment for heat-treating or normalizing the forgings so as to remove all the strains of the metal after the forging operations are completed. This normalizing of the steel causes a refinement in the structure of the grain and increases the elastic limit.

The piercing presses are of 350 tons capacity, and the drawing presses of 210 tons capacity. At *A* is shown an elevated platform 2½ feet above the floor level and 6 feet wide, which provides for a clear passageway. Gravity conveyors for the hot forgings pass underneath this platform from the piercing to the drawing presses. Hand trucks carrying dies and tools use the platform. At *B* are shown the 21-inch by 15-foot hydraulic accumulators, which work at a pressure of 1500 pounds. Ore is used for ballast. At *C* are shown steam pumps which are triple-expansion, condensing, and work with a 26-inch vacuum, producing 1500 pounds per square inch discharging pressure. The steam pressure is 140 pounds per square inch. The steam cylinders are 18, 29, and 46 inches in diameter, respectively, and the stroke is 24 inches. The pump cylinder is 6 inches in diameter. At *D* are shown boilers of 450 horsepower rated capacity, each producing steam at a pressure of 160 pounds per square inch. The circle at *E* indicates a concrete fuel oil storage tank having a capacity of 80,000 gallons, the daily demand for the plant shown being 4000 gallons.

CONTOUR- AND RADIUS-MEASURING INSTRUMENT

UNIVERSAL TYPE OF INSTRUMENT FOR MEASURING IRREGULAR PROFILES, RADIUS GAGES, AND CONTOURS THAT CANNOT BE TESTED BY ORDINARY MEASURING DEVICES

THE accurate measurement of contour and radius gages is often very difficult, if not impossible, when ordinary measuring appliances are utilized. The contour- and radius-measuring instrument to be described is designed especially for the accurate measurement of irregular profiles, circular edges, or various combinations of straight and curved sections. This instrument was designed by J. H. Wilhelm for the Frankford Arsenal. An instrument of this general type was required for measuring the contour of rifle bullets (which must conform within close limits to a given size and shape), but the instrument as finally made is a universal type that is applicable to all kinds of profile measurement.

This instrument (see Figs. 1 to 3) is equipped with a microscope having cross-hairs or lines which are adjusted to coincide with the different edges and intersecting points on the part being measured, and these hair lines, in conjunction with the graduations and Johansson gages used, indicate the amount of error or enable measurements between different points to be taken. The microscope *A*, Fig. 2, is mounted upon a cross-arm or carriage *B*, which is pivoted at each end to holders *C*. The fulcrum pins are adjustable along the holders, and they are accurately located in any desired position by Johansson blocks. These pins are reduced one-half their diameter, and by inserting different combinations of gage-blocks, any radius from 0 up to 6 inches can be measured. For instance, if 0.020-inch blocks are inserted in each holder, a radius of this dimension can be measured accurately. The gage-block holders are pivoted to brackets *D* attached to slide *E*, and the outer ends of the holders are connected by a tie-rod. The horizontal slide *E* provides a lateral adjustment of six inches, the micrometer and the straightedge at *F* (which is integral with slide *E*) moving in parallel planes. This adjustment is effected by a rack and pinion operated by handwheel *G*. The screw *H* is used for making fine adjustments after a split nut is engaged with it. This fine adjustment is indicated by a scale and vernier at *J*, and Johansson blocks may also be inserted at *K* when a very accurate movement of the slide is necessary. The horizontal slide is locked in position by clamping screw *L*.

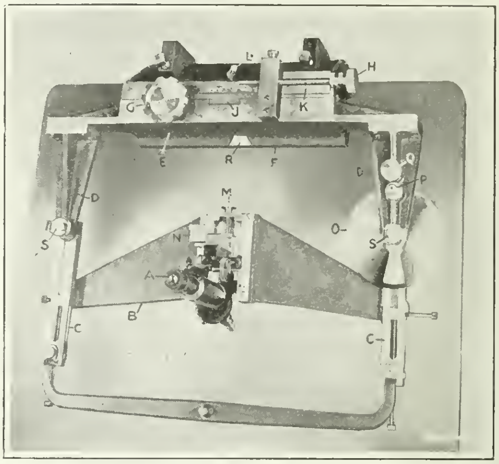

Fig. 2. Plan View of Contour- and Radius-measuring Instrument

The microscope is carried by a slide which can be adjusted at right angles to straightedge *F*. There is a total movement of two inches in this direction, and either Johansson blocks at *N* or a scale and vernier may be used when making the adjustment, which is effected by screw *M*. The circular movement of the microscope and its carriage is indicated by dial *O*, which is graduated to 90 degrees on each side of the zero mark, or to 180 degrees in all. By means of a vernier scale, direct readings to 5 minutes can be taken. The disk is shown in the zero position in Fig. 2 and in the 90-degree position in Fig. 3. It is held positively in the zero position by lock-pin *P*, and it may be clamped in any other position by clamp screw *Q*. When the lock-pin is in place, the hair line on the microscope coincides with a plane which is at right angles to the straightedge *F* and intersects the center line *R* on this straightedge.

These different adjustments and means of measurement make it possible to determine very accurately the movements of the microscope, whether the direction of motion is parallel to straightedge *F*, at right angles to it, or along a circular path. The microscope is provided with six objectives, the three shown in position being interchangeable with three others. By using these different objectives, the magnification may be varied from 20 to 100 times. In some cases, high magnifying power would not be suitable, because irregularities in the edge or contour of the part being inspected would be enlarged to such an extent as to make it difficult to follow readily the general outline; moreover, the constantly changing focus due to pronounced irregularities would interfere, so that a relatively low magnification is desirable for the rougher classes of work, and a more powerful objective for exceedingly fine work.

Before using the contour- and radius-measuring instrument, a glass scale having graduation lines spaced 0.001 inch apart is placed on the surface plate and the microscope is focussed onto it. The microscope is fitted with an adjustable eye-piece (not shown in the illustration) and the hair line is traversed from one of the graduations on the glass scale to the next one, and the reading of the graduated dial of the adjustable eye-piece is noted. If this is a fractional reading, the microscope is adjusted vertically and focussed again; another reading is then taken, and if it is necessary other readjustments are made, until a movement of the hair line from one graduation line to the next one gives a reading on the eye-piece dial equal to an even or whole number of divisions. The dial then gives direct readings and may readily be used for measuring errors in gages or other parts under observation.

The work to be inspected is placed on the surface plate which forms the base of the instrument and is located, in some cases,

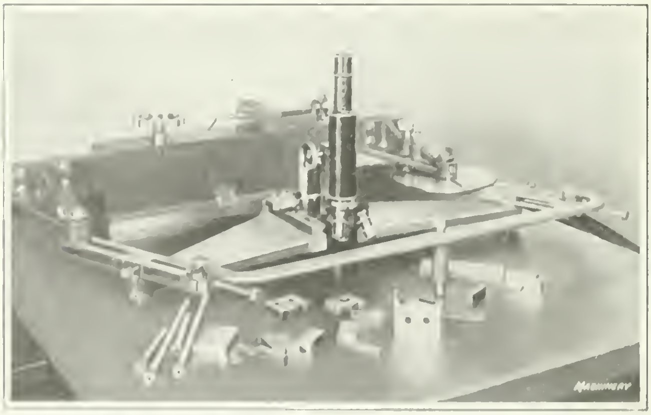

Fig. 1. Contour- and Radius-measuring Instrument for testing Accuracy of Irregular Profiles or Circular Edges on Templet Gages, etc.

with reference to the straightedge *F*. For instance, it may be necessary to have a straight section of a contour gage parallel with this straightedge. The work can easily be set in this parallel position by simply adjusting it until the intersection of the hair lines follows the straight section when slide *E* is traversed laterally. If a contour gage or templet is being measured, the distance between parallel edges or surfaces lying in different planes is, as a rule, measured by moving the slide upon which the microscope is directly mounted and also by adjusting the main slide *E*, as may be required. As previously mentioned, the extent of these movements may be determined accurately either by vernier scales or the Johansson gage-blocks. For instance, in testing the accuracy of the profile gage shown diagrammatically in Fig. 4, the measurements indicated by the letters *a*, *b*, *c*, etc., would be taken first, since they represent distances between important surfaces and intersecting points. It might be necessary also to check angle *x*. This could be done readily by the method shown on an enlarged scale at the lower part of the illustration. The hair lines are first set to coincide with the angular edge as at *A*, and then the microscope is adjusted to some position *B*. An adjustment at right angles is next made, the movement *y* in this direction equalling dimension *z* times the tangent of the required angle.

When measuring the radius of an arc or circular edge, the pivots of the cross-arm *B*, Fig. 2, which carries the microscope are set in the zero position or in line with the fixed pivots *S*. The intersecting point of the hair lines is then set in line with the center of the arc, this center being located by adjusting the microscope longitudinally and laterally with reference to locating points on the work and according to dimensions on the gage drawing. After the microscope has been set in this way, the cross-arm pivots are adjusted to the required radius by inserting Johansson blocks in the holders *C*; then, as the holders swing about pivots *S*, the intersecting point of the hair line should follow the circular edge of the gage. This test not only shows an error in the radius, but also an error in the location of the circular edge. The amount of error may be measured by the graduated dial of the adjustable eye-piece previously referred to. If the angle included by the arc is required, it is simply necessary to note the reading on dial *O* as the cross-arm traverses from the beginning of the arc to the point of tangency or to the end of the circular section.

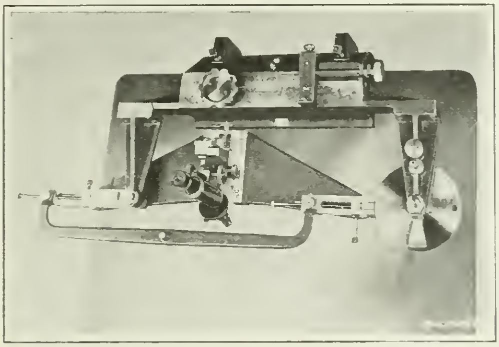

Fig. 3. Microscope and its Carriage set in 90-degree Position

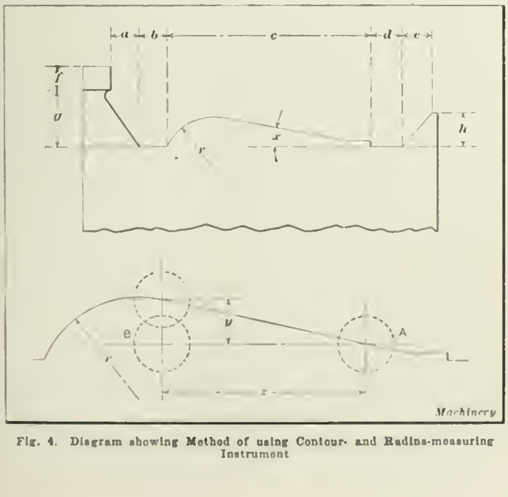

Fig. 4. Diagram showing Method of using Contour- and Radius-measuring Instrument

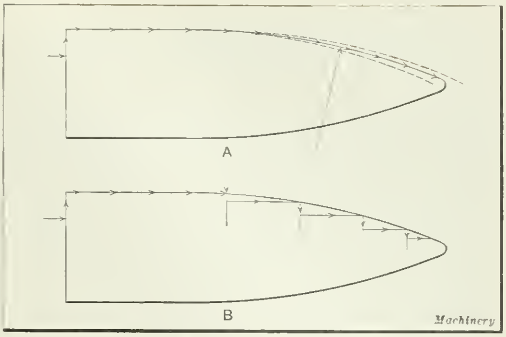

Fig. 5. Two Methods of measuring Rifle Bullets

When this instrument is to be used for measuring parts of circular cross-section (such, for example, as rifle bullets) the microscope is first focussed on the point of tangency or with reference to a horizontal plane intersecting the center of the object to be inspected. As it would be difficult to focus on the point of tangency or on the side of a cylindrical part, the proper focus is obtained by placing on the surface plate Johansson blocks having a total height equal to one-half the diameter of the part to be tested. The microscope is then focussed on the surface of the upper block. Fig. 5 illustrates two methods of measuring the contours of rifle bullets. The method shown at *A* consists in measuring from the base of the bullet to the point of tangency, then measuring the radius of the arc after locating the microscope directly over the center of the arc, and adjusting the cross-arm pivots the required amount. The dotted lines indicate how errors either in radius or in the proportions of the bullet may be detected. What might be defined as the "step method" is illustrated at *B*. After measuring from the base to the point of tangency, the contour is checked by a series of lateral and longitudinal movements as the illustration shows. The universal adjustment of this instrument makes it possible to test the accuracy of practically any profile for comparing it either with a master gage or with prescribed dimensions. F. D. J.

* * *

According to figures collected by John Lind, assistant secretary of the National Lumber Manufacturers' Association, one large automobile concern, in 1913, lost $2,500,000 in hiring, temporarily training, and then losing or dismissing 52,445 men in order to keep a constant working force of 13,000 men. This may be an extreme condition, but it indicates the cost of changing men and shows that it pays to keep a steady permanent body of labor. This large labor turnover has now been greatly reduced by this firm. A Pittsburg corporation with a permanent force of 16,000 men had a labor turnover, in 1916, of 187 per cent. Experts estimate that it costs from $40 to $150 to hire and train a new workman; hence this amount is lost if he is dismissed or becomes dissatisfied and leaves of his own accord.

* * *

Figures published by the Bureau of Labor Statistics indicate that there is an increase of 1,426,000 in the number of women employed in the United States in 1917 over the number employed in 1914. Women have replaced 1,413,000 men since 1914; 530,000 more women are now in the industries than in 1914, and 214,000 additional women are in government service.

IMPROVED METHOD FOR FINDING CONTENTS OF CYLINDRICAL TANKS

BY CARLO M. EYSTER[1]

On page 644 of the March number of MACHINERY, the writer described a graphic method of finding the contents of cylindrical tanks, but that method has since been displaced by two improved charts. The problem, as explained in the previous article, is to determine the height of various quantities of liquid in a cylindrical tank, placed as shown in Fig. 1. The heights thus obtained are used for graduating wooden gage sticks that measure, roughly, the contents of cylindrical oil and gasoline tanks; the graduations read in even number of gallons. These sticks are divided into from twenty to one hundred parts, depending on the tank size.

The first of the improved charts, Fig. 2, is the original curve with the addition of a series of percentage curves. The single curve in the right-hand part of the diagram is constructed on the principle that there is a constant relation between the quantity of liquid in any tank and the height to which this quantity will reach. In other words, the per cent of total capacity and the per cent of diameter are in a constant ratio at any point in all tanks. This is the curve shown in the March number and is explained in detail there. The percentage curves in the left-hand part of Fig. 2 eliminate any multiplying in changing from per cent of diameter to height, in inches, and are based on the fact that a percentage curve is a straight line. Percentage curves could also be constructed with the percentage of the total capacity as one coordinate; the latter curves, however, would lie below the main original curve in the same manner as the percentage curves shown lie to the left. Then, given a tank of a certain capacity and diameter to compute the height to which a given quantity will reach, all values can be read off directly in gallons and inches.

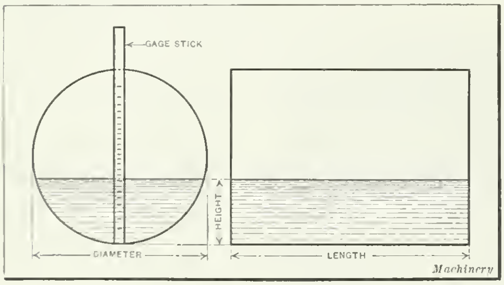

Fig. 1. Use of Gage Stick in Cylindrical Tank

The second chart, shown in Fig. 3, is simpler and more accurate than the first. The abscissa is the percentage of the total capacity, as before, but instead of each per cent being equal in length, as in the previous curves, the spaces are laid off as they will appear on a gage stick. The divisions decrease in length as they approach the center and increase after passing it; their length can be computed from the tables given in any handbook for the areas of segments of a circle.

The original chart of Fig. 3 was constructed by assuming a tank 100 inches in diameter and 100 gallons capacity in order to change readily from units to per cents. Values were computed for the height, in inches, to which each additional gallon of liquid would reach. Each of these quantities was then considered a percentage of the total capacity, and laid off a distance, from the left, on the horizontal base line equal to the height, in inches, just computed. The spaces on the horizontal base line, or abscissa, as they are constructed, are the divisions of the diameter to which the various percentages of the total capacity will extend. Since these divisions, although labeled percentages of capacity for convenience in applying the chart, are in reality the percentages of the diameter, straight oblique lines can be constructed as shown, and these are the working curves. The figures at the right of Fig. 3 represent the diameter of the tank and the graduations to be used on the gage stick, in inches.

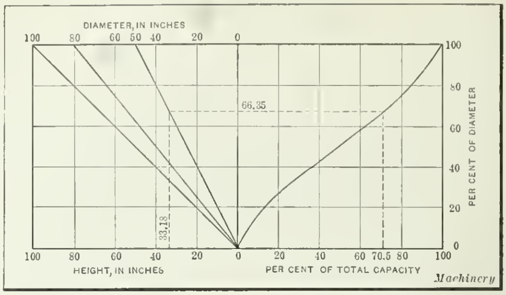

Fig. 2. Chart for graduating Gage Sticks

It will be perceived that per cent curves can be constructed in Fig. 3 also, so that quantities expressed in gallons can be read off directly without having to deal with the percentage of the capacity. The reason that this is not done in the case illustrated is that the diameters and lengths of tanks are all in even inches, so that the capacities of the tanks vary somewhat from the nominal rating. Thus, a tank specified as a 1000-gallon tank may contain 1018 gallons, since the volume is a function of both length and diameter. There would thus be an endless number of total capacity lines, whereas the diameters are all covered by perhaps ten curves, because standard-size heads are used.

Example—Suppose that it is desired to lay out a gage stick for a tank 50 inches in diameter and 100 inches long, with a total capacity of 850 gallons, the gage to be graduated in units of 20 gallons. To determine, for instance, to what height in the tank the first 600 gallons will reach, divide 600 by 850; this shows it to be 70.5 per cent of the total capacity. Drawing a line from this point on the base line until it intersects the straight oblique curve for a 50-inch diameter tank, and then drawing a line at right angles to the value for height in tank, in inches, will give 33.18 inches as the length on the gage stick at which 600 gallons will be indicated. Each value can be quickly determined in this manner.

The figures given, in inches, in both curves can be considered either diameters of the tank or heights of the liquid. The double row of figures illustrates what can be done in order to obtain more accurate readings, since the smaller values, running from 0 to 25 inches, will give closer results than those from 0 to 100 inches, and should be used for tanks less than 25 inches in diameter. The oblique percentage curves should never be more than 60 degrees nor less than 30 degrees from the horizontal for the sake of accuracy. Both of these curves are so broad as to be applicable to any depth in any tank of any diameter and length.

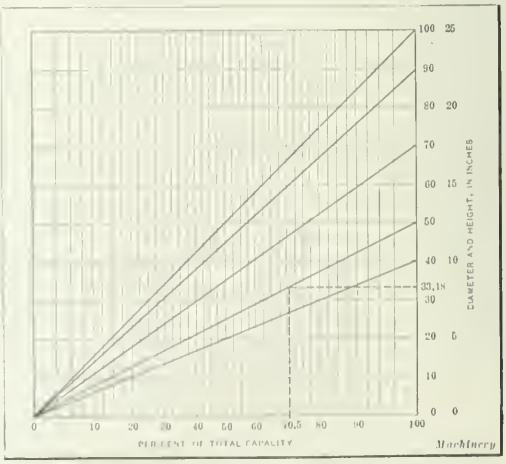

Fig. 3. Improved Chart for graduating Gage Sticks

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[1] Address: 3206 Central Drive, Fort Wayne, Ind.

CONSERVING MECHANICAL ABILITY

BY A. H. J.

The time is ripe for mechanical men in this country to get together and in some way draw the attention of the Government to the urgent necessity of exempting from active service the machine and tool designers, toolmakers, and gage-makers, who are proving more and more every day that it is part of their job to win this war. The proposition can be taken up in much the same way as the medical profession obtained its exemptions, for the mechanical men of the country are just as valuable in their line as the medical men are in theirs. Furthermore, if mechanical ingenuity and thought had not been applied to the medical profession it would not be in as advanced a stage as it is. No surgeon would attempt a capital operation with instruments of crude manufacture; neither could he use the X-ray, pulsometer, testing microscope, or any of his other instruments if it had not been for the toolmaker or designer whose ingenuity made it possible for these instruments to be manufactured in such a high state of perfection. There is little doubt that of the millions of articles manufactured today in this country, 99 per cent were invented or improved by mechanical men.

If this is true, which can easily be determined by an investigation, why is it that the Government should take such constructive men away from their work which has required years to learn and make destructive, non-producing men out of them? Is it of advantage to this country to reduce the high production and high standard of quality for which we are known throughout the world? For that is what we are doing when we draft into the army men trained to keep this production and quality at its present level.

It has been stated that in the first 5 per cent of the draft they received at Camp Upton twenty-five designers, six mechanical engineers and twenty-five or thirty mechanics, such as toolmakers, gage-makers, machinists, etc. If each mechanical engineer is a graduate from a college having a four-year course, but without the practical experience, for the six men this will mean twenty-four years of preparation. In order to be a designer, a knowledge of machine shop practice is essential. Assuming that the designer serves an apprenticeship of four years, and in addition has from six to twelve months' training in mechanical drawing and from two to three years on detail work, according to ability, the preparation of a designer requires about six to eight years; to be conservative, say five years. For the twenty-five designers this means 125 years of preparation. Machinists serve a four-year apprenticeship; toolmakers, who are graduate machinists, five to six years; gage-makers, five to seven years. As a result, considering five years as the average instruction period required by the mechanic, the time spent by these men preparing for their work is:

25 mechanics	125 years
25 designers	125 years
6 mechanical engineers	24 years
Total	274 years

This does not mean a staff of "dyed-in-the-wool" practical, experienced men, but men who will, after the war is over, help in the reconstruction period.

Under present methods of warfare in Europe it would appear that we might be able to use about two out of every four or five men if they all came back; but, assuming that we lose two out of five men, one being killed in battle and one maimed, the loss is:

2 mechanical engineers	8 years
10 designers	50 years
10 mechanics	50 years
Total	108 years

In other words, 108 years of mechanical skill is lost. Can you imagine what a staff of men like this in any plant in the country could do to produce articles that are urgently needed? The same men, working under an experienced engineer, could do more effective work in a ten-hour day at a plant on government work than they could do in a month in the trenches. These figures do not include men who have had ten, twelve, or fifteen years practical experience, and there are some men at Yaphank who have had a number of years of experience in this line of work.

It is not the writer's intention to give the impression to men outside of the mechanical field that all mechanical men should be exempted. It is strongly urged that the Government mobilize all these producing men in a great army and send them throughout the country to plants where they will be able to do their best in speeding up the manufacture of the thousand and one articles necessary to the successful prosecution of the war; and when the reconstruction period comes, they will be in a position that will require no readjustment. France and England realize the great mistake they made in letting their mechanical men go to the front, and have had to come to this country for their supplies. If we make this same mistake, there is no source to which we can turn, and so will have to take the consequences.

There are at present, to the writer's knowledge, about a dozen concerns around New York that are doing government work, but have only half enough men to get out the work, because of the scarcity of men. One firm in July, 1917, inserted advertisements for draftsmen in two New York papers for one week and only received twelve replies. Out of these twelve, about five applicants appeared promising, so letters were sent to these asking each to call. Four of the men called. One did not think he was able to handle the job, one man was capable, and the other two men were not experienced in that branch, but were willing to learn. So the result of one week's advertising was one capable man and two green hands. This firm pays its men well and the men in charge have good reputations in handling men, yet it is unable to obtain enough men. If this is true concerning conditions a short time ago, what will it be a little later?

* * *

PULVERIZED COAL AS A FUEL[1]

Owing to the fuel famine, the use of pulverized coal as a fuel is now being carefully studied. Practically any coal can be burned in the pulverized form with a proper furnace and burning equipment, but each application must be governed by the quality of the fuel available. Generally speaking, however, the coals that will give the most satisfactory results are those having an ash content of less than 10 per cent, volatile content between 30 and 40 per cent, and a fixed carbon content between 40 and 50 per cent. The sulphur content should be low, although coal with a sulphur content as high as 4½ or 5 per cent has been satisfactorily burned. In the pulverized forms, many coals that are now thought unsuitable will be made available for use, especially the various grades of lignites and low-grade coals of the Northwest.

The value of this form of fuel has been recognized by the steel industry which today is using about two million tons annually, in its open-hearth, heating, puddling, annealing, and forging furnaces, and soaking pits; between thirty and forty million tons have been used in the manufacture of Portland cement; for the desulphurizing and roasting of various grades of ores and the nodulizing of flue dust, one installation alone requires 120 tons a day; and one of the many electrical power plants that use this fuel burns over 100,000 tons annually. Pulverized coal is also successfully used in burning lime in rotary kilns for making oxide of lime for use in the open-hearth furnaces and also for burning dolomite to replace magnesite used for furnace linings. This fuel is so abundant that in the anthracite field alone from eight to ten million tons are annually pumped back into the mines to fill up old workings, and around steel plants there are large quantities of waste in the form of coke breeze. Tests made with one furnace of the Calumet Steel Co. showed a saving of $6019 in one year. With coal at $2.65 per net ton and oil at 3 cents a gallon, a daily saving in fuel of 49 per cent was made. In addition, at least 2 per cent less scale was formed.

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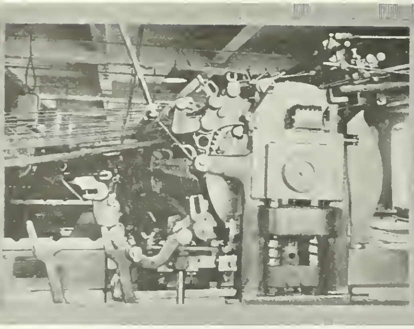
[1] Abstract of a paper by Henry G. Barnhurst, read before the Cleveland Engineering Society



Ingenious Mechanical Movements

By Franklin D. Jones[1]

Second Installment of an Article on Mechanisms for Transmitting, Modifying, and Controlling Motion to Secure Changes of Velocity, Direction, and Time of Action[2]

THE design of a mechanism for changing rotary motion to rectilinear or straight-line motion, or vice versa, may depend upon the kind of motion required, the amount of power to be transmitted, or other considerations. The crank and connecting-rod is not suitable for some classes of machinery, either because of the irregular motion imparted to the driven slide or cross-head by a revolving crank, or because such an arrangement would require too much space in case a long stroke or traversing movement were necessary for the driven member. Some of the most ingenious mechanisms for converting rotary motion into rectilinear motion are found on printing presses of the flat-bed or cylinder type. When presses of this general class are in operation, the sheets to be printed are carried around by a revolving cylinder so that contact is made with a flat form on the press bed, which moves horizontally beneath the cylinder. This cylinder makes one revolution during the printing stroke and a second revolution while the press bed is being returned. The rotation of the cylinder is continuous in one direction, and it is imperative that the cylinder and press bed move exactly in unison. The circumferential velocity of the cylinder should equal the linear velocity of the bed, because any relative motion would cause slurring on the printed sheets and it would be impossible to obtain sharp, clean-cut impressions. As the cylinder revolves at a uniform speed, obviously the mechanism for driving the bed must be designed to give a uniform motion while the impression is being made. Several press-bed motions are provided with a driving gear which rotates continuously in one direction and is located between parallel racks, and so arranged that it can be engaged with first one rack and then the other, in order to reverse the motion of the bed to which the racks are attached. With mechanisms of this class, one rack is first traversed past the gear; when the gear and rack are entirely disengaged, the gear is shifted axially far enough to align it with the other rack. While this shifting movement takes place, the motion of the bed is arrested, and it is reversed by some auxiliary mechanism which moves it far enough to bring the other rack into engagement with the driving gear. Press-bed motions of this general type differ principally as regards the method of moving the press bed at the ends of the stroke, at the time when the driving gear and rack are disengaged.

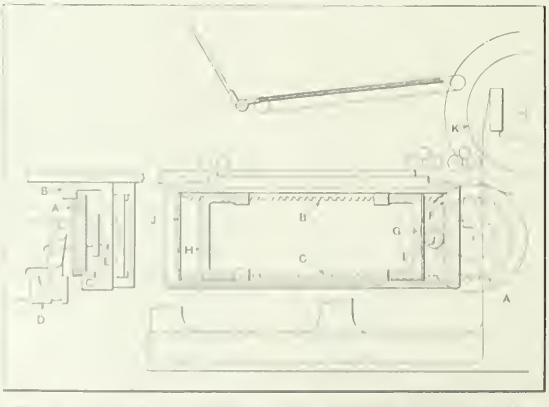


Fig. 16. Double-rack Shifting-gear and Crank Combination for traversing Bed of Printing Press

Crank Type of Reversal for Press-bed Motion

A mechanism of the double-rack and shifting-gear type, such as is applied to the Miehle flat-bed or cylinder presses, is shown diagrammatically in Fig. 16. In order to time the motion of the cylinder and bed properly, the cylinder is connected by gearing and suitable shafts with gear *A*, which transmits motion to the bed; therefore, the press-bed motion must be designed to reverse the movement of the bed without reversing the motion of gear *A*, since this gear rotates in unison with the cylinder or continuously in one direction.

This driving gear *A* is mounted between parallel racks *B* and *C*, both of which are attached to and travel with the bed. The distance between the pitch lines of these racks corresponds to the pitch diameter of the driving gear *A*. The racks are not directly in line, but are offset as shown by the end view, so that, when the gear is in mesh with one rack, it will clear the other. The lateral movement of gear *A* for aligning it alternately with racks *B* and *C* is derived from cam *D*, which transmits motion by means of a lever and yoke engaging the gear hub.

When the press is in operation, the bed is moved in one direction by the engagement of gear *A* with rack *B*, and in the opposite direction by gear *A* meshing with rack *C*. If gear *A* is revolving in a clockwise direction while in mesh with rack *C*, the latter and the press bed (the motion of which is constrained by guides) will move toward the left. When the press is in motion, this movement toward the left continues until the rack is entirely out of mesh with gear *A*; just before the disengagement of gear *A* and rack *C*, the crankpin *E*, which is provided with rollers, comes around and enters between the parallel faces of a fixed reversing shoe *F* and a swinging or movable reversing shoe *G*. The fixed shoe is rigidly attached to the press bed and rack frame, whereas the movable shoe is pivoted and is free to swivel. This swinging reversing shoe has a pin on its lower side (not shown) which engages a slot or cam that controls its swinging movements. As soon as rack *C* has moved far enough to the left for shoe *G* to clear the crankpin, the cam swings the shoe inward so that crankpin *E* is confined temporarily between the faces of shoes *G* and *F*, which form a vertical guide or slot. As the crankpin passes its lowest position and begins to move upward, the roller on it bears against the face of *G* and picks up the load as gear *A* moves out of mesh with rack *C*.

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[1] Associate Editor of Machinery.

[2] A chapter that will be included in the author's book "Mechanisms and Mechanical Movements" to be published in the near future.

When crankpin *E* assumes the position shown in the illustration, the motion of the press bed is reversed, because a roller on the crankpin then engages the face of shoe *F*, thus moving the driven member toward the right. The motion continues to be derived from the crank independently of the disengaged gear and rack, until the crankpin has passed the top quarter or highest position; then gear *A* enters the upper rack *B* and the motion is transmitted entirely through the gear and rack until the crank again comes into action at the opposite end of the stroke. At this end, the crankpin is again confined between a swinging shoe *H* and a fixed shoe *J*. After rack *B* has moved out of engagement with gear *A*, crankpin *E*, which is now in its highest position, comes into contact with shoe *H* and continues the movement toward the right while making a quarter turn, and then reverses the motion as it swings downward against the face of shoe *J*. While crankpin *E* is controlling the motion and gear *A* is entirely out of mesh, this gear is shifted by cam *D* out of line with the rack *B* which it just left, and into line with rack *C*.

An ingenious feature of this mechanism lies in the provision of two rollers for crankpin *E* and the location of the fixed and swinging shoes in different vertical planes. With this arrangement, each roller is free to revolve in opposite directions as the crankpin moves along the vertical faces of the shoes. The momentum of the bed is gradually checked at the points of reversal, by air cushions or air springs. A plunger enters a cylinder at each end of the stroke and air is compressed to arrest the movement; as the air expands, it assists in accelerating the motion of the heavy bed. Provision is made for regulating the air cushion or pressure according to the speed of the press. The air cushion is a feature common to flat-bed or cylinder presses in general.

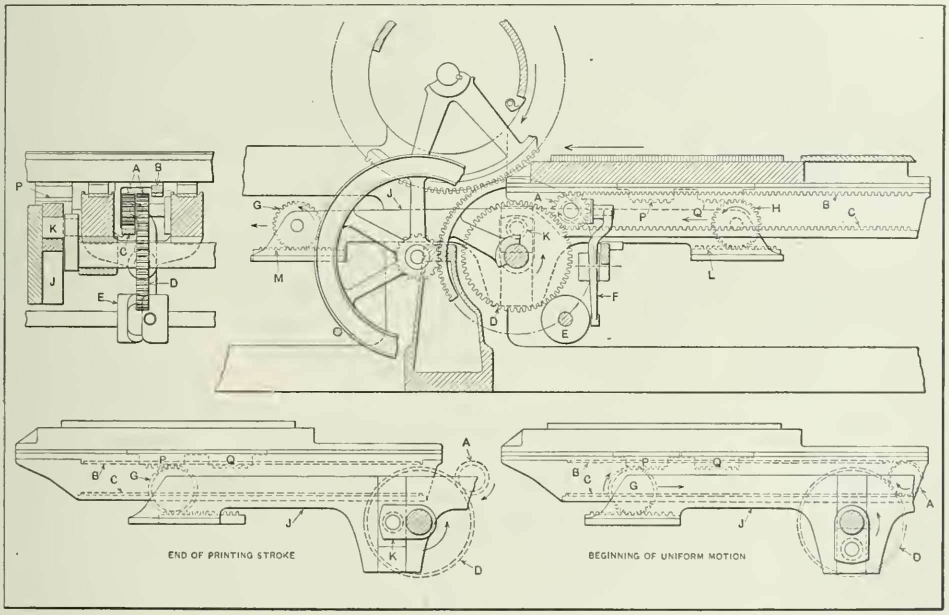

Fig. 17. Double-rack and Shifting-gear Mechanism for Press Bed having Reciprocating Pinions for controlling Motion at Ends of Stroke

Reversal of Motion by Reciprocating Pinions

The mechanism illustrated in Fig. 17 is similar, in some respects, to the press-bed motion just described, in that the parallel-rack and shifting-gear construction is employed. The method of operating the press bed at the ends of the stroke, however, is entirely different from that shown in Fig. 16, as reciprocating pinions are used to pick up the load and reverse the motion. The uniform motion of the bed is derived from pinion *A*, which is constantly in mesh with gear *D* carried on the main driving shaft. Pinion *A* is located between parallel racks *B* and *C* which are attached to the press bed. These racks are offset, as in the design shown in Fig. 16, so that the pinion will clear one rack while in engagement with the other. The shifting of the pinion is controlled by cam *E*, which transmits motion to the pinion by means of lever *F*. The pinions for reversing the motion of the bed are located at *G* and *H*. The shafts upon which these pinions are mounted are connected to a heavy yoke *J*, which has a vertical slot or groove in which a swiveling block attached to the crank *K* operates. This crank is rotated by the main driving shaft, and transmits to yoke *J* and pinions *G* and *H* a rectilinear motion equal to the throw of the crank. This is a harmonic motion, as yoke *J* and the sliding crank-block operate on the same principle as the well-known Scotch yoke. The outer ends of yoke *J* are supported by horizontal guides, and the pinions *G* and *H* are constantly in mesh with short racks *M* and *L*, along which the pinions roll as the crank moves them to and fro.

The action of the mechanism will be apparent by considering the various movements that occur during a forward and return stroke. The side view of the assembled mechanism shows the press bed in the position where the driving pinion *A* has just come into engagement with the lower rack *C*. As this pinion rotates in a clockwise direction, the bed will be driven to the left with a uniform motion. The relative positions of pinion *A* and racks *B* and *C* are clearly shown by the end view. When the bed has moved so far to the left that pinion *A* is about to roll out of mesh at the right-hand end of rack *C*, pinion *G*, which, meanwhile, has been moving along its rack *M*, comes into engagement with another short rack *P* (see also end view) attached to the bed. To insure the proper engagement of pinion *G* with rack *P*, the action of crank *K* is so timed relative to the motion of the bed that pinion *G* is rolling to the left when rack *P*, which is also moving to the left, comes into engagement with it. As pinion *A* leaves rack *C*, pinion *G*, which is then in mesh with *P*, continues the movement of the bed toward the left until crank *K* is in the position shown by the diagram in the lower left-hand corner of the illustration, which represents the end of the printing

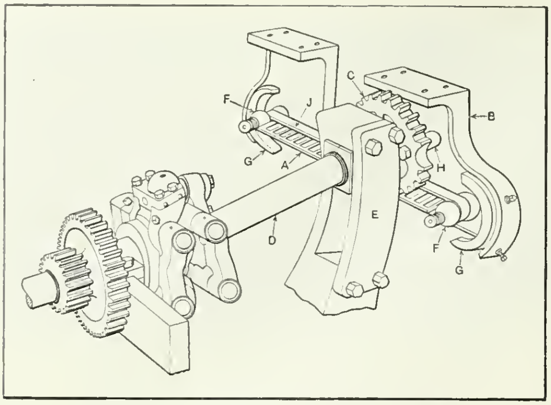

Fig. 18. Napier Motion for Flat-bed Printing Press

stroke. Further rotation of crank *K* in the direction indicated by the arrow causes a reversal of the rolling motion of pinion *G* and starts the press bed toward the right, motion being transmitted from *G* to rack *P*. While this reversal of movement is taking place, pinion *A* is being shifted by cam *E* into alignment with the upper rack *B*.

When crank *K* has moved a quarter revolution from the position it occupies at the extreme end of the stroke, pinion *A* comes into mesh with the upper rack *B* and the short rack *P* leaves pinion *G*. The view at the lower right-hand corner shows pinion *A* about to enter rack *B*, and pinion *G* leaving rack *P*. As the rectilinear motion of yoke *J* is harmonic, the movement of the bed is uniformly retarded as it approaches the point of reversal and is then accelerated until pinion *A* engages its rack, when the motion is uniform. When pinion *A* enters at the end of either rack, the velocity of the movement derived from crank *K* and the reciprocating pinion corresponds to the velocity obtained from the driving pinion *A*, so that there is no abrupt change of motion as the load is being transferred from the reversing pinion to the driving pinion *A*. As the press bed approaches the opposite end of its stroke, pinion *H* comes into engagement with rack *Q* and continues the movement for a short distance each side of the point of reversal or while pinion *A* is out of mesh with either rack and is being shifted, the action being the same as previously described.

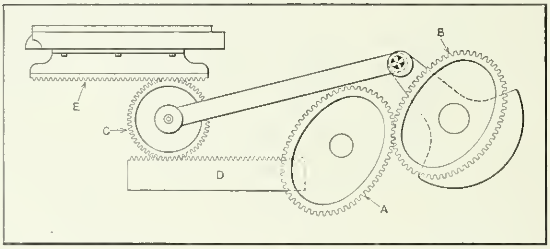

Fig. 19. Crank-driven Pinion engaging Stationary and Movable Racks for doubling Stroke

Napier Motion for Press Beds

When a gear or pinion is in mesh with a single rack and rotates in one position, obviously both the gear and rack must reverse their direction of motion at the end of each stroke. The gear, however, may rotate continuously in one direction if it is arranged to engage the upper and lower sides of a rack designed especially to permit such engagement. A mechanism of this type, known as the Napier motion and also as "mangle gearing," has been extensively used for imparting a rectilinear motion to the tables of flat bed printing presses. The principle of the Napier motion will be apparent by referring to Fig. 18. The rack *A* is attached to a frame *B* which is secured to the table of the printing press. The rack teeth are of such a form that the gear *C* can mesh with the rack on either the upper or lower sides. The shaft *D*, upon which gear *C* is mounted, is rotated through a universal coupling, which permits it to swing in a vertical plane so that the gear may pass from the upper side of the rack to the lower side, and vice versa. The gear shaft is made to move in a vertical plane by a stationary slotted guide *E*, having a vertical slot that is engaged by a sliding block mounted on the shaft. Spherical-shaped rollers *F* are mounted at each end of the rack, and the gear has a socket or spherical depression formed in it for engaging the rollers each time the gear moves around the end of the rack when passing from one side to the other. Opposite each end of the rack, there are guide plates *G* having curved surfaces which are concentric with the rollers at the ends of the rack. Gear *C* also carries a roller *H* which engages these curved guides as the gear moves upward or downward at the points of reversal.

The action of the mechanism is as follows: If the gear is on the upper side of the rack, as shown in the illustration, and it is revolving to the left or counterclockwise, the rack will be driven to the right with a velocity equal to the motion at the pitch circle of the gear. As soon as the gear engages the roller *F* on the end of the rack, it begins to move downward in a vertical plane, because its motion is constrained by guide *E*. When the gear is in mid-position so that its axis coincides with the center line of the rack, it will have made a quarter turn, thus moving the center of roller *F* farther to the right, a distance equal to the radius of the pitch circle. Further movement of the gear downward causes the rack to reverse and move toward the left; the gear then operates on the under side of the rack until the roller at the right-hand end of the rack is engaged, when the upward movement of the gear takes place and there is another reversal of motion.

The total length of the stroke is equal to the distance between the centers of the rollers on the rack plus the pitch diameter of the gear. The length of the rack must equal the pitch circumference of the gear or some multiple of it, so that the rollers at the end will engage the socket or depression in the gear at the points of reversal. If a gear having two roller spaces located 180 degrees apart is used, the length of the rack or the center-to-center distance between the rollers may be some multiple of half the pitch circumference. The teeth on each side of the rack incline from the horizontal at the same angle as the gear axis when in its upper and lower positions, to obtain a full contact of the gear teeth. The gear also has a plain cylindrical shoulder on the inner side, which rolls upon a plane surface *J* at the base of

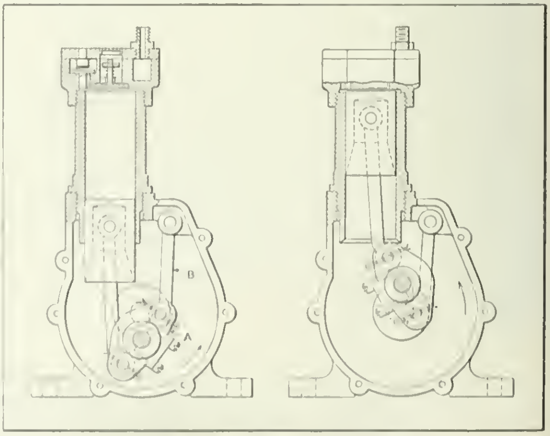

Fig. 20. Crank Mechanism for doubling Stroke

the rack, to give a smoother action than would be obtained from a gear supported entirely by tooth contact. This arrangement of gearing imparts a uniform motion to the press table, with the exception of any variation in movement resulting from a universal joint, and gives a gradual reversal of motion at the ends of the stroke. The Napier motion may be designed for any length of stroke, although the stroke remains constant, as there is no way of making an adjustment.

Crank-driven Pinion Engaging Upper and Lower Racks

A method of doubling the stroke when a crank of relatively small size is necessary, owing to a limited space or because a compact design is desirable, is by means of a stationary and a movable rack having a crank-driven pinion interposed between them. The pinion is pivoted to the end of the crank connecting-rod so that it is free to roll along the stationary rack when the crank revolves. As the result of this rolling movement of the pinion, the movable rack is given a rectilinear motion equal to twice the stroke of the crank or twice the diameter of the path described by the crankpin. This mechanism has been used for driving the beds of cylinder presses.

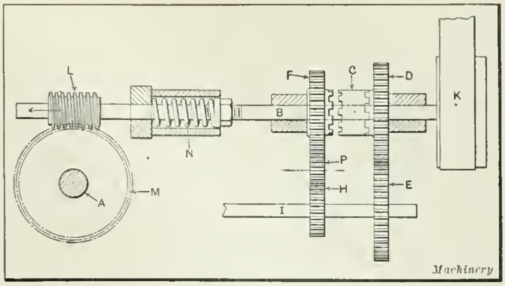

Fig. 23. Device for automatically stopping Feeding Motion when Resistance to Rotation becomes Excessive

A modification of the plain gear-driven crank is shown in Fig. 19, which illustrates the bed motion of a two-revolution pony press. The driving and driven gears *A* and *B* are of the elliptical form in order to compensate for the motion derived from a crank rotating at uniform velocity. The driven gear *B* revolves the crank, which, in turn, transmits motion to pinion *C* by means of the connecting-rod shown. This pinion is rolled in first one direction and then the other along the stationary rack *D*, and imparts a rectilinear motion to rack *E* and the press bed. The press bed moves a distance equal to twice the distance that the axis of gear *C* moves, or four times the radius of the driving crank. The elliptical gears are so proportioned and located relative to the crank as to give a more uniform motion to the press bed than could be obtained with a crank rotating at uniform velocity. With an ordinary crank, whatever part is given a rectilinear motion starts from a state of rest, and the velocity gradually increases toward the center of the stroke and then decreases until it again becomes zero at the opposite end of the stroke. With the elliptical gearing shown, as the pinion *C* approaches either end of its stroke and the crank advances toward the dead-center position, the long side or radius of the driving gear comes into engagement with the driven gear and increases its velocity, and also the velocity of the crank. As the return stroke begins, the velocity of the driven gear and crank gradually decreases, because the radius of the working side of the driving gear gradually diminishes; the result is that, when the crank is at right angles to the line along which the axis of pinion *C* moves and is in a position to impart the maximum velocity to pinion *C*, the speed of the crank is slowest, because it is then driven by the shortest radius of the driving gear. As the crank moves away from this central position at right angles to the center line of motion, the speed is gradually accelerated again, so that pinion *C* does not slow down as it would with a crank rotating at uniform speed. The reversal of the heavy press bed is assisted by means of air springs or cushions, the same as on cylinder presses in general. This mechanism is intended for small presses.

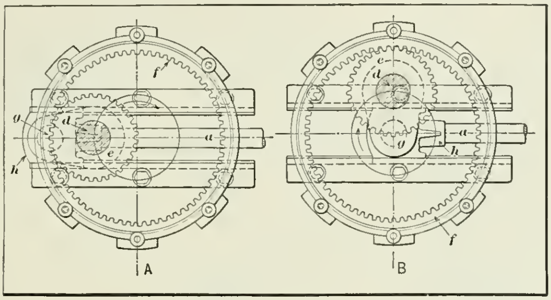

Fig. 21. Planetary Gear and Crank from which Reciprocating Motion is derived

Crank Mechanism for Doubling Stroke

A crank and link mechanism is shown in Fig. 20 which makes it possible to obtain a rectilinear motion approximately equal to twice the throw of the driving crank. This mechanism is shown applied to an air pump for use on automobiles, either for the inflation of tires or in connection with engine starting apparatus requiring compressed air. The crank proper is of the center type with a bearing on each side. The connecting-rod is attached to the yoke *A*, which is mounted on the main crankpin. The opposite end of this yoke is pivoted to link *B*, which is suspended from a pin attached to the compressor casing. As the crankshaft rotates, this link oscillates and so controls the position of yoke *A* that the stroke of the piston is approximately doubled. The view to the left shows the piston at the lower end of its stroke. As the crank turns in a counterclockwise direction, link *B* swings to the right so that the right-hand end of yoke *A* is forced downward and the left-hand end upward, as indicated by the right-hand view, which shows the piston at the top of its stroke. The advantage of this crank mechanism is that it enables a comparatively large capacity to be obtained from a small, compact pump.

Planetary Gear and Crank Combination

The mechanism illustrated in Fig. 21 is applied to an electric coal-puncher. One of the difficulties encountered in designing coal-punchers, with the exception of the solenoid type, has been changing the rotation of the motor into a reciprocating motion for the drill. If the blow is directly dependent upon the motor, the latter causes trouble, owing to the vibrations and strains incident to the blows of the pick; and if springs are utilized, they are likely to break. Types having separate motors and flexible shaft connections have also been tried, but complications were introduced which at least partially offset the benefits derived.

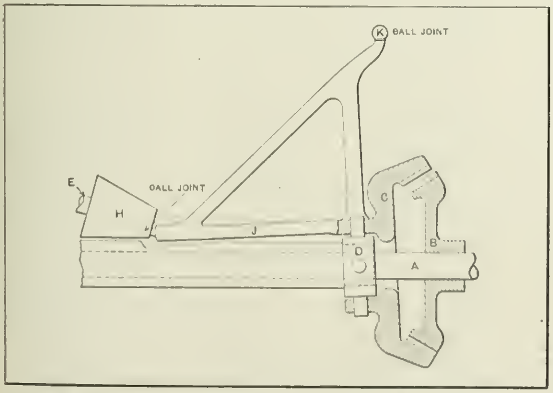

Fig. 22. Planetary or "Wabble" Gearing for producing Rapid Reciprocating Motion

The coal-puncher of which the mechanism shown in Fig. 21 forms a part uses both compressed air and electricity. Power for operating the coal-puncher is obtained from a motor and the compressed air gives the blow. There is no direct connection between the motor and striking pick, so that the vibrations are cushioned. The illustration shows the mechanical means by which the rotation of the motor armature is changed to a reciprocating motion for driving the air-compressing piston. A small pinion attached to the armature shaft engages a large driving gear (not shown) which has a solid web carrying the stud *d* upon which the crank pinion *e* is mounted. This crank pinion has thirty-three teeth and meshes with internal gear *f*, which is rigidly fastened to the frame of the machine and is concentric with the main driving gear which surrounds it. The pitch diameter of the crank pinion *e* is just one-half that of the internal gear *f*, which has sixty-six teeth. The crankpin *g* is attached to the pinion *e* and engages cross-head *h*, which is mounted in guides and receives a rectilinear motion as pinion *e* revolves around the internal gear. Attached to the cross-head, there is a piston-rod *a* which enters the air-compressing cylinder and has a piston secured to its forward end.

When the main driving gear is revolved by the motor, the crank pinion stud *d* describes a circular path, as indicated by the arrow, thus causing pinion *e* to revolve about the stud and around the internal gear. When stud *d* has moved one-quarter of a revolution, it will be in the position shown by the illustration to the right, and pin *g* attached to cross-head *h* will be in the center of the internal gear. At the completion of one-half a revolution, pin *g* will have moved in a straight line a distance equal to the pitch diameter of the internal gear, and will be at the right-hand end of its stroke. Similarly, at three-quarters of a revolution, the pin will again be in mid-position, and at the completion of a full revolution, it will be at the starting point, as shown by the view to the left. In this way, the crank pinion, as it revolves around the internal gear, transmits to pin *g* and the attached cross-head *h* a rectilinear forward and backward movement. The cross-head is mounted in guides, but pin *g* would follow a straight line even though guides were not used. This mechanism has the advantage of giving a long, gradually increasing and decreasing motion with a short crank and without the use of a connecting-rod or a slotted cross-head; therefore, it can be applied to some classes of mechanisms where there would not be sufficient room for a connecting-rod or in preference to the slotted yoke, because of mechanical objections to the latter. In designing this mechanism, the center of pin *g* should exactly coincide with the pitch circle of the internal gear; then, if the internal gear has twice as many teeth as the revolving gear, the center of *g* will move in a straight line, even though its motion is not constrained by means of guides.

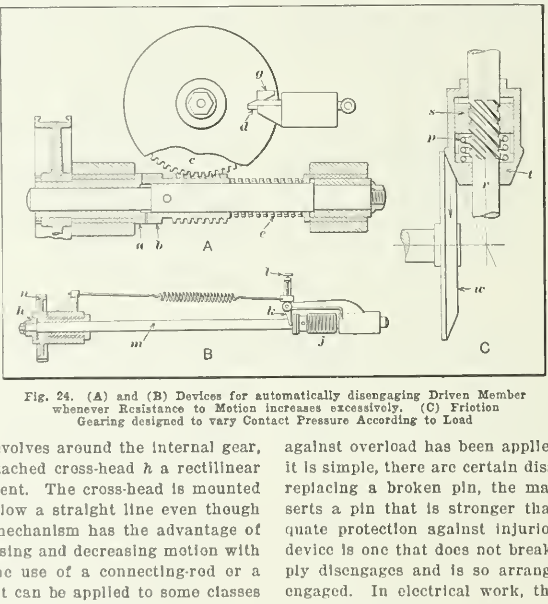

Fig. 24. (A) and (B) Devices for automatically disengaging Driven Member whenever Resistance to Motion increases excessively. (C) Friction Gearing designed to vary Contact Pressure According to Load

Reciprocating Motion from Planetary Gearing

What is known as a "wabble" gear is used on mowing machines for imparting a rapid reciprocating motion to the cutter-bar. The arrangement of this gearing and the other parts of the mechanism is shown in Fig. 22. The internal gear *C* is so mounted that it cannot rotate, but is free to oscillate on a universal gimbal joint *D*. The gear *H* which meshes with one side of *C* is mounted on the main shaft which connects with the driving wheels. The frame *J* is rigidly connected to gear *C* and is pivoted in the revolving part *H*. By this means, gear *C* is given an oscillating or wabbling movement, so that the entire gear describes or follows a circular path. This circular motion causes the teeth of gear *C* to mesh with those of gear *B* all around the circumference for each rotation of the part *H*. Part *H* turns on a fixed shaft *E* and acts somewhat as a flywheel to maintain steadiness of action, besides constraining gear *C* to follow a circular path.

In this case, gear *C* has forty-eight teeth, and gear *B*, forty-six teeth; therefore, if gear *B* were free to turn on its shaft, it would be displaced two teeth for each rotation of part *H* or each time gear *C* completed a circular movement. Consequently, twenty-three revolutions of part *H* and a like number of oscillations of frame *J* would be required to turn *B* one revolution. Tracing the motion in the opposite direction, it will be noted that one rotation of gear *B*, which acts as the driver when the mechanism is in operation, will cause twenty-three oscillations or wabbling movements of gear *C* and a like number of rotations of part *H*. The frame *J* is connected to the cutter-bar by the ball joint at *K*, so that one turn of the driving wheels which are mounted on shaft *A* will traverse the cutter-bar twenty-three times. This combination of gearing makes it possible to use a gear *B* having only two teeth less than the number in gear *C*, which would be practically impossible with gears having teeth parallel to the axis of the shaft. With the usual forms of planetary gearing, in which a high velocity ratio is obtained, the efficiency of transmission is low on account of the excessive tooth friction, but, in this case, the efficiency is said to be nearly as high as that obtained with a train of spur gears having the same velocity ratio.

Automatic Safeguards against Overload

Some types of machines are so arranged that any unusual resistance to motion will automatically stop either the entire machine or whatever part is affected, in order to prevent damaging the mechanism or straining it excessively. A simple form of safety device consists of a pin which shears off or breaks in case the overload becomes excessive. This method of protection against overload has been applied in various ways, and, while it is simple, there are certain disadvantages. In order to avoid replacing a broken pin, the machine operator sometimes inserts a pin that is stronger than it should be to afford adequate protection against injurious strains. The ideal safety device is one that does not break in case of overload, but simply disengages and is so arranged that it can readily be reengaged. In electrical work, this principle has been applied by substituting circuit-breakers for fuses which melt when the current becomes excessive.

Automatic Clutch Control to Prevent Overload

The principle governing the operation of an automatic device for disengaging a clutch when the overload becomes excessive is illustrated by the diagram Fig. 23. This mechanism was applied to a metal-cutting machine, the object being to disengage the feed automatically in case the resistance to the rotation of the tool becomes abnormally high. The mechanism is also arranged to reverse the feeding movement if, for any reason, the excessive resistance should continue after the feed has been disengaged. The spindle to which the cutting tool is attached is represented at *A*. This spindle is driven through worm-wheel *M* and worm *L* from the driving shaft *B*, which receives its motion from a countershaft through a belt operating on pulley *K*. The driving shaft *B* is free to move in a lengthwise direction within certain limits. The clutch *C* is keyed to this shaft so that it will rotate and move axially with the shaft. The gears *D* and *F* on each side of clutch *C* are free to revolve upon the shaft, but are prevented from moving in a lengthwise direction. The inner side of each gear is provided with clutch teeth corresponding to those on clutch *C*, which is used to lock either gear to shaft *B*. The shaft *I*, which transmits feeding movement to the cutting tool, is driven either through gears *D* and *E* or through gears *F*, *P*, and *H*. When clutch *C* engages gear *D*, the cutting tool is fed forward by shaft *I*, and a reversal of the feeding movement is obtained when clutch *C* is shifted into engagement with gear *F*.

When clutch *C* engages with gear *D*, excessive resistance to the motion of the cutting tool will cause the clutch to be shifted to the neutral position, thus stopping the feeding movement. This automatic action is obtained as follows: The shaft *B* is normally held by spring *N* in such a position that clutch *C* engages gear *D*, so that the feeding movement is forward. The tension on this spring is regulated by the nut shown. In case the resistance to the rotation of the cutting tool and spindle *A* should become excessive, the pressure between the teeth of the worm *L* and the worm-wheel *M* causes the worm to move in the direction indicated by the arrow, the worm-wheel acting somewhat like a nut. This lengthwise movement of the worm *L* and shaft *B*, against the tension of spring *N*, disengages clutch *C* from gear *D* and stops the feeding movement. If the resistance to rotation again becomes normal, clutch *C* is automatically returned into engagement with gear *D*. On the other hand, if the resistance to rotation increases, clutch *C* may be drawn over into engagement with gear *F*, thus reversing the feeding movement.

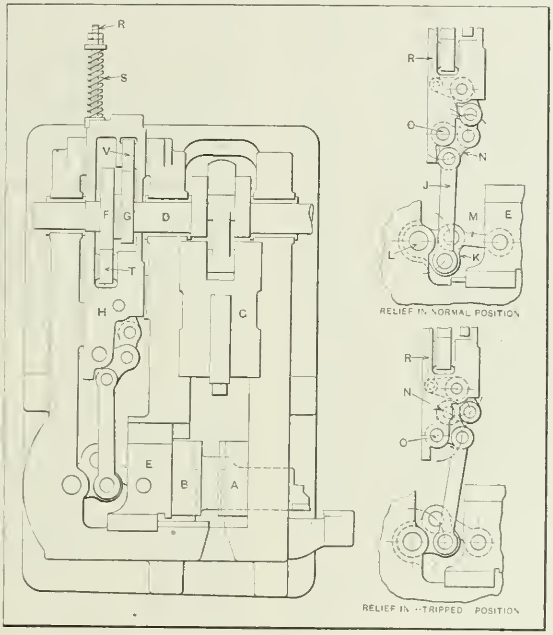

Fig. 25. Plan and Detail Views of Forging Machine showing Automatic Relief or Tripping Mechanism

Other mechanical devices for automatically disengaging the driven member whenever the resistance to motion increases excessively are shown at *A* and *B* in Fig. 24. These devices operate on the same general principle as the one previously described, but differ somewhat in regard to the arrangement. The mechanism illustrated by diagram *A* is designed to allow a worm-wheel to make one revolution and then stop; the movement, however, may be discontinued before the revolution is completed, if the resistance to rotation becomes excessive. The sleeve *a* is revolved constantly by a pulley on its outer end. The inner end of this sleeve has clutch teeth intended to engage corresponding teeth on the end of sleeve *b*. The latter is attached to the shaft and both are free to move slightly in an endwise direction. The body of sleeve *b* is threaded to form a worm which engages worm-wheel *c*. The spring *e* tends to shift sleeve *b* to the left and into engagement with clutch teeth on sleeve *a*. The stop at *d* is utilized in this particular case to disengage the driving clutch after the worm-wheel has made one revolution. If stop *d* is withdrawn, spring *e* revolves the worm-wheel slightly and moves the worm and clutch *b* to the left and into engagement with the constantly revolving clutch *a*. The worm-wheel then begins to revolve and continues until the lug *g* strikes the stop *d* or until some unusual resistance too great to be overcome by the spring is encountered; then, as the worm-wheel remains stationary, it forms a nut for the worm which screws itself out of engagement with clutch *a*. The strength of spring *e* is proportioned with reference to the safe or maximum load to be transmitted. One of the advantages of this type of mechanism is that the motion is positively transmitted until an excessive load causes the driving clutch to be disengaged. Provision may readily be made for the adjustment of spring *e* so that the tension can be varied according to conditions.

Diagram *B*, Fig. 24, illustrates a modification of the same general type of mechanism. The shaft *m* is free to move slightly in an endwise direction and is keyed to the tapering disk *h*, which fits into a seat of corresponding taper in the hub of gear *n*, thus forming a friction clutch. Motion is applied to gear *n* and is transmitted by worm *j* to a worm-wheel (not shown), for any desired purpose. Shaft *m* turns freely in the hub of gear *n*, but is attached to worm *j*. The lever *k*, which has a spring fastened to it above the fulcrum or pivot, supplies the necessary amount of thrust to keep *h* in engagement with *n* under ordinary conditions. This thrust may be regulated by the thumb-screw *l*, which changes the position of the block to which the spring is fastened. If the resistance to the motion of the worm-wheel becomes excessive, the worm moves bodily along the teeth of the wheel, as though it were a nut, and, by moving shaft *m* and disk *h* to the left, disengages the friction clutch. The endwise thrust from lever *k* might be obtained by means of a weight instead of a spring.

Pressure of Friction Gearing Varied According to Load

A novel design of friction gearing, in which the pressure between the two friction wheels is automatically regulated by the amount of power transmitted, is shown at *C* in Fig. 24. The wheel *w*, which is the driver, revolves in the direction shown by the arrow. The driven pinion *t* is free either to rotate or slide in a lengthwise direction upon shaft *r* within certain limits. This shaft has a screw of coarse pitch which passes through nut *s*. This nut slides in grooves in the friction pinion *t* so that the pinion and nut revolve together. A spiral spring *p* inserted between nut *s* and the pinion forces the latter against the driver *w* with a pressure depending upon the position of the nut. If wheel *w* is revolving in the direction shown by the arrow and the driven shaft meets with an unusual degree of resistance to rotation, as soon as shaft *r* lags behind or stops revolving, nut *s* moves downward, owing to the action of the screw, and increases the compression on spring *p* and also the pressure between pinion *t* and wheel *w*. When the resistance to rotation again becomes normal, the spring moves the nut upward slightly and reduces the endwise thrust. While this device may not be entirely practicable, it embodies an interesting principle.

Automatic Relief Mechanisms for Forging Machines

Forging machines are equipped with a tripping or relief mechanism which prevents excessive straining or breakage of the parts controlling the motion of the movable die, in case the stock to be forged is not placed in the grooves of the dies but is caught between the flat faces. These relieving mechanisms differ somewhat in design, but the object in each case is to release the movable die, temporarily and automatically, from the action of the driving mechanism, in case the operating parts are subjected to a strain or pressure that is abnormally high. The release may be obtained by inserting bolts or "breaker castings" in the mechanism, which will shear off or break if there is an excessive strain; another type of relief mechanism depends for its action upon a spring which is proportioned to resist compression for all ordinary strains but to compress sufficiently to release the pressure on the dies when that pressure increases beyond a safe maximum. Two forms of spring-controlled relief mechanisms will be described.

The plan view of a National forging machine, shown in Fig. 25, illustrates one method of arranging a spring and toggle relief mechanism. When this machine is in operation, the stock is gripped between the stationary die *A* and the movable die *B*. The heading slide *C*, which carries a ram or plunger for performing the forging operation, is actuated by a crank on the crankshaft *D*. The gripping slide *E* to which die *B* is attached is moved inward for gripping the stock and outward for releasing it, by means of two cams *F* and *G*. These cams transmit motion to slide *H*, which is connected with slide *E* through a toggle and link mechanism. Cam *F*, acting upon roll *T*, moves the slide *E* for gripping the stock, whereas cam *G*, in engagement with roll *V*, withdraws the die after the forging operation is completed. The upper detail view to the right shows the relief mechanism in its normal position, and the lower view shows it after being tripped to relieve any abnormal pressure on the dies.

When the machine is operating normally, link *J*, which connects with link *K* of the main gripping toggle, oscillates link *K* about pivot *L* and, through link *M*, imparts a reciprocating motion to the gripping slide *E*. If a piece of stock or some other part is caught between the flat die faces, the gripping action continues until the strain exceeds a certain amount; then the backward thrust upon link *N* causes it to swing about pivot *O* (see lower detailed view), carrying with it the other links of the by-pass toggle and compressing the spring *S*, which is shown in the plan view at the left. As the result of this change in the position of the by-pass toggle, pressure on the gripping die is released. Meanwhile the heading tool attached to slide *C* completes its full stroke and, upon the return stroke, the by-pass toggle is reset automatically by spring *S*, which expands and, through rod *R*, swings the toggle links back to their normal position shown in the upper detailed view. This automatic resetting of the toggle makes it unnecessary to stop the machine, which is necessary with safety devices of the breaking-bolt type. There is no movement of the by-pass toggle, except when a "sticker"—to use the shop expression—is caught between the gripping dies. While this relief mechanism safeguards the working parts from excessive strains, it is capable of transmitting enormous pressures to the gripping dies.

* * *

LOSS OF HEAT VALUE OF COAL IN STORAGE

According to investigations carried out by the Bureau of Mines, the expense of under-water storage equipment is not justified except as a preventive of fires from spontaneous combustion. In fact, the amount of deterioration of coal during storage has been commonly overestimated. While under-water storage of coal prevents deterioration of calorific value, in five years' storage in the open air Pittsburg coal deteriorated only about 1 per cent in one year, 2 per cent in two years, and from 2.5 to 3 per cent in five years. Pocahontas coal—a semi-bituminous type—lost less than 1 per cent of its heating value during two years of outdoor exposure. The Sheridan, Wyoming, sub-bituminous coal, known as "black lignite," lost 3 to 5.5 per cent of its heat value in two and three-fourths years of outdoor storage, the greater part of this loss being in the first nine months. The lumps became badly cracked so that they broke up on handling. By the use of bins with air tight bottoms and sides and a protecting layer of fine slack, the loss in heat value in one year can be kept below 3 per cent and the physical deterioration will thus be largely prevented.

RESEARCH AND MANUFACTURING METHODS

BY COLE NEWMAN

A short time ago, the writer was asked to find all the possible methods of manufacturing, in large quantities, a rather complicated automobile accessory, consisting preferably of a single piece, so that the best method and material could be determined. At first he thought of collaborating with some person who might be designated by the name of "manufacturing engineer," but he found that no such person was accessible. Men who might be called by that title are usually specialists in some one method, more or less secret, and employed by some firm. He also found that manufacturing, as a science, does not appear to be taught in the technical schools. The few men who have a broad knowledge of the subject are executives of private firms and their services are not to be had, nor are they, as a rule, men of mechanical skill; their equipment consists of business knowledge only.

The writer then made a canvass of available methods and found that this piece could be manufactured, with slight modifications, by any of the following processes: die-casting, metal extrusion, die stamping, casting from bakelite, electrolysis, drop-forging, pressing from papier-mache, pressing in fiber, pressing in wood pulp, molding from amyl acetate in the form of celluloid, molding in rubber. However, no one man or organization could give information about these various processes together with their relative methods, costs and practicability. The different methods are in various stages of development; for instance, manufacture by electro-deposition is in the inventive stage, while some of the other methods are highly standardized. After investigating the various processes in use, an appeal to experts in physics and chemistry for suggestions in new processes and ideas opened up a more fertile field than the problem required. Since that time the writer has ventured to assume the initiative in thinking up possible new methods of manufacture for research and investigation.

During this canvass, the writer also became impressed with the need of courses, in the technical schools, that would give men a broad knowledge of manufacturing engineering. After the usual two years of training in mathematics and elementary engineering subjects, he would suggest a study of the action of materials when subjected to the various processes of manufacture and modern manufacturing methods, especially those on which the great industries of this country have been based. In the first two years would be included a thorough knowledge of materials and their behavior under all possible physical conditions and in all possible combinations, special attention being paid to the microscopic structure and the chemical formulas of the materials in question.

Many basic questions of manufacturing engineering await research and accurate technical solution; among these are the following: How does a cutting tool cut? Does the metal split ahead of it or is it crushed? Is the progress of the tool continuous or vibratory in nature? What is the action of cutting compounds and lubricants upon the tool and how do lubricants reach the edge of the tool, if they do reach it? To what extent can machine work be eliminated by die-casting? To what extent can castings and complicated structures be built up by electro-deposition? As electrically deposited metals are crystalline, can processes be developed for lengthening the crystals into fibers, as pig iron crystals are lengthened into tough fibrous wrought iron? How much pressure is required for causing various metals to flow under conditions of extrusion and hydraulic pressing processes? What qualities of metals require draft in dies? What qualities of metals require several dies to obtain a given extrusion? What qualities in metal permit of spinning? Can cheaper methods be devised for building dies? Given a certain object, what is the most satisfactory method of manufacturing a given number, investment and all other elements being considered? All these subjects have been discussed in the technical magazines and by the different engineering societies, but the manufacturing processes have not been coordinated as a science.

Loss to Industry through Lack of Manufacturing Engineers

When anyone proposes to take up a certain line of manufacturing activity, he tries to find a promising young man who will work with him for several years before a going factory is developed, because there is no such group of persons available as "manufacturing engineers." To be sure, there are factory experts, efficiency experts, etc., but these are usually men experienced in certain highly standardized methods of manufacturing, who refuse to conduct experiments or research along radical lines. Special processes, such as metal extrusion, making of steel cylinders, electrolytic deposits for the purpose of securing thin metal shavings, etc., have been developed by private firms or individuals who, for obvious reasons, will not permit them to come into general use. Each of these represents the result of high initiative and successful research.

What would be the result in this country if the physical, chemical and mechanical talent of our great universities were turned toward research in manufacturing processes? The writer ventures to look forward to a day when very intricate objects will be made by electrolytic deposits on paraffin patterns instead of our present cumbersome foundry methods. Then ships in a dry-dock will be plated electrolytically with pure copper instead of being painted by hand with a coating that can wear only a few months at best. He also looks forward to standardized ships, standardized docks, houses, streets, and everything else that requires fittings of metal or other material that can be in duplicate and standardized form.

There is something fundamental about the factory system of American industry that rises above the mere making of money and cheapening of the products; this is the lifting of the burden of manual labor from the individual. The average individual in the factory today works fewer hours and under vastly better conditions than the mechanic of fifty years ago. Where, at that time, could be found a shop that provided sanitary wash rooms, lockers, sunshine, recreation and a general cheerful atmosphere for its employes? Everything possible has been done to relieve the load of labor. The American system is to think a thing out once and then let the machine do it. Under the old system it had to be thought out every time the job was done.

All the material in this country is available for the manufacturing engineer, but it has not been assembled in the form of a definite profession. Reference books cover a large part of the field, but the processes that are less well-known or are still in the inventive stage have not been recognized seriously by those who conduct scientific researches. They have been left to inventors, whose educational and financial equipment may be insufficient. No work could be more worthy of government recognition and research than that of manufacturing processes.

When the average American graduates from a technical school, he thinks that the mechanical world consists entirely of turbines, gas engines and other prime movers waiting for his professional attention. When he enters the drafting-room or machine shop of an automobile, turbine, or electric motor factory, he is almost entirely blind to the relative importance of methods of manufacture. His thoughts unconsciously turn to the lines along which he has been trained to think, that is, the design of the automobile engine, or the steam turbine, or electric machinery, with little, if any, consideration for the vastly more important questions of how these things are to be manufactured in large quantities. What methods are to be employed? How many are to be made? What manufacturing machinery is available? What methods are available throughout the country? Where may the various parts be contracted for? What is the relative merit of each of these methods? Where can they be found? In what engineering form can they be put so as adequately to bring forward all the elements to be operated?

The practical business man secures the best results possible by the use of common sense; but the history of industry is that the use of "horse sense" has always been succeeded by careful analytical methods that eventually put horse sense and rule-of-thumb methods entirely out of the running. The blacksmith may laugh at the college man because he cannot shoe a horse properly nor swing a sledge hammer, but eventually the college man develops the automobile and the blacksmith goes out of existence for lack of a job.

Mechanical Effects Obtained by Men Who Know Metals

The writer at one time had the problem of manufacturing a nozzle for spraying, in which it was necessary to have a bored taper hole of excellent finish. No practical mechanic could make a fully satisfactory suggestion, owing to certain complications involved. A professor of physics suggested that the nozzle be made from a tube pulled in a testing machine until a certain reduction of area was obtained. The pieces could then be cut at the point of reduced area and nozzles of the desired taper obtained. This system was found to work perfectly. The pieces from the testing machine were put on a turret lathe, threaded, and cut at a reasonable total manufacturing cost. The professor knew nothing of manufacturing methods, but he knew materials and their physical characteristics.

The writer has made a number of tin flasks by simply clipping the edges of two disks together on a seaming machine, sealing them with solder, and then forcing water between the disks through a neck seamed onto one of them. The water pressure forced the disks apart, making an oblate bottle, which met the requirements. At another time, in Cleveland, the writer saw steel flasks capable of withstanding 2000 pounds pressure per square inch blown by hydraulic pressure, just as a glass bottle is blown in its mold by a glass blower. The steel bottle was blown by means of steam hydraulic compensating plungers, which multiplied pressure until from 15,000 to 20,000 pounds per square inch were momentarily obtained. On the Pacific Coast, a man makes an excellent living plating fruits, flowers and botanical specimens with copper. He has made careful researches in this line and conducts most of the work by methods known only to himself.

Now that the study of physical chemistry, with its more complete explanation of colloids and emulsions, is beginning to make clear the reasons for metal structure, and indeed for the structure of all materials, it seems propitious to inquire about the possibility of manufacturing research. It is being hinted by great investigators that transparency is the natural state of any pure substance; that is, if a substance is not transparent, it is a colloid, an emulsion, or both. The various organic substances, such as wood, paper, bone, hair, skin, leather, etc., are known to be dried emulsions, as it is possible to duplicate all of them entirely without the phenomena of life. This brings us very close to the possible manufacture of new materials, new substances besides our time-honored metal and wood.

The last twenty-five years has brought out only two or three important new substances for general industrial use. If research were directed along the lines suggested, who knows but that near equivalents for iron, steel, expensive hard woods and expensive building materials would be developed. Emulsion substitutes have been made, but they have not come into general use because of lack of research.

* * *

PRIZE OFFERED FOR HARDNESS-TESTING METHOD

Because of the difficulty of determining high hardness, that is, 580 Brinell hardness numeral and upward, where the material becomes so hard that it will scratch glass, Sir Robert Hadfield has given £200 (about $1000) to the Institution of Mechanical Engineers in London, England. This money, with any income therefrom, will be awarded as a prize for the description of a new accurate method of determining the hardness of metals. All or a part of it may be awarded at any time if a communication is received of sufficient originality and importance to accomplish the object sought; or, from time to time, parts of the fund, which do not exceed £75 in any year, for communications that seem to advance the knowledge of methods of testing hardness but do not completely solve the problem. Detailed information concerning this prize may be obtained from the Steel Treating Research Society, 762 Book Bldg., Detroit, Mich., of which Sir Robert Hadfield is a member.

INDICATOR GAGES USED IN GASOLINE-ENGINE CONSTRUCTION[1]

GAGES FOR INSPECTING CYLINDER DEPTH, LENGTH, EXTERNAL DIAMETER, CAM LIFT, PROFILE, AND ECCENTRICITY

BY C. C. MARSH[2]

WHILE many concerns strive to obtain a high degree of accuracy in production, they sometimes think that it is not necessary to maintain this accuracy in certain products because of the expensive inspection methods. Such tools as micrometers, vernier calipers, and hardness testing instruments, as well as various special recording and measuring devices, are costly, and the men required to do this work must be skilled mechanics, who, as a rule, must be paid more than toolmakers and machinists. Some manufacturers, however, have partly solved the problem of high inspection costs by designing and making special measuring tools by which ordinary mechanics will obtain a degree of accuracy close enough for their purpose.

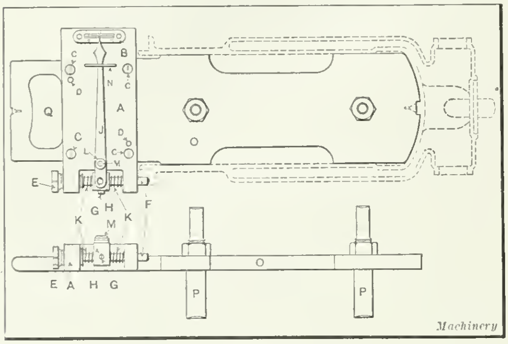

Fig. 1. Cylinder Depth Gage

Many lines of manufacturing require accuracy in machining combined with rapidity of production. Among these is gasoline-engine construction. Manufacturers of automobiles know that the inspection of machined parts on the engine requires more labor, a larger force of inspectors, and a greater number and variety of measuring tools and devices than the rest of the car. This is because the accuracy must be maintained on a greater proportion of the small parts on the engine than on the car. Yet there are many small concerns who do not hold the operator to a limit, except in such parts as actually have to be kept to some close measurement in order that they may fit and function properly.

Some machining fixtures may be so designed as to be nearly fool-proof, and also so as to produce accurate work when new, but after an operator who is doing piecework, and knows that his wages depend on the amount of work he turns out, uses a fixture a short time, the accuracy curve on that particular fixture begins to drop. As a result, there must be a new fixture and perhaps a new operator; also, the inaccurate parts must be scrapped or machined to "out sizes" so that they may be used. Either way is expensive. Still, many inspection operations on gasoline engines, although requiring much time on account of the inadequate measuring tools provided, do not give accurate results. These cases require measuring tools that can be used by an ordinary inspection-operator who can turn out a fair amount of work without misusing the tool. One type of gage for this kind of inspection is an indicator gage that may be adapted to many kinds of measurement.

It does not aid rapid production to give a machine operator a large, awkward gage to use; the simpler it is, the more likely is he to use it correctly. The operator's accuracy on production depends not only on having accurate and easily operated machine tools and fixtures and on his skill in operating these, but also on having gages that he can use quickly and that will gage accurately. Although the indicator gage is better adapted for inspection uses where rapid operations are required, it is possible to adapt it to the operator's use. Where large diameters are turned, holes bored, and shoulders faced, indicator gages of the types shown in Figs. 1, 3, and 4 are satisfactory.

While all of these types of indicator gages may be successfully designed and used, indicator gages should not be used for gaging internal diameters. Measuring an internal diameter accurately is a more delicate operation than measuring external diameters and lengths; therefore, a gage of this design is too heavy, and is hard to revolve so as to determine whether or not a hole is out of round. Besides, the plunger-pin would have to work so that it would be certain to rest against the side of the hole in such a manner that its longitudinal center would coincide with the axial center of the hole. This might be done, but provision would have to be made so that the error in the size of the hole would not affect the plunger-pin in such a way as to cause the hand to indicate the error from one side instead of both sides of the hole.

Even with the accurate machine tool equipment that is now procurable, accuracy in production cannot be obtained without constant care in gaging and measuring. Few machine tools retain their accuracy after they have been used for a time; even those that are very heavy and rigidly built cannot maintain their accuracy under constant wear and the strain of rapid production. The same conditions prevail in regard to measuring tools, which should, therefore, be made simple and should have some means of adjustment to compensate for wear. Although adjustment may not be practicable in all cases, it will result in a great saving of time in production as well as the time necessary to replace the tool.

Indicator Gage for Cylinder Depth

The gage shown in Fig. 1 does not require much accurate tool work in making, yet, if properly made, it gages accurately and quickly. A sectional view of the assembled plunger-pin plate *A* is shown in Fig. 2. An indicator gage, of course, multiplies the error, the degree of multiplication depending on the depth of the hole and the length of the gage. The latter must be approximately determined, together with the ratio between the long and the short end of the indicator hand, before designing the tool. When this ratio is decided upon, it is necessary to find the distance between the graduation lines.

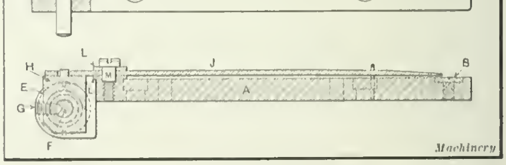

Fig. 2. Plunger Indicator and Plate of Gage shown in Fig. 1

In the case shown, the drawing of the cylinder called for a bored depth of the barrel of 13 1/16 inches ± 0.005 inch. It will be noted that the graduated plate *B* at the end of the plunger-pin plate *A* is marked + on the left-hand and — on the right-hand side of the zero mark, under the graduations. The ratio of the long end to the short end of the indicator hand *J*. measuring from the pivot screw *M*, is 7.8125 to 1. Thus, when the plunger-pin *F* moves 0.002 inch, the point of the indicator hand *J* will move 1/64 inch. Then the graduated lines must be scribed 0.015625 inch apart at the end of the hand *J*, and radiating outward from the center of the pivot screw *M*.

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[1] For other articles on indicating gages, see "Profile and Indicating Gages," November and December, 1916, and articles there referred to.

[2] Address: 1338 Barth Ave., Indianapolis, Ind.

This plate can be accurately graduated on a dividing head by computing the circumference of a circle having a diameter equal to twice the length of the long end of the indicator hand and dividing this by the distance required between the graduations. This will give the number of divisions required on the dividing head, from which the necessary number of turns of the dividing head can be determined. The following formula may be used for this:

$$N = \frac{2\pi L}{D}$$

in which L = length of long end of lever;
D = distance between graduations;
N = number of divisions in circle.

In the case of the gage shown, where the length L of the long end of the lever is 7.8125 inches, the number of divisions N on a circle 15.625 inches in diameter, when the distance D between the graduations is 0.015625 inch, is:

$$\frac{2 \times 3.1416 \times 7.8125}{0.015625} = 3141.6$$

The figure 3141.6 is so near 3142 that on so many divisions the 0.4 difference will make so slight an error as to be practically of no consequence; therefore, it is quite safe to use the latter figure as the proper number of divisions.

The graduated plate *B* can be made of ordinary machine steel and left soft, although both sides should be surface-ground before graduating. It fits in a recess milled in the plunger-pin plate *A* and is fastened in place by two flat-head screws. It should fit this recess without play so that the center line passing through the zero mark is coincident with the center line of the indicator hand.

The plunger-pin plate can also be made of ordinary machine steel, and is held in position on the gage-plate by four fillister-head screws *C*. Two pins *D* keep it from slipping and allow it to be replaced in the same position should it be taken off at any time. The plunger-pin holes should be bored in line and one hole tapped for the screw bushing *E* that adjusts the tension of the compensating springs. The plunger-pin *F* should be made of drill rod or tool steel and hardened on the engaging end. It should be left soft in the middle where the lock-screw *G* holds it in the block *H* that actuates the hand *J*. The latter should be made of spring steel and should be at least 1/16 inch thick. Its point should be tapered and sharpened so that it will point between the graduated lines. The springs *K* are made of music wire; the one on the bushing side should be a little stronger than the other, so that the adjusting bushing *E* may be screwed back and forth until the hand *J* rests in the proper position when adjusting the gage. The plunger-pin *F* should be round on the engaging end, so that it will touch only on one point, which should be the longitudinal center of the pin.

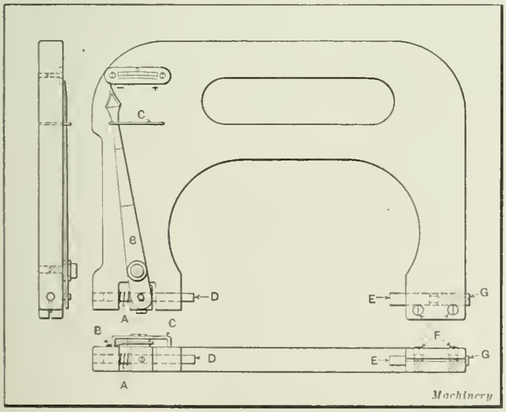


Fig. 3. External Diameter Gage

The block *H* on the plunger-pin *F* that actuates the indicator hand *J* should be made of tool steel, and the round shoulder that fits into the hand *J* should be turned to fit the hole in the latter with not over 0.0005 inch play. The amount of this play should be known and kept in mind so that allowance may be made in reading measurements made with this gage. This shoulder should be polished so that it will work freely, yet without too great an error. Hardened washers *L* with sides ground true should be placed above and below the indicator hand where the pivot screw *M* passes through; these act as guides to the indicator hand and prevent any vertical movement. The pivot screw *M* should have an accurately turned, polished, and hardened section under the head on which the indicator hand *J* swings. The shoulder of this screw rests firmly against the plunger-pin plate *A* and should be about 0.003 inch longer than the combined thickness of the indicator hand and the two washers, so as to allow free movement of the hand on the screw. A piece *N* of No. 30 drill rod, bent in the shape of a staple, is pressed into holes in the plunger-pin plate to keep the hand from being bent by accident. A sheet-metal guard may be provided, if desired, to completely cover the indicator hand up to the graduated plate; this can be held in place by round-head screws.

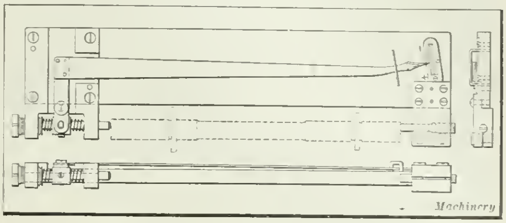


Fig. 4. Adjustable Length Gage

The gage-plate *O*, Fig. 1, is made of machine steel, and the end that fits the bottom of the hole, as well as the sides, should be carburized, the edges relieved, and two holes drilled through it on the longitudinal center to receive the two studs *P* that keep the plate central in the hole while in use. These studs are made of cold-rolled steel and carburized, and a small amount of stock is left on the ends so that, after fitting to the plate and after the latter is centered, the plate and the studs together can be turned on a lathe. The carburizing should be deep enough so that all of the carburized surface will not be turned off in the lathe. About 1/64 inch is enough to remove, and 0.01 inch should be left on the ends of the pins and the edges of the plate for grinding after the plate is hardened. This work must be done before fitting the plunger-pin plate. The centering pins *P* have a shoulder, which rests on one side of the gage-plate, and as these pins are threaded, they may be held very firmly with the nuts as shown. When grinding the gage-plate on centers, it must be borne in mind that the plate must easily enter the hole in which it is to be used so that proper allowance will be made for this. By cutting the oblong hole *Q* in the other end of the plate, a convenient handle is formed for the gage.

Adjustable Length and External Diameter Gages

The gages shown in Figs. 3 and 4 are an adaptation of the same principle, with such changes in design as are needed for the difference in purpose. The gage shown in Fig. 3 has only one plunger-pin spring *A*, in order that the hand *B* may be pushed over as far as the guard *C* will allow. This gage does not require a very strong spring, and the plunger-pin *D* should always protrude from the gage, as shown. Another feature of this gage is the adjustable anvil *E*, which is a hardened pin and is held in place by two screws *F*. By having pins of different lengths, it is possible to give the gage quite a wide range of use. A set-screw *G* makes the adjustment of the anvil easy. The setting of this gage is quite simple, the only tools necessary being a thin piece of metal to slip under the indicating hand, a small clamp, a screwdriver, and a micrometer for measuring inside diameters. The metal shim is placed under the indicator hand and the clamp is used to hold the hand in the middle position. After the micrometer has been set, the anvil *E* is placed in position and the clamping screws *F* tightened slightly; then the anvil is adjusted to the micrometer by means of the adjusting screws *G* and the clamping screws *F* are tightened. When the clamp and shim are removed, the gage is ready for use.

In using this type of gage, the distance between the anvil and the plunger-pin must be enough less than the lowest limit of the length or diameter that the gage is to measure so that, when the part measured is of the correct dimension called for on the drawing of the part on which the gage is to be used, the indicator hand points to zero. That is, this dimension must be between the upper and the lower limits that are specified. The exact dimension is zero; the left-hand side of the graduated plate is the minus side and the right-hand side is the plus side. The hand will indicate whether the dimension is less or greater and how much. The graduating is done in the same manner as on the cylinder depth gage.

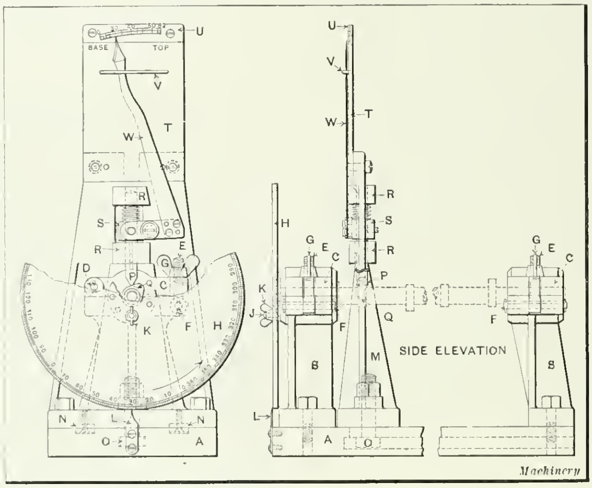


Fig. 5. Cam Lift, Profile, and Eccentricity Gage

As the gage shown in Fig. 4 is for longer measurements, it is made of more pieces for ease and economy in construction. Two springs are provided, as on the cylinder depth gage, on account of the length of the indicator hand; these serve to keep the hand steadier, but both are not entirely necessary. The indicator hand has a slight bend at the outer end, so that the point will move in a direct radial arc from the center of the pivot screw. The length of the long end of the indicator hand in this gage is taken to be the shortest distance between the end of the hand and the center of the pivot screw. The hand is made in two pieces, which are fastened together with round-head screws, while two dowel-pins are used to prevent play in the screws, the hand moving in recesses milled in the plunger-pin plate. In order that the gage will not be too thick, the plunger-pin and anvil plates are fitted to the long plate that forms the body of the gage with mortised joints. This construction will insure that the plunger and anvil pins do not come above or below the sides of the long plate. The leverage of the indicator hand can be in much greater proportion than in the gages already shown; consequently the graduations can be farther apart, though they can represent smaller figures in relation to the plunger-pin, thus making this gage read closer. The adjustment of the anvil pin is accomplished in the same way as the one on the gage shown in Fig. 3; this pin also can be replaced by others of varying lengths. Both pins should be rounded slightly on the engaging ends. A sheet-metal cover may be provided instead of the wire guard to cover the indicator hand, if desired. This gage may be constructed so that it will reach over quite wide shoulders on various parts that require close dimensions.

Cam Lift, Profile, and Eccentricity Gage

A three-purpose gage intended for use on camshafts, but which may be adapted to other similar uses, is shown in Fig. 5. The first purpose of this gage is to determine whether or not the cams, which are generally integral with the shaft, have the proper lift and fall, so that the valves may be opened and closed the proper distance and in the proper time; the second purpose is to determine if the profile is correct all the way around the cam, so that the valves will have a uniform action; the third purpose is to determine if the cams are at the proper angles to one another and whether they are concentric to the center of the shaft. The last fact must be known if a quiet-running motor is desired. This gage consists of a cast-iron base *A* with a cast bracket *B* at each end. It is machined on the top and bottom, and its size depends on the length of the camshaft. The brackets support the camshaft when it is placed in the bearings, which are bored to fit the journals at each end of the shaft. The caps *C* on these bearings are pivoted on pins *D* in the manner of a hinge, so that the shaft may be quickly placed in the bearings. Eyebolts *E* that swing on a pin *F* in a similar manner and are fitted with wing-nuts *G* are used to tighten the caps.

A large circular plate *H* is graduated, in degrees, completely around its outer edge and is counterbored on the opposite side of the graduations to fit closely the gear flange on the end of the camshaft. Two dowel-pins in this plate fit into two drilled holes in the gear flange. As these holes are spaced so that the gear can only be placed on the flange in one position, this flange will fit the graduated plate in the same position each time. The holes are drilled in the gear flange in an accurate jig; therefore, they are quite likely to be uniform as to spacing and diameter. A small screw *J* with a countersunk head that fits the countersink in the drilled holes is placed in the gear flange before the shaft is placed in the fixture and is passed through the graduated plate *H;* it is then fastened in place by a small wing-nut *K*. The end of a small pointer *L* fastened by two round-head screws to the base *A* shows the angle through which the plate and camshaft are turned. The point of this indicator is tangent to the perpendicular center of the fixture.

The gaging part of the fixture, which is separate and detachable, is a casting *M* with a base in which are two steel tongues *N* that fit into grooves planed into the base *A*. The gage, therefore, can be slid along on the base *A* and yet retain its lateral position. A T-bolt *O*, the head of which slides easily in a slot in base *A*, allows the gaging device to be locked firmly over any one cam by the use of a wrench that fits the nut on the bolt; this allows the plunger-pin *P* to come into the correct position over the cam *Q*. The plunger-pin works in a vertical direction through two bosses *R*, which are a part of casting *M*. These two holes should fit the pin without play and should be bored and line-reamed at right angles to the machined base. The bosses may be fitted with hardened bushings, although these are not necessary unless the gage is to be used a great deal. A similar block *S* is fastened to the plunger-pin *P* by a lock-screw for actuating the indicator hand *W*, which is similar to that on the gages previously described. On account of the position of the plunger-pin, it is necessary to have a bend in the indicator hand *W*, while the bosses *R* make it necessary to have a slight curve in the upper end of the hand so that the end of the hand will line up with the center of the pivot screw and swing in an arc that will be nearly divided on equal sides of the perpendicular center line of the machine-steel plate *T* that is bolted to the casting *M*.

The graduations on the plate *U* must equal the rise per degree, or other required division of the cam periphery, and must radiate from the center of the pivot screw. It will be noted that the word "base" is stamped on the left-hand end of the plate, while on the right-hand end the word "top" appears. The arrow on the circular plate *H* shows in which direction the shaft and plates are to be rotated. A wire guard *V* on the upper part of the gage allows the hand to swing far enough past the last graduated line on the plate *U* to show any error on the base circle of the cam or the rounded part that is concentric with the shaft.

When the fixture *M* is placed in the correct position for testing a cam, the plunger-pin *P* rests on the base circle at the point of tangency to the line forming the beginning of the rise or opening point on the periphery of the cam. The pointer *L* on the base *A* now points to zero on the circular plate *H*, or the beginning of rotation, and the indicator hand *W* should point to the first line on the graduated plate *U*, which is also marked zero. As plate *H* is rotated, indicator hand *W* shows the acceleration of the rise on the cam. Suppose the cam is intended to rise for, say, 62 degrees of the rotation of the shaft; if the periphery is correct, pointer *L* on base *A* shows when that point in the travel of the cam is reached, and the travel of indicator hand *W* will coincide with it until the total rise is reached. If the rise is incorrect, because the cam has either a convex or a concave surface, indicator hand *W* will not be in synchronism with pointer *L* and there will be an incorrect opening action of the valve. If the cam does not have the proper radius on the top of the rise, the hand will not agree with the pointer.

The fact that a cam may have a convex or a concave surface may not affect the opening, especially if the cam is designed to use a mushroom follower or to use a roller and to be what is known as a constant-acceleration cam. Cams using a mushroom follower have a convex flank, while a constant-acceleration cam has a concave flank. The kind having a straight flank, and called a tangential cam, would show the error more to advantage. This does not mean that inaccuracies on the flanks of the two former types could not be detected with this form of gage; but the actual rise may vary slightly on the two former types without causing serious error in the action of the valve, the main thing being that the cam must raise the valve the correct distance in the proper time, which, of course, must be in the proper angle of rotation of the shaft.

As the shaft is rotated, if the cam is supposed to be symmetrical on either flank, after the top of the cam is reached, the fall will be the reverse of the rise and the indicator hand will retrace its swing and arrive at the zero mark on the inserted plate at precisely the same moment that the pointer *L* has reached 124 degrees on the plate *H*. By means of the graduations on plate *U*, it is possible to find any incorrect spot on the flank. If the cam is designed so that it has a rest at the top of the rise, the indicator hand will remain stationary, as the periphery is concentric. The same thing will occur with the hand when the end of the fall, or the closing side of the cam, is reached and the plunger-pin rests on the base circle of the cam. Unless the base circle is concentric with the shaft, the indicator hand will show movement when the shaft is rotated through the remaining part of the 360 degrees as indicated by the pointer.

The plunger-pin *P* is a round pin flattened on two sides, or tapered so that a small curve can be machined on the engaging end. The flattened sides should always remain at 90 degrees to the profile line of rotation of the cam, so that the pin will always present a rounded end to the periphery of the cam and act the same as the face of a small roller. As most of the imperfections on the cam faces are depressions or humps, which are, as a rule, simply tool marks, the pin should be set so that it drops into or is raised by them, as the case may be. These marks usually run clear across the face of the cam; those that do not probably will not affect the action of the roller used on the cam. The small curve on the end of the pin will act better than a roller, as the latter must be large enough to have a pin through it to turn on. The arc of contact is less for a small curve than for a roller; therefore, the pin will show a smaller error. A small key should be fastened in the lower pin boss and a keyway provided in the pin to allow the pin to move up and down, though it is prevented from turning.

Now, suppose it is necessary to find out if the next cam of the same set, say the intake side, is supposed to be in a position of 90 degrees to the first cam, rotating counterclockwise. The locking nut on the T-bolt *O* is loosened, the gaging fixture *M* then being slid along to the position over the second cam. The plunger-pin *P* is then raised by pushing over the indicator hand *W* with the finger, and the locknut is tightened again on the T-bolt. The camshaft is left in the same position, or on the point of rise of the first cam, the pointer being at zero. After the gage is locked in place, the indicator hand *W* is allowed to rest on the periphery of the second cam. If the second cam is correct, the indicator hand will register the top of the rise while the pointer *L* registers 152 degrees. Thus it is possible to find the relative position of angles and the opening, closing, and rest points of all cams of that set. It is necessary, however, to have a separate gaging device to fit on the base for the cams of the other set, that is, one for the intake and one for the exhaust cams.

It is seldom necessary to gage all the cams on all shafts. There are always a few faulty cams, however, that pass the inspector who uses some other kind of measuring instrument than the indicator gage. When these cams are assembled into motors they may cause erratic running of the engine on the block-test, in which case, when the engine is being torn down after the block-test, the camshafts may be removed for inspection on this fixture.

There is an apparatus that records the outline of the periphery of the cams by means of electric contact, using an indicator hand that traces a curve on a geometrically ruled chart. This instrument records the profile curve of all the cams on the shaft in one revolution. While this is quite a feature, the instrument is expensive and is necessarily delicate and must be used by skilled operators. It is also more likely to be affected by temperature, while the gage here described may be used in almost any place where there is room on a bench or a table.

The graduating on the inserted plate on the former gage can easily be done by using a master cam, or one that is known to be correct. After the circular plate has been graduated in degrees and the dowel-pins placed in the correct position, the plate is placed on a shaft with a master cam fastened on in the proper position and the disk rotated with the shaft by degrees, or greater divisions, while the point of the indicator hand shows where the lines should be scribed; this must be done after fastening the inserted plate in place.

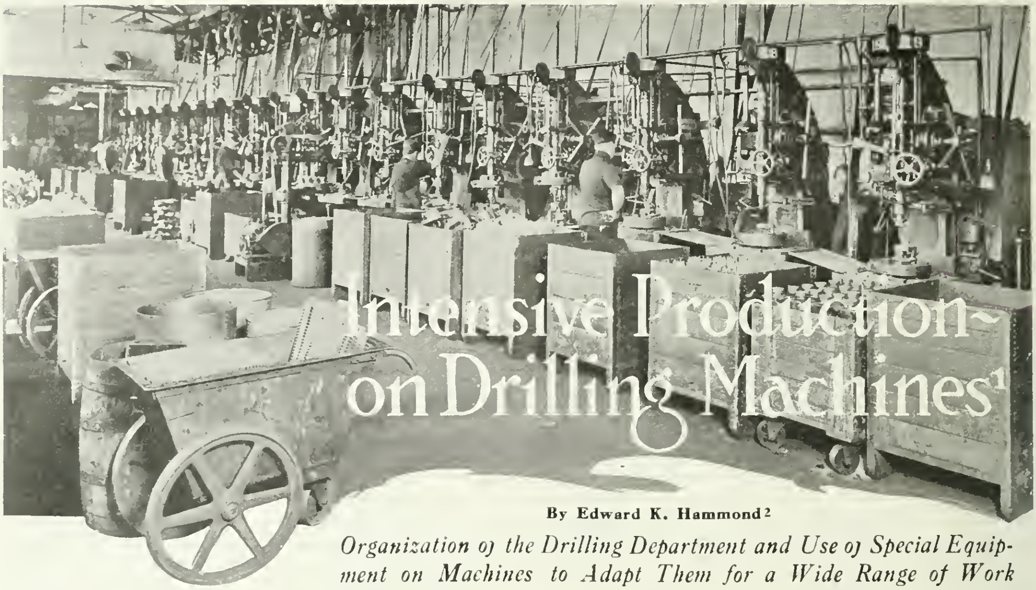
There is no doubt that the indicator gage will find a more general use and can well be adapted for other uses than gasoline-engine construction. Some of the various purposes may make some change in design and necessary improvements that will probably cause it to become a popular tool.

* * *

"It is generally believed that I built the Panama Canal," said Major-General George W. Goethals at the meeting of the American Society of Mechanical Engineers, when honorary membership in the society was conferred upon him. "That is a mistake. I claim to have been one of fifty thousand men who built it. I learned exactly where I came in, in a trip that I took across the canal in a Panama railroad train, when the foreman, describing the canal to a visitor, led the visitor to understand that he was doing pretty much all of it. The visitor finally turned to him and said: 'What is the "Old Man," as you call him, doing?' The foreman replied: 'Oh, he comes around and sees us doing it, jollies us a bit, and then goes back and sits in the office and entertains visitors.'"

* * *

The French military authorities claim that their famous 75's owe their longevity to the fact that the steel liner contains molybdenum, which increases the life about twenty times. It has been found that tungsten-lined guns crystallize, after a certain number of shots have been fired, and are rendered practically useless, whereas molybdenum-lined guns seem to last indefinitely.



Intensive Production on Drilling Machines[1]

By Edward K. Hammond[2]

Organization of the Drilling Department and Use of Special Equipment on Machines to Adapt Them for a Wide Range of Work

THERE are many shop superintendents and men in charge of the planning of machining operations who do not realize the full scope of work which may be efficiently handled on drilling machines. In many shops gratifying results are obtained in the performance of such operations as drilling, counterboring, reaming, and tapping; but most factory executives have a well defined idea of what constitutes "drill press work," and the use which they make of their drilling machines is confined to those pieces which come under this arbitrary classification. Those in charge of the machine shops in some progressive manufacturing plants have recently broken away from this idea and have extended the use of drilling machines to provide for handling many operations for which turret lathes, engine lathes and other types of machine tools were formerly employed. In so doing the quality of workmanship has been kept up to the previous standards and in practically every case rates of production have been materially increased. There are few shops where a wider range of manufacturing operations are handled on heavy-duty drilling machines or where higher rates of production are obtained on this type of machine than at the plant of S. F. Bowser & Co., Inc., Fort Wayne, Ind. This concern operates a battery of twenty-eight of the No. 310 high-duty drilling machines built by Baker Bros., Toledo, Ohio, and the organization of systems for the expeditious handling of work and the development of jigs, fixtures and special cutting tools for use on these machines has been carried to a high degree of perfection by Sherwood Hinds, factory engineer of the Bowser Co.

Many shop men who have formed their own opinions as to what constitutes the range of work that can be efficiently handled on drilling machines would be greatly surprised at the results which Mr. Hinds is obtaining in the Bowser shops. Two points would doubtless be the first to attract attention, namely, the great variety of machining operations that are performed, and the extremely high rates of production which are secured with a relatively small labor cost for the operation of machines. In addition to the familiar operations of drilling, counterboring, reaming, tapping, etc., a variety of other operations, including turning, threading, facing and boring, are performed under conditions that give very satisfactory results from the standpoints of finish, accuracy and rates of production. There are necessarily a number of details concerning the operation of this department which vary according to the character of the work, but the basic principles governing the handling of all classes of work are as follows: The machines are set up in one row and placed close enough together so that sheet metal troughs extend from table to table of adjacent machines. As a result, when the operation on one machine has been completed, the work may be pushed across to the next machine with a minimum expenditure of time and exertion on the part of the operator. The parallel between this plan and the operation of turret lathes for handling the same work will be obvious. Instead of indexing a turret to bring successive tools into operation, the work is moved along under the spindles of machines carrying the required tools. Operations are conducted on the progressive system, but although many parts are handled which require a considerable number of operations to complete them ready for the assembling department—running as high as twelve operations in some cases—it is never found advisable to have so many machines working on the same piece at one time.

Before giving the subject serious consideration it would doubtless appear that the most efficient results would be obtained by setting up a sufficient number of machines to enable the work to be completed without the necessity of intermediate handling between the performance of different series of operations. Experience has shown, however, that on the average classes of work handled on these machines, one operator is able to take care of four machines. Accepting this as a basis of operation, and considering the case of a piece in which twelve operations are required to finish the machining, it at once becomes apparent that three operators and three groups of four machines would be necessary. So long as there is no interruption in the process of manufacture, the greatest efficiency would result through setting up twelve machines so that the work could be handed along progressively until the last operation was completed, after which the pieces would be transferred to the painting department preparatory to being assembled. As a matter of fact, the method of procedure would probably be to handle the first four operations as if their completion resulted in finishing the work: this set of four machines would then be dismantled and set up for the second set of four operations, and after these operations had been completed, the machines would again be dismantled and set up for the final operations. The reason for adopting this method is that experience has shown that where more than four machines are operated at a time, delays resulting from the breakage of tools on any one machine or the temporary absence of one operator from his group of machines would result in a congestion of work and delay of one or more of the other operators, which would far more than offset the time saved by the avoidance of what might appear to be two unnecessary transfers of the work from machines to trucks, and vice versa. Another advantage of subdividing the total series of machining operations in this way is that the percentage of the total machine equipment used on a single piece at any one time is greatly reduced. As there are a large number of different parts constantly going through the shop, it would be poor practice to tie up as many as twelve machines out of twenty-eight on a single job.

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[1] For information on drilling practice previously published in MACHINERY, see "Drill Grinding," in the May number.

[2] Associate Editor of MACHINERY.

No difficulty has been experienced in using four machines for a piece, regardless of the number of operations. Pieces with one operation would have four sets of tools and fixtures; pieces with two operations would have two sets of tools; and pieces with six or ten operations would have the tools doubled for the last two operations, which would enable the operator to do the last two operations on four machines, finishing two pieces at a time. With pieces requiring three, five, seven, or nine operations, etc., it is usually possible to combine two of the operations so as to fit an even number of machines, or else, in cases where there is one long operation, to set up two machines for this, the operator having time to perform the other two operations of this group on two pieces while either of the first two machines is performing one operation. An example of nine operations being performed on eight machines is shown on piece No. 15 of the listed parts; an example of a piece with three operations being performed to advantage on four machines is shown on part No. 2; and an example of a piece with five operations being performed on four machines is shown on part No. 4. The detailed method of operations on this piece is as follows:

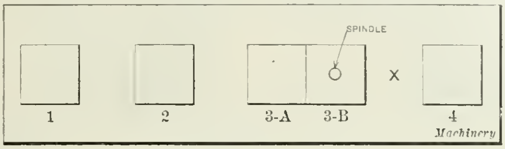


Fig. 1. Diagram illustrating Procedure in moving Work from Machine to Machine to keep All Machines in Group constantly in Operation

Referring to Fig. 1, it will be seen that four machines are used, the boring operation being performed on the first, turning on the second, tapping on the third, and threading on the fourth. The third operation is really a double one, because the piece is tapped with a taper pipe tap from each side. The machine for this operation has a sliding fixture with provisions for holding two pieces, one of these being inverted. The order followed by the operator of this group of machines in going about his work is as follows: (1) Remove bored piece from machine No. 1 and set up fresh blank. (2) Remove turned piece from machine No. 2 and set up bored piece from machine No. 1. (3) Remove piece from 3-B and place in position marked by a cross between 3-B and 4 in Fig. 1; remove piece from 3-A and place in position 3-B; take bored and turned piece from machine No. 2 and place in position 3-A; slide fixture until spindle is over 3-A and start machine No. 3. (4) Remove finished piece from machine No. 4 and set up piece which was set in position marked by cross between machines Nos. 3 and 4. (5) Go back to machine No. 3, hole at 3-A being tapped by this time, push fixture over and start spindle in piece in position 3-B. (6) Return to machine No. 1.

Another point which helps out the machining of pieces where it is necessary to perform a number of operations is the possibility of using portable machines, such as tappers, etc., to take a fifth and seventh operation. Piece No. 11 in the List of Parts, Order of Machining Operations and Rates of Production is an example of this. With such highly systematized methods for the performance of a sequence of opera-

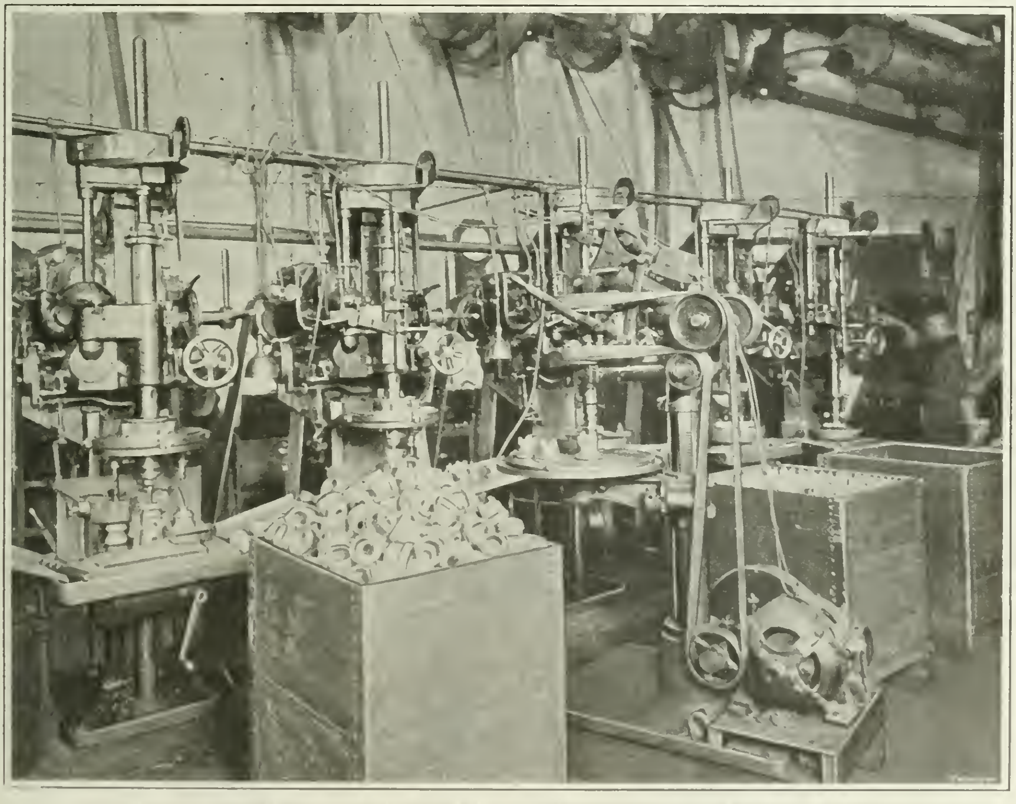
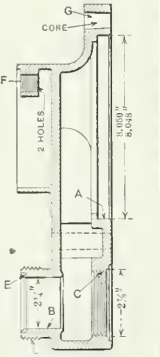
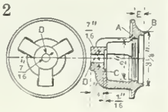
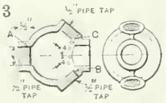
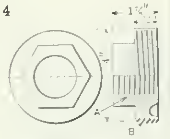
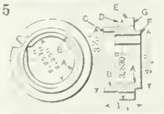
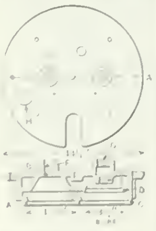
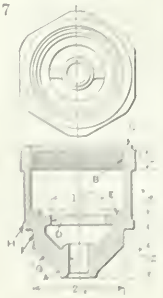


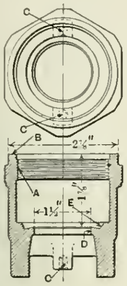
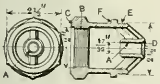
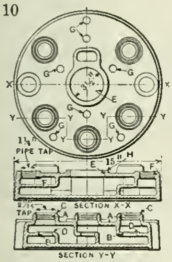
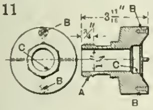
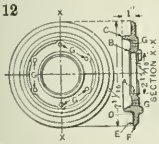
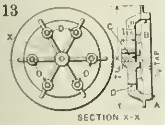
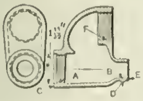
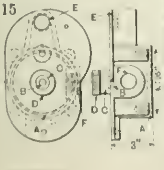
Fig. 1A. Garvin Tapping Machine mounted on Skid to be handled by Elevating Truck, and equipped with Individual Motor Drive

LIST OF PARTS, ORDER OF MACHINING OPERATIONS AND RATES OF PRODUCTION

	Oper. No.	Operation	Notes on Special Features of Tool Equipment	Material Production Time
1 	1	Grind top and bottom of work.	Besly double disk grinder.	Cast iron. 13 minutes.
	2	Bore hole *A*.	See Figs. 12 and 13.	
	3	Ream hole *A*.	See Figs. 12 and 14.	
	4	Rough-bore holes *B* and *C*, and chamfer top of hole *B*.	See Figs. 12 and 16.	
	5	Finish-bore and face top of hole *B*, counterbore and face top of hole *C*.	See Figs. 15 and 17.	
	6	Tap hole *C*.	See Figs. 12 and 18.	
	7	Finish valve seat at top of hole *B*.	See Fig. 19.	
	8	Turn and face top of union *D*, bore seat for bronze bushing *E*.	See Figs. 20 and 21.	
	9	Ream seat for bushing *E*.	See Figs. 20 and 22.	
	10	Thread union *D*.	See Fig. 20.	
	11	Press in bushing *E*.	Portable arbor press.	
	12	Chamfer bushing *E*.	See Figs. 20 and 23.	
	13	Drill two holes *F*.	See Figs. 20 and 24.	
	14	Tap two holes *F*.	See Fig. 20.	
2 	1	Bore hole *A*, face flange *B* and counterbore at *C*.	Combination boring, counterboring and facing tool with provision for holding dimension *E*.	Cast iron. 1 minute.
	2	Drill holes *D* in two pieces.	Jig to hold two pieces and two-spindle head.	
	3	Tap hole *A* in two pieces.	Note: Two machines on Operation 1.	
3 	1	Drill hole *A*.		Cast iron. 1 minute.
	2	Drill hole *B*.	Angle-plate jig with pilot in hole *A*.	
	3	Tap hole *B*.	Angle-plate jig with pilot in hole *A*.	
	4	Drill hole *C*.	Angle-plate jig with pilot in hole *A*.	
	5	Tap hole *C*.	Angle-plate jig with pilot in hole *A*.	
	6	Tap hole *A*.	Note: Operations 2 and 4 and Operations 3 and 5 performed on same machine.	
4 	1	Bore hole *A*.		Cast iron. 1¼ minute.
	2	Turn boss *B*.	Piloted turning tool.	
	3	Tap hole *A*.		
	4	Thread boss *B*.	Opening threading die. Note: Hole A is tapped from both sides with a 1½-inch taper pipe tap.	
5 	1	Bore holes *A* and *B*, face flange *C* and clean up surface *D*.	Combination boring and facing tool for two holes and two faces.	Cast iron. 2½ minutes.
	2	Turn diameter *E*, face flange *F* and clean up face *G*.	Combination turning and facing tool. Note: Two machines on Operations 1 and 2.	
6 	1	Rough-bore and chamfer hole *A* and face flange at top of hole.	Combination boring, chamfering and facing tool.	Cast iron. 5 minutes.
	2	Ream hole *A*.		
	3	Drill hole *B*.		
	4	Rough-bore holes *C*, *D* and *E*.	Stepped boring tool.	
	5	Ream hole *C*.		
	6	Tap hole *E*.		
	7	Bore and turn gland *F*.	Piloted comb. turning and boring tool.	
	8	Thread outside of gland *F*.		
	9	Bore hole *G*.		
	10	Tap hole *G*.		
	11	Bore hole *H*.		
	12	Tap hole *H*.	Note: All other holes drilled on multiple-spindle machine carrying two pieces.	
7 	1	Drill hole *A*, rough-bore hole *B*, face flange *C*, chamfer hole *A*.	Four-spindle drill head. Work is turned over twice.	Bronze. 2½ minutes.
	2	Finish-bore hole *B* and finish-face flange *C*; bore *D* and counterbore *E*.	Combination stepped boring, counterboring and facing tool which holds 1⅞ inch height.	
	3	Turn diameter *F*.	Piloted turning tool.	
	4	Thread diameter *F*.		
	5	Tap hole *B*.		
	6	Chamfer hole *D*.		
	7	True up face of flange *C*.		
	8	True up face *H*.		

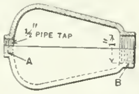
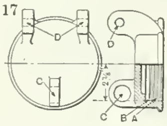
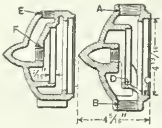
Machinery

LIST OF PARTS, ORDER OF MACHINING OPERATIONS AND RATES OF PRODUCTION

	Oper. No.	Operation	Notes on Special Features of Tool Equipment	Material Production Time
8 	1	Rough-bore hole *A* and face flange *B*, drill two holes *C*.	Four-spindle drill head. Work turned over once.	Bronze. 1½ minute.
	2	Finish-bore *A*, finish-face *B*, bore *D* and counterbore *E*.	Combination stepped boring, counterboring and facing tool.	
	3	Tap hole *A*.		
	4	Chamfer hole *D*.	Note: Holes C tapped on portable machine.	
9 	1	Drill hole *A*, bore and counterbore hole *B*, face flange *C*, chamfer hole *A* at *D*.	Three-spindle drill head. Work turned over twice.	Malleable iron. 1½ minute.
	2	Turn diameter *E* and face flange *F*.	Combination piloted turning and facing tool.	
	3	Thread diameter *E*.		
	4	Tap hole *B*.		
10 	1	Bore holes *A* and *B*; index fixture five times for these holes.	Indexing fixture and stepped boring tool.	Cast iron. 15 minutes.
	2	Face flanges *C* and *D* and counterbore holes *A*.	Combination counterboring and facing tool that holds height between faces *C* and *D*.	
	3	Tap five holes *A*.	Indexing fixture.	
	4	Chamfer holes *B*.	Indexing fixture.	
	5	Bore hole *E* and face flange *H*.	Combination boring and facing tool.	
	6	Bore two holes *F*.	Sliding fixtures to locate second hole for boring or tapping.	
	7	Tap two holes *F*.		
	8	Drill out seven cored holes *G*.	Note: Fixture is indexed five times to machine holes A and B.	
11 	1	Turn diameter *A*.	Turning tool.	Cast iron. 1½ minute.
	2	Thread diameter *A*.		
	3	Drill and countersink two holes *B*.	Four-spindle drill head—work turned once.	
	4	Drill hole *C* to depth shown; holes *B* tapped on portable machine.	Note: Holes B tapped on portable machine.	
12 	1	Bore hole *A* and face flange *B*.	Combination boring and facing tool.	Cast iron. 4 minutes.
	2	Turn diameter *C*, face flanges *D* and *E* and turn diameter *F*.	Combination turning and facing tool.	
	3	Drill two sets of three holes *G*.	Three-spindle drill head.	
	4	Chamfer hole *A* to 30 deg.	Note: Holes G tapped on portable machine.	
13 	1	Face flange *A* and bore hole *B*.	Combination boring and facing tool.	Cast iron. 3 minutes.
	2	Drill hole *C*.		
	3	Drill out six cored holes *D*.	Three-spindle drill head—two operations. Note: Two machines on Operation 1, hole C, tapped on portable machine.	
14 	1	Bore and counterbore hole *A*, bore hole *B* and face *C*; turn diameter *D* and face *E*; bore hole *F*.	Three-position fixture and multiple-spindle head; stepped boring and facing tool; combination turning and facing tool. Work reset three times.	Malleable iron. 2 minutes.
	2	Thread diameter *D*.		
	3	Tap hole *A*.		
	4	Tap hole *F*.		
15 	1	Bore and chamfer hole *A*.	Boring and chamfering tool.	Cast iron. 4 minutes.
	2	Ream hole *A*.		
	3	Drill hole *B*.		
	4	Bore hole *C* and turn diameter *D*.	Piloted boring and turning tool.	
	5	Thread diameter *D*.		
	6	Bore hole *E*.		
	7	Tap hole *E*.		
	8	Bore hole *F*.		
	9	Tap hole *F*.	Note: Operations 7 and 9 performed on one machine with two-position fixture.	

Machinery

LIST OF PARTS, ORDER OF MACHINING OPERATIONS AND RATES OF PRODUCTION

	Oper. No.	Operation	Notes on Special Features of Tool Equipment	Material Production Time
16 	1	Drill hole *A*.		Malleable iron. 1 minute.
	2	Tap hole *A*.		
	3	Drill hole *B*.		
	4	Tap hole *B*.		
17 	1	Rough-bore hole *A*.		Malleable iron. 2 minutes.
	2	Under-cut hole *A* at *B*.	Cam-operated under-cutting tool.	
	3	Tap hole *A*.		
	4	Drill hole *C* and two holes *D*.	Angle-plate jig and two-spindle drill head.	
18 	1	Bore holes *A* and *B*.	Angle-plate jig; work turned over to drill and tap hole *B*.	Cast iron. 2½ minutes.
	2	Tap holes *A* and *B*.		
	3	Rough-bore holes *C* and *D*.	Stepped boring tool.	
	4	Ream hole *C*.		
	5	Drill hole *E*.		
	6	Tap hole *E*.		
	7	Drill hole *F*.		
	8	Tap hole *F*.		*Machinery*

Note: The time of each operation does not include an allowance for setting up machines or grinding tools, but does allow for changing dull tools for sharp ones. The time of setting up machines varies from fifteen minutes to half an hour per machine, depending upon the nature of the tools and fixtures which are required.

tions, it is believed by the management of the Bowser factory that the highest rate of production that is possible is obtained from each machine.

Organization of Department Management

Reference has already been made to the fact that in operating these machines, it is the practice never to have more than four machines working on the same piece; however, it occasionally happens, that the length of operations on a group of machines is such that the operator can perform the first operation on the group of four machines next to his own in less time than the other operator can perform the remaining three, in which case, the machines are divided up five and three between the two operators, although the parts being machined each require four machines. There is a set-up man in charge of the department who is under the jurisdiction of the general foreman, and it is the duty of this man to assist the operator in dismantling his machine at the completion of each job and in setting up the new jobs. He also sees that sharp tools are furnished to the operators at such times as they need them and can also substitute for any of the regular machine operators at such times as the latter are away, in order to keep all the machines constantly employed during the working days. Figs. 1A and 1B show the application of portable machines for performing an extra operation for which a machine is not available.

Special Equipment for Machines

Mention has already been made of the fact that the machines used for this work are the Baker No. 310 high-duty drilling machines. Standard machines were purchased, but in order to adapt them for the special requirements of this work it was found necessary to apply some additional equipment. Actual changes made in the machine details include the following: Provision of special gears in the feed train to allow for cutting threads of the desired pitches, including the 11½ pipe threads; provision of an automatically operated air cylinder on each machine for shifting the double belt drive, to provide for reversing the direction of rotation for backing out taps and backing off threading dies; and the provision of a special feed release mechanism which disengages the feed clutch but allows the spindle to continue rotating for the necessary length of time to insure the removal of tool marks when performing facing, chamfering and counterboring operations.

In this connection it might be mentioned that a special arrangement of counterweights is provided which are much lighter than the standard counterweights furnished on the machine. These weights are of the slotted disk type and the number of weights used can be such that the boring tool, tap, or die can either be just floated off the work or actually returned to the starting position automatically, so that all the operator has to do is to pull the spindle down and throw in his feed lever. The capstan placed in the base of each machine under the counterweight provides for regulating the height to which the spindle is raised so that the height of the spindle in its "up" position can be made to suit each job. It also prevents the spindle quill from striking the top of the machine in cases where heavy counterweights are used. This is accomplished by raising or lowering the capstan so that it stops the fall of the counterweight at just the required point.

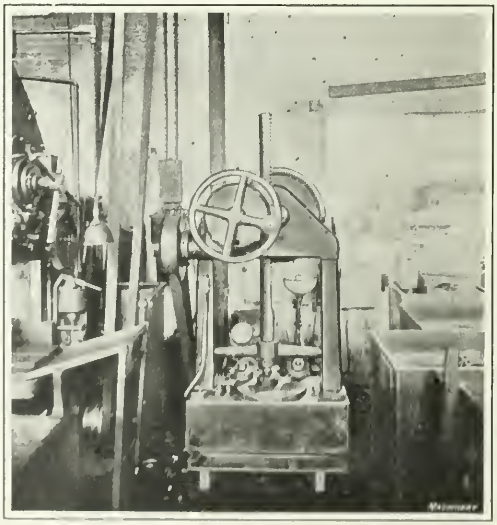


Fig. 1B. Arbor Press mounted on Skid so it can be set in Place to press in Bushings during Performance of a Sequence of Machining Operations

Special Provision for Threading and Tapping

On these machines, threading and tapping operations are performed on work where it is required to cut from eight to twenty threads per inch. On the Baker high-duty drilling machines changes in feed are obtained by first placing lever *A*, Fig. 2, in one of the three positions controlled by inserting a pin into holes in the dial over which this lever rotates. Any of the rates of feed obtained in this way may be compounded through slip gears *B*, *C*, *D*, and *E*, which have 27, 33, 20, and 40 teeth, respectively. It will be apparent that both pairs of gears *BC* and *DE* have a total of 60 teeth, so that they may be placed on fixed centers, and by transposing gears *B* and *C* or transposing gears *D* and *E*, the three available rates of feed obtained for different settings of lever *A* are combined to give a total of 12 feed changes. The total range of feeds runs from 0.010 to 0.050 inch per revolution. This mechanism is standard for the Baker drilling machines with the exception of the fact that shafts *F* and *G* are made 5 inches longer than the standard dimension to provide for introducing special gears into the feed train in order to secure the desired rate of advance for the spindle when performing threading and tapping operations, which are the only operations for which these special gears are used.

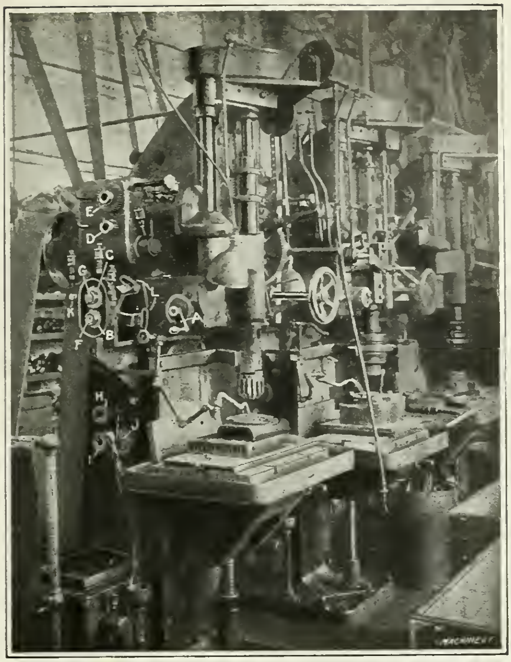


Fig. 2. Arrangement of Special Gears introduced into Feed Train to provide for performing Threading and Tapping Operations

When the machine is to be set up for threading or tapping, the first step is to remove the gears from shafts *F* and *G*. As a substitute for these two gears, one of the special change-gears *H*, *I*, or *J* is introduced into the feed train; this special gear has twice as many teeth as there are threads per inch on the work which is to be machined. For instance, a gear with 23 teeth is employed for threading or tapping work with the 11½ threads per inch commonly employed on pipe fittings. This gear is mounted on a pull-pin *K*, after which quadrant *L* is pulled up to readjust the position of the gears in the feed train so that this special "transposing" gear for threading and tapping operations is brought into mesh. Before starting threading or tapping it is necessary to remove the gears from shafts *F* and *G*, but if so desired the transposing gear may be left in place on the pull-pin *K* when the machine is used on other classes of work. When this is done, the gears are simply replaced on shafts *F* and *G* and quadrant *L* is dropped so that the transposing gear is no longer in mesh. Under such conditions, transmission is through the regular feed-gears on shafts *F* and and *G*. Hooks are provided for the feed change-gears and for the special gears for threading and tapping, so that there is little danger of their being misplaced when not in use.

Automatic Compressed-air Reverse for Threading and Tapping

Reversal of the direction of spindle rotation for the performance of threading and tapping operations is accomplished by the standard arrangement of forward and reverse belts furnished on the Baker high-duty drilling machines. A change in the method of operating these belts has been provided, however; instead of using a hand-lever, shifting of the belts is accomplished automatically by compressed air. At the right-hand side of two machines in each group of four, there will be seen a small air cylinder in which runs a piston that actuates the belt shifter.

A good idea of the way this mechanism operates will be obtained from the view of four machines, Fig. 3, and the detail views of the control mechanism, Fig. 4. At the left-hand side of the machine within convenient reach of the operator there will be seen a lever *A*, Fig. 3, which actuates the air valve. When this lever is thrown up it opens the valve to admit air to the under side of piston *B*, which forces this piston to the position at the top of the cylinder shown in Fig. 4. Connected to the piston-rod there is a rack *C* which meshes with a pinion on shaft *D*, by means of which the belt shifter is actuated to throw the "forward" driving belt onto its tight pulley, while the "reverse" driving belt is shifted onto its loose pulley. When it is desired to reverse the direction of rotation, lever *A*, Fig. 3, is thrown down to admit air into the cylinder above the piston, with the result that this piston is forced to the bottom of the cylinder. Through rack *C* and the meshing pinion carried on shaft *D*, the "reverse" belt is thrown onto its tight pulley and the "forward" belt is shifted to its loose pulley, which provides for backing out the tap or backing off the threading die.

So far we have considered the operation of this mechanism as if it were hand operated, but, as a matter of fact, the operation is automatic. By making suitable adjustment of hand-lever *E* at the top of the air cylinder, provision may be made for either stopping the machine or automatically reversing the direction of rotation. To stop the machine, lever *E* is thrown down, and the connection of this lever with link *F* and bell-crank *G* results in sliding bolt *H*

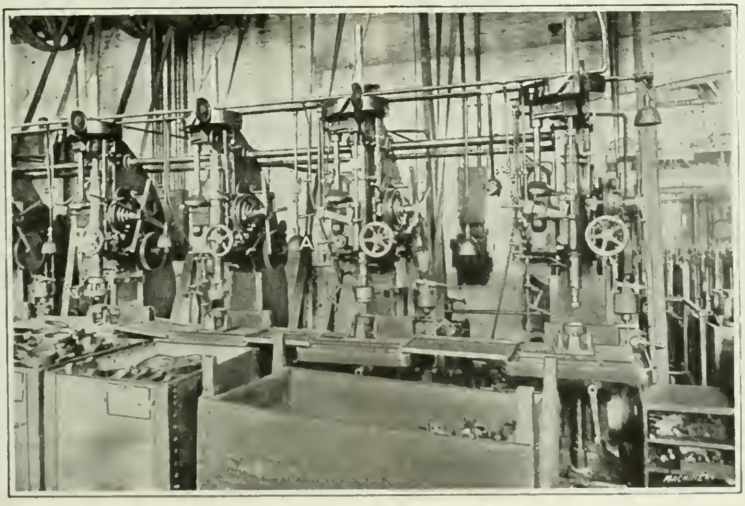


Fig. 3. Arrangement of Compressed-air Control for Spindle Reverse Mechanism for Threading and Tapping

to the right. In this position cam *I*, attached to the back of rack *C*, comes down until the flat bottom of this cam engages bolt *H*. In this position the forward belt has been shifted onto its loose pulley, but the reverse belt has not been shifted from its loose pulley to the tight pulley. As a result, both the forward and reverse belts are running on their loose pulleys, and so the machine stops.

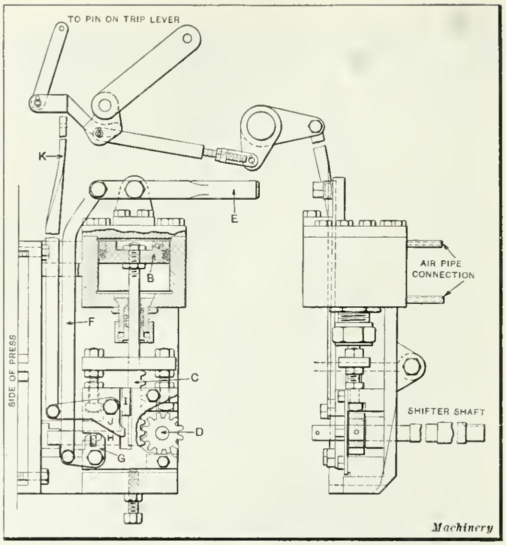
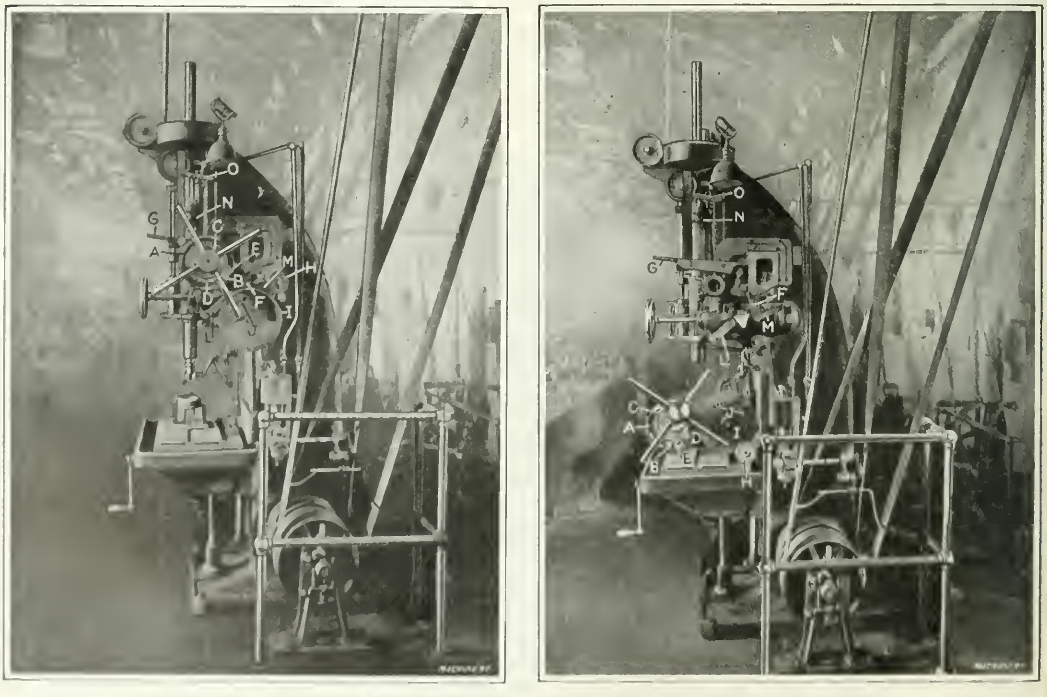


Fig. 4. Mechanism of Compressed-air Control for Spindle Reverse, shown in Place on Machine in Fig. 3

If, on the other hand, it is desired to have the machine reverse automatically, lever *E* is pushed up so that bolt *H* is withdrawn. It is now possible for the piston to descend right to the bottom of the air cylinder, thus allowing rack *C* to shift the "forward" belt to its loose pulley and the "reverse" belt to its tight pulley. This reverses the direction of rotation of the spindle to back out the tap. In this position of the mechanism, cam *I* descends and engages with a corresponding cam surface on bellcrank *J*, which results in rocking this lever and raising rod *K*. This rod is connected to a link mechanism, which drops the feed worm out of engagement with the worm-wheel at the time that the reverse belt is shifted onto the backward driving pulley. Under these conditions the spindle is free, so that the tap or die can be backed off the work. A collar on the drilling machine spindle trips valve lever *A* to provide for reversing the machine at the bottom of the spindle travel, i.e., when the tap or threading die has reached the desired depth; and a second collar again reverses the machine ready for the next operation. To start the machine, it is merely necessary for the operator to throw the feed worm into engagement with the worm-wheel in the usual way.

Connected with the same air line that supplies the cylinders for reversing the direction of rotation of the spindles for threading and tapping operations, connections are made at each machine with a flexible tube and metal nozzle, on which there is a push-button valve. This equipment is found convenient for blowing chips and cutting compound off the work after an operation has been completed. All bolts on the machine have standard heads to fit a single socket wrench.

It will be seen that there is a second pipe line running along at the top of the machines, this being provided to carry cutting compound to the machine from a single distributing station. Each machine has its individual electric light with a shade which protects the operator's eyes and directs all light down to the work. At each third machine, connection is made with a power circuit, the purpose of this being to provide for driving portable tools. The purpose of this is to allow a portable drilling or tapping machine to be brought into place for performing one or two operations in cases where the number of operations to be performed is such that they cannot be conveniently divided up among the machines. When not required, the portable machine is carried away on an elevating truck; it is mounted on a skid for this purpose. At each machine a safety plug is provided which may be pulled out to stop the main driving motor in case of emergency.



Figs. 5 and 5A. Close View of Mechanism employed to hold Feed Constant while completing Facing Operations

Provision for Holding Feed to Complete Facing Operations

There are a number of different parts that are machined on this battery of drilling machines on which it is required to perform facing operations. This work can readily be handled on drilling machines equipped with suitable facing tools, but where a fine, smooth finish is required—as in cases of couplings on gasoline pumps, etc.—trouble would be experienced through having tool marks show on the work if the facing head were simply advanced to the work until the feed mechanism was tripped automatically and the spindle returned to its upper position. To overcome this trouble, a special equipment has been furnished on all machines, which provides for disengaging the clutch at the end of the feed worm and still holding this worm in contact with the worm-wheel, so that the spindle continues to rotate with its position held stationary, as far as vertical feed movement is concerned. In this way the facing operation is completed without any tool marks being left. The same device is used to secure a smooth finish when performing chamfering and counterboring operations.

Two complete revolutions of the capstan wheel are necessary in order to obtain the full travel of the drill spindle. In working out the design of this mechanism for rotating a cutter without any feed movement, while completing a facing operation, provision had to be made for obtaining practically the full spindle travel to meet the requirement of those cases where it is necessary, before the feed is tripped. For this purpose the following means are employed, as shown in Figs. 5 and 5A. A disk *A* is bolted to the feed worm-wheel, and this disk has a circular T-slot milled in it to carry an adjustable dog *B*. Pivoted freely on the face of this disk there is a second member *C* on which there is arranged a lever *D* that may be pulled to advance a catch *E* out of the edge of disk *C*. This catch *E* ultimately engages the upper end of a bellcrank lever (the lower end of which is shown at *F*) which results in causing the lower end of this lever to disengage the clutch at the end of the feed worm shaft.

In operation, the position of dog *B* is adjusted in the circular T-slot in disk *A*, so that this dog causes catch *E* to trip the feed worm clutch when the spindle has reached the desired position. As two complete revolutions of the capstan wheel are required to secure the maximum feed motion for the spindle, it was necessary to employ the double arrangement of disks shown at *A* and *C*, in order that disk *A* can make a complete revolution to bring dog *B* to the opposite side of the lug on disk *C*, after which continued revolution of disk *A* causes dog *B* to carry disk *C* around. When this revolution has been completed catch *E* engages bellcrank lever *F* and trips the feed worm. Of course, any portion of the maximum feed movement of the drill spindle may be obtained by making a proper setting of dog *B*.

When the clutch has been disengaged on the feed worm shaft, it will be apparent that the worm is still in engagement with the worm-wheel, which prevents the counterweight from returning the spindle; at the same time, the spindle continues to rotate, thus completing the facing operation with a fixed vertical position of the cutter, so that the work is finished without showing any tool marks. To complete the cycle of operations, it will be apparent that the feed worm must be thrown out of engagement with the worm-wheel so that the spindle may be returned to the starting position. The mechanism provides means of doing this automatically, the operation being as follows: The preceding description has explained how catch *E* comes into contact with bellcrank *F* and results in disengaging the clutch on the feed worm shaft. After this has been done, it is necessary for pinion *H* to be brought into mesh with gear *I* in order that a dog mounted in one of the holes *J* in gear *I* may engage with a link to throw the feed worm out of engagement with the worm-wheel.

After catch *E* has engaged with bellcrank lever *F* and moved this lever sufficiently to disengage the clutch on the feed worm shaft, catch *E* plays no further part in the operation. Carried by lever *G* there is a spring plunger with a roller at its end, which runs over the V-shaped block secured to the frame of the machine. At the same moment that catch *E* has disengaged the feed clutch, this roller carried by the spring plunger on lever *G* has reached the position at the apex of the V-shaped block. The spring behind the plunger is now compressed so that its maximum tension is exerted, and as the roller passes over the top of the vee the spring pressure becomes effective in causing the roller to run down the decline of the V-shaped block. In so doing, a further movement is imparted to lever *G* which has the following effect. Pinion *H* is carried on a quadrant, which has been gradually swung over during the time that catch *E* is in contact with bellcrank *F*. As the roller carried by the spring plunger on lever *G* runs down the decline of the V-block, movement imparted to lever *G* is transmitted through a link mechanism of which *M* is a part, which results in bringing pinion *H* into mesh with gear *I*.

As previously mentioned, a pin carried in one of the holes in this gear, trips the feed worm out of engagement with the worm-wheel. The counterweight then returns the spindle to its upper position. At this point collar *N* carried by the spindle engages lever *O*, which imparts the reverse movement to the mechanism which has just been described. In the first place, the quadrant which carries pinion *H* is rocked back so that this pinion is disengaged from gear *I*. Gear *I* is made heavy at what is the lower side in the starting position, and this gear is free on its shaft, so that when the pinion is disengaged, gear *I* is automatically returned to the starting position, where the heavy side of the gear is at the bottom. Bellcrank lever *F* and the extension *G* of this bellcrank are also returned to their starting positions ready for the next cycle of operations. When the operator has set up the next piece of work, he merely has to engage the feed worm with the wheel, after which he goes on to the next machine.

* * *

EMPLOYMENT OF WOMEN IN MUNITION FACTORIES

In a paper read before the British Institution of Mechanical Engineers, O. E. Monkhouse called attention to the many difficulties that were met with in the introduction of women into machine shops. A large proportion of the women employed were not accustomed to factory life and discipline; most managers and foremen were not accustomed to managing women workers; the shop conditions were planned with a view to the employment of men; and the women were unaccustomed to the use of machinery. Besides, there was the difficulty of maintaining discipline in a mixed shop. Other difficulties were the long hours and the question of physical strength. At the present time, nothing but harm can be done by praising the power of women too highly, but there are many cases where women have shown great ability and have acquired a knowledge of certain branches of shop work greater than that which would have been obtained by an apprentice in the same period under prewar conditions. This state of affairs is due largely to the fact that women have been definitely taught, whereas the apprentices had to pick up their trade; that women have, for the most part, been extensively taught everything in the shop itself under production conditions, rather than in an apprentice school; and that present conditions have actuated and spurred on everybody to greater effort from patriotic motives. There is little doubt that the advantage of getting their training under production conditions has been instrumental in speeding up women's training.

It is extremely difficult to start women in the same shop with men unless the latter are in sympathy with the movement. Experience has shown that the only satisfactory way is to start women in a shop by themselves under a broad-minded foreman. Government training schools have done much in England by supplying a nucleus of trained labor to the shops; while a few large firms have started their own training schools.

There is no doubt that, generally speaking, a woman is a better judge of a woman than is a man; so in England successful firms have experienced women supervisors who hire all the women workers. In one case, where some of the women were chosen by a woman and the rest by a man, there was great complaint of the efficiency of the women hired by the latter; investigation showed that those women who were rejected by the woman were generally engaged by the man.

ROUTING AND HANDLING SHELLS

GENERAL PRODUCTION METHODS AND SHORT-CUTS ON LARGE SHELLS

BY JAMES FORREST[1]

WHEN a large contract is received many important questions arise. If the job is entirely different from anything that has been done before, as is generally the case with a shell contract, the first questions to be decided are whether the work can be handled with the equipment already at hand; whether this equipment can be altered and rearranged to advantage; or whether an entirely new shop with an installation of machines for the purpose will be necessary. In most cases the last course will be found advisable on account of the magnitude of munition contracts, the money involved, and a consideration of the great handicap under which ordinary machine tools labor in comparison with single-purpose machines built expressly for the hardest and roughest use.

The following points should be borne in mind when selecting munition machinery: The machines must be able to run twenty-four hours a day, which means the working parts must be more liberally proportioned than is usually the case, and the members that support the working parts must be so sound, solid, and rigid, that there will be no vibration under the most trying conditions. It should be remembered that these machines will be expected to produce many times in excess of preconceived ideas of production, that the cry will always be for more, and that in many cases, far from being set on a solid concrete base, the machines are set down on cinders that cover what only a few weeks previously may have been a swamp. The machines will also be run for long periods without proper care by irresponsible men who will handle them roughly.

A machine may be large, heavy, and coarse looking and yet not have the required strength. It is not enough to simply look at a machine and then say, "Oh, it looks heavy enough, I guess it is all right." It is necessary to study its parts and get down on one's back to see that it is all right. For instance, a heavy, rugged, boring machine, built by a reputable firm, though a new one, which was well proportioned and designed, had a weak point in one of the walls of the carriage. When one machine after another broke in service, an investigation showed that the side of the carriage which took all the thrust of the cut was only half as strong as the trailing side. Convenience is another point to be kept in mind. When it is considered how many times a day and for how many months the various operating parts will be actuated, it will be realized that they should be easy of access, easy working, and not likely to get out of order.

Routing the Work

Side by side with the purchase of machinery comes the problem of arranging it in place. This problem will, in a way, solve itself if the attention is focused on the place where the rough forgings must be brought in and where they must be shipped when completed. If the shipping station is at the opposite point of the compass from the receiving station, and there is enough space between these points for the different operations, the routing of the product will follow a direct line from one point to the other in progressive steps. If two sizes of shells are being made, a double line of shops may be built with store-rooms, tool-rooms, offices, and other adjuncts that apply to the product as a whole, placed in between; or the heavier shells can pass along the first floor and the lighter along the second. If the shipping point is at the same end as the receiving point, the product may be elevated to the second floor, passed along until half completed, and then dropped to the first floor and sent along back to the shipping point. Of course these suggestions will be modified by a consideration of the various operations; for instance, heavy hammering cannot be done on a second floor. The principal thing is to have the product follow a straight line so that it will not double back at any stage in its path, as this means more men to handle it and much loss of time in consequence.

If a new shop must be constructed, the floors should be made of concrete, thus providing the proper foundation for the machines at the beginning. The floor of rooms where machinery using cutting fluid will be installed should have the chip troughs, with connecting ducts to the main return conduits, incorporated as a part of the concrete floor. Then all troubles due to leaky or clogged return pipes will be prevented, the machines will turn out better work on account of less trouble from vibration, and the chips will be easier to

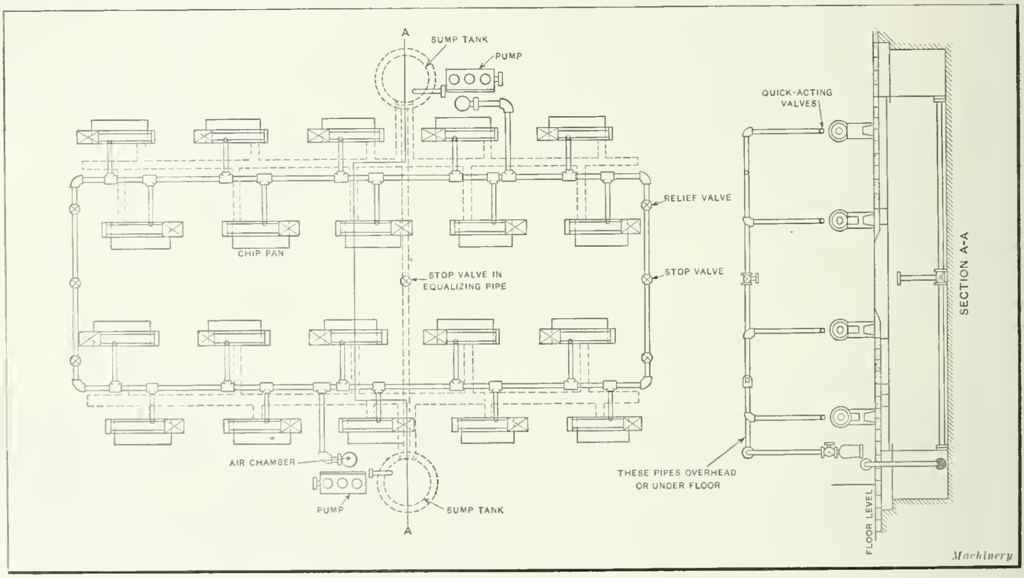


Fig. 1. Lubricant Drainage System

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[1] Address: 121 E. Hopocan Ave., Barberton, Ohio.

WEIGHT OF FRENCH SHELLS DURING PROCESS OF MANUFACTURE

Operation	220-millimeter Shells		270-millimeter Shells	
	Weight before Operation, Pounds	Loss of Weight, Pounds	Weight before Operation, Pounds	Loss of Weight, Pounds
Forging	355.500	.....	528.50	.....
First cut to length	319.500	36.00	433.50	95.00
Rough-turn	244.000	75.50	348.00	85.50
Bore	203.000	41.00	307.00	41.00
Base cut	188.500	14.50	286.50	20.50
Finish shell (no band)	161.145 + 155.450 —	27.35 33.05	237.39 + 227.83 —	49.11 58.67
Average total weight lost	....	197.20	......	295.90

Machinery

remove, as the troughs under the machines can be made with an incline at the rear, up which the chips may be raked. Besides, the floor can be kept in a much more sanitary condition on account of the ease with which it may be flushed, and it will be drier and more comfortable for the men, as all liquid will drain off into the ducts and troughs. A platform of wooden slats may be placed for the operators to stand upon. The concrete floor will also present a much better surface for transportation of machines, supplies, and products, than any other material, thus effecting a saving in tires and the power consumption of transfer trucks.

Handling the Work

After a plan of routing has been developed and the location of machines decided upon, much time and study should be devoted to the details of handling the shells from the time they are received from the steel mill through the sequence of operations until they are finally shipped. These details will depend greatly on the weight of the shells at each operation. More expense can be saved by foresight at this time than at any other, for while machines may be speeded up without cost, and production increased thereby, in most cases it costs a great deal of money to change a faulty system of handling as new equipment must be bought.

The motions that are most often repeated are those upon which attention should be concentrated. If the shells, as soon as an operation is completed, are placed in the position to be lifted into the machine for the next operation, a material saving in time will result. For instance, when unloading shells from a car, if the only object were to empty the car in the shortest possible time, a lifting magnet could be used to raise the shells over the side of the car and they could be dropped wherever room could be found. But the shells would have to be twisted, wedged, and levered out of the pile again, one by one, to start them off to the next operation. A better plan is to pile them in regular formation on an elevated platform so that they may roll down by their own weight to the next operation.

The installation of a complete monorail system, together with electric hoists, around the aisles between the machines, with switches and sidetracks to carry the shells in to the machines, will give the best results in facility and low cost of handling. If the transferring between operations is done on the floor, each shell must be hoisted to the height of the machine centers and lowered back to the floor again, two lifts for each operation. With standardized lifting devices, a stop can be applied to the hoist so that the shell is automatically stopped when it is raised to the correct height to be placed in the machine. This monorail system can be easily arranged so as to feed into a main aisle where an electric traveling crane will handle all the shells in large quantities.

The operations on French 220-millimeter and 270-millimeter shells, from the time the forgings are received until the shell is finished are as follows: Unloading from car, rolling into shop, pickling, inspecting rough forgings, marking for cutting off, assigning serial numbers, cutting off to length, centering, rough-turning, inside boring, base cutting to exact thickness, nosing, heat-treating, nose boring and facing, threading nose, finish-turning, grinding bourrelet, washing, sand-blasting, hydraulic testing, banding, band turning, finish inspection, boxing and shipping. The weight of the shells during the different stages is given in the accompanying table.

Machinery for shell work ought to have individual motor drives to avoid the delays caused by belting systems. If a belt comes off, even on one unit, that unit is thrown out of action and the other units in the system are idle while the belt is being put on. Even after the lineshaft is running again, it will be some little time before the machines are running with the same efficiency as before. Some of the operators will have discovered they are hungry, or need a chew of tobacco, or a drink, and so on; perhaps the pump will have to be primed; or someone may break a tool picking up a cut again. If the main driving belt gives trouble, the effects of the shutdown are increased a hundred fold. When consideration is taken of these facts and of the initial cost and the upkeep of lineshafting, pulleys, belting and belt-shifting mechanisms, of increased danger to life and limb that the care of these things entail, and of the restrictions they impose on the installing of shell-handling appliances, it will be seen that the balance is in favor of individual motor drive. With such a drive, an automatic overload cut-out placed in the motor circuit will save many an expensive tool.

On a long contract of any kind as much care and forethought as the circumstance will permit should be expended on the evolution of methods for making the series of actions

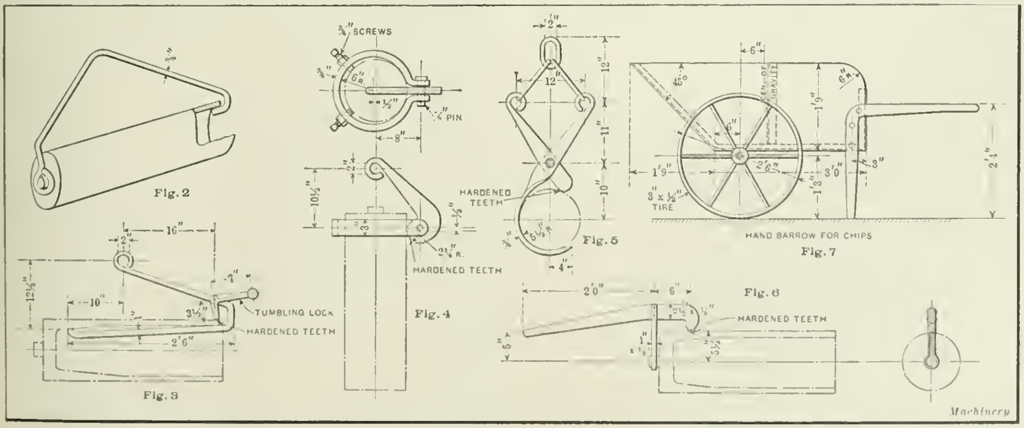

Fig. 2. Device for rolling Shells on Floor. Fig. 3. Holder for lifting Shells into Chucks on Boring Machines. Fig. 4. Holder for lifting Shells vertically. Fig. 5. Holder for lifting Shells horizontally. Fig. 6. Device for lifting Shells with Heavy End Up. Fig. 7. Hand-barrows for Chips

that the operators must frequently perform as fast and easy as possible. Nuts that must be loosened and tightened many times a day can often be replaced by cams with handles attached. The same result may also be obtained by having two wrenches for the nut; one a very short light-weight wrench for putting the nut down fast and the other a regulation wrench for tightening it. All wrenches should be of the proper weight and balance to make their use as little tiring as possible and they should have hard jaws that exactly fit the nuts. Double-end wrenches can be used for parts near each other that are adjusted at the same time. The best of the odd tools and appliances the more intelligent workmen gather around their machines, in order to increase their piecework pay, should be standardized and supplied to all. Valves for the cutting compounds should open and close immediately instead of being of the slow screw-down variety seen in many shops.

All machine bearings should be fitted with self-feeding lubricators dropping into a waste-packed cap and the cap should be attached by a chain, or a hinge to the bearings. These lubricators should be filled by a man hired for the purpose. If these precautions are not taken, the bearings of many of the machines will run dry and the machines will not have a lubricator when they have been in operation perhaps but a month. Glass should not be used in these lubricators as there is continual breakage. Electric or air hoists, depending on what is adopted as standard, will tend to multiply production when judiciously placed, and will also relieve the men of much hard, tiring work.

Handling Cutting Compound and Chips

Pumps for cutting compound should be so placed that one is always in reserve in case of breakdown, also piping systems should be installed, so as to be easily accessible for the removal of obstructions. Stop-valves should be introduced into the line so that all the machines need not be shut down in case an obstruction or blow-out occurs in one part of the piping. A practical arrangement is shown in Fig. 1, where the pipes run in a double row, connected by a cross-over pipe with stop-valves inserted, and there is one pump on each row of pipes. This arrangement will give the least number of shutdowns on the machines for pump trouble. The sump tanks, if there are more than one, should be connected by an equalizing pipe with a stop-valve for use when cleaning the tank or during breakdowns. The return from the machine pans to the sump tanks should be of a very large diameter. It is preferable to have the return flow back through an open concrete duct covered with trap boards which are easily removed for cleaning the dirt. At various points in this trough, wire screens should be placed to remove the chips and rubbish that invariably find their way into the fluid and clog the pump valves if not removed.

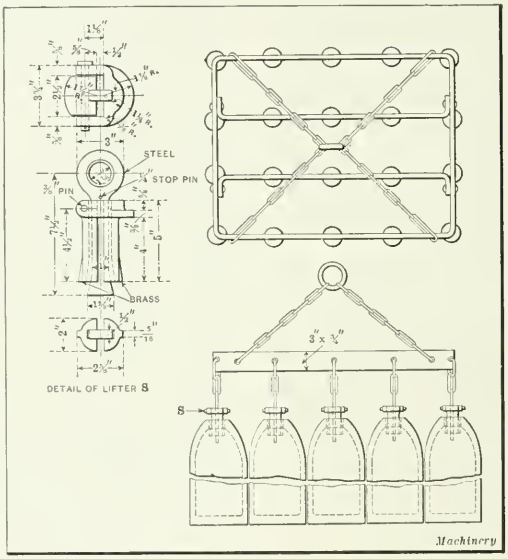

Fig. 8. Device for lifting Twenty Nosed Shells at One Time

The pipes should be well supported to take care of the vibration. As a pressure of at least one hundred pounds per square inch will be required on the boring operations, there should be proper relief valves and air chambers in the system. The pans under the machines should be large and deep, in proportion to the machine, to take care of the strong flow of the compound and the accumulation of chips. Some cutting compounds become rancid after a period of rest, as on a Monday morning and the smell causes some of the operators to become sick. This smell can be eliminated by applying crude carbolic acid frequently and in small quantities. The best way to apply the acid is to have an ordinary self-feeding lubricator behind each machine and drop the acid continuously into the troughs.

For handling the chips in the machine bays hand-barrows fitted with two wheels of very large diameter, and of such construction and balance as to be easily tipped and dumped, will be found convenient. The wheelbarrow shown in Fig. 7 throws little weight on the man wheeling it. These barrows are dumped into large hopper-bottom bins, fitted with lifting hooks, sunk flush in the floor in the main aisle, where the traveling crane can pick them up and dump them into the cars. The cutting compound may be drawn off the chips while they are in the bins by having a tank underneath each to receive the drip, or a centrifugal separator may be used. By this means it will be unnecessary to wheel the barrows long distances and up gang planks into cars.

Methods of Obtaining Maximum Production

On repetition work of any kind an effort should be made to place everyone in any way connected with the work on a piecework basis. It is quite possible, with the cooperation of the shop executives, to accomplish this, and make it apply to laborers, oilers, beltmen, inspectors, and repairmen, though, of course, it will not be possible at the beginning of a new job to do this. The supervising force, from the foremen up, should have a salary and a percentage depending solely on the output. By this means there is a zest and force impelled into the organization as a whole, making for increased production.

Two good methods might be used to increase production and quality of work. A small prize could be offered each week, on each operation, for the operator who has produced the largest number of pieces that pass the inspector for that week, and his name, together with the quantity of work produced each day, could be posted on the bulletin board for a month. There could also be posted, under the heading Black List, the names of those operators who have produced work that did not pass the inspector, together with the amount of such work for each day. There is no more valuable method for promoting friendly rivalry and discussion among the operators to the consequent increase and betterment of the work turned out and it also gives a check on undesirable employes.

A great deal of confusion and loss of time can be eliminated if each operation is assigned a color. Each shell, after the operation has been performed and inspected, should have a ring about two inches wide painted round it with the operation color. This band will be more visible and full of meaning than the inspector's obscure stamp to those responsible for pushing the shells onto the next operation. The foreman, or anyone interested, can tell at a glance whether the shells are in a place where they do not belong and immediately take steps to have them moved. There is not as disagreeable a job as grubbing among a lot of unidentified shells, searching for the almost effaced inspector's stamp. If the stamp is not found, there is always the uncertainty that it has been missed. The rooms where the different operations are performed may be named the "black" room, "red" room, or whatever color may have been assigned to the operation, and if a shell with any other than the operation color finds its way into a room that shell should at once be ejected.

Shell Handling Appliances

Fig. 2 shows a device that may be used to good advantage when a few shells have to be moved a short distance along the floor; this holder can be taken into corners and through contracted spaces if necessary. Fig. 4 shows a device for lifting shells vertically as in centering machines, etc.; it will be seen that this has two screws for adjusting when the teeth wear. Fig. 5 is for lifting shells horizontally into machines, like lathes. The action is such that if the shell is not caught exactly at the center of gravity, it is prevented from sliding through and injuring the operator.

Fig. 3 shows a device for lifting shells into machines with long chucks as in boring machines. This is an example of a highly dangerous device converted into one that is perfectly safe by the application of a quick and efficient safety lock actuated by the operator's hand. The device shown in Fig. 6 is used for lifting shells up on end. It is very necessary, for without such an appliance it is a difficult job to raise a shell up with the heavy base uppermost, and in one case at least, to the writer's knowledge, a man was injured through attempting to lift the shell without this device.

Fig. 8 shows an apparatus for lifting and placing twenty nosed shells in regular formation; it consists of a steel frame with twenty lifters slung from it. These lifters *B*, as shown in detail, consist of two hinged brass grips that are expanded by a central sliding steel piece. This device can be used for lifting shells that have been threaded without damage to them. If it were desirable the frame could be made larger to suit the work being handled.

* * *

HOLDER FOR GRINDING ACCURATE THREAD-CUTTING TOOLS

The thread-cutting tools used by the Blair Tool & Machine Works, Inc., 515 Greenwich St., New York City, for making thread gages and for other precision screw-cutting operations are ground on the surface grinder, as illustrated in Figs. 1 and 2. The cutting point or tool, which is held in a tool-holder while in use, is fastened in a block, mounted on the magnetic chuck of the surface grinder. Fig. 1 illustrates the position of this block for grinding one side of the tool, and Fig. 2 illustrates how the top surface or face is ground. In one case, the side of the block is placed against the plate, and in the other, the end surface. This block holds the tool in such a position that it is given a clearance angle of 15 degrees and at the same time is ground to the standard included angle of 60 degrees in the plane of the cutting face. The diagram Fig. 3 illustrates more clearly the relation between the sides of the block and the tool. The sides *A* and *B* are used for grinding U. S. standard thread tools. The sides *C* and *D* are used when grinding Whitworth thread tools. When using sides *C* and *D*, the tool to be ground is inserted in end *E* of the tool slot.

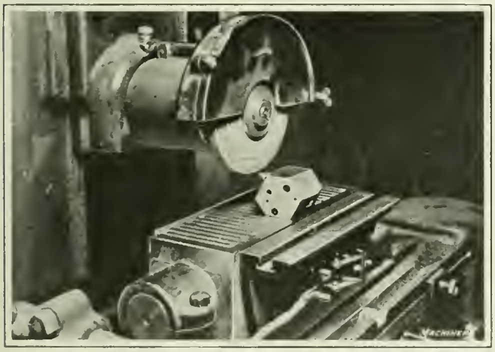

Fig. 1. Grinding One Side of Thread-cutting Tool on Surface Grinder

In making a block of this kind, it is necessary to modify the angles between the sides and the center line of the tool-holding slot, so that the cutting edge of the tool will be ground to the correct included angle in the plane y–y of the top face. This means that the angle of the tool in a plane x–x at right angles to the front edge will be somewhat greater than 60 degrees; consequently the angle a between the sides which rest against the chuck and the center line of the tool must exceed 30 degrees. The tangent of

$$\text{angle } a = \frac{\text{tan one-half of thread angle}}{\text{cos front clearance angle of tool}}.$$

Assuming that the clearance angle is 15 degrees and the thread angle 60 degrees,

$$\tan a = \frac{\tan 30 \text{ degrees}}{\cos 15 \text{ degrees}} = 0.5977,$$

and angle a = 30 degrees 52 minutes; therefore, the tool is ground to an included angle of 61 degrees 44 minutes in a plane at right angles to the front edge, in order to obtain an angle of 60 degrees in the plane of the top face.

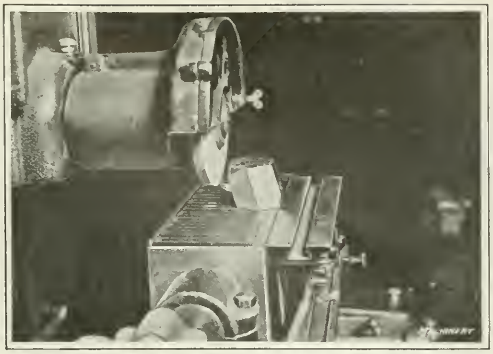

Fig. 2. Grinding Top Face of Tool on Surface Grinder

The end surfaces of the block are parallel with the tool-holding slot, which is inclined to correspond to the front clearance angle of 15 degrees. It will be noted that just above the tool there is a vertical surface, which simply provides clearance for the wheel when grinding the top face. This block is formed of two sections, which are held together by screws and dowel-pins. The joint between the two sections intersects the tool-holding slot and is parallel with the end surfaces.

F. D. J.

* * *

The following figures have been sent out by the Signal Corps, Aviation Section, of the materials necessary for a single airplane of the more simple type, and exclusive of all the materials necessary for the engine: nails, 4326; screws, 3377; steel stampings, 921; forgings, 798; turnbuckles, 276; veneer, 57 square feet; wire, 3262 feet; varnish, 11 gallons; dope, 59 gallons; aluminum, 65 pounds; rubber, 34 feet; linen, 201 square yards; spruce, 244 feet; pine, 58 feet; ash, 31 feet; hickory, 1½ foot.

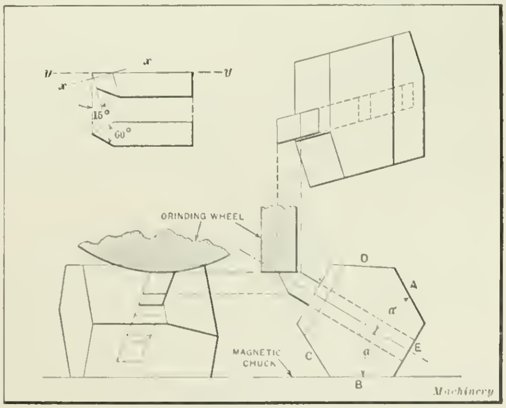

Fig. 3. Showing Inclination of Sides of Holder Relative to Thread Tool

OPERATING THE GRIDLEY AUTOMATIC TURRET LATHE—1[1]

COMPLETE INSTRUCTIONS FOR TOOLING SETTING-UP, AND OPERATING

BY DOUGLAS T. HAMILTON[2]

The Gridley automatic turret lathe is of the single-spindle type. It has three cam-drums for operating the various mechanisms. The main drum, which is located at the left-hand end of the machine, carries cams for operating the work-holding and feeding chucks and the tool-slides on which the end-working tools are held. The turret has four slides, and hence must be indexed four times for each revolution of the camshaft. When the corner stop is used, a fifth indexing is necessary. The indexing of the turret is accomplished by dogs carried on a drum located near the center of the main camshaft; this drum also carries dogs for operating the fast and slow feeds. The third cam-drum, located at the right-hand end of the camshaft, carries the cams for operating the forming slide and the cutting-off slide.

As each tool-slide is operated by a separate cam and as the travel of each slide is governed by the length to be turned, drilled, etc., it is necessary to select suitable cams, and in some cases, to cut the standard cams or make special ones. It is, therefore, necessary for the operator to understand how to lay out these cams in order to operate the machine at its highest efficiency. The cams are laid out with relation to the main cam-drum, which makes one revolution in forty-two minutes on the slow feed, and one revolution in thirty-six seconds on the fast feed, the latter being used for the idle movements. The cams are laid out so that they advance the slides a certain specified distance per inch of circumferential travel of the drum on which they are held. In laying out any particular job, however, the first question to settle is the speed at which the work is to be rotated; this is governed by the diameter of the work, nature of the material, and character of the operation. In order to illustrate the procedure, a practical example will be taken and each step described.

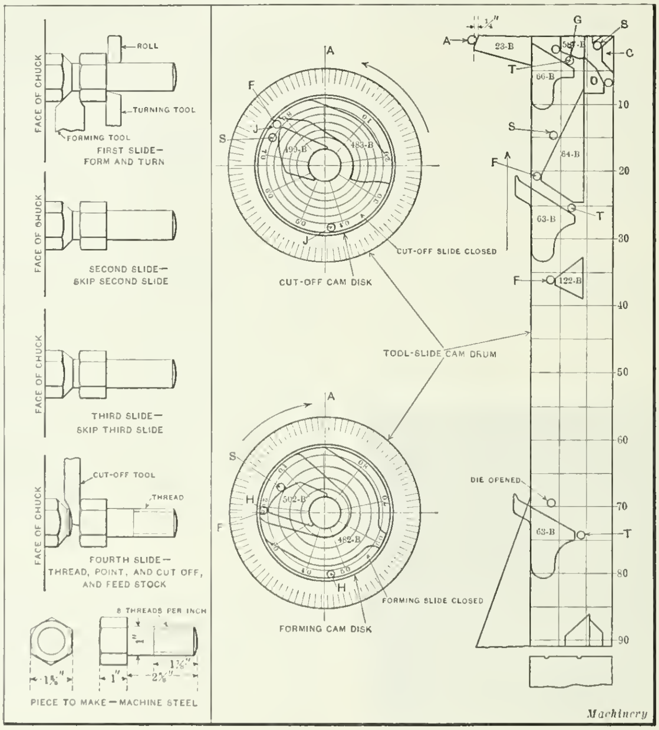

Fig. 1. Order of Operations and Lay-out of Cams for making Cap-screw

Method of Tooling

The shape and size of the part to be made largely govern the method of tooling that should be employed; the type of tools used also must be considered. In making a cap-screw of the form shown in Fig. 1, the forming tool is used for breaking down and chamfering the head, the box-turner on the turret-slide is used for turning, and the cutting-off tool cuts off and points the next screw. The threading, as a rule, is done with an opening die, which eliminates backing off the die.

After having decided on the order of operations and the tools to be used, it is necessary to determine the number of revolutions required to complete the cut and to select the cam to use. When the part to be made is to be threaded, two spindle speeds are usually necessary, especially for steel parts, so that all the other operations are performed at one spindle speed. As a general rule, the speed at which the forming cut can be satisfactorily taken may be considered the deciding factor. It is then necessary to determine the spindle speed required, which is governed by the diameter of the bar and the material. As most screw-machine tools are made from high-speed steel, a speed at least 25 per cent greater than would be possible with ordinary carbon tools may be employed.

The screw shown in Fig. 1 is to be made of hexagonal machinery steel, 1 5/8 inch across the flats, or 1 25/32 inch across the corners; hence the screw will be produced on a 2 1/4-inch machine. A surface speed for the work of 100 feet per minute will require a spindle speed of approximately 215 revolutions per minute.

Selecting Turret Feed-cam

The drum that carries the cams for operating the tool-slide has a circumference of 91 inches; and as it makes one complete revolution, on the slow feed, in forty-two minutes, it evidently travels 91 ÷ 42 = 2.166 inches per minute. As shown in Table 1, several cams having different angles of rise are provided, so the problem is to select a cam having a rise sufficient to give the desired feed with a certain spindle speed. Fig. 1 shows that the turning tool must take a heavy cut, and so the cam having the slowest feed will be selected. The cam designated by the manufacturers as 64-B, Table 1, advances the tool-slide 0.4663 inch per each inch of circumferential travel of the drum; or, in other words, it advances the tool-slide at the rate of 1.01 inch per minute. The rise of the cam, in inches, per inch of travel of the drum is equal to the tangent of the angle on the cam; so the rise or advance per minute is found by multiplying the advance per inch of circumferential travel by 2.166.

It is next necessary to see if cam 64-B will give a suitable feed with the work rotating at 215 revolutions per minute. The feed of the tool per revolution of the work is found by dividing the feed of the cam per minute by the number of revolutions of the work; thus, 1.01 ÷ 215 = 0.0047 inch. As the length to be turned is 2⅝ inches, with a feed of 0.0047

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[1] For previous articles on Gridley multiple-spindle automatic screw machines, see "Operating the Gridley Multiple-spindle Screw Machine," May, 1918, and articles there referred to.

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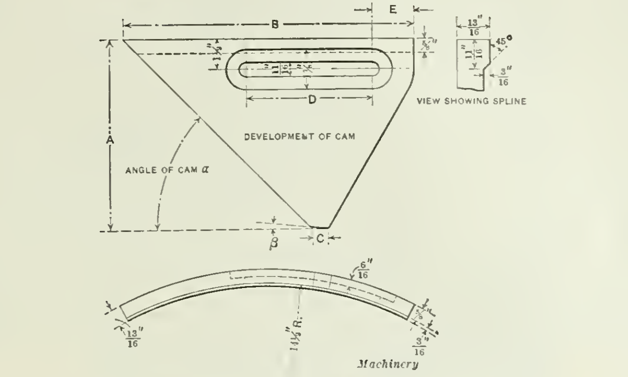
TABLE 1. DIMENSIONS OF STANDARD TURRET FEED-CAMS USED ON GRIDLEY 2¼-, 3¼-, AND 4¼-INCH AUTOMATIC TURRET LATHES



Number of Turret Cam	Angle α of Cam, Degrees	Angle β Deg.	Advance of Slide, Inches per Minute	Advance of Slide per Inch of Drum Travel	Principal Dimensions of Cams, Inches				
					A	B	C	D	E
64-B	25	..	1.0100	0.4663	6	16¾	¾	4 13/16	2 11/32
154-B	25	..	1.0100	0.4663	8	18	..	5 5/16	2 23/32
278-B	28	5	1.1516	0.5317	9	19	⅜	7	2 1/16
62-B	30	..	1.2504	0.5773	6¼	14⅜	¾	5 5/16	2 3/16
61-B	38	..	1.6923	0.7813	6¼	11½	¾	4 1/16	1 27/32
122-B	40	..	1.8175	0.8391	3⅞	5¾	7/16	..	1 11/16
60-B	45	..	2.1666	1.0000	6	10	¾	3 9/16	2 3/32
65-B	45	..	2.1666	1.0000	6¼	13¼	4¼	5 5/16	1⅞
329-B	45	5	2.1666	1.0000	9	13¾	⅜	6	1 15/16

inch per revolution, it will require 458 revolutions to make the complete cut.

Selecting Forming Cam

Reference to Fig. 1 will show that the forming tool is not required to take a wide cut; hence it will stand a comparatively heavy feed. Table 2 shows that there are three forming cams provided; so the one giving the coarsest feed, or that designated as 502-B, will be taken. The forming tool is required to travel a distance equal to 1/2 (1 25/32—1), or 0.391 inch. Cam 502-B has a total rise of 2½ inches and will more than cover the distance. As this cam advances the forming slide at the rate of 0.3384 inch per minute, and as the work is rotating at 215 revolutions per minute, the feed per revolution is evidently 0.00157 inch. This is satisfactory under the conditions, and as the time required to take the forming cut is much less than that required for turning and the operation is accomplished at the same time, it need not be taken into consideration in determining the time required to complete the part.

Threading

As all the tool-slides are not necessary to complete this screw, blocks are inserted in the index-plate, and the second and third slides skipped, bringing the turret around from the first to the fourth position for threading. This procedure saves considerable time, when only one tool is necessary on the tool-slide, with the exception of the die.

The time required for threading depends upon the pitch and length of the thread and on the material being threaded. Brass can be threaded, as a rule, at a speed of from 50 to 60 feet per minute, whereas the surface speed for soft steel should not exceed 30 feet per minute. Assuming in this case that the threading is to be done at 107 revolutions per minute, and figuring on a basis of 15 threads, 15 revolutions must be made to advance the die to the required distance. This will require 30 revolutions when figured on the basis on which the turning and forming is done because, for threading, the spindle is only operated at one-half the speed of that used for turning.

As the cam for operating the slide carrying the opening die should never follow the die up on the work, it is possible to use almost any cam, the one requirement being that the rise or advance per revolution of the work does not exceed the lead of the thread. Cam 122-B, according to Table 1, advances the slide at the rate of 1.817 inch per minute and as the spindle is rotating at 107 revolutions per minute, the advance per revolution is approximately 0.017 inch. As the pitch of the thread is 0.125 inch, the cam will not follow up the die.

TABLE 2. RISE OF STANDARD FORMING AND CUT-OFF CAMS AND ADVANCE OF SLIDE

Cam Number	Total Rise of Cam, Inches	Rise of Cam per Inch Travel of Drum	Advance of Slide per Inch Travel of Drum	Travel of Slide, Inches per Minute
Forming Cams				
502-B, coarse	2.500	¼	5/32	0.3384
501-B, medium	1.500	5/32	3/32	0.2033
503-B, fine	0.750	5/64	1/32	0.0676
Cut-off Cams				
499-B, coarse	2.500	¼	7/32	0.4737
500-B, fine	1.500	5/32	9/64	0.3046

Machinery

Selecting Cutting-off Cam

The cutting-off tool is required to take only a comparatively light cut and hence the coarsest feed-cam will be used. As shown in Table 2, cam 499-B advances the cutting-off slide at the rate of 0.4737 inch per minute, and at 215 revolutions per minute gives a feed per revolution of the work of 0.0022 inch. As the cutting-off tool has to travel approximately 0.520 inch, the number of revolutions required will be 236.

Summary of Operations

As it requires 36 seconds for the camshaft to make one complete revolution on the fast feed, this gives 9 seconds to index from one position to the next, and approximately 1 second to withdraw the plunger, making a total of 10 seconds for indexing. The tool-slides have a total travel of 8½ inches when the standard return cams are used, so it takes 3 seconds for the tool-slides to be returned the full distance. Allowing 3 seconds to feed the stock and close the chuck, the time required to complete the screw can be determined, as the spindle is operating at 215 revolutions per minute, or approximately 3.6 revolutions per second.

Operation	Time, Seconds	Number of Revolutions
Feed stock to stop and chuck	3	10.8
Index turret	10	36.0
Advance turner and turn	127	458.0
Return turner and index two spaces	21	75.6
Thread and withdraw die from work	10	36.0
Cut off and index turret	66	236.0
Withdraw cut-off and feed stock	15	54.0
Total	252	906.4

It is thus found that approximately 4.2 minutes will be required to complete this screw.

Setting Cams and Tools

When setting up the Gridley automatic turret lathe to produce any piece of work, all the cams, dogs, etc., should be set before the tools are set or adjusted. The arrangement of the various cams for producing the hexagon-head screw is shown in Fig. 1. As only two turret-slides are used, the first step is to insert blocks in the turret index slots that will not be used. Then, when the turret is in-

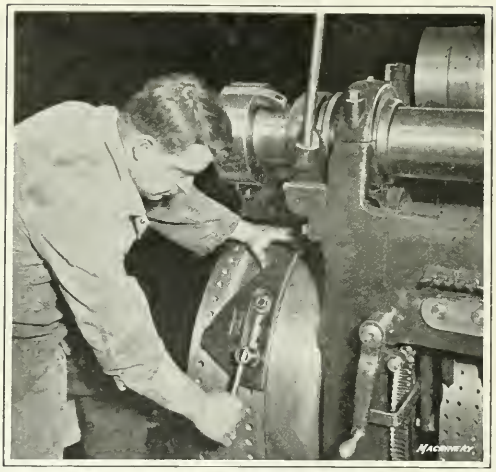


Fig. 2. Clamping Cams on Main Cam-drum

dexed, it jumps from the first to the fourth slide, skipping the second and third. The stop is held on the corner of the turret, and so the next step is to set the cam for the stop. The high point of the stop cam and the high point of the chuck-closing cam should be equal. When roll *B* is on the high point of the chuck-opening cam *D* and roll *G* is on the stock-feed cam 587-B, roll *A* should have a quarter-inch lead on cam 23-B in order to release the chuck. Cam 587-B should be relieved according to the amount that the collet feeds forward when gripping the stock. To return the stock stop, cam 66-B should be set with clearance for the roll to pass between it and cam 587-B. When the roll is flush with the high point of the return cam, the indexing dog should be set on the cam-operating drum against the revolving lever at this point, as shown in Fig. 3. Indexing should be done only on the fast feed. The turret is now indexed to the first slide and the machine stopped at this point. In all the examples given, indexing points are marked *T* and points where changes in speed occur are marked *S* and *F*, which designate slow and fast speeds.

Setting Turret Feed-cam

As the cam to be used for operating the turning tool has been selected, the next step is to clamp this to the drum, as illustrated in Fig. 2. Cam 64-B is now set up against roll *G* and the slow-feed dog, shown in Fig. 4, should be set on the cam-operating drum at this point for safety in setting up the machine; the dog is properly located later. Crank the machine forward, by hand, until the roll *G*, Fig. 1, is at the high point of cam 64-B; then set the forming cam 502-B, which was previously selected for operating the forming slide, at the high point of the roll *H*, allowing clearance for the roll to pass between cams 502-B and 482-B. Also set the fast-feed dog on the operating drum at this point as shown in Fig. 4. Now set the forming slide return cam 482-B and the tool-slide return cam 63-B, allowing clearance for rolls *G* and *H*. Then crank the machine forward until roll *G* is at the high point of the return cam 63-B and set the indexing dog, as shown in Fig. 3, at this point. Index the turret from the first to the fourth position or slide, where the threading is to be accomplished. The die is to be operated at a slower spindle speed than the other tools so that the belt should be shifted from the fast to the slow spindle speed as soon as the drum shaft starts to rotate at the fast feed. As soon as the turret has indexed to the fourth slide, stop the machine and set the roll *G* at the high point of the die cam 122-B. The drum rotates on the fast feed until the die opens. The return cam for the die slide should now be set as shown in Fig. 1; then crank the machine until the roll *G* is on the high point of the cam 63-B, and measure down on the cut-off cam 499-B a distance slightly greater than the amount of travel actually required to cut off the piece. Set roll *J* at this point and clamp cam 499-B in position. Crank the machine, by hand, until roll *J* reaches the high point of the cam and set the cut-off cam 499-B and the return cam 483-B so as to return the cut-off tool clear of the spindle nose when roll *B* is on the high point of the chuck-opening cam *C*. Set the dog on the operating drum to change from slow to fast feed when roll *J* is on the high point of the cut-off cam 499-B; also set the dog to index from the fourth slide to the stop. This completes the rough setting of the cams.

Setting the Tools

Before proceeding to set any of the tools, it is a good plan to give attention to points that have not been mentioned; one is the placing of the weights, see Fig. 5, on the chain that operates the stock-feeding mechanism. The number of weights to use is governed by the weight and size of the bar being handled, so that it is sometimes necessary to add weights after the machine has been set up. Usually, after the operator has had some experience, he can tell how many weights are required without trial.

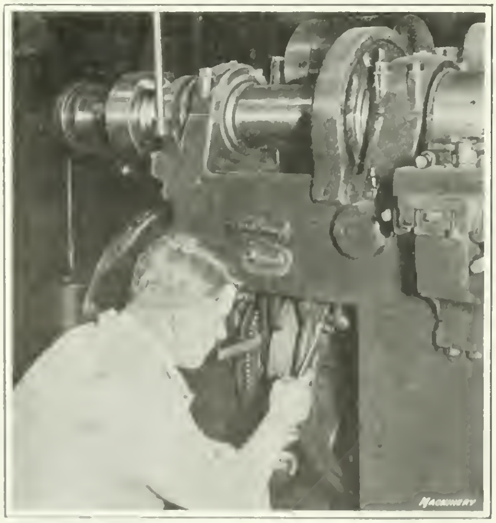


Fig. 3. Adjusting Dog for Indexing Turret

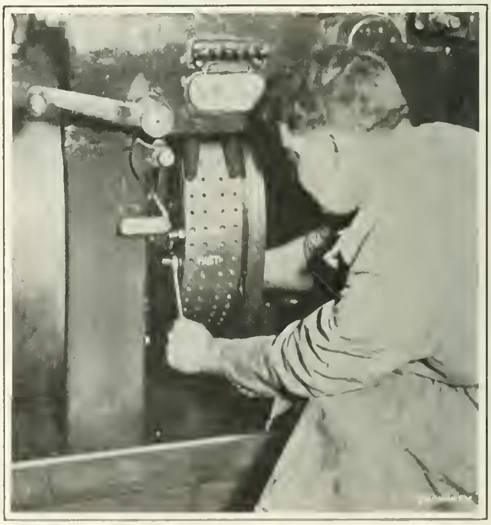


Fig. 4. Adjusting Dog for changing from Slow to Fast Feed

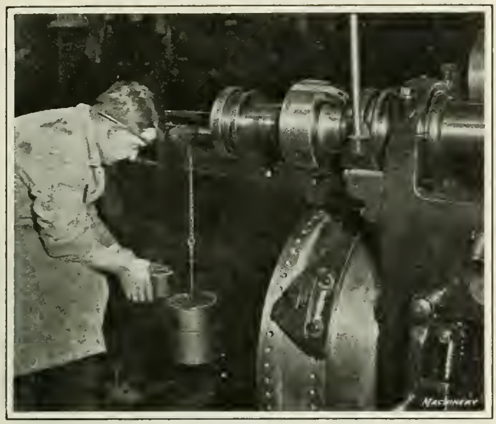


Fig. 5. Changing Weights on Stock-feeding Mechanism

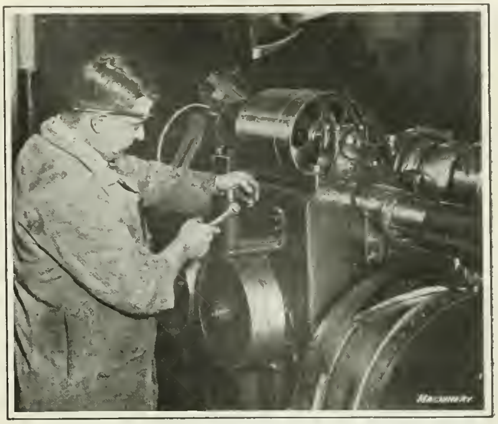


Fig. 6. Adjusting Friction for Fast-feed Pulley

Another point that should receive attention is the setting of the friction on the pulleys that control the operation of the fast and slow feeds of the camshaft; this is set as shown in Fig. 6. The set-screw is released and the plunger forced down by hand sufficiently to exert the required friction on the pulley, after which the set-screw is tightened. If this friction is not tight, and the tools are set close to the work before changing to the slow feed, a slight slippage of the belt is likely to cause the tools to dig into the work, with the result that they may be broken. Many operators do not give this friction any attention until they experience trouble; it should be adjusted each time the machine is set up, and on a long run of work, it should be frequently inspected.

Setting the Stop

The first tool to set is the stop; as a general rule, the corner stop is used. The machine is cranked by hand until the roll is at the high point of the stop cam 587-B, Fig. 1; then the stop is placed in position on the corner of the turret and moved into the approximate position. A scale is used to measure from the face of the chuck, as shown in Fig. 7, allowance being made for clearance for the forming and cutting-off tools and for the thickness of the cutting-off tool. When the stop has once been properly set, it is clamped in position. The stop cam should be relieved according to the amount that the collet feeds forward when gripping the stock. This relieves the pressure of the stock on the stop caused by the chuck closing on the work. Then the return cam should be set for the stop, so as to come into action just as the roll leaves the high point of the cam that advances it. The draw-bar roll at this time should be flush with the high point of the stop return cam. Now the dog on the operating drum, Fig. 3, should be brought up to the lock-pull lever and the machine indexed by power on the fast feed of the camshaft by setting the dog for shifting the belt on the pulleys shown in Fig. 6. The belt shifter should be so set that it throws the belt over the full distance and does not allow it to drag on the slow-feed pulley; then, as the lock-bolt drops into place, the machine should be stopped by pulling over the belt shifter by hand and the dog placed for shifting to the slow feed at this point.

Setting Forming Tool and Turner

As the forming cam has been set in position, the next step is to set the forming tool to the spindle nose, and not for turning to the correct diameter. The forming tool to use is clamped in the proper holder, and the latter located on the forming slide, as shown in Fig. 8, by means of a scale, measuring from the face of the chuck to the rear of the forming tool. In setting this tool, it is necessary to take into consideration the amount that was allowed for clearance and, in some cases, the amount used up by the tool in cutting off the piece from the bar. Then set the turning tool relative to the face of the chuck, as shown in Fig. 9. In this particular case a single turner is being used, which is placed on the first slide and moved into the approximate position; then, by means of a scale, measure from the face of the chuck to the front edge of the turning tool, making allowance for clearance for the forming tool and the distance that the turning tool has to travel on the work.

The next step is to set the turning tool to approximately the correct diameter. First open the chuck by hand and insert a bar of stock, letting it project from the face of the chuck the required distance. Then close the chuck by hand and pull over the belt shifter to start the spindle rotating. Before starting to turn the crank handle, release the roller-rests and withdraw them so that they will not come into

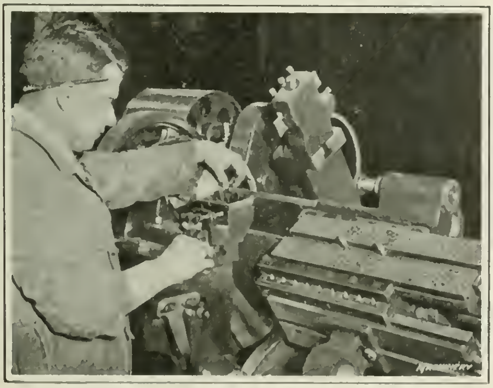


Fig. 7. Setting Corner Stop Relative to Spindle Nose

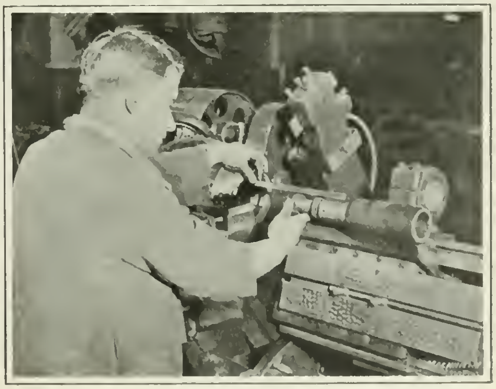


Fig. 8. Setting Forming Tool Relative to Spindle Nose

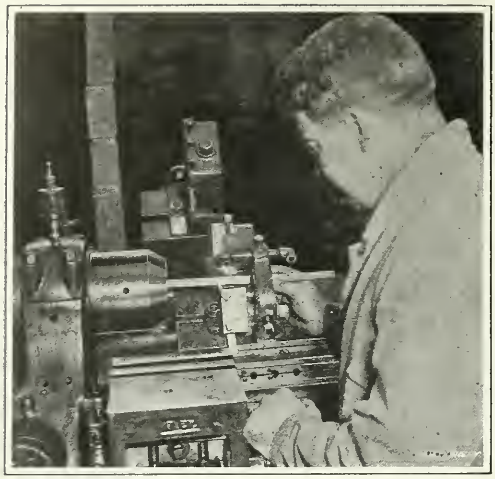


Fig. 9. Setting Turning Tool Relative to Spindle Nose

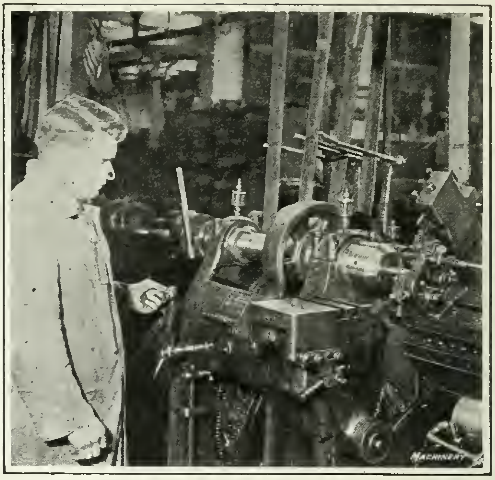


Fig. 10. Setting Turning Tool to partly turned down Work

contact with the work. Then set the turning tool to approximately the center of the bar, clamp the holder and the tool in position, and turn the bar down for a distance of about 1/4 inch, cranking the machine by hand. Now stop the spindle and measure the work; if it is not correct, crank the machine backward until the tool is free from the work and adjust it. Continue in this manner until the tool has been properly set. Then, with the tool still in contact with the work and the spindle stopped, set the roller-supports to the work. Crank the machine by hand, see Fig. 10, until the roll is at the high point of the cam and the tool set so that it will turn to the required length.

Before setting the dog to shift to the fast feed, set the forming tool in the correct position and adjust the forming cam, if necessary, so that the roll is at the high point of the cam when the forming tool just clears the work. Start the spindle rotating and feed in the forming tool, by operating the screw that adjusts the slide, until the forming tool has turned the bar down to the correct diameter. Then set and lock the stop in the forming slide, so that the forming tool will always advance to the same position. It is a good idea to put a slight spring or tension in the lever operating the forming slide, so that the forming tool will finish up with a light cut. Set the dog to shift to the fast feed on the high point of the cam, and set the return cams, 63-B and 482-B, if necessary, leaving sufficient space for the rollers to pass between them and the advancing cams. Clamp the cams in position and crank the machine until the roll is on the high point of the return cam 63-B. Then set the dog as required for indexing the turret.

Setting Die and Die-operating Attachment

As soon as the turret has been indexed to the point where the fourth slide is in line with the chuck, stop the machine and set the die attachment. Rotate by the hand-crank until the roll is on the high point of the threading cam 122-B. Then move the die attachment up on the slide, bringing the die up against the end of the work. Exert pressure on the die-holder to compress the spring, Fig. 11, and at the same time tighten the screws that clamp the die attachment to the slide. Set the cams to shift the belt from the fast to the slow or threading spindle speed. This cam should be set so that the belt is shifted before the roll reaches the high point of the threading cam. The dog for shifting from the fast to the slow feed is not set, as the screw is threaded on the fast feed.

After the tension on the die has been set with the die closed, open the die and move it out of the holder to the desired distance for the length of thread. If threading to a shoulder, set the die 1/16 inch away from the shoulder. Place the stop on the corner of the turret-slide, as shown in Fig. 12, so that the die will be opened at this point, and later adjust the stop so that the die is advanced to the exact position before opening. Crank the machine backward so that the roll is free from the die cam, and adjust the screws in the stop on the corner of the turret, as shown in Fig. 13, to close the die when it returns. Then bring the die forward by cranking the machine and note that the spindle shifts from the fast to the slow spindle speed before the die comes into contact with the work. Allow the die to thread or advance on the work by power until the die is opened; then place the return cam one inch from the roll, placing the high-speed cams so as to shift

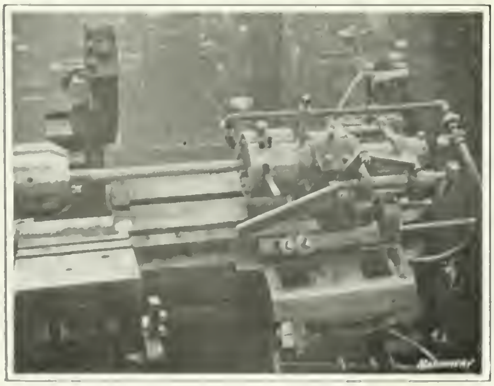


Fig. 11. Setting Opening Die with Roll on High Point of Cam

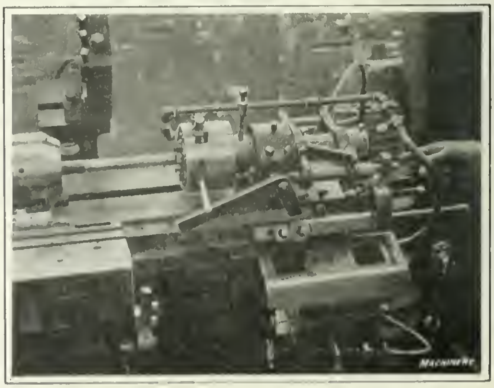


Fig. 12. Setting Stop for threading to Length with Die Open

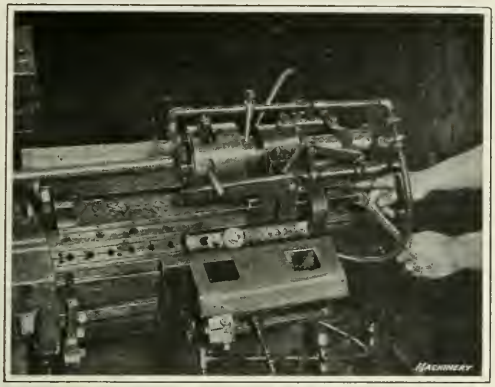


Fig. 13. Setting Stop for closing Die

the machine to the fast spindle speed. This completes the setting of the die attachment; and in order to set the die so that it will cut a thread of the correct diameter, it is advisable to set the chasers to a plug gage, as shown in Fig. 14. The die is closed by operating the closing lever and then the chasers are adjusted to the plug gage.

Setting Cut-off Tool

Now set the cut-off cam 499-B, Fig. 1, as shown in Fig. 15, so that the cut-off tool will start to work by the time the spindles have changed to the fast speed. This cam should be set so that when the spindle is changed to the fast speed, the roll will be on a point of the cam that measures an amount equal to the distance that the slide has to travel from the high point of the cam to cut off the piece. It is generally advisable to measure this distance with a scale and scribe a mark to which the roll should be set.

The chuck can now be opened (if the cut-off tool has not previously been set), the bar pulled back, and the cut-off tool set relative to the center of the chuck, as shown in Fig. 16. To do this, it is necessary to crank the machine by hand until the roll is on the high point of the cut-off cam; then set the cut-off tool and clamp it in position. Now crank the machine back to the point where it will start to cut off, push out the stock, set it, and close the chuck; set the slow-feed dog at this point. The piece is now cut off by cranking the machine by hand, and, as the tool passes the center, set the dog to shift to the fast feed; also, set the dog to index from the die slide to the stop. Set the return cam 483-B, Fig. 1, to return the cut-off slide, leaving space for the roll to pass between the two cams. Leave the machine running on the fast feed until the first tool is in position to start on the work; then set the slow-feed dog. This completes the setting up of the machine, cams, etc., but in some cases it may be necessary to make a few minor adjustments when the tools are working.

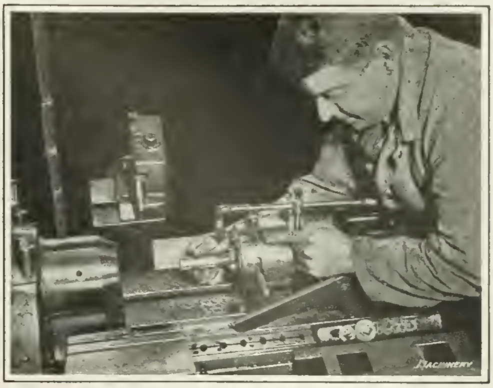


Fig. 14. Setting Die for Size to Plug Gage

The second installment of this article, to be published in the July number, will deal with specific tooling lay-outs, and will conclude the series of articles dealing with the operation of Gridley automatic machines.

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ROCHESTER'S DEPARTURE IN MECHANICAL EDUCATION

An interesting departure in mechanical and engineering training has been made by the Rochester Athenæum and Mechanics Institute, where two-year courses have been instituted along the lines of mechanical, electrical, and chemical engineering. The object of these courses is to provide a thorough specialized training to fit men for supervisory positions in the industries. The courses will train men for the responsibilities of engineering work in industrial plants and for shop superintendents and factory management. The object is to train young men who have shown progress in mechanical work but who have not had the advantage of a complete high-school education, and who, for that reason, are unable to go to a regular engineering college. In the courses, special emphasis is laid upon designing for the machinery trade and upon shop methods for production, without entering into the purely theoretical side of engineering problems, except in so far as the theory is required for the solution of the practical problems met with throughout the courses. As experience is gained, it is likely that similar courses will be instituted elsewhere in manufacturing centers, and that the courses inaugurated by the Rochester Athenæum and Mechanics Institute will prove to be of pioneer value in the solution of a problem of mechanical education that has been found puzzling in the past.

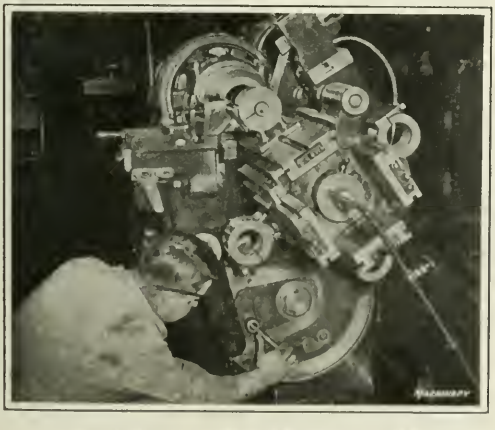


Fig. 15. Setting Cams on Forming and Cut-off Drum

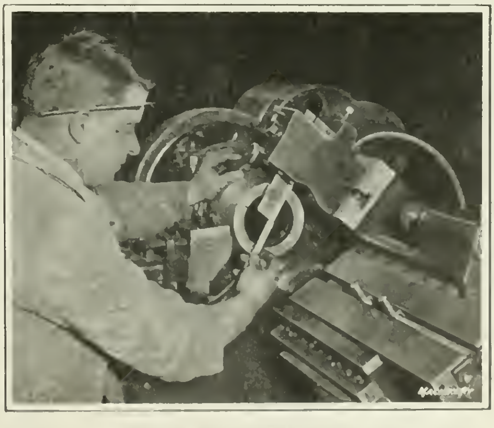
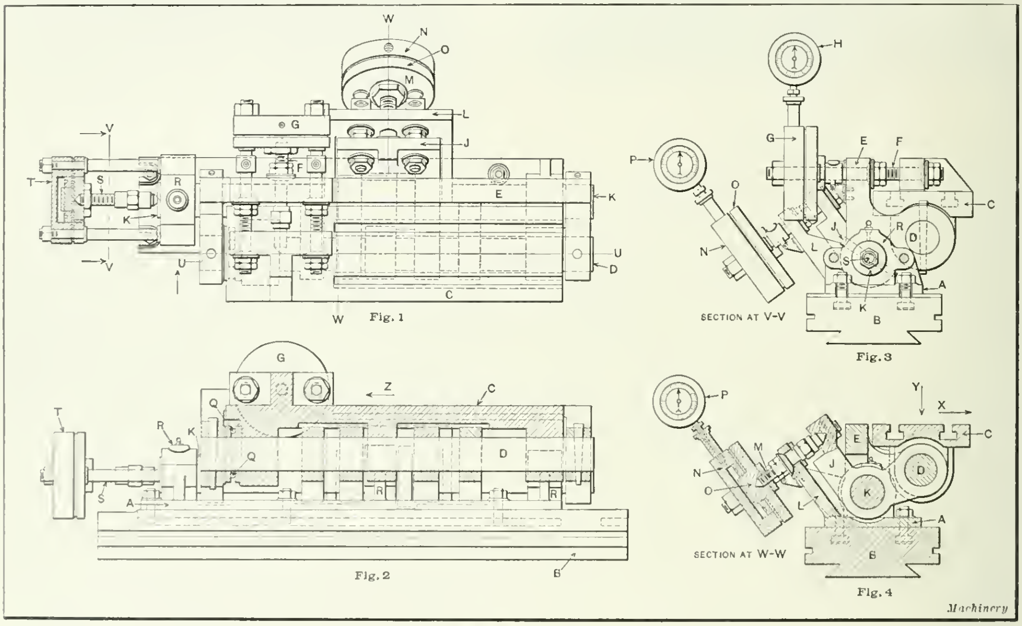


Fig. 16. Setting Cut-off Arm and Tool

UNIVERSAL MILLING MACHINE DYNAMOMETER

BY R. POLIAKOFF[1]

The dynamometer shown in the accompanying illustration was designed for measuring the pressure that a milling machine cutter exerts on the work and on the various parts of the milling machine through the work. The purpose of ascertaining these pressures is to determine the strength required of the different parts of the milling machine or the cutter itself; incidentally it also affords a means of determining the causes of unsatisfactory finish on the surfaces machined, discrepancies in dimensions, etc. This dynamometer is termed "universal" because it determines the pressure exerted by a cutter of any type and size within its capacity. Fig. 1 is a top plan view of the dynamometer. Fig. 2 is a vertical sectional view on line U–U, Fig. 1. Fig. 3 is a cross-section on line V–V, Fig. 1, and Fig. 4 is another cross-sectional view on line W–W, Fig. 1.



Figs. 1 to 4. Universal Milling Machine Dynamometer

The dynamometer is supported on the foundation plate A as shown in Fig. 4, and is held in place on the table B by T-head bolts. The work is placed on the auxiliary table C of the dynamometer and securely fastened by bolts. The milling cutter is then brought into contact with the work. The resultant pressure exerted upon table C through the work may be resolved into three components, each component being at right angles to the other. The horizontal arrow X pointing in the right-hand direction indicates the direction of one of these components, and the vertical arrow Y pointing downward through the table C indicates the second component. The direction of the third component is designated by the arrow Z in Fig. 2, which points in the left hand direction. The pressure imposed by the cutting tool on the work may thus be divided into its three components by the dynamometer, and the amount of pressure in each component direction is registered on separate gages, so that it may be quickly and accurately determined. The strength required of all parts of the milling machine can therefore be checked accordingly.

The pressure exerted in the direction of the arrow X, Fig. 4, will tend to rock the table C in a clockwise direction about the shaft D, without affecting the carriage E. In executing this movement, table C will draw the rod F, Fig. 3, to the right. This exerts a pressure on the gage box G in a manner which causes the liquid contained in it to be driven up through the connection into the dial H in an amount proportionate to the amount of pressure exerted. The hand of dial H will consequently be moved to a corresponding extent to indicate the degree of this pressure. Referring to the component exerted by the cutting tool on the work in the direction of arrow Y, Fig. 4, the pressure exerted on the table through the work will cause the table to descend, rocking plate J about shaft K. As plate J is moved away from arm L, rod M will cause a compression of the gage box N and the amount of pressure will be indicated by the position of the hand of dial P.

The pressure exerted in the direction of the arrow Z, Fig. 2, will force the table C in a longitudinal direction. This longitudinal movement will be communicated to carriage E, Fig. 4, through thrust bearing Q, Fig. 2, and, in turn, by reason of the connection with shaft K, carriage E will cause shaft K to move in a longitudinal direction in bearing R, which is part of the foundation plate A. When so moved, shaft K exerts a pressure on gage box T through spindle S. This pressure is recorded by a gage attached to gage box T.

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* * *

PROTECTION OF TRADEMARKS ABROAD

Since the outbreak of the war, American manufacturers have been constantly urged to take advantage of the trade opportunities awaiting them in foreign fields. In very few cases, however, has the subject of trademark registration been presented to them. This registration, however, is most necessary to the opening of business relations in any country, for in some cases the legitimate owners of trademarks have been unable to sell their goods in certain countries because some pirate has forestalled them in the registration of their mark. The statutes of many countries provide that the first person to register a trademark is entitled to the exclusive use thereof, regardless of whether or not he is the originator and actual owner of the mark.

* * *

Last year, this country's imports from South America amounted to \$598,000,000, an increase of \$151,000,000 over the year before; it exported to South America \$312,000,000 worth of goods, an increase of \$90,000,000.

LETTERS ON PRACTICAL SUBJECTS

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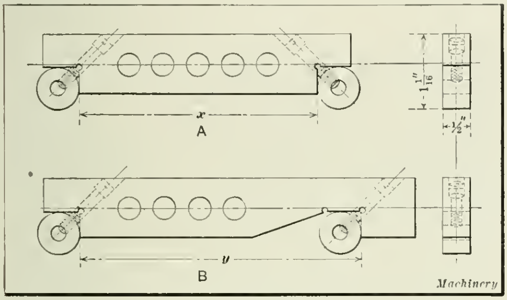
SINE BARS OF IMPROVED DESIGN

The improvement in the sine bars to be described is in the method of locating and fastening the disks or buttons to the bar. The bar illustrated at *A* has an over-all length of 5½ inches with a center-to-center distance between the disks of 5 inches. As these disks are 0.750 inch in diameter, the distance *x* between the shoulders of the bar is 4¼ inches. The bar illustrated at *B* also has a center-to-center distance of 5 inches between the disks, which corresponds to the distance *y*. This bar has the advantage over the other one in that more acute angles can be obtained and it is also a fool-proof design on account of the arrangement of the faces or shoulders against which the disks are held. For instance, if too much material is ground from the right-hand surface, it is simply necessary to regrind the surface or shoulder at the left in order to obtain the correct distance *y*.



Sine Bars having Shoulders against which Disks are held by Screws placed at an Angle of 45 Degrees

These bars and disks are hardened and ground, and the disks are lapped to size. As the illustration shows, the disks are secured to the bars with fillister-head screws (No. 12), which pass through holes drilled at an angle of 45 degrees so that the disks will be drawn against both the horizontal and vertical surfaces at the ends of the bars.

New Britain, Conn. WILLIAM C. BETZ

MAKING AIR-RIFLE TRIGGER GUARD

The accompanying illustrations show the trigger guard of an air-gun, and the die for giving it the second and final form. In Fig. 1, *A* is the finished guard and *B* is the guard when it is ready for the second die. At *A*, Fig. 2, is shown a plan of the die with the levers, or jaws, closed, and at *B* is shown the die with the jaws open to receive the work. At *A*, Fig. 3, is shown a side view of the left operating pin, with the collars and the layout of centers for turning it, together with a partial view of the shoe and the punch-holder. The front view of the pin is shown at *B*. The letters *T*, *L*, and *R* refer to similar points on the pins shown in Fig. 2.

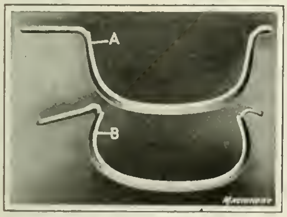


Fig. 1. Air-rifle Trigger Guard

The dies for the first two operations on the guard are not shown. The first is a simple blanking die for making a flat blank from a strip of round-edge flat wire, cutting at the ends only, and the second is a simple U-forming die. The final shape necessitates the use of a collapsible inner form, and the die shown was designed as being the easiest to make and operate. It consists practically of two pairs of heavy pliers laid flat on the bed of the die and operated together by two round tapered pins set into a punch-holder, which is not shown. As shown in Fig. 3, the taper on one side of the pins is short and steep. These tapers operate against the inner levers and force them to take their closed position first without any resistance; they are held closed by the straight sides of the pins. The outer levers are operated by the long easy tapers of the pins.

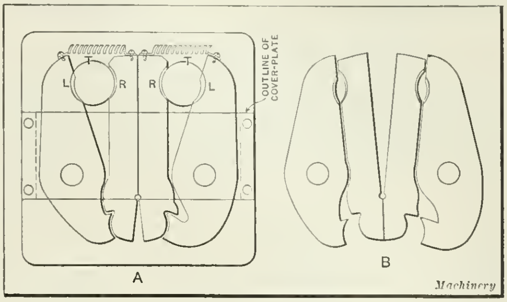


Fig. 2. Last Die used for forming Trigger Guard

It is necessary to use round pins, because the paths of the levers are arcs and the points of contact travel around the pins. Round pins are, of course, much more difficult to lay out than an ordinary flat wedge, but they were carefully figured and laid out on the drawing-board. The inner levers were set together on a faceplate and bored, as they are straight except for a beveled corner, which was filed. All the work they do is, of course, in a straight line. The outer levers were laid out on each side from the drawing and filed. The cross-section of the levers and their relation to the pins is shown in Fig. 3.

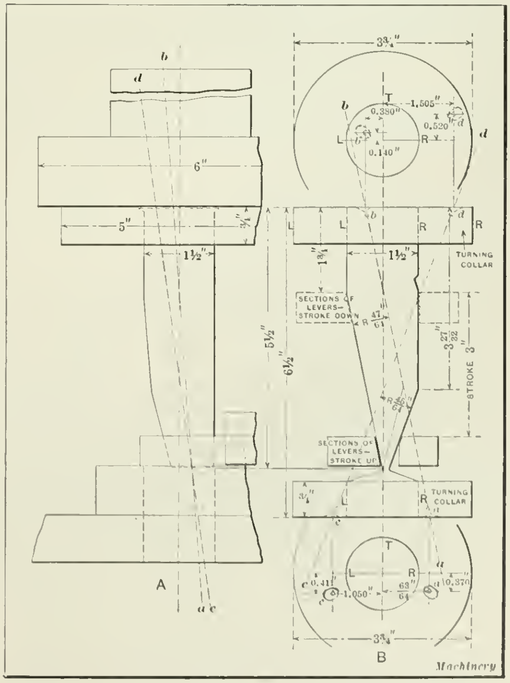


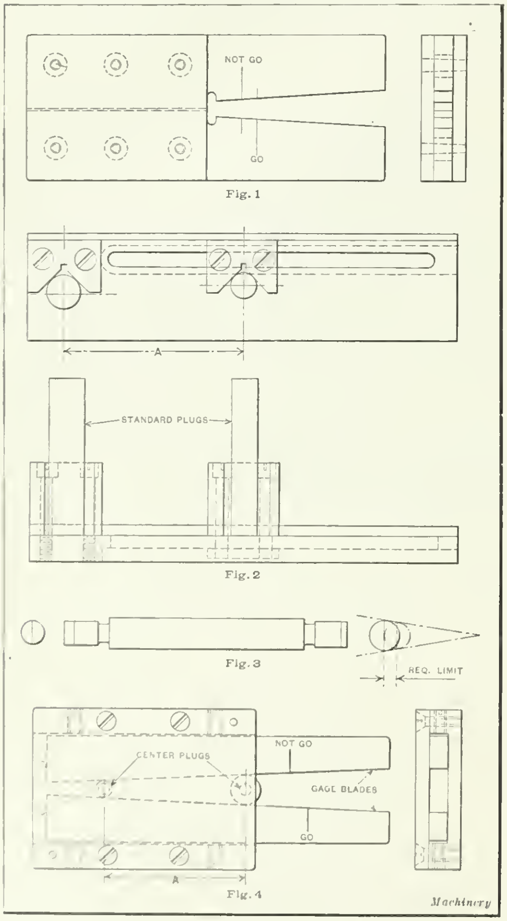
Fig. 3. One of the Operating Pins with Collars and Lay-out for Turning

The levers are covered on the inside faces by a piece of 1/2- by 3-inch steel, held by screws at each end. The outer levers swing on hardened 3/4-inch pins, which are flush with the top of the cover-plate and extend down into the casting base for an inch. The inner levers swing on a small loose pin between them, and are held in position by bearing on the outer levers and the driving pins.

Plymouth, Mich. W. B. Greenleaf

TAPER GAGES AND GAGING

The making of taper gages is what toolmakers call a "tough job," and experience has shown that even skilled men do not get satisfactory results, compared with the price of the gage. The general way of making these gages is to machine a tool-steel blank until there is just enough material left for grinding and lapping after hardening. The degree of skill required and the trouble that develops are widely known, and probably about 50 per cent of the finished gages, when tested for hardness, will be subject to rejection.



Figs. 1 to 4. Taper Gages and Devices used in assembling them

How this trouble may be avoided by making the gage in four parts—two gage-plates and two cover-plates—is shown in Fig. 1. The machining is an easy matter. Before hardening, the gage is assembled just as if finished, except that the holes for the taper pins are not reamed, but are just drilled straight. After that, the gages are taken apart and holes are drilled in the gage-plates large enough to insert soft plugs after hardening. The rest is simple: hardening, grinding, lapping only straight surfaces, and assembling. The taper pins are riveted over slightly on the small end and secure the parts in position. To assemble these gages with accuracy, the attachment shown in Fig. 2 is used. Standard plugs are employed and the distance *A* is determined with the help of shop trigonometry.

A limit taper gage may be easily made by etching two lines across the gage, as shown in Fig. 1. The positions of these lines are determined with the help of a limit plug, shown in Fig. 3. The two diameters of the plug must, of course, correspond with the required limit of the finished part. It is only necessary to etch the lines exactly over the center of these plugs, for the distance between the lines will give the limit. This plan will render unnecessary the making of a double-end gage and also will save 50 per cent of the time when inspecting the work.

Fig. 4 shows a more costly design, which in the long run will be more economical, particularly when the amount of wear on the gage is taken into consideration. When it is once made, all that needs to be done when the surfaces are worn is to take out the gage blades, regrind or relap them, and put them back into place; no adjusting or inspecting will be necessary. Last but not least, it is the only gage that it is possible to inspect directly with the micrometer and be sure it is right. This type also can be used as a straight gage if the two center plugs are of the same diameter.

New York City Max T. Voigt

SALVAGE OF WORN GAGES BY ELECTROPLATING

Methods of making worn thread gages, plug gages, etc. larger or smaller, as the case may be, are of considerable importance to every manufacturer. Many of these expensive tools can easily be saved by plating on them a film of hard, close-grained nickel and then lapping the gages to size.

In depositing nickel on gages, it is necessary to remove all grease due to handling, as the bath used is very nearly neutral. This may be done by placing the gages, for fifteen minutes, in a bath, consisting of eight ounces of caustic potash to two gallons of very hot water; this bath should be renewed quite often if many gages are to be plated. When removed from the bath, the gages should be thoroughly scrubbed with pumice stone and water, rinsed, and then placed in a bath consisting of eight ounces of hydrochloric acid to one gallon of water; this bath is used cold. Fifteen to thirty minutes immersion will remove any oxide that may have formed. The gages should then be thoroughly rinsed, and dried without touching them with the hands, so that greasy spots will not be made on them.

The plating bath is made of twelve to fourteen ounces double sulphate of nickel and ammonia (pure) per gallon of bath, distilled water being used. The nickel salts are put in a wooden tank and dissolved by pouring hot water on them and stirring with a clean wooden stick. After the salts are completely dissolved, cold water is added to bring the solution to the right proportion. Common table salt is then added to decrease the resistance. The bath should be a little bit acid, as it makes the nickel somewhat harder; the acidity of the bath can be tested with a piece of litmus paper. The anode should be made of pure cast nickel as it gives better satisfaction than rolled nickel. The surface of the gages should be calculated and the same amount of anode surface exposed.

The current used should be regulated very carefully, as the results are highly dependent on this. The plating should be begun with a current of 9 to 10 amperes per hundred square inches of plating surface and be reduced after the deposit starts to from 0.75 to 1.25 ampere. The voltage used depends somewhat on circumstances, but should begin at 5 volts and be diminished to from 1.5 to 2 volts. The amount of metal deposited on the gages may be determined by the use of a pair of micrometers in the case of plug gages. With thread gages, a piece of steel stock of known size may be immersed in the bath and measured to determine the amount of metal deposited on the threads.

A great many manufacturers have outfits for plating small parts that they manufacture. A little cooperation between the tool-room and the plating room will be a source of considerable profit. A boy can do all the operations involved if the directions given are carefully followed. That the tools do not have to be annealed is an advantage that every toolmaker can appreciate.

Jackson, Mich. Richard Gibbs

COOPERATION WITH THE TOOL ENGINEER

The editorial in the February number of Machinery entitled "Cooperation with the Tool Engineer" does not go far enough; in addition to the tool engineer, the designer should consult with the shop superintendent and the foreman of the department in which the machine is to be used. Too often, the man who makes the design is looked on as a necessary evil, and some shops have tried to do away with him. This, no doubt, accounts for the crude designs, called "machine tools," that are to be seen in some shops. One of these, a one-purpose lathe, was so constructed that the gears were enclosed by the head casting and the only way in which speed changes could be made was by having the operator get under the machine and reach through the bed. Needless to say, the operator avoided changing the speeds as much as possible and the best results were seldom obtained.

One reason why many machine tools are not well designed is that the designer does not come into contact with the shop as much as he should. Of course, some draftsmen think that it is unnecessary for them to mingle with the men who wear overalls. On the other hand, many firms have the idea that the time spent by a designer in the shop is wasted. They think that he should spend all his time working at the board, and fail to recognize the value of information he obtains by seeking the criticisms of the men who operate the machines. By obtaining these criticisms, he is able to improve the machines or the designs of new ones.

If a new design is submitted for criticism to the tool engineer, superintendent, and the foreman of the department in which it will be used, any faults of construction or operation it may contain will be found, and it is much easier to correct these on the drawings than after the machine is made. However, such criticisms should be made in a spirit of cooperation rather than through a desire to find something wrong. By having these men discuss the designs with the designer, the latter gradually absorbs ideas from the other men and his vision is broadened. Besides, much of the fault finding now prevalent will be done away with; it will be impossible for the foreman to say, whenever a machine proves faulty, "If my opinion had been asked I could have prevented that mistake." Having attended the conference at which the design was discussed, the superintendent and foreman will be better satisfied with the tools given them, and the designers will become more capable and better pleased with their product. In addition, the method of finding in the shop any mistakes the design may contain is avoided.

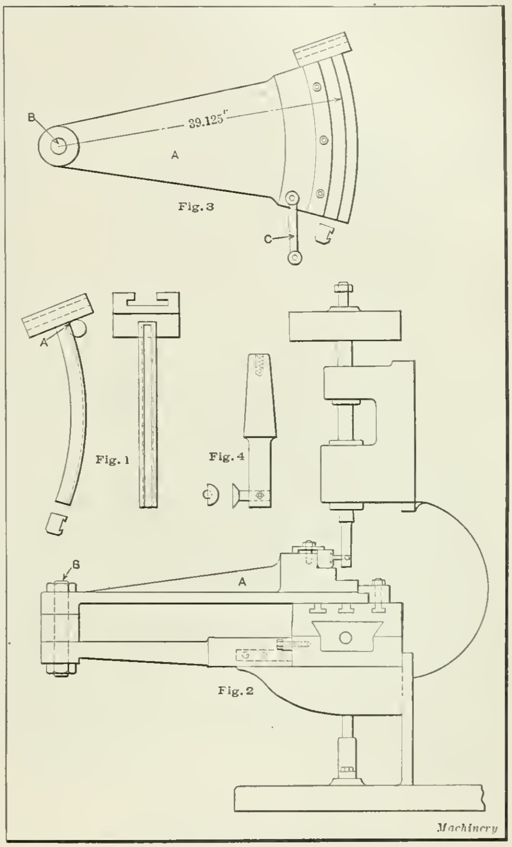
Providence, R. I. Robert Mawson

CUTTING A DOVETAIL SLOT IN A GUN SIGHT

A shop doing munition work found it necessary to cut a dovetail slot for the graduated German silver scale in a radial sword arm for a five-inch gun sight. This slot is 0.125 inch deep, has a maximum width of 0.75 inch, and its sides are at an angle of 55 degrees and must be parallel, with only 0.001 inch tolerance in the full length of the sword arm, which is 26 inches. The radius is 39.125 inches to the outside diameter. As shown in Fig. 1, the slot must be carried close up to the head of the sword arm. In order to produce an interchangeable job, precision and accuracy are required; also an extremely smooth surface is necessary, for chatter marks are rejected. The work cannot be done on a planer because there is no clearance for the tool and it is impossible to shift the stroke to exactly the same position each time; furthermore, it is necessary to have complete control of the speed at all times.

After considering several methods, it was decided to plane the slot on a vertical milling machine, as shown in Fig. 2. The operator attends to the tool, feed, etc. while a helper moves the table back and forth by means of the rapid traverse handle, which is not laborious work. When the table is moved, it causes the plate *A* to rotate on its bearing *B*, as the plate and the table are connected to each other by a link *C*, Fig. 3. The bracket for the sword arm is also milled in this fixture.

First of all, a slot is cut in the center of the arm by a regular flat milling cutter mounted on a screw arbor, using the regular machine feed, etc. This, however, leaves some stock *A*, Fig. 1, at the head end, so the bar is removed, gripped in a milling machine vise, the head end squared, and this part of the slot is dovetailed with a small mill. Although this is straight milling and not radial, the difference is so slight that it is not noticeable; besides a clearance space is provided for the dovetailing planer tool. The space is so small, however, that no planer, nor any other tool that is not absolutely under control, will reverse in it. By moving the table by hand, the operator is able to reduce the speed as the end of the slot is reached and thus cut very slowly into the clearance space. A stop is also placed on the ways to limit the table movement. After the slot is milled in the arm and the head end is dovetailed, the bar is returned to the fixture, the spindle is locked by inserting the back-gear without the spring pin, and the slot is finished by means of the planing tool shown in Fig. 4. This tool is held in a special arbor, which can be made at a very small cost.

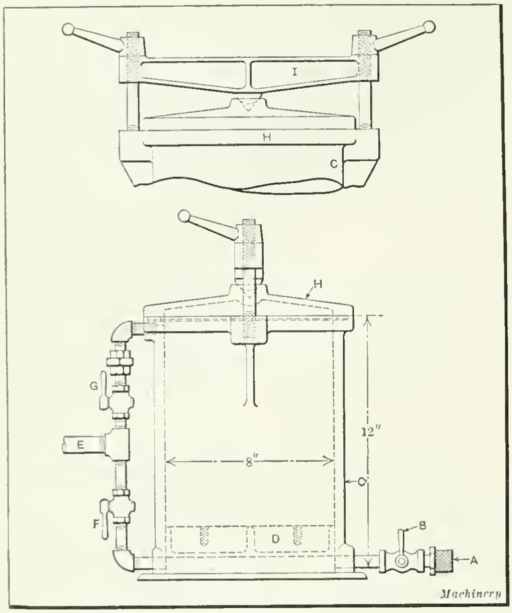


Figs. 1 to 4. Gun Sight in which Dovetail Slot is cut and Arrangement for cutting Slot

Baltimore, Md. Raymond H. Dauterich

DEVICE FOR FILLING GREASE CUPS

The usual method of filling grease cups before they are placed on the bearings is to unscrew the cup, pack the grease in it with a paddle, and then screw the cup on the retainer, which takes about one or two minutes' time. But with the device here shown the cups may be filled within a few seconds. It is only necessary to insert the threaded end of the grease cup in nozzle *A* and turn the lever *B* to fill the cup instantly. If desired, a spring may be attached to lever *B* and to the body of the device and a foot-lever attached to the valve-lever *B*. As the device may then be operated by foot, the operator will be able to use both hands for handling the cups.



Device for filling Grease Cups

The device consists of a cast-iron cylinder *C*, a piston *D*, and the necessary connections to the compressed air line *E*. To operate, the lower air valve *F* is turned downward and air is admitted below the piston *D;* this raises the piston to the top of the cylinder so that it can be removed and then the air is shut off. After the cylinder is filled with grease, the piston *D* and cover *H* are put in place and lever *G* is turned so that compressed air is admitted to the top of the piston. Then when a grease cup is inserted in the nozzle *A* and lever *B* is turned, the compressed air forces the grease into the cup. The cover *H* is held in place by the bronze casting *I*, which has a ball joint that fits into the top of the cover, making a flexible but secure joint.

Flint, Mich. C. C. Spreen

INDEXING ATTACHMENT

In Fig. 1 is shown an indexing attachment that may be easily adapted to a number of purposes. It was designed for making the saddle slide of an ordinary engine lathe, shown in Fig. 2, which requires the operations of facing the surface *A*, turning, boring a hole *B* in the center, cutting T-slots, and graduating. With this attachment, all these operations can be done at one setting of the piece in the chuck.

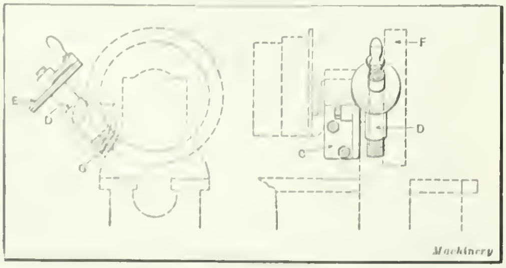


Fig. 1. Indexing Attachment for Engine Lathe

The main bracket *C*, Fig. 1, of the attachment is fastened to the side of the lathe headstock, as shown, and the bracket *D* carrying the worm-shaft and supporting the dividing plate bearer *E* is swiveled on a stud in the bracket *C*. A worm-wheel mounted at the rear of the chuck *F* allows the worm *G* to engage with it. It is not necessary to detach this arrangement for ordinary use, as the bracket *D* carrying the worm *G* can be swung clear of the worm-wheel so as to leave the lathe free to be used for ordinary work.

To do the particular job shown, a six-side turret was employed. One side carried a turning tool for facing the surface *A;* the next side carried a drill for hole *B;* the third side carried a reamer for hole *B;* the fourth side carried a bar with the tools shown at *C*, Fig. 2; the fifth side carried a bar with the tools shown at *D;* and the sixth side carried the marking tool for indexing. By using this attachment and set-up, an average time of fifty minutes per piece was saved on previous times.

Energy

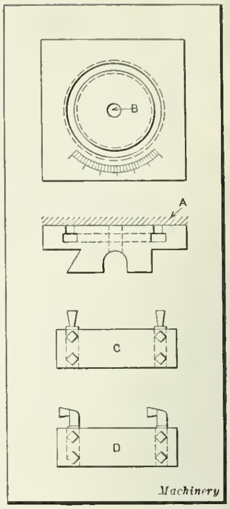
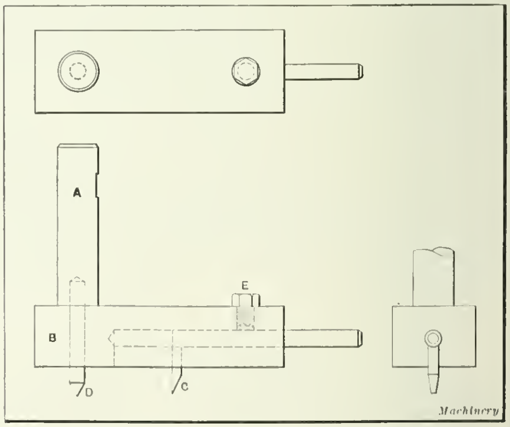


Fig. 2. Work for which Attachment was designed and Tools used

CUTTERS FOR SOFT COMPOSITION WASHERS

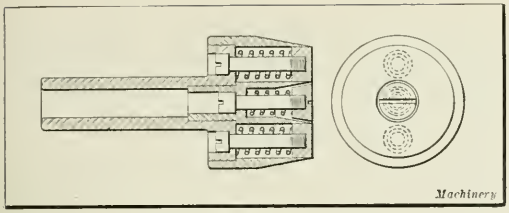
The tool shown in the February number of Machinery for cutting washers out of leather, rubber, and other soft material has one disadvantage in that a cutter must be made for each size of washer that is to be cut. This disadvantage is avoided in the tool here shown, which may be used for any size of washer within its capacity. The shank *A* is made to fit the spindle of the drilling machine and terminates in a rectangular bar *B*, which carries the cutting tool *C* and the steel center *D*. This center is a forced fit in the rectangular bar *B*. The cutting tool *C* slides in a slot and is held in position by a set-screw *E*. To make a washer, it is only necessary to set the cutting tool, which is ground to a knife-edge, to the correct radius, place the center *D* in the material, and rotate the tool, which is held in the spindle of the drilling machine. The tool can be quickly set to cut any size of washer desired.

A. Towler



Adjustable Cutter for Washers of Soft Material

The tool here shown for cutting soft composition washers is an improvement on that shown in the February number of



Cutter for Composition Washers

MACHINERY. While the initial cost is considerably higher, the possibility of the washers and centers sticking in the cutter is entirely eliminated. The tool is preferably made of steel, and by making the large cutter separate, as shown, a great deal of work and material will be saved when replacing. This cutter will work satisfactorily either on a drilling machine or when used as a punch.

Dubuque, Iowa **CHESTER W. HATHAWAY**

LAPPING PLATE AND CABINET FOR EMERY WHEELS AND OILSTONES

For the users of ring emery wheels, india or corundum oilstones, or any end-cutting wheels, which are certain to glaze from constant use, the accompanying description and diagram of a lapping, or rubbing-down, plate and cabinet may be of interest. Ring wheels of emery, corundum, carborundum, or other abrasives that are mounted on chuck stems or taper shanks should be trued by a diamond and then rubbed on the cast-iron plate, using either coarse or medium grains of emery, depending on the work to be ground. This operation of rubbing, using a circular motion and frequent turning of the wheel, breaks the lines left by the truing diamond and leaves the surface in good condition. It can be repeated several times, as a wheel becomes glazed by use, before being returned by the diamond.

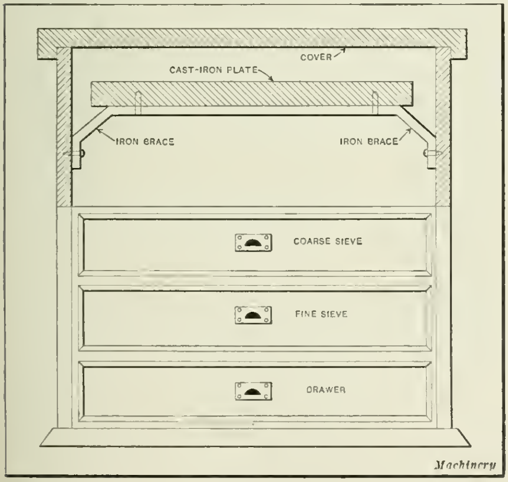


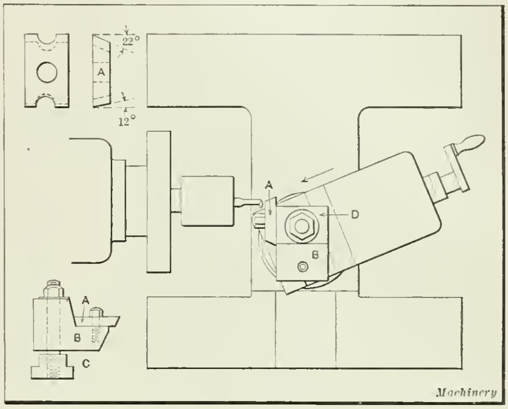
Plate and Cabinet for lapping Emery Wheels and Oilstones

The cabinet, or holder, of the rubbing plate is about 2 feet square and 2 feet, 6 inches high. The cast-iron plate is suspended in the upper part of the cabinet on two iron braces, made of ½- by 1-inch strap iron or cold-rolled steel, and is held in position by two dowels. Directly beneath the plate are two drawers with sieve bottoms to catch and sift the emery. The first drawer has a sieve of the proper mesh to retain the coarse emery; the second sieve is of finer mesh and retains a grade of emery useful for blocking oilstones, permitting all dust to drop to the lower drawer. A small scoop or shovel should be kept with the outfit to clean the plate and put on new emery as needed.

Jersey City, N. J. **WARREN H. DUNBRACK**

TOOLS FOR FORMING AND RELIEVING CONVEX MILLING CUTTERS

It is often necessary to make convex cutters that are not in stock, and the method to be described has been quite satisfactory for making small lots or special sizes. The form tool shown in the upper left-hand corner of the illustration is made with an arc having a radius at one end which is a little larger than the standard radius of the milling cutter. This end is given a clearance of about 12 degrees and is used for rough-turning the cutter blanks. The opposite end of the forming tool is made to the required cutter radius and is given a clearance of 22 degrees, as it is used for relieving the cutter while finishing it to size. The cutter *A* is held in a tool-block *B*, as shown at *C*, while turning and relieving the milling cutter. This tool-block is also used as shown at *D* when turning or boring the concave or circular part of tool *A* by using a compound rest as indicated in the illustration. Tool-block *B* is set with the face at right angles to the center line of the spindle and the compound rest is set at the required clearance angle. The tool *A* is clamped in position on the side of block *B*. The tool is turned or bored to the required radius by using an eccentric chuck which is held in the spindle. A feeding movement in the direction of the arrow is obtained by the compound rest, and the depth of cut is regulated by the cross-slide. In this way, a true arc is obtained on the face of the tool. It is sometimes necessary to give the tool a little clearance on the sides of the concave surface, but on tools of small radius this is seldom necessary.

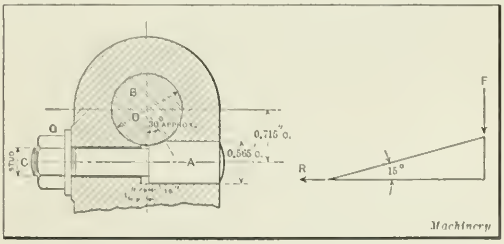


Method of turning Concave or Circular Part of Tool for forming and relieving Convex Milling Cutters

Detroit, Mich. **O. F. SCHWEITZER**

TANGENT CLAMP

There are at present several methods in general use for clamping pins, rods, screws, and spindles, but the "tangent clamp," owing to its simplicity and effectiveness, is especially applicable, whenever a non-positive clamp can be used. The principle involved is similar to that of the toggle joint or moving strut. Hence, it is possible to formulate an expression of its effectiveness in definite terms. The angle of 30 degrees in the illustration indicates the highest point on



Section showing Design of Tangent Clamp and Principles involved the stud or cylinder *A* with relation to the spindle *B* being clamped, and is about the necessary maximum for both effectiveness and strength. One half of this angle, the mean of the surface in contact, corresponds to the angle of the toggle joint arm or moving strut, and its effectiveness, neglecting friction, is indicated in the diagram, where F = applied force, and R = clamping result on spindle. Then:

$$R \times \sin 15 \text{ degrees} = F \times \cos 15 \text{ degrees}$$

$$R = \frac{F \times \cos 15 \text{ degrees}}{\sin 15 \text{ degrees}}$$

If the angle is increased, the effectiveness is decreased, or vice versa, but it will be found that the mean angle cannot very well be decreased and leave enough metal to resist the thrust. Should the stud be made larger than the indicated diameter, it should be cut away on the top in order to keep the highest point of tangency as near 30 degrees as possible. The tangent clamping stud *A* should not be hardened, as the clamping effect would be less satisfactory, and the spindle *B*, or other object clamped, would be marred or chipped. The clamping stud *C* should be made as large as possible on smaller sizes, and no larger than necessary on large sizes of spindles. It is often desirable to use a quick-operating handle in place of the nut *G*.

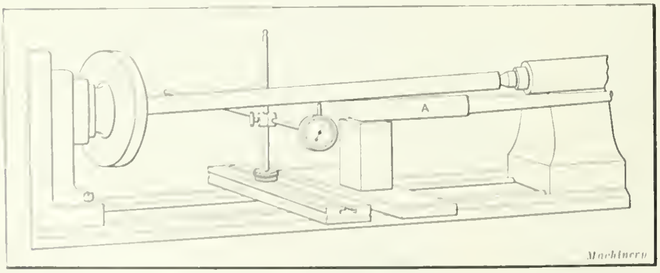
The design shown for drawing the clamping stud against the spindle has proved most effective, but the following methods may also be considered. The clamping block may take the form of a bushing and have a screw running through it into a tapped hole beyond. If this form is used, it is advisable to increase the diameter over that shown in the illustration, and remove the metal beyond 30 degrees, as previously described. A pair of opposing clamping blocks may be used, drawn up and centered upon the spindle by means of a screw through one and a tapped hole in the other. Another suggestion is a stud running through both bushings with a nut at each end.

The proportions shown in the illustration are the results of experiments by the author, and very satisfactory results have been obtained for spindle sizes from 1/2 inch to 3 inches. Many designers have used this type of clamp without giving due consideration to proportioning the parts, and have obtained less satisfactory results.

Washington, D. C. WILFRID GRIFFIN

STRAIGHTENING SHAFTING

For quickly straightening slight bends, such as are found at times in crankshafts and shafts of small diameter, the indicator should be placed beneath the shaft, as illustrated, and adjusted so that when the shaft makes half a turn the instrument will register the amount, in thousandths of an inch, that the shaft is out of true. Assuming that the indicator registers 0.004 inch, the shaft should be bent upward 0.002 inch. Without removing the indicator, by means of the crowbar *A* the shaft is bent upward, and then carefully lowered into contact with the indicator, which shows if more or less pressure on the crowbar is required in the next bend. By having everything needed for the operation in place, no time is spent resetting the indicator, laying down the crowbar, picking it up again and starting and stopping the machine to see if the shaft is running true. The writer has found this method to be generally satisfactory.

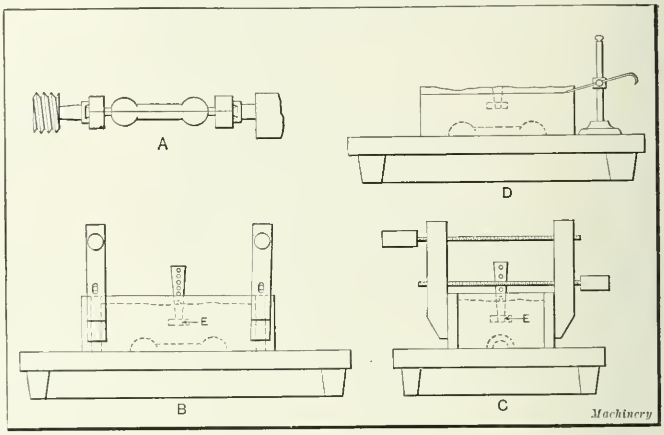


Method of straightening Slight Bends in Shafts

New York City E. J. HIGGINS

ECONOMICAL DIEMAKING

In the January number of MACHINERY there is an article entitled "Economical Diemaking." The following method is suggested, however, as more in keeping with modern practice; it is quite generally used, especially by manufacturers of agricultural implements where a large number of plaster-of-paris dies are made for straightening malleable castings, bending operations, and forging. The model shown at *A* is the same as that shown in the previous article.



Making Plaster-of-paris Molds for Dies

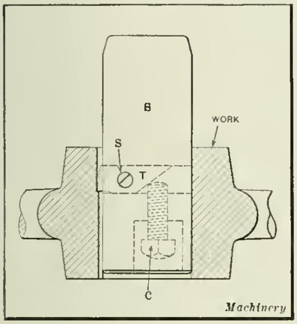
The model should be turned from two pieces of wood, which are joined and held together by pinch-dogs or by gluing with a paper joint. The centers for the lathe must be located on the joint. After the pieces are turned, they will separate at the joint and thus eliminate the necessity of sawing and joining to the center line. The model is then placed with its joint flat on a faceplate and the box is placed in position. The sides of the box should not be nailed together or fastened permanently, but should be held together by clamps, as shown at *B* and *C*. As plaster-of-paris does not shrink, or change its shape, it is difficult to remove a mold from a solidly built box. A piece of cast iron *E* drilled and tapped for a foundry draw-screw should be suspended in the center of the mold by passing a rod, the ends of which rest on the sides of the box, through one of the holes in the tapered mandrel to which the draw-plate is screwed. After the plaster is poured, the tapered mandrel is removed, leaving the draw-plate firmly embedded in the plaster form.

The plaster should be mixed thin enough to pour and conform perfectly to the shape of the model and then poured into the box. After the plaster has set, the box can be removed by taking off the clamps, when the sides will easily come away from the form. Before the plaster form is lifted from the faceplate, a thickness line should be scribed at the top by using a surface gage, as shown at *D;* this will give a plain surface true to the center line of the model. By varnishing the wooden model and the sides of the box with shellac and covering the surface with a thin coat of oil or vaseline, a perfect surface will be produced, if the plaster has been sufficiently mixed to work out the air bubbles. The blocks or sides for the box may have draft or be of almost any shape that will leave the form in condition for the foundry after the surface grease has been scraped off and the form given two coats of shellac.

Peoria, Ill. PAUL L. HATFIELD

KEYSEATING TOOL

In the January number of MACHINERY a tool for cutting keyseats when no keyseater is available is described. This tool is not uncommon in small mill repair shops where the machine equipment is usually limited and the range of work very large, but using the tool in the spindle of a drilling machine is a novelty, and it is readily seen that small keyseats, ¼ or ⅜ inch wide, can be cut more quickly in this manner than by the method to be described. The accompanying illustration shows a tool which is practically the same as that described in the January number except that it is not used as an attachment to a machine. The cutting action is accomplished by driving the tool through the work with a sledge. The bar *B* is a sliding fit in the bore of the work and carries the tool *T* in a slotted hole. The tool is held rigid by a headless set-screw *S* and is adjusted for the cut by screw *C*. The distance from the lower end of bar *B* to the tool should be long enough to serve as a pilot at the beginning of the stroke, and the total length of the bar should be a little longer than the longest keyseat to be cut. The head of adjusting screw *C* enters a counterbore, to protect it from injury when the bar falls through the work. The screw should never project beyond the end of the bar, and it is, therefore, operated with a socket wrench. Very light cuts should be taken during the first few strokes to lessen the possibilities of the bar turning in the work. Keyseats up to ¾ inch have been cut successfully in this manner.



Tool for cutting Keyseats

Olean, N. Y. E. J. GIBSON

VALUE OF REPAIR LISTS FOR REPAIR ORDERS

The article on page 642 of the March number of MACHINERY, entitled "Ordering Parts for Machine Tool Repairs," was read with great interest, and the solution of the problem suggested by the author will eliminate much of the trouble caused through lack of definite information as to what is desired in filling an order for repair parts. However, merely attaching to the machine a brass plate upon which is stamped the manufacturer's name and address and some serial or shop order numbers requisite to its identification does not remove all danger of confusion.

In filling in the requisition to the purchasing agent for a broken part, the question might arise, "What is the part called?" "What is its correct technical term?" Sometimes the owner, fearing that the manufacturer might misinterpret the order, sends the broken piece by parcel post or express, thereby causing additional expense and the possibility of losing the part in transit. In the case of an ordinary type of machine tool, say a planer, sold to manufacturers of drilling machines, milling machines, or other machine tools, there should be no cause for error or delay, for the reason that the names of the parts of the machine are generally well known. But where a repair order is for a machine of intricate design or one containing a cumbersome gear-box mechanism, quite a different angle of the situation is presented. Also, should one of the many contacts wear down or a magnet burn out on a controller forming part of the electrical apparatus on an elevator, the same condition might arise.

In certain electrical lines, the manufacturer sends a repair list with the finished product. This list consists of a diagram of the assembled unit on which are placed the names of the various parts entering into the design, together with their piece or pattern numbers. The fact that the piece number is given on a repair order often has been the means of knowing what is wanted, particularly where the manufacturer's records are somewhat misleading. Why cannot this method be adopted in the machine tool industry? It is not essential that an assembly drawing of the complete machine be sent; just a simple line drawing, without dimensions, of the units subject to repair orders is sufficient.

Cincinnati, Ohio JOSEPH PLOOMANN

FIGURING IN THE METRIC SYSTEM

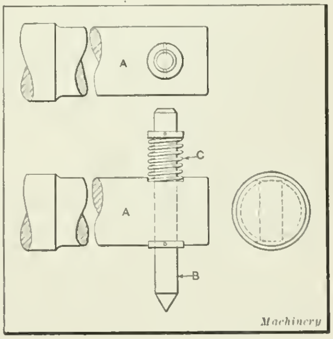
Now that we are doing so much foreign work, we are encountering metric dimensions at every turn. It seems to be the common practice to convert the metric dimensions into decimal equivalents and work with these. That is all very well. But when it comes to figuring out dimensions from metric drawings, especially when the foreign inspectors use metric gages, a lot of time and work can be saved by using the metric figures all through the calculations and converting the answer only. Time and again draftsmen in solving such a problem, for instance, as finding the square root of 5 squared plus 6 squared (metric dimensions), which can be done with very little effort, convert these figures into decimal equivalents first and then have an example like this: finding the square root of 0.19685 squared plus 0.23622 squared.

Why wrestle with all those figures when the problem could almost be done without even a pencil and paper? Further, there is a slight error every time a figure is converted, which means quite a variation in a long calculation. It is strange that the same draftsmen who design labor-saving jigs and fixtures do not take their own medicine and cut down labor and insure greater accuracy. Still, that is what is found in so many cases that the writer brings up this point.

Hartford, Conn. J. C. P. BODE

LAYING-OUT FIXTURE FOR MILLING MACHINE

In the April number of MACHINERY, on page 744, there appears an illustration of a laying-out fixture for use on a milling machine. In the accompanying illustration is shown another design of fixture for holding a center-punch. The arbor *A* fits the spindle of the milling machine, and should be held in such a position as to bring the punch *B* perpendicular to the axis of the work, which is held between the centers of the indexing head. The center-punch is held up from the work by the spring *C*. This fixture permits rapid spacing and marking, as it is only necessary to bring the work into each position by means of the indexing head and strike the head of the punch just hard enough to produce the required centering mark.

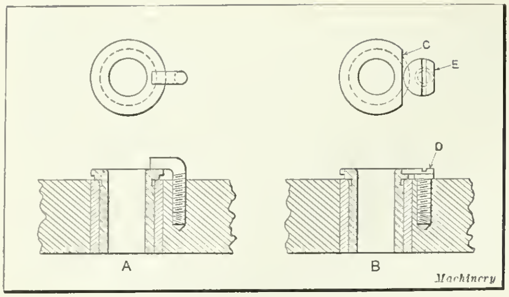


Laying-out Fixture for Milling Machine

New York City E. J. HIGGINS

SLIP BUSHING WITH RETAINING DEVICE

In the March number of MACHINERY on page 649, C. Jouve describes a retaining device for a slip bushing. The method shown is new to the writer, but there is no doubt but that it serves the purpose in view. A criticism that might be made



Retaining Device for Slip Bushings

is that the same end could be obtained by a much simpler and cheaper device. In the accompanying illustration at *A* is shown about the cheapest retaining device which can be made. This consists of a piece of steel wire about 1/4 or 5/16 inch in diameter, which is screwed into a tapped hole in the wall of the jig or fixture. The upper end of the wire is bent as shown. When it is desired to prevent the bushing from being drawn out with the drill, the wire is turned to the position shown. When the bushing is to be removed, a quarter turn of the wire brings the bent portion into a position that allows the bushing to be taken out. It is sometimes desirable that the face of the bushing be used as a stop for counterboring, spot-facing, or similar operations. Under such conditions, any retaining device that projects above the face of the bushing is useless. In the illustration at *B* is shown a good retaining device which may be used when conditions such as noted are necessary. It is neat, easily made, and convenient to use. The head of the slip bushing is machined with a flat, as shown at *C*. The retaining screw *D* has a portion of the head cut away as shown at *E*. The distance between the center of the screw and the flattened portion must be slightly less than the distance between the center of the screw and the edge of the slip bushing. When the screw is in the position shown, the bushing cannot be removed and any spot-facing or similar operation may be performed without danger of the tool interfering with the retaining device. When it is necessary to remove the bushing, a half turn of the screw brings the flattened part in such a position that the bushing may be taken out.

Providence, R. I. Robert Mawson

INVENTIONS AND INVENTORS

The article on page 703 in the April number of Machinery is a rather severe indictment of the laws under which the inventor works and the financial pirates among whom he falls. The patent, it is stated, gives absolutely no protection (unless there is capital behind it), while the patent laws require that inventors reveal their inventions to the public; the inference is that this is a most unfair state of affairs, a theorem for which the writer of the article presents little proof.

The grant of a patent is an agreement between the Government of the United States and the inventor by which, in consideration of free public use after seventeen years, the Government grants to the inventor exclusive use of the child of his mental vision during that period. But this product must have sufficient personality to be differentiated from thousands of similar cherished offspring of inventors. The writer has been doing his share for thirty years to increase the number of inventions and, on the whole, he has no complaint to make of the treatment he has received from the Government, on the one hand, or from the "pirates of finance," on the other.

In many instances, not only has the patent grant secured to the inventor his just rights but it has also enabled him to bar progress in an art. Our patent laws in this respect are far too favorable to the inventor. They should compel the inventor to work his invention or license its use to those who will. Right here is where the inventor usually flounders. The Government grants his patent, but unfortunately it can neither furnish him business experience nor a sense of values, and as a result he often demands a price and terms for his invention that prevent any sane business man dealing with him.

Lump-sum price demands have wrecked the chances of many inventions. Still it is safe to say that no really good thing in any line goes begging if offered on a reasonable royalty basis, coupled with a minimum yearly compensation to insure working by the licensee. Too often the inventor demands that the manufacturer shall take all the chances of business failure or success when both the manufacturer and the inventor would be better served by the safer and more just basis of royalty, which instead of being a myth is both a common and an essentially workable form of agreement. There are business pirates, of course, as there are violators of all laws, but this is no reason for an inventor to whine for more protection from without. What he needs is more horse-sense in marketing his wares, and this it is fervently hoped the Government will not attempt to furnish. As a guild, inventors are in no need of particularly tender care because their "imaginative, sensitive, suspicious, and reclusive" natures cannot stand the treatment men get in other lines of endeavor. As the writer knows them, they are far from being a race apart who must be humored to secure the rich flow of their inventive genius; oftener they are intensely practical, of wide business experience, and do their work under the spur of business necessity. At least they go about their task without whimpering and get such reward as comes to men who work hard and well.

St. Paul, Minn. E. E. Johnson

SAVING TIME IN MAKING DRAWINGS

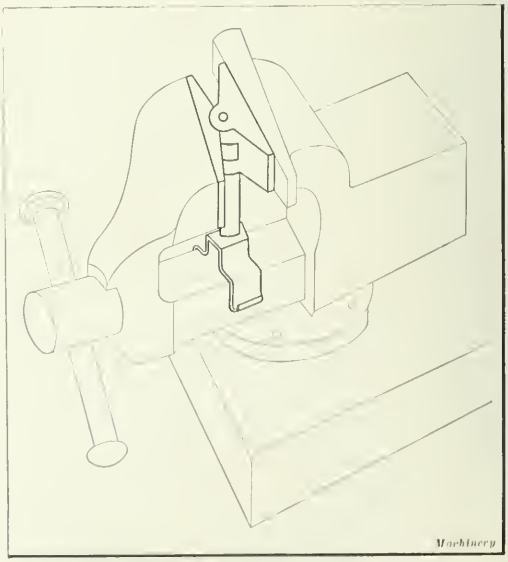
In the article "Saving Time in Making Drawings," on page 649 in the March number of Machinery, Mr. Perlman refers to a thin piece of celluloid shellacked to the drawing as being an improvement over horn centers. The writer agrees with him, but believes the following method is even better: Use a piece of Dennison's gummed cloth tape about 3/16 inch square and leave it on the drawing. It will then always be ready for use.

New Britain, Conn. F. E. Potter

EQUALIZING VISE JAWS

The equalizing jaws illustrated are handy for gripping irregular shaped and tapered work in either a machine or bench vise. The faces of the jaws can be serrated to insure a firm grip, and then hardened.

Concord, N. H. Charles H. Willey



Device for holding Irregular Shaped Pieces in a Vise

HOBS AND HOBBING[1]

The method of producing gears by hobbing has been understood in its theoretical aspects for many years, but conditions, which are now radically changed, delayed its general adoption until recent years. One of the early conditions which retarded progress was the fact that quantity production in its present meaning did not then exist, and quantity production is the field to which the hobbing process is especially well adapted. The introduction of the automobile and its manufacture on a large scale necessitated the manufacture of duplicate gears in very large quantities, and thus afforded a chance for the hobbing process to show its capabilities, but it still lacked the refinements necessary to enable it to do high-quality finishing work.

From a study of the various methods of cutting gears and a consideration of the advantages and disadvantages of each, an ideal system would have the following characteristics:

1. A continuous cutting action, as in milling with a disk cutter.
2. Generation of each tooth by a single tooth or tooth profile, as in the single tooth generating process, so that each tooth will be a duplicate of its mates.
3. Distribution of the cutting action around the blank so that an even heating may take place.
4. Continuous indexing by rolling so that inaccuracies in spacing by intermittent methods may be eliminated.

The hobbing process has all these characteristics. The cutting action of the hob is obviously a continuous milling cut. Each tooth in the gear is generated by the same set of teeth in the hob. An inaccurate hob may produce an incorrectly shaped tooth; but even so, all the teeth will be alike. Both work and cutter rotate rapidly, thereby assuring uniform distribution of heating and expansion. The indexing is continuous by rolling. Every revolution of the hob spaces out a tooth on the blank as it rotates, in proper relation with the latter. The indexing is in no way affected by shock and jar, as in the intermittent method.

It being accepted that the hobbing process combines these desirable features, the problem then is to design a machine to give practical effect to them in the best manner. The trend today is toward specialization, and it is well recognized that making a specialist of a machine, while limiting the range of work to which it is applicable, is profitable for quantity production, because it increases its efficiency on the work within its range. Applying this view to hobbing machine design, it seems apparent that by limiting the diameter of the gears to be cut to twelve inches and the diametral pitch to 3, a machine can be produced having great rigidity for the kind of work expected of it, and at the same time having a range sufficient to cover most of the quantity production. Being a manufacturing machine, speedy loading and unloading should be a main feature of the operation. The vertical arrangement of the work-spindle lends itself to machines of large capacity, as a more compact design can be worked out with this arrangement than is possible with the spindle in the horizontal position, but for a range of sizes up to twelve inches, the horizontal arrangement has many advantages. In the quickness with which the work can be loaded, in combination with the stiffness that can be built into the work-supporting means, the horizontal machine is superior to the vertical type. Cleanliness is another feature in favor of the horizontal spindle, as chips fall clear of the work-support and do not hinder speedy reloading nor impair the accuracy of the results. Therefore, for the machine in view, the horizontal work-spindle is superior. The hob support should be arranged with a minimum overhang and a simplicity of design that would give the results desired.

From the first, the hobbing process has proved itself to be a rapid method of producing gear teeth, and for this reason its advocates have had little difficulty in demonstrating its ability for roughing, where quantity is required. The hobbing cut has the advantages of being continuous, of breaking up the chip, of operating on a rotating blank, thus equalizing the load and distributing the heat, of having no portion constantly under cutting action, thus facilitating heat radiation and dissipation, and of distributing the load upon a great many teeth, no tooth removing metal for its whole depth, therefore facilitating a rapid and complete circulation of the cutting compound. The constant rolling indexing method of spacing the teeth also allows a much higher operating speed than is practicable with intermittent spacing devices.

But roughing is not the only consideration. Gears require to be finished, and finished with a high degree of accuracy, especially at the present time. As the demand for accuracy in the gears increased, and as the use of high-speed steel became a necessity in economical production, the relative disadvantages of the hobbing process in finishing became more marked, and today, for high-class finishing, it would be out of the race entirely if there were no means available for correcting the hobs after hardening. Fortunately, such a means exists today in the modern ground hob.

Duplicate hobs of any form can now be made with reliability and certainty, and the hob can be set to cut on any part of its surface without changing the result in the finished gear, so that the whole wearing life of the hob can be utilized, whereas with hobs that are not ground, the distortion of hardening often results in there being one point on the hob which will produce good results, whereas no other place on the hob will do so. The hob which is formed and not ground is still recognized as the proper tool for roughing, and it may be used for some classes of finishing, but not where a high quality is required, for, although it will make all the teeth in the gear alike, it cannot be relied upon to give an accurate tooth shape unless every tooth in the hob follows in proper relation, without zig-zagging from the theoretical path. There are a number of causes that account for the zig-zag or drunken path that the hob tooth of an unground hob may take. Sharpening is a cause of wide variation in the relation of one tooth to its adjacent mate, but can be corrected to a degree that reduces the error from this source to a minimum. The teeth of the hob must necessarily be equidistant from the axis at the cutting edge to get a continuous true relation of one to the other. Hardening is most difficult to control, as the materials of which hobs are made require high heats and cold quenching, setting up strains that cannot be predetermined. Hole grinding is also a cause of variation. This, however, can be corrected to some extent in sharpening. Relieving the thread is often the cause of error, even though the operation is performed on heavily constructed machines. The material is not always ideal in working qualities, no matter how carefully the steel is manufactured, heated or treated, and variation in hardness, even in the same bar, is a cause of error. These difficulties have defied the art of the hob maker and forced him to resort to grinding, which today is entirely successful and practical.

Aside from the production of spur and spiral gears, the hobbing process has a further field in the production of spline shafts, which have come into such common use in automobile construction, and which are now being more and more adopted in other lines. The spline shaft owes its popularity and, from a manufacturing standpoint, its practicability to two modern processes—pull-broaching and hobbing.

Hobbing is particularly well adapted to spline shaft generating, as in this work the uniform distribution of the heating effect is even more important than in cutting gears, and added to this is the fact that in making spline shafts by milling with intermittent indexing methods, the releasing of surface strains from one side of the shaft at a time throws the shaft out of true and makes accurate results extremely difficult to attain. This is not so in hobbing, because the stock is gradually removed from all sides at once, working progressively from one end, the effect of the removal of stress-resisting material is balanced, and no distortion takes place.

Besides these important features, we have the accurately indexed keys, each a duplicate of the other, with off-center keys eliminated, and added to all this is the high rate of production. There is no limit to the number of keys it is possible to hob with little or no increase in production time for shafts of equal diameters. This has undoubtedly led to the present wide adoption of shafts, particularly for axle drives, with eight, ten or more keys, giving a greater root diameter for a given key driving strength, the accurately indexed splines distributing the load evenly.

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[1] Abstract of a paper by F. G. Hoffman and John Edgar, of the Barber-Colman Co., Rockford, Ill., read before the American Gear Manufacturers' Association convention at White Sulphur Springs, W. Va., April 18 to 20, 1918.

Another field that the ground hob has opened for hobbing is the silent chain sprocket. Sprockets of a large number of teeth have been handled successfully by the formed hob, but those with a small number require the greater accuracy of the ground hob. Hobs are used extensively to cut teeth in roller and block chain sprockets. These are usually range hobs, each covering a small range in numbers of teeth possible with each hob. Special cases of hobbing also include those in which teeth in ratchets, slotting saws, burrs, etc., are generated. Hobs may be made to generate almost any toothed section that has teeth equally spaced on a cylindrical base; it is not necessary that the teeth be symmetrical on an individual axis.

* * *

THE MACHINE TOOL INDUSTRY AND THE WAR[1]

It has been stated a great many times that the machine tool industry is a fundamental industry, and this is especially true during war. Therefore, it should be clearly and fully drawn to the attention of everyone in this industry that he should do his utmost to increase production of a kind required by the Government, and, with this in view, to overcome all of the many known obstacles in the way. These obstacles might be enumerated as a shortage of skilled labor for the machine shop; the moving about from one community to another of labor, both skilled and unskilled; and the difficulty of securing certain materials.

Attention should be paid to the fact that it is not possible to produce the larger sizes of machine tools, which apparently will be urgently required, at short notice, and a program should, therefore, be laid out as far in advance as possible, so that when production is demanded the proper machinery will be in readiness. Attention should also be paid to the fact that the smaller sizes of machine tools seem plentiful, and the supply of these is probably greater than the demand. There is, however, a scarcity of the larger sizes of machine tools, most of which are wanted quickly.

Great care should be taken in making plans to meet the labor shortage. First we must stop, in so far as it is practical to do so, this bidding for men, which causes them to move from one community to another. To the time lost in transporting these men may be added that consumed in teaching them new occupations, which later are abandoned as the men become dissatisfied with their new surroundings. In short, men should be convinced that they are best serving their country by remaining on the jobs they know best. The mechanical trades have developed so rapidly during the last few years that there is naturally a shortage of skilled labor, and we must look the facts in the face and start to make skilled labor out of unskilled labor. This applies to both man and woman labor. This is one of the most important things to bear in mind, because there could be no greater catastrophe than to find the machine tool shops of this country so undermanned that they could not produce the necessary machine tools for the building of aircraft, machine guns, cannon, and ships; in fact, everything for which machine tools are used.

The creation of a vast army and of the accessories that go with it has been a tremendous job. When it is considered that within one year this nation has been transformed from an unmilitary nation into one that has fast become a great military power, it is no wonder that there have been some disappointments and much criticism, both among our allies and in this country, but it is time for all thoughtful men to take themselves in hand and to stop all criticism which is idle and malicious, or made without good reasons. Big men, as a rule, can stand honest and just criticism, and perhaps that kind of criticism, particularly if it is constructive, is good for any of us, but it must be constructive, or else it may do more harm than good. Words of encouragement do more toward creating efficiency than bitter criticism and denunciation.

Everyone today is reasonably familiar with the advanced cost of almost every commodity. The machine tool builders have had to pay the advanced cost of labor, of cast iron, of steel, of bronze, and, in fact, of all material which enters into the construction of machine tools. They know also that the overhead burden has been greatly increased, brought about largely by the necessity of manufacturing with greater speed than before and by the necessity for training operators who had no previous knowledge of the trade, but who had to be paid while they were being taught. This naturally has made it necessary for every machine tool builder to increase his selling prices. When the increased cost of almost every article is taken into consideration, there can be no criticism at the modest advance of prices in the machine tool industry. This is particularly true of the older builders of machine tools, who have reputations to maintain and who expect to remain in the machine tool business in the future; but it is hoped and believed that every member of the National Machine Tool Builders' Association will consider the necessity of his country at war, and therefore advance his prices only as it becomes necessary. There is, of course, such a variety of machine tools, as regards design, workmanship, accuracy, and productive capacity, that they are difficult to compare, but it is urged that every member of the National Machine Tool Builders' Association make it his duty to keep his selling price as low as good business practice will permit.

In this connection we should remember our debt to our allies, to Great Britain, to France, to Belgium, and to Italy, as well as to others who are aiding us in this great struggle. We have advanced them moneys and credit, but they have given largely of those things which no man can replace, namely, their limbs, and blood, and many of them their lives. We have sent them machinery and equipment which they have carried, through their own personal effort and great sacrifice, to the various front lines where they have laid down everything that they hold dear in this stupendous struggle for world freedom. Our responsibilities are even greater than they would have been had we plunged into the struggle at an earlier date. Therefore, we should exert ourselves the more to make up for this lost time, and all of us should pause and determine in our own minds what might have happened had not our European allies held back the enemy. However, we are all now working, giving, fighting, and dying together for a great cause, and it is a hope and belief that when this great struggle ends in a tremendous victory for the Allies, the love and cooperation born of this enormous sacrifice will be evident in the peaceful pursuit of both business and pleasure, and as we visit the countries of each other as friends do, we shall all feel ourselves a part of the great Allied family.

* * *

LICENSING FOREIGN TRADE

To prevent the useless consumption of materials and labor in making articles that, for the present, may not be exported, and to save tonnage, exporters are required, under regulations in force since May 15, to obtain the written approval of the mission sent to this country by the country to which the exportation will be made. On July 1, all outstanding licenses granted on or before May 14 will be revoked. Any goods not then exported against such licenses may be shipped only if licenses are secured after being approved by the mission of the country to which the goods are to be sent.

On and after May 27, no commodities, except in a comparatively few cases covered by general import licenses, shall be approved for shipment to the United States by the consuls in any country in the world until applications for licenses have been acted upon favorably by the War Trade Board, and the number of the United States license covering the shipment is submitted. This practice has been effective in connection with the restricted list, but the present ruling makes it applicable to all commodities. This rule will prevent unnecessary production in any of the nations allied against Germany.

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[1] Abstract of an address by J. B. Doan, president of the American Tool Works Co., Cincinnati, Ohio, presented before the National Machine Tool Builders' Association convention, Atlantic City, May 16-17, 1918.

MACHINE TOOL REQUIREMENTS OF THE ORDNANCE DEPARTMENT[1]

A SPECIFIC OUTLINE OF THE LARGE MACHINE TOOLS NEEDED BY THE GOVERNMENT IN THE NEXT YEAR

When problems of such magnitude as are arising today come up for action, it is impossible to handle them through the recognized channels of peace times; and so the Ordnance Department has, in the past, frequently called upon machine tool manufacturers for assistance not only in expediting the delivery of machine tools so urgently required, but also in determining the requirements of the machines necessary to build certain types of ordnance. The machine tool builders have given the services of their engineers to the Ordnance Department for this work of organization, as it was felt by the latter that the best results could be accomplished by making up a tentative schedule of machine tool requirements for some of the most important types of ordnance, rather than by eliminating the preparatory engineering work and ordering machine tools indiscriminately, trusting that enough of them would be fitted for the work to take care of the various contracts. By this preliminary time-study work, it is safe to say that the purchase of probably several million dollars' worth of unnecessary machine tools has been avoided, thus relieving, to a certain extent, the tense machine tool situation that existed last fall.

How the Machine Tool Builder can Serve the Government

The question has often been asked: How best can the machine tool builders serve the Government? This may be answered broadly by stating that they can best serve by turning out as many machine tools as possible in the quickest possible time. There are, however, so many phases of the problems to be considered that they may be enumerated in their order of importance.

The Ordnance Department asks for a greatly increased production of large machine tools. The success of the program for large guns depends upon the output of heavy machines for the remainder of the year. In other words, the success or failure of the 1919 drive, as far as the use of large caliber guns is concerned, rests squarely upon the shoulders of the machine tool builders who are expected to carry that load. The machines available are insufficient, and it is understood, from reliable information, that unless the present rate of output for large machine tools is considerably increased, the program for large guns will be jeopardized. The members of the National Machine Tool Builders' Association are in the best position to work out a successful plan to produce the required machines, and they are asked to cooperate with the Machine Tool Section of the War Industries Board to determine how the results can best be obtained.

Closer Contact with War Industries Board

Closer contact should be maintained between the National Machine Tool Builders' Association and the Machine Tool Section of the War Industries Board, so that the members of the association can, at all times, be fully informed as to the requirements of the Ordnance Department, as well as of the other branches of the National Government. The time has arrived when it may be necessary for certain machine tool builders who have, in the past, strictly adhered to certain types and sizes of machine tools, and who have enjoyed a national reputation as the manufacturers of these tools, to change their commercial commodity. The time has arrived when it is not a question of maintaining past standards, but of manufacturing types of machinery that are most urgently needed.

A manufacturer who is equipped for making certain machine tools for which there is no urgent demand by the Government should immediately take steps to devote his energies to some type of machine for which there is a demand; or, if his equipment is such that he cannot change to some other type of machine tool, then it is his duty to inquire into the needs of the Ordnance Department to determine what material he can supply with the equipment that he has.

By keeping in close touch with the Machine Tool Section of the War Industries Board, machine tool builders can, at all times, be posted as to the machine tool requirements of the Government; and the Machine Tool Section of the War Industries Board should be able to advise them as to the advisability of changing from machine tools to straight ordnance manufacturing, provided their equipment is such that it would be impossible for them to produce machine tools which the Government really requires; and it is felt that with the Machine Tool Section of the War Industries Board acting as the intermediary between the Ordnance Department and the machine tool builders, an alliance can be formed between these two bodies that will be extremely beneficial to both. It should be remembered, however, that in approaching the Machine Tool Section of the War Industries Board, the machine tool builder should be in the frame of mind to accept the Government's decision as to what they can best build to suit the Government's needs, and not consider what they would like to build to suit their own convenience.

Advice Needed as to Best Machines

It has been suggested that far too little time is devoted by the machine tool manufacturers in assisting their customers to determine what machine tool equipment would best suit their requirements. During peace times, every progressive machine tool manufacturer would check up the requirements of his customers so as to be assured that each tool sold to the customer was the one best fitted for his needs. This service has probably been discontinued to a certain extent, for two main reasons:

1. Owing to the enormous demand for machine tools during the war period, it was not necessary for machine tool builders to solicit business; and, therefore, it is very easy for them to discontinue their engineering services, which heretofore had been given to the operating departments of their customers' plants.

2. Owing to the general unfamiliarity as to the machine tool requirements for ordnance work, the machine tool builders have been loath to offer any suggestions as to what tools would be best fitted for the manufacturing of ordnance material.

The result has been that, all too frequently, equipment has been sold to manufacturers holding contracts for ordnance material which was not suited for their needs. Because of the vast amount of new material to be manufactured, and the difficulty in securing the proper personnel for the Ordnance Department, it has been practically impossible to determine in detail the machines required for all classes of ordnance material; and, because of these difficulties and the lack of advice from machine tool builders, quite a large number of machine tools have been delivered that are unsatisfactory for the work they are expected to perform.

The machine tool builders should realize that it is necessary to let contracts for ordnance material to manufacturers who have had little or no experience in the past on up-to-date machine shop practice; and, therefore, they should increase the service heretofore rendered their prospective customers in advising them as to what they should and should not buy. To illustrate this point: Upon checking the machine tool list submitted by a contractor of the Ordnance Department recently, it was discovered that he proposed to buy one hundred and eighty 12-inch lathes. Had these lathes been purchased, it would have been impossible to use any of them on the contract. While admitting that this is an extreme case, it might frankly be stated that every government contractor would have been benefited had the machine tool builders cooperated to their fullest extent in advising the types and sizes of machines to be purchased.

Another important service in which the machine tool builders can assist the Ordnance Department is in driving the machine tool parasites out of business. Such men reflect discredit upon the industry as a whole, even though those of us who are well informed realize their actions are not tolerated by the machine tool builders, and it is requested that the manufacturers and legitimate sales agents use their influence toward the elimination of the pernicious activities followed by this class of men.

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[1] Abstract of an address made by Lieutenant-Colonel H. W. Reed before the National Machine Tool Builders' Association convention, at Atlantic City, May 16-17, 1918.

Machine Tool Requirements for the Coming Year

As stated in a letter from Mr. Merryweather, chairman of the Machine Tool Section of the War Industries Board, the present requirements of the Ordnance Department for machine tools are, in general, as follows:

> The American machine tool industry is apparently well able to cope with all the demands that may be made on it for small and medium size tools up to approximately 24-inch lathes; 24-inch planers; 36-inch vertical boring mills; radial drilling machines up to 4-foot swing; all small drilling machines; turret lathes; automatic screw machines; surface grinders, etc. There is, however, much evidence of a dangerous shortage of planers, lathes, slotters, vertical and horizontal boring mills, radial drilling machines, and milling machines of sizes larger than those specified above.

A summary of the large machines required and the estimated value is given in the following:

Combination Boring and Turning Lathes—Sixteen, 85-inch by 50-foot; six, 75-inch by 50-foot; three, 52-inch by 50-foot; fifteen, 72-inch by 50-foot; two, 52-inch by 30-foot; and five, 72-inch by 20-foot.

Boring Lathes—Twenty-eight, 54-inch by 12- to 22-foot; five, 40-inch by 50-foot, double-end; eighteen, 50-inch by 25-foot, double-end; eight, 40-inch by 25 foot; one, 32-inch by 25-foot, double-end; two, 72-inch by 30-foot.

Turning Lathes—Two, 36-inch by 6-foot; seventeen, 60-inch by 6- to 26-foot; twenty-nine, 54-inch by 6- to 24-foot; eight, 70-inch by 50-foot; twenty-two, 72-inch by 30-foot; ten, 85-inch by 50-foot; four, 60-inch by 50-foot; five, 48-inch by 30-foot.

Planers—Twelve, 48-inch by 12-foot; ten, 72-inch by 16-foot; five, 60-inch by 14-foot; six, 48-inch by 14-foot; twenty-five, 36-inch by 12-foot; five, 96-inch by 24-foot; fourteen, 120-inch by 30-foot; eight, 64-inch by 24-foot; three, 42-inch by 16-foot; one, 120-inch by 24-foot; four, 72-inch, open side.

Slotters—Six, 36-inch; one, 30-inch; five, 24-inch; six, 12-inch; three, 48-inch; eight, 14-inch; eleven, 26-inch; three, 10-inch; three, 18-inch.

Radial Drilling Machines—Eight, 6-inch; thirteen, 5-foot.

Milling Machines—Four, 6-inch spindle, horizontal; seven, No. 6 vertical; six, No. 5 vertical; two, No. 3 universal; two No. 5 universal, horizontal; three, No. 4 plain; three, No. 4 universal; six, No. 3 plain.

Vertical Millers—Two, No. 6; eight, No. 5; two, No. 3; two, No. 4.

Horizontal Boring Mills—Twenty-nine, 4-inch; six, 5-inch; five, 6-inch; three, 3-inch.

Vertical Boring Mills—One, 14-foot; eight, 20-foot; one, 12-foot; five, 10-foot; eight, 48-inch; seven, 72-inch; three, 66-inch; eight, 90-inch; eleven, 60-inch; three, 50-inch; one, 96-inch; three, special.

Floor Boring Mills—Three, 7-inch by 7-foot; two, 7-inch by 5-foot.

Rifling Machines—Three, 50-foot; two, 30-foot.

Miscellaneous—Eighteen, 48-inch jump lathes; three, 60-inch gear-cutters; two, 24-inch gear-hobbers; three, 24-inch by 8-foot grinders; three, 72-inch gear-cutters; two, draw shapers; one, No. 4 gear-cutter; three, No. 5 gear-cutters; one, 16- by 50-inch grinder; one, 10- by 72-inch grinder; one, 18-inch rotary saw; three, 26-inch shapers.

Summary of Machines in Great Demand

Boring Lathes	$1,239,000
Turning Lathes	1,747,000
Combination Boring and Turning Machines	1,535,000
Radial Drilling Machines	83,000
Milling Machines, General	165,000
Milling Machines, Vertical	33,000
Milling Machines, Horizontal	306,000
Vertical Boring Machines	1,150,000
Horizontal Boring Machines	306,000
Slotters	332,000
Planers	2,118,000
Rifling Machines	146,000
Floor Boring Machines	52,000
Miscellaneous	170,000
Total	$9,382,000
Value of Available Tools	924,000
Total Estimated Cost	$10,306,000

It has been stated that the mechanical power of an army in the field may be measured by the industrial army at home, making the necessary munitions of war; but beyond this, the efficiency of the manufacturing industrial army may be gaged, not only by turning out an adequate number of machine tools, but also by turning out the types that will perform the best service for manufacturing the ordnance material required. If the machine tool builders will do their part by turning out the required machines, the Ordnance Department can take up the work at that point, and the nation will be assured that the required guns and equipment will be delivered.

* * *

NATIONAL MACHINE TOOL BUILDERS' CONVENTION

The spring convention of the National Machine Tool Builders' Association, which was held at Atlantic City, May 16-17, was, perhaps, one of the most successful spring conventions in the history of the society, and it was certainly the one that brought to Atlantic City the largest number of machine tool builders. The first session, held Thursday morning, May 16, was opened by an address by the president of the association, J. B. Doan, of the American Tool Works Co., Cincinnati, Ohio. An abstract of this address will be found on another page in this number of MACHINERY. Mr. Doan's address was followed by a stirring appeal by Isaac F. Marcosson, a war correspondent who has seen active warfare at all the European fronts, and who particularly warned against too great optimism and against the insidious German propaganda. Maurice T. Fleisher, of Philadelphia, spoke on "Trade Acceptances," and A. Babcock, of the Guaranty Trust Co., New York, spoke on "The Business Survey."

The afternoon session was opened by an address by Admiral R. S. Griffin, engineer-in-chief, U. S. Navy, who spoke on the relations of the Navy Department to the machine tool building trade in general. Admiral Griffin's address was followed by another on the machine tool requirements of the Ordnance Department, by Lieutenant-Colonel H. W. Reed, which is published on another page. Charles T. Foster, of the American Radiator Co., who now serves with the Priorities Board of the National Government, spoke on the subject of "Priority." The meeting was closed with an address by H. E. Miles, chairman of the section on Industrial Training for the War Emergency Council of National Defense, who spoke on the subject "Women in Industry."

Thursday morning an executive session was held, at which George Merryweather, chairman of the Machine Tool Section of the Council of National Defense, made an address on the machine tool requirements of the Government. H. W. Dunbar, of the Norton Grinding Co., Worcester, Mass., also spoke at this meeting on "Safety Devices on Machine Tools." Friday afternoon was devoted to committee meetings.

* * *

SPRING MEETING OF AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The spring meeting of the American Society of Mechanical Engineers will be held in Worcester, Tuesday, June 4, to Friday, June 7, the headquarters being at Hotel Bancroft. The principal professional sessions will be held on June 5 and 6 at the Worcester Polytechnic Institute. One session on Thursday afternoon will be held at the Norton Co.'s plant, where a paper will be read on the results of a questionnaire upon housing, issued to leading industrial firms, after which an inspection will be made by members of the society and guests of the company's community housing and garden projects. Of special interest will be the so-called "New England sessions," at which papers will be presented upon subjects relating to New England's industries under war conditions, including "Converting a Factory for Munitions Manufacture"; "Training Labor for Shipbuilding"; "The Small Industry in a Democracy," and "Fire Protection." A special session will also be held on industrial safety and workmen's compensation; and another on vocational training. The evening session on Wednesday will be devoted to war subjects, including "Ordnance and Ships for the Navy Department," "Munitions for the Army," and "Aircraft Material." Plants in and about Worcester will also be visited by the members during the convention.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

IN THIS NUMBER

Bullard Maxi-mill. Bullard Machine Tool Co., Bridgeport, Conn. 945
Expandem Boring Tool. Expandem Tool & Mfg. Co., 215-217 W. Superior St., Chicago, Ill. 947
Buffalo Slitting Shear, Punch, and Bar Cutter. Buffalo Forge Co., Buffalo, N. Y. 947
Franco Tosi Shell Lathe. Franco Tosi, Legnano, Italy 948
Lea Thread Lead Tester. West & Dodge Co., 167 Oliver St., Boston, Mass. 949
Economy Scrap Metal Baler. Economy Baler Co., Ann Arbor, Mich. 950
Westinghouse Pressed-steel Automatic Starter. Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. 951
Lynd-Farquhar Radial Drilling Machine. Lynd-Farquhar Co., 419-425 Atlantic Ave., Boston, Mass. 951
Evertite "Sta-lok" Nut. Evertite Nut Corporation, Marquette Bldg., Detroit, Mich. 952
Watts Angular Hole Drilling Tools. Watts Bros., Turtle Creek, Pa. 952
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Biggs-Watterson Thread Miller. Biggs-Watterson Co., 1235-1237 W. 9th St., Cleveland, Ohio 955
Newton Rail Drilling Machine. Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa. 956
Davenport No. 2 Milling Machine. Davenport Mfg. Co., Meadville, Pa. 956
Adams Short-cut Lathe. Ogden R. Adams, 159-161 St. Paul St., Rochester, N. Y. 957
Gray Knurling and Bourrelet Rolling Machine. Gray Machine Tool Co., Inc., 2661 Main St., Buffalo, N. Y. 958
Lambert Horizontal Boring Machine. Lambert Machine & Engineering Co., 1967 E. 55th St., Cleveland, Ohio 958
Mattison Propeller Shaping Machine. C. Mattison Machine Works, Beloit, Wis. 959
Niles-Bement-Pond Extension Boring and Turning Mill. Niles-Bement-Pond Co., 111 Broadway, New York City 959
Universal Tapping Machine. F. Lowenstein, 397 Bridge St., Brooklyn, N. Y. 959
Industrial Tractor and Locomotive. Industrial Truck Co., Holyoke, Mass. 960
Langelier Automatic Ignition Tube Drilling Machine. Langelier Mfg. Co., Arlington, Cranston, R. I. 961
Orenstein-Arthur-Koppel High-level Truck. Orenstein-Arthur Koppel Co., Koppel, Pa. 962

BULLARD MAXI-MILL

IN the latest addition to the line of boring and turning mills built by the Bullard Machine Tool Co., Bridgeport, Conn., it is claimed that the designers have incorporated all features of Bullard machines of this general type which have been found of practical value since this company built its first machine in 1883. This latest addition to the Bullard line—known as a 61-inch "maxi-mill"—is shown in Figs. 1, 2, and 3, and the remaining illustrations show important features of the design of this new machine. In working out the design of vertical turret lathes, this company has adopted the unit plan of construction, in which the drive, feed works, spindle mechanism, rail construction, lubrication system, etc., are made complete units. These standard features have been incorporated in the present machine, so that, while the machine itself is new, it consists largely of an aggregation of parts which have demonstrated their ability to give satisfactory service under actual conditions of shop operation.

On this machine, a continuous-flow system of lubrication is furnished for oiling all gears, bearings, and spindles, and, in connection with this system, there is a filter which removes all dirt and other foreign matter from the oil, and insures its cleanliness before going back to those members of the machine where lubricant is required. This is the means of avoiding delays due to scored bearings, overheated boxes, and other familiar causes of trouble. All gears and shafts are made of heat-treated chrome-nickel steel. The familiar principle of centralized control is applied, which adds largely to the productive capacity of the machine; and the control clutch and brake for starting and stopping the table are conveniently arranged for the operator, whether he is at the right- or the left-hand side of the machine.

Another important point in enabling this machine to produce work of the desired quality rapidly is the provision of means for effectively delivering a copious flow of cutting lubricant to exactly the required positions on the work and cutting tools, without the possibility of its entrance into the machine. The success of this construction lies in the fact that the machine was designed with this idea in mind, and in this connection it is interesting to note that the experiments which led up to the final form of construction covered a period of four years. Attention is called to the elimination of crank handles, with the object of avoiding danger of accidents in operating a machine where there are high-speed shafts required for obtaining the rapid traverse of heads, etc. The patented "hammer" handwheels used on this Bullard machine put lost motion to good use, and although they eliminate all danger of accidents from operators being struck by rapidly revolving cranks, these hand-

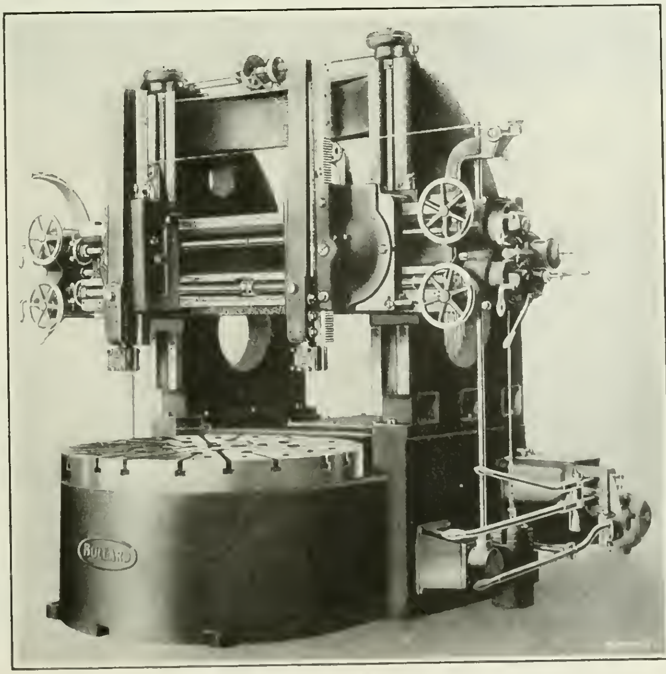

Fig. 1. Sixty-one-inch "Maxi-mill" built by the Bullard Machine Tool Co. This Illustration shows Speed Control Levers at Right-hand Side, Provision for traversing Heads and raising Rail by Power, and "Hammer" Handwheels for Fine Adjustment of Tools

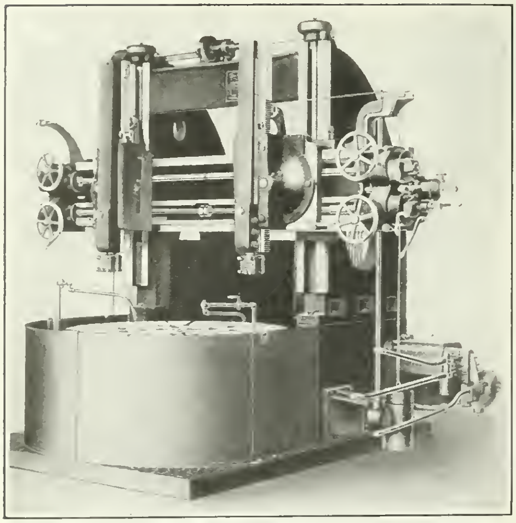

Fig. 2. Arrangement of Cutting Lubricant System on Bullard 61-inch Maxi-mill

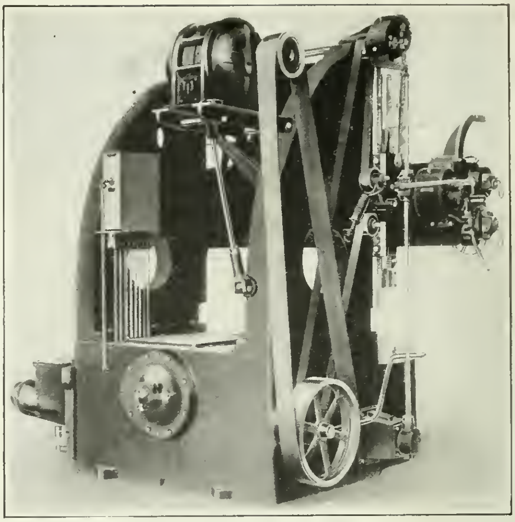

Fig. 3. Arrangement of Continuous-flow Oiling System, Motor Drive, and Left-hand Clutch and Brake Lever

wheels actually increase the operator's ability to obtain fine settings of the tools. Clearly graduated scales are mounted on the face of the cross-rail and on the tool-slides, to give the coarser settings; and micrometer dials, graduated to 0.001 inch and equipped with Bullard "observation stops," afford means of rapidly making finer settings.

Having made a statement of the special features of the Bullard maxi-mill, we are in a position to outline briefly the various details of its construction. The capacity of the machine is for handling work up to 63 inches in diameter by 52 inches in height under the cross-rail and tool-holders. The table is 61 inches in diameter and has parallel T-slots machined in it to provide for the use of four faceplate jaws. Twelve changes of table speed are available, covering a range of from 2.5 to 42.18 revolutions per minute, these changes being obtained by sliding gears and positive friction clutches, which are operated by conveniently located levers that interlock with the clutch and brake lever. The gear-cases in which primary and secondary speed changes are obtained are shown in Figs. 4 and 5, from which a good idea will be obtained of the arrangement of the mechanism. The speed-control levers will also be seen at the right-hand side of the machine in Fig. 1. There are eight changes of feed, covering a range of from 1/96 to 1/2 inch per revolution of the table, either vertical or horizontal. In Fig. 8 is shown the feed works for the right-hand head, and in this illustration a good view will also be obtained of the "hammer" handwheels and arrangement of the power traverse levers.

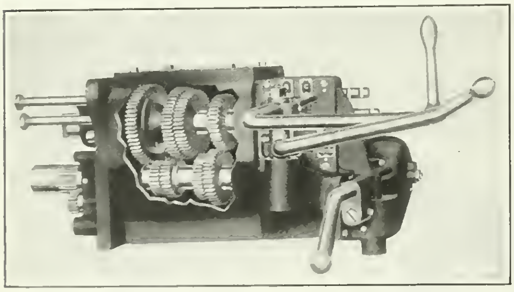

Fig. 4. Primary Speed Change Case, showing Arrangement of Control Levers, Gearing, and Interlocking System

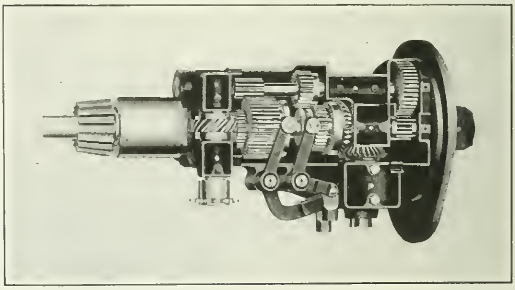

Fig. 5. Secondary Speed Change Case which is designed as a Unit having Ample Power and Durability

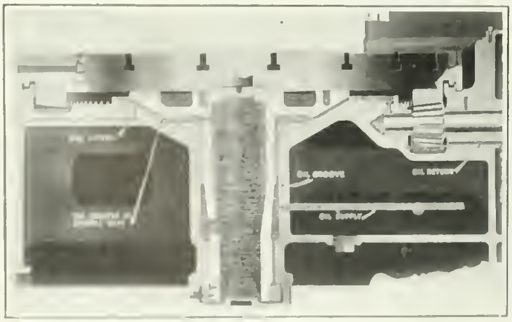

Fig. 6. A Continuous Flow of Oil lubricates the Table Spindle and the Overflow oils the Table Gear and Pinion as well as their Bearings

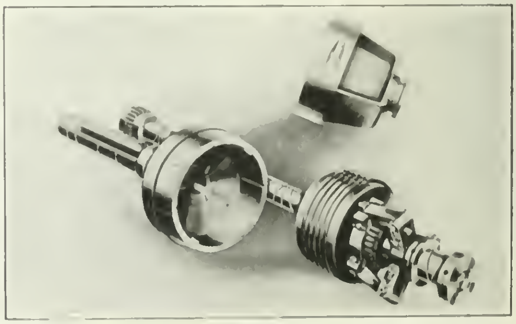

Fig. 7. Parts of the Multiple Disk Clutch and Brake-drum which are kept immersed in Oil to reduce Wear to a Minimum

The tool-slides are made of cast iron of high tensile strength, and they are of box form to give the desired rigidity. Inserted tool-holders are used, and a maximum vertical movement of 36 inches is obtained by means of a rack and pinion adjustment. The tool-holders may be swiveled 45 degrees at either side of the vertical center. All gears and shafts throughout this machine are made of heat-treated, oil-tempered alloy steel, and with the exception of the table driving gear, which is of such dimensions as to preclude the practicability of heat-treatment after machining, all gears are treated in such a way that they have a scleroscope hardness of 70. All bearings and gears having a fixed relation to the bed are lubricated by a continuous-flow system of oiling which is so designed that doubly filtered oil is circulated by a pump connected to the main driving shaft. Thus the pump runs whenever the main driving pulley is in motion.

In Fig. 6 is shown the manner in which lubricant is maintained at a constant level beneath the table by a continuous stream of oil which flows into the reservoir; this oil overflows and lubricates the table gear and pinion, as well as their bearings. The way in which oil circulates through this system and the provision made for the lubrication of the table bearing will be apparent from this illustration. All gears are enclosed, although they are readily accessible; the table is guarded, and, as previously mentioned, the use of crank handles and square-end shafts has been eliminated. These safety features go a long way toward eliminating the possibility of injury to the operator. The driving pulley is 24 inches in diameter by 5½ inches face width, and it should run at 405 revolutions per minute. Where motor drive is employed, a 15-horsepower constant-speed motor may be mounted on a bracket at the rear of the machine and connected with a driving pulley by a belt. When equipped with motor drive, this machine occupies a floor space of 11 feet long by 13 feet wide; the minimum height is 9 feet 10 inches, and the maximum height with the bars in their extreme upper position is 10 feet 10 inches; the net weight of the machine is 28,000 pounds.

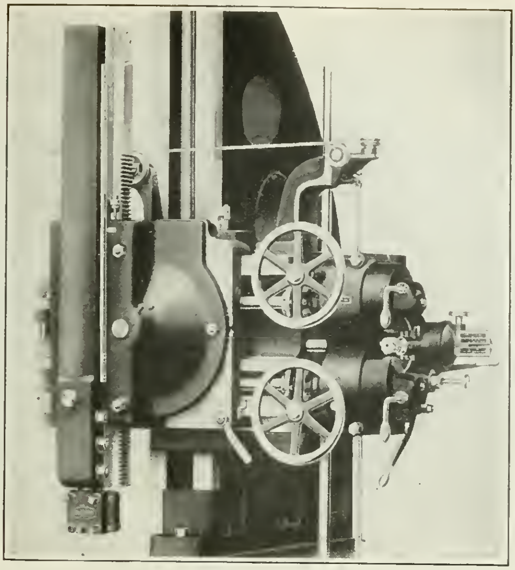

Fig. 8. Arrangement of Right-hand Feed Works, "Hammer" Handwheels, Power Traverse Levers, and Head with Steel Ram

EXPANDEM BORING TOOL

The Expandem Tool & Mfg. Co., 215-217 W. Superior St., Chicago, Ill., is now manufacturing an expansion boring tool which works on the same principle as a two-jaw chuck. The cutters *A* are so designed that their production is a simple milling machine job, and the threads that are engaged by the right- and left-hand adjusting screw *B* are in the form of oil-hardened steel blocks laid in the cutters. In this way, the cutters are placed under positive screw control for both expanding or contracting, and they are furnished with an absolute micrometer adjustment. In addition, there are what are termed "follow-up blocks" *C*, which are located opposite the cutting edges and directly against the backs of the cutters. As the cutters expand one block follows each cutter, thus supporting them as they come out of the bar. Locking is effected by means of a cam *D*, which comes into direct contact with a clamping pad *E* that is located against the follow-up blocks. It is claimed that these tools lose very little of their rigidity after maximum expansion, and that expansion is not limited to a dead stop, as the cutters can be expanded with absolute safety to 1/16 or even 1/8 inch beyond what is termed the maximum expansion of the tool.

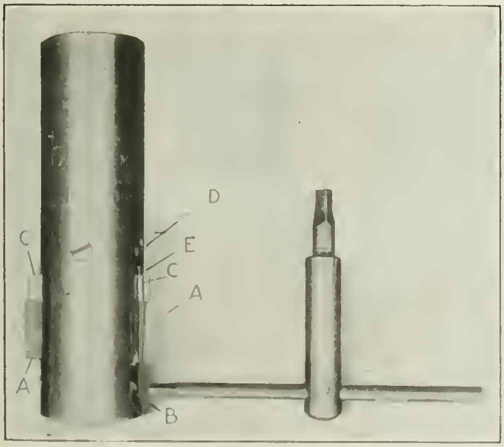

Fig. 1. Adjustable Boring Tool made by the Expandem Tool & Mfg. Co. The Key is shown in Position for adjusting Cutters

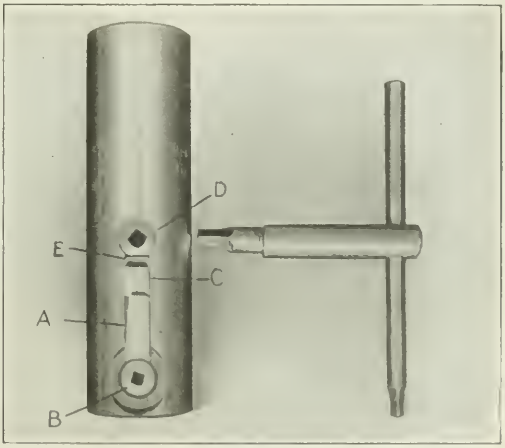

Fig. 2. One End of Key turns Adjusting Screw and the Other End tightens Binder after Cutters have been set in the Desired Position

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BUFFALO SLITTING SHEAR, PUNCH, AND BAR CUTTER

A No. 25 universal slitting shear, punch, and bar cutter is now being built by the Buffalo Forge Co., Buffalo, N. Y., which has the frame made of armor plate instead of an iron casting, making it possible to provide the same strength for the machine although the weight is only approximately one-sixth of what it would be with the cast-iron construction. In a sense, this machine may be said to represent a war development, because machines constructed with armor-plate frames were formerly imported from Germany. Not only is the weight less,

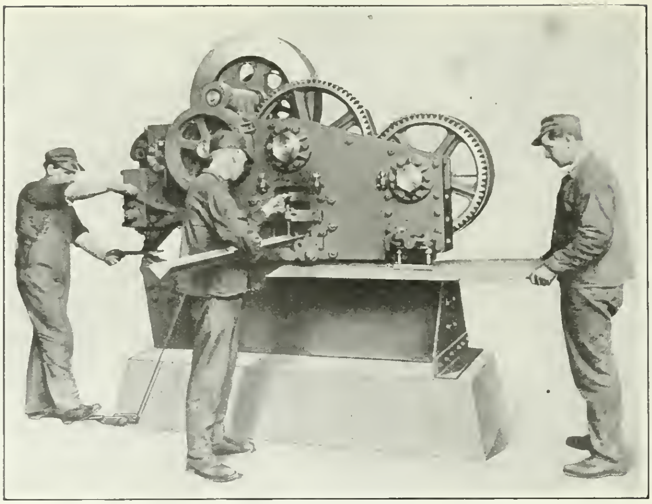


Fig. 1. No. 25 Combination Slitting Shear, Punch, and Bar Cutter built by the Buffalo Forge Co. The Frame is made of Armor Plate

but it is possible to make machines of much more compact design for a given capacity. The present machine is a universal slitting shear, punch, and bar cutter, which is an unusual combination. A shear with capacity to slit plates of any width or length is combined in a single unit with a punch having capacity for handling sheets, channels, I-beams, and other special sections, and a bar cutter for cutting angles and tees, either square or miter. By the substitution of special knives provision may be made for cutting channels, beams, and other rolled sections. Three distinct operations can be performed on this machine without in any way interfering with each other. It will be apparent that the machine is operated by either a foot-treadle or hand-lever, and three members of the machine may be operated independently or simultaneously.

Each of the members of this universal machine runs at twenty-five strokes per minute, and the capacities are as follows: Shear: Plates up to 5/8 inch in thickness and flats up to 3/4 by 3 inches. The length of knives is 8 inches. Bar cutter: Angles cut square, up to 1/2 by 4 inches; angles cut mitered, up to 5/16 by 2½ inches; T-irons, up to 3/8 by 3½ inches; round bars, up to 1½ inch in diameter; square bars, up to 1¼ inch; I-beams and channels, up to 6 inches. Punch: Holes up to 1 inch in diameter in plates up to 5/8 inch thick. The height of stroke is 1 inch.

This machine may be built for either individual motor drive or belt drive. All gears are machine-cut from steel blanks and the pinions are cut from solid manganese steel blanks. All bearings are of ample proportions and provided with bronze bushings, the high-speed shaft being carried in ring-oiled bearings. On the punch end, in addition to the gag operated either by foot or hand, there is a second gag with a handle which is used in place of the customary handwheel to provide for bringing the punch down onto the work without penetrating the material. This provides for locating center marks and also for setting up dies and punches. The shear is engaged by a jaw clutch and the stripper is readily adjusted in place by two spiral gears operated through a crank and pinion. In the illustration of the bar cutter section, there are shown the adjustable stops, which can be moved to the right or left to provide for cutting mitered ends. The design has been worked out in such a way that the operation of the machine is quite simple. Where the machine is motor-driven, a 5-horsepower motor is required, although it is recommended to use a motor developing 7½ horsepower. The high-speed shafts run at 350 revolutions per minute.

FRANCO TOSI SHELL LATHE

In the accompanying illustrations there are shown two views of a special lathe developed by Franco Tosi of Legnano, Italy, for use in machining 10-inch and 12-inch shells. These lathes were originally developed by this firm for its own use in filling shell orders secured from the Italian Government, but the machines have proved so successful in operation that it was recently decided to build them for the market. An office is maintained at 82 Wall St., New York City, for handling sales in this country. To men who are familiar with the design of standard engine lathes and single-purpose shell lathes built in the United States, it will at once become apparent that the design of this machine has been worked out along decidedly different lines. The shell is chucked in a central geared head and a series of turret tools are used for performing machining operations on the nose of the shell.

The base of the shell projects through the back of the geared head, thus providing for simultaneously performing machining operations on the base. For this purpose, it will be seen that a cross-slide is mounted at this end of the lathe bed and that it carries two square turret heads. These heads are furnished with tools used for facing off the base of the shell, turning the band seat, and performing other operations that are required. To give an idea of the high rate of production that is

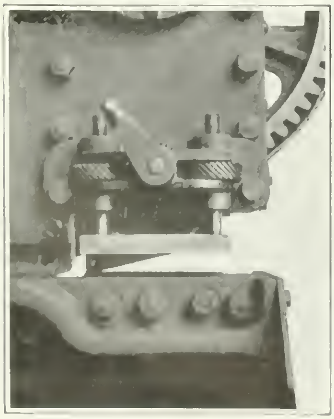


Fig. 2. Close View of Shear

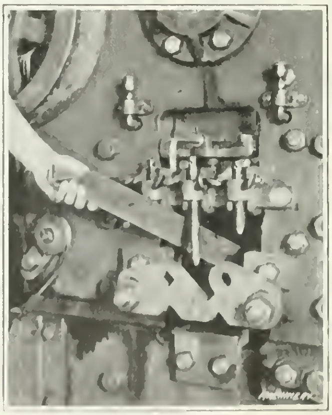


Fig. 3. Close View of Bar Cutter

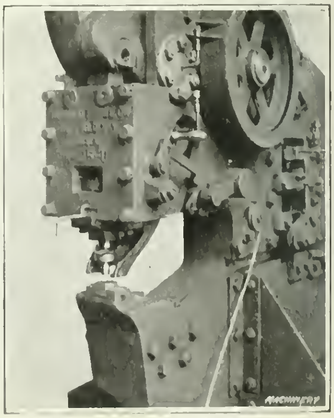


Fig. 4. Close View of Punch

made possible through the simultaneous performance of machining operations on both ends of the shell, it may be mentioned that the National Radiator Co., of Brescia, is using five of these lathes for machining 260-millimeter shells and is turning out 200 shells per day. As another example of production, it may be mentioned that this company has machined 260-millimeter shells in 22 minutes, which certainly represents an excellent rate of production.

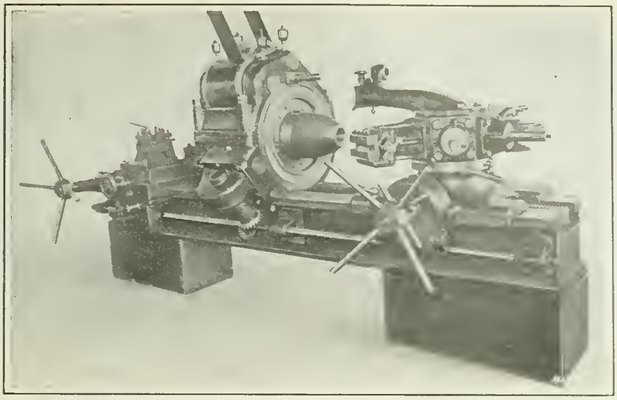


Fig. 1. Franco Tosi Shell Lathe, showing Turret carrying Tools for Working on Nose of Shell

At the beginning of the war, this company studied the requirements of machining operations on large shells and designed this special lathe for handling the work. Fifty of the lathes were built and installed in the ammunition department, and it is said that they have run for over two years without giving any trouble. These machines are belt-driven and a forward speed of 270 revolutions per minute and a reverse speed of 210 revolutions per minute are available. The machining operations performed are as follows: On the front end of the shell the nose hole is bored and threaded, the nose of the shell is machined to the required form, and the insulating ring is also turned, automatic and hand carriage movement being employed in operating the tools used for these purposes. At the opposite end of the shell, the operations are: turn flat bottom; turn copper band seat, and machine "waves" in band seat.

The principal dimensions of this machine are as follows: swing, 12 inches; length of bed, 10 feet 7½ inches; inside diameter of shell-holder, 12 13/64 inches; length of head, 18 45/64 inches; maximum distance between head and square turrets, 19 11/16 inches; maximum distance between head and front turret head, 35 7/16 inches; maximum stroke of square turrets, 23⅝ inches; maximum stroke of front turret, 33 29/64 inches; and weight of machine, 8800 pounds.

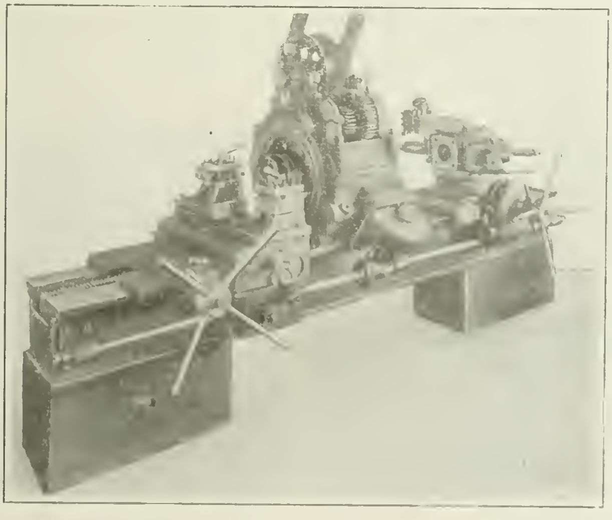


Fig. 2. Franco Tosi Shell Lathe, showing Turret carrying Tools for working on Base of Shell

LEA THREAD LEAD TESTER

For use in testing the lead of thread gages and other parts where a high degree of accuracy is required, the West & Dodge Co., 167 Oliver St., Boston, Mass., is now building a special form of lead tester, which is shown in use in the illustrations which accompany the following description. This machine was developed by Charles Lea, of the West & Dodge Co. Figs. 1 and 2 show front and rear views of this apparatus set up for testing the lead of a thread gage, and the best idea of the way in which the work is handled will be gathered from these illustrations. It will be seen that the thread gage is supported between centers and that a plug which is accurately ground at the point to fit the threaded work is supported by an arm at the back of the machine. This arm is carried on a slide, so that its position may be adjusted for handling any work which comes within the range of the machine, and the holder in which the plug is carried has rack teeth milled on its under side to engage a pinion that is turned by means of a knurled thumb-screw. In this way the position of the holder may be adjusted to bring the point of the plug into position for handling threaded work of any diameter up to 6 inches; the machine also has a capacity for handling work up to 6 inches in length. Attention is called to the fact that when the lead tester is in use, the arm which supports the pointed plug that engages the thread to be tested is securely clamped to the slide, and the holder in this arm is also clamped in position. When it is desired to change the pointed plug from one thread to another on the work, this is accomplished by drawing the plug back in the holder by means of the small knurled extension which will be seen at the top of the holder in the rear view of the machine.

At the end of the machine there is a Brown & Sharpe micrometer head which had a large graduated wheel mounted on it so that readings may be accurately taken to 0.0001 inch. The spindle carried by the micrometer head is extended to engage the plunger of a B. C. Ames dial test indicator, and after the pointed plug has been set in position in a thread, the micrometer spindle is advanced to engage the indicator, after which the reading of the indicator is carefully noted. It may be considered desirable to set the indicator needle back to the zero position on the dial after the plunger has been engaged by the micrometer spindle, although this is not really necessary. The next step is to withdraw the pointed plug from the thread and move the plug along so that it may be entered into the adjoining thread or the second or third thread from the one in which the point was originally placed. Referring to the rear view of the machine, it will be seen that the arm which carries the micrometer head and the arm which carries the pointed plunger that engages the threaded work are both carried on a sliding bar. Emphasis is laid on the fact that both of the arms carrying the mechanism are rigidly clamped to the dovetail slide at the top of this bar, so that the bar itself moves on the bed of the machine, carrying these two members with it, just as if the bar and the arms that are carried by it were a single piece.

After the pointed plunger has been reengaged with the threaded work, the micrometer spindle is again advanced into contact with the indicator point and screwed up until the needle of the indicator comes back to the same position which it occupied

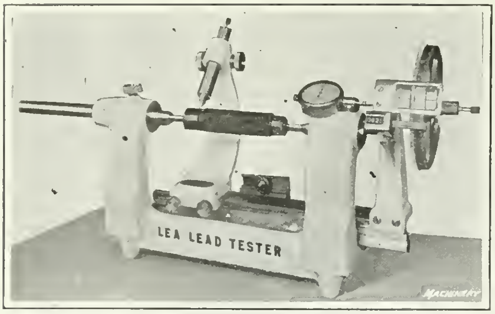


Fig. 1. Lea Thread Lead Tester built by the West & Dodge Co.

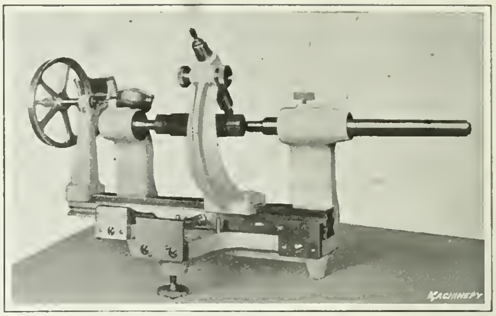


Fig. 2. Opposite Side of Lea Thread Lead Testing Machine

after the first setting was made. Then, if the pointed plug was engaged with the next thread on the work, the difference in readings of the micrometer head between the first and second settings should correspond with the lead of the thread, provided there is no error. In case the point was entered into the second or third threads from the one in which it was originally placed, the micrometer reading should be two or three times the lead, as the case may be. It will be seen that the large graduated dial on the micrometer head has gear teeth cut around it meshing with a long-faced pinion that transmits movement to an automatic counter made by the Veeder Mfg. Co. This counter is arranged so that it records each interval of 0.0001 inch, thus making the apparatus direct-reading and saving the time which would be required in taking readings of the micrometer. As a result, it is possible to test threaded work very rapidly with an apparatus of this kind, and the method of operation is so simple that the use of this lead testing machine can be safely entrusted to girls.

When so desired, Johansson Swedish gage-blocks may be used in connection with this machine for checking the accuracy of the lead of any threaded work. Figs. 3 and 4 show two possible methods of procedure. As shown in Fig. 3, a gage-block is used, the thickness of which represents some exact multiple of the lead of the thread. The pointed plunger is introduced into one thread on the work, after which the micrometer head is screwed up against the gage-block which is introduced between the micrometer spindle and the plunger of the dial test indicator. The reading of the indicator is then taken, and if it is considered necessary, the needle may be set back to the zero point. The next step is to lift the pointed plunger out of engagement with the work and move it along so that it may be entered into a groove separated from the groove in which the first setting was made by a number of threads that is equal to the multiple which the gage-block is of the thread lead. The micrometer spindle is then directly in contact with the plunger of the indicator, and it should bring the needle back to the same position which it occupied for the original setting. If there is any error in the lead of the thread, this is indicated by the micrometer when the indicator has been brought back to the required position. It will be apparent that by this method the Johansson gage constitutes a distance piece and saves time which would otherwise be required to screw the micrometer spindle through a considerable distance each time the change of setting was made.

By the other method of using a Johansson gage-block, the dial test indicator is dispensed with and a fixed stop substituted in its place, as shown in Fig. 4. The pointed plunger is introduced into a groove in the threaded work, and the micrometer spindle is then screwed up to just come into contact with a gage-block held against this fixed stop. After this has been done, the micrometer reading is noted and the pointed plunger is moved over and introduced into the proper thread, so that, with the Johansson gage-block removed, the fixed stop and micrometer spindle will be in contact. If there is any error in lead, this is indicated by the micrometer reading when screwed up into contact with the gage-block. As an alternate method, the micrometer spindle can be locked and the testing done with Johansson gage-blocks, using the dial indicator to determine the amount of error.

ECONOMY SCRAP METAL BALER

For use in compressing scrap sheet metal, punch and stamp skeletons, wire, metal trimmings, etc., into compact bales ready for shipment, the Economy Baler Co., Ann Arbor, Mich., has developed a mechanically operated baling press, which is illustrated and described herewith. Machines of this type may be built to special order for producing any desired size of bale, in addition to the two standard sized machines, which produce bales 10 by 10 inches by any third dimension up to 16 inches, and 6 by 12 inches by any third dimension. The first machine,

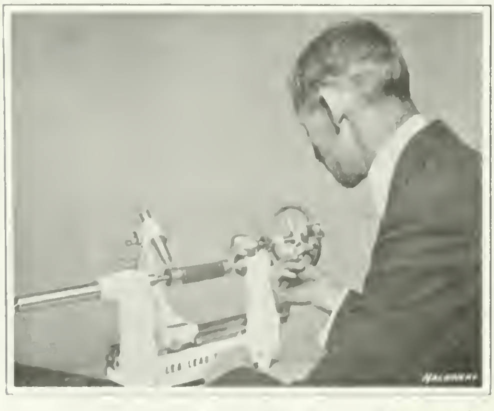


Fig. 3. Use of Johansson Swedish Gage-blocks with Micrometer and Dial Test Indicator

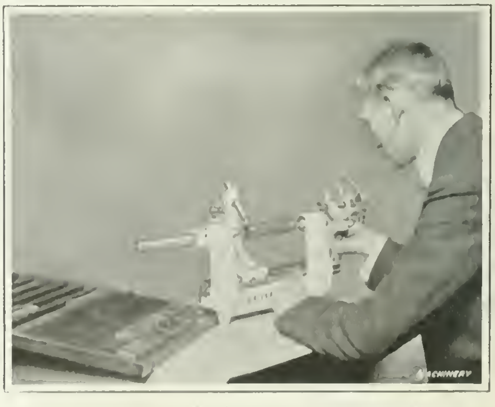
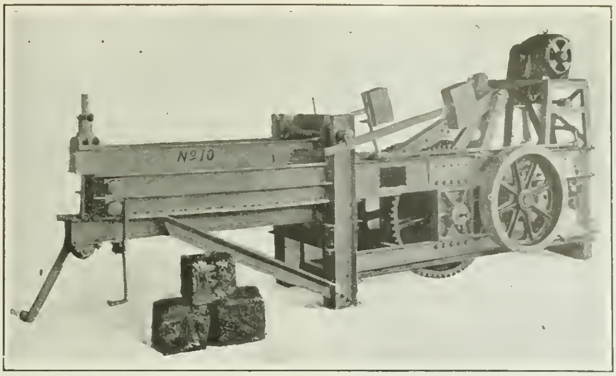


Fig. 4. Use of Johansson Swedish Gage-blocks with Micrometer and Fixed Stop in Place of Indicator

to which reference has just been made, is usually built to produce bales measuring 10 by 10 by 10 or 10 by 10 by 12 inches, which weigh from 75 to 100 pounds. The second machine is used chiefly for baling scrap copper, brass, and similar metals, and is usually made to produce a bale 6 by 6 by 12 inches in size.

One of the chief claims made for this machine is that it is designed to be operated by one man, and that it is equipped with an automatic "bale kicker" which automatically removes the finished bale from the machine. Approximately fifteen seconds is required to compress a charge of scrap sheet metal. The feeding box is 5 feet long, so that ample capacity is provided to enable work to be thrown in promiscuously without the necessity of cutting up or folding long pieces. It will be of interest to note that machines of this type have recently been adapted for use in the United States Mint at Philadelphia. When so desired, the machine can be sunk to bring the top of the compression box level with the floor line.

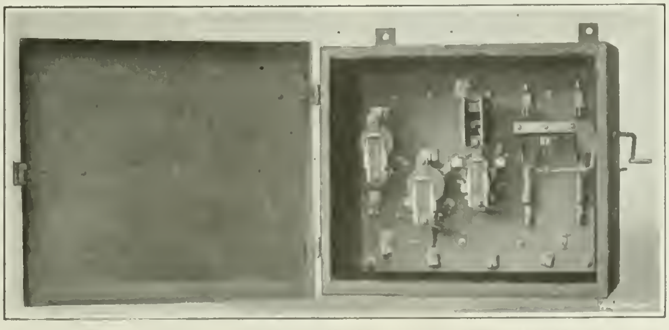


Machine built by Economy Baler Co. for use in baling Scrap Sheet Metal

WESTINGHOUSE PRESSED-STEEL AUTOMATIC STARTER

The advantages of automatic control for machine tools have been so persistently preached by the motor and control manufacturers that it is doubtful if there remain many operators who are not fully convinced that this type of control is both economical and productive. This kind of starting gives the operator a sense of relief to know that he need not face the possibility of injuring the motor or his machine by improper starting. It permits him to concentrate his attention on the work on his machine, and thus gives a greater output of the finished product. The Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has been building automatic starters for many years, and is now marketing a small compact starter, specially adapted for direct-current motors of ten horsepower and less.

The complete controller is entirely enclosed in a dustproof case (approximately 15 inches high, 17 inches long, and 10 inches deep), which may be locked to prevent unauthorized persons tampering with the switches. The knife line switch is operated from the outside of the case by a crank handle extending through one end, thus isolating the operator from current-carrying parts. The switch may be locked in the off position if so desired. The counter E. M. F. method of acceleration is used, and as the time of acceleration is dependent on the motor load, positive protection against too rapid acceleration is assured—a feature which is of great importance.



Pressed-steel Automatic Starter made by Westinghouse Electric & Mfg. Co.

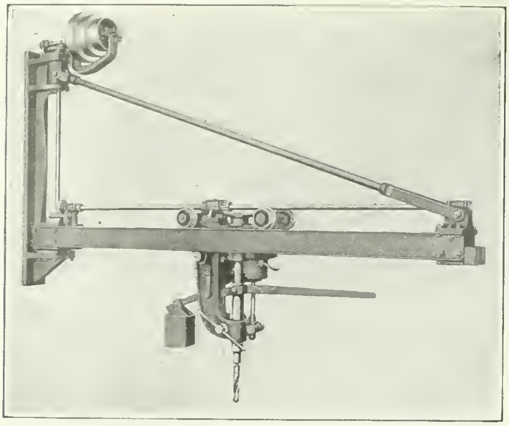
Experience has shown that in all ordinary service, motors up to fifteen horsepower require only two points of acceleration, and these are obtained in this starter by the use of only one accelerating contactor. Where the starting is exceptionally heavy, as in the case of machine tools with large flywheels, positive pressure blowers, or long lineshafting, two accelerating contactors are used, giving three points of acceleration. The main parts of the contactors are made of pressed steel, thus combining great strength, uniformity, and light weight. Provision is made for either conduit or open wiring, through the top, bottom, and end of the case, opposite the switch handle.

These starters are provided with protection against failure of power, and may be so arranged that either the motor will be started again when the power returns or it will require the service of the operator to start it. The latter arrangement is used for machine tools and similar applications where the unexpected starting of the machine might cause injury to the mechanism or to the operator. The former method is applicable where it is desired to have as little interruption of the service as possible, as in the case of pumps, compressors, and similar services. By using pressure gages, or other automatic devices in connection with these starters, automatic service may be obtained, and continual operation provided, without any attendant. They are built both with and without provision for dynamic braking, and may also be used with a field rheostat for adjustable-speed service.

LYND-FARQUHAR RADIAL DRILLING MACHINE

The wall-type radial drilling machine which forms the subject of the following description is one of the recent products of the Lynd-Farquhar Co., 419-425 Atlantic Ave., Boston, Mass. In working out the design of this machine, particular care has been taken to centralize all the control levers so that they are within easy reach of the operator. The radial arm is constructed of channels which are accurately planed at the top and bottom, and provided with substantial supporters at each end. At the outer end, the arm is supported by heavy steel brace bars connected to the top of the wall bracket. This bracket is ribbed to give it the necessary strength, and it is planed on the back surface where it is bolted to the wall; the bracket is 10 inches wide by 6 feet 10½ inches high. Attention is called to the fact that the bracket at the top of the machine, with the bevel gear housing, can be located in any one of three positions to facilitate belting the machine to the countershaft. In cases where individual motor drive is employed, a 5- to 7½-horsepower variable-speed motor is mounted on suitable brackets which are substituted for the bracket that carries the bevel gear housing.

It will be seen that the drill head is mounted on four flanged wheels, which are fitted with roller bearings, so that it moves very easily along the arm. All gears are accurately cut from solid blanks, and the feed-gears are made of steel. All bearings are lined with bronze bushings, which may be easily renewed when necessary. The hand-feed lever is counterbalanced by an adjustable weight and can

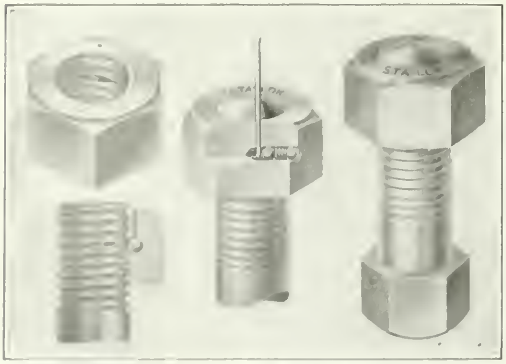


Wall Type of Radial Drilling Machine built by the Lynd-Farquhar Co.

be regulated to remain in any position. Two changes of power feed are available at the rates of 0.015 and 0.025 inch per spindle revolution. These feeds can be changed while the machine is running. Automatic release of the power feed is provided at the extreme limit of the spindle traverse, to avoid danger of damaging the mechanism. The spindle is made of high-carbon steel; it is 2½ inches in diameter in the bearings and accurately finished to size by grinding. Renewable bronze bearings of ample size support the spindle, which has a maximum traverse movement of 7 inches and is bored with a No. 4 Morse taper hole. The spindle thrust is carried by a ball bearing. When the spindle has been located in the desired position for drilling, a clamping lever secures the head in place on the arm. Tie-bar lugs are provided at the extreme end of the arm to receive tie-bars, in the event that their use should be found desirable when performing exceptionally heavy drilling operations. The countershaft is equipped with tight and loose pulleys, 16 inches in diameter by 4½ inches face width, which are run at 350 revolutions per minute, and this countershaft is furnished with means of automatic lubrication.

EVERTITE "STA-LOK" NUT

A lock-nut is manufactured under the trade name of "Sta-lok" by the Evertite Nut Corporation, Marquette Bldg., Detroit, Mich., which is claimed to be so constructed that it will not loosen under heavy stress or prolonged vibration in high-speed machinery. This nut has the same appearance as an ordinary nut, but reference to the accompanying illustration, which shows the interior mechanism, will make the provision for locking the nut quite apparent. Contained in the body there are two hardened steel balls with a compression spring between them, and when the nut has been screwed up, the spring forces one of these balls inward through a channel, so that the ball comes into place in the thread groove. Any tendency for the nut to unscrew causes this ball to bind more tightly. When it is desired to release the nut, a small finishing nail is pushed down through a hole drilled in the top of the nut, and the nail is tapped lightly to provide for forcing the ball back out of the thread groove. Should the keyhole become filled with dirt, it is easily cleaned out with a small wire or pin. Nuts of this type are manufactured and carried in stock in various sizes in U. S. and S. A. E. standard threads.

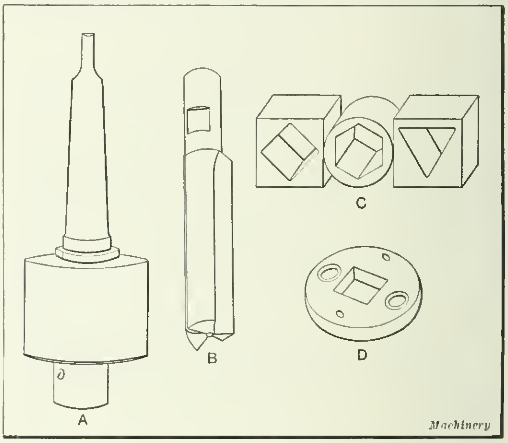


Evertite "Sta-lok" Nut showing Principle of locking and Method of releasing Nut

WATTS ANGULAR-HOLE DRILLING TOOLS

For use in drilling triangular, square, hexagonal, octagonal, and other angular shaped holes, Watts Bros., Turtle Creek, Pa., are now manufacturing the tools which are illustrated and described herewith. These tools are adapted for use in cutting metal, wood, marble, and other materials, and enable the work to be done in a very small fraction of the time that is required to cut holes of these shapes by other methods. They can be used in a drilling machine where the tool is revolved or in a lathe where the work is revolved. This method is not adapted for cutting deep holes.

In operation, the drilling tool is held in a floating chuck *A*, which is provided with a standard Morse taper shank to fit the socket in a machine tool spindle. This chuck is universal in its scope, and it is so designed that provision is made to prevent breaking tools or producing bell-mouthed holes. The form of tool *B* which is used depends upon the shape of hole that it is desired to drill, and a guide *D* corresponding to the shape of the hole is clamped on the work. The range is for cutting holes from 1/4 inch square, hexagon, octagon, etc., across the flange up to any size which may be required.



Tools made by Watts Bros. for Use in drilling Triangular, Square, Hexagonal, and Similar Shaped Holes

In order to explain the way in which the operation is performed, suppose that a square chuck wrench or hexagon socket wrench is to be made. After the wrench body has been machined, a guide-holder of the proper shape with the guide inserted is placed in position on the work and securely fastened. The drill is introduced into this guide and the machine is started. The guide is made of the same shape and size as the hole to be drilled, and so controls the movement of the tool that it exactly duplicates the form of the hole in the guide. Where there are a number of pieces to be drilled, it will usually be found desirable to make a jig furnished with guide bushings of the desired form. In sharpening the drills, care should be taken to grind the cutting lips square with the sides and to provide a 7-degree clearance back of the cutting edge.

AUTOMATIC ROUTING MACHINE FOR FIRING PIN PLUGS

The time fuse firing pin plug illustrated on an enlarged scale in Fig. 1 requires two grooves or channels, as the end view shows. The automatic machine to be described is for routing these grooves. When the machine is in operation the work is given an oscillating movement equal to the length of one groove, and the routing operation is performed by a small "fishtail" cutter, which advances to the proper depth. When the first groove is finished and the cutter has withdrawn to clear the work, the latter is indexed one-half revolution. The oscillating movement then continues while the second groove is being cut. As soon as the routing operation is completed, the cutter withdraws and the machine stops. After the work is placed on the spindle and the machine is started by lifting the starting lever into engagement with a catch, all movements such as the traversing action of the cutter-slide, indexing, and stopping the machine are controlled automatically.

The machine is driven by two belts, there being one for the cutter-spindle and another for the operating mechanism. The work-spindle consists of an inner and outer section, and when the cutter is at work, the outer section is locked in position by a pawl while the inner part receives an oscillating movement. The latter motion is derived from a crank *A* (see Fig. 2) which connects by the rod shown with a pin attached to disk *B*. Crank *A* is mounted at the end of shaft *C*, Fig. 3, from which all the motions of the machine are derived except the rotation of the cutter-spindle. After the first channel has been routed and just before the machine indexes, the outer section of the work-spindle is unlocked, and this part is turned one-half revolution while the inner section is held stationary by the action of a clutch.

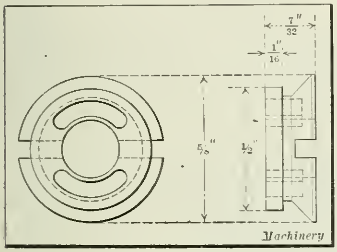


Fig. 1. Firing Pin Plug upon which Routing Operation is performed

After a plug has been placed over the expanding arbor and clamped by the operator, the starting lever is lifted into engagement with the catch and the cutter-slide is advanced by cam *D*, which is driven through worm-gearing from shaft *C*. This cam engages a lever *E*, which, in turn, is connected to the cutter-slide. This is not a direct connection, as the end of the lever engages a supplementary slide, the position of which is controlled by screw *F*, which serves to regulate the lengthwise position of the cutter and the depth of the groove formed in the work. When the first groove is completed and the cutter has withdrawn, a cam located back of cam *D* lifts the end of a lever *G*, which, in turn, unlocks the outer section of the work-spindle. This movement of *G* through suitable connecting levers at the end of the machine (see Fig. 2) also serves to shift a clutch from the oscillating disk *B* over into engagement with the inner spindle, which is thereby locked in place temporarily. As soon as the motions referred to have occurred, clutch *H* is thrown into engagement with gear *J*, which revolves freely on its shaft except during the indexing movement. The action of clutch *H* is derived from a bell-crank lever having a pin that drops into a notch formed in the cam which operates lever *G*. The engagement of clutch *H* causes disk *K* to revolve, and this disk carries a pin that engages a notch in a Geneva wheel. This wheel is thus caused to turn one-quarter of a revolution, and it is connected by 2 to 1 gearing with the outer spindle; consequently, the latter is revolved one-half a revolution, which is the required indexing movement.

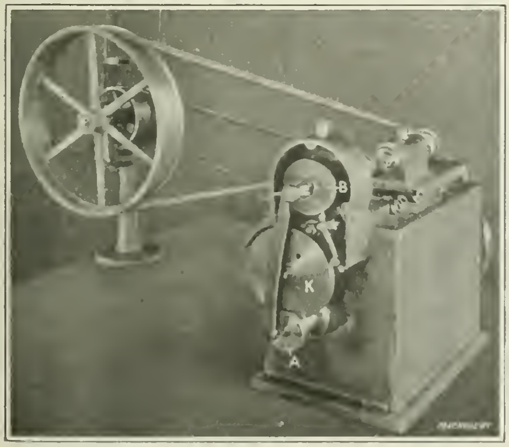


Fig. 2. Automatic Routing Machine

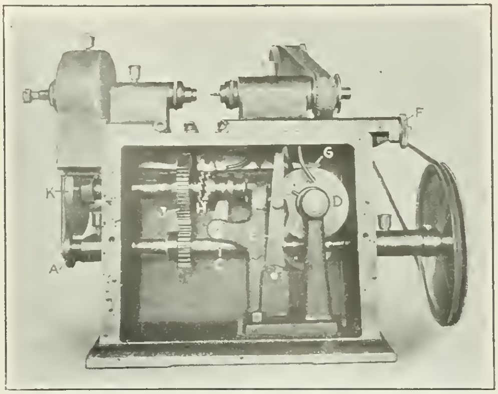
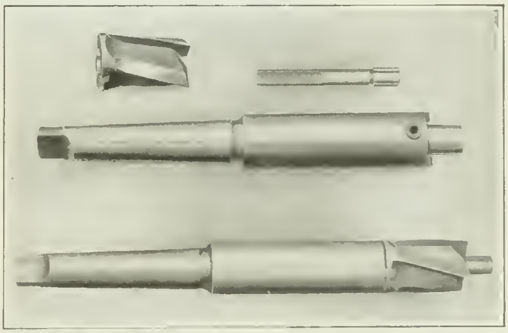


Fig. 3. Cover removed to show Mechanism of Automatic Routing Machine

One operator can easily attend to three of these machines and the production of each machine is about 200 parts per hour when the cutter-spindle is revolving 15,000 revolutions per minute. This machine is manufactured by the Automatic Engraving & Mfg. Co., 79 E. 130th St., New York City, and it was designed by E. A. Lundvall, vice-president of the company.

CLEVELAND COUNTERBORES

The Cleveland Milling Machine Co., Cleveland, Ohio, has recently placed on the market a line of interchangeable counterbores and spot-facers of the type shown in the accompanying illustration. It will be seen that the tool is of simple design, consisting of a shank, cutter, and pilot. The shank is made of high-carbon steel, heat-treated to give the desired physical properties; and care is taken to grind the taper perfectly concentric. The cutter is made of high-speed steel and has a taper hole fitting the arbor. It is driven by two-face keys, so that cutters of various diameters may be used interchangeably. With this construction, it is an easy matter to grind the face of the counterbore true. The pilot is made of high-carbon steel, heat-treated and ground to fit the hole in the shank and cutter, and it is designed in such a way that any diameter of pilot may be used with any diameter of cutter, changes of pilots and cutters being quickly made. The pilot is ground 0.0015 inch smaller on the diameter than the specified size.



Interchangeable Counterbore made by the Cleveland Milling Machine Co.

FOSTER UNIVERSAL TURRET LATHE

In the March, 1917, number of MACHINERY, a description was published of a Foster Type 1B universal turret lathe. In the accompanying illustrations, is shown a combination turret lathe adapted for handling both bar and chucking work; this is styled a No. 2B universal machine, and it is the latest product of the Foster Machine Co., Elkhart, Ind. This machine is of quite similar design to the one previously described, and the following description will be chiefly devoted to describing those features which are different. The machine is adapted for handling bar work up to 3¼ inches in diameter by 30 inches in length, and chucking work up to 13 inches in diameter can be machined. Owing to the larger swing over the horns of the carriage, this lathe is able to handle light chucking work up to 20 inches in diameter. A belt 4 inches in width running over a single pulley, 15 inches in diameter, drives the machine, and for high-speed steel cutting tools, this driving pulley runs at 500 revolutions per minute. When stellite tools are used, a higher cutting speed is required, and it is recommended that the pulley be driven at 750 revolutions per minute. With the belt running at a speed of 1960 feet per minute, 8½ horsepower is delivered to the machine, which corresponds to a torque at the spindle nose of 43,000 inch-pounds with the spindle running at 12 revolutions per minute. The reason for this apparently excessive power of the head is that this machine is frequently required to take as many as four or five cuts simultaneously with a comparatively coarse feed, and ample power is provided for handling severe service of this character.

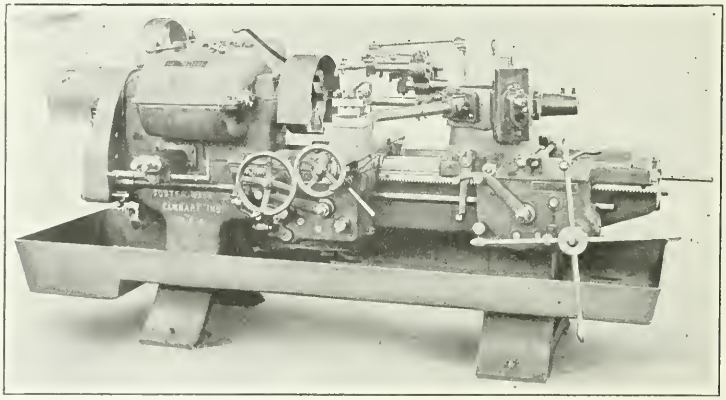


Fig. 1. No. 2B Universal Turret Lathe built by the Foster Machine Co.

Twelve changes of longitudinal carriage feed are available, ranging from 0.0055 to 0.150 inch per spindle revolution, and for the cross-feed there are twelve changes, ranging from 0.0029 to 0.080 inch per spindle revolution. Six of these feed changes and the reverse for them are obtained by means of sliding gears in the apron, and these changes are multiplied by two other adjusting gears in a box located at the head end of the bed to provide either of two speeds of rotation for the feed-rod. A drop-off feed friction in the apron on the turret saddle is automatically disengaged in a manner similar to that operating the feed friction for the carriage apron, control being provided by stops which are adjustably mounted on a long stop-roll located between the ways of the bed. This stop-roll is long enough to take care of work up to the maximum capacity of the machine. The saddle is equipped with quick traverse, which is operated by means of a lever mounted on the front side of the saddle, as shown in Fig. 3. The quick-traverse mechanism is shown in Fig. 2; it is mounted at the rear side of the saddle and consists of a right- and left-hand screw, with nuts which are intermittently locked by means of a double friction controlled by the lever shown at the front of the saddle in Fig. 3. A rod, which is adjustably mounted in a bracket secured to the rear end of the bed, automatically disengages the quick traverse, and thus limits the backward movement of the saddle. The quick-traverse screw is fully protected from chips and dirt by means of a telescoping tube; it is driven from the main driving pulley. Attention is called to the fact that the sliding gear clusters and gears engaging them in the carriage apron are made of chrome-nickel steel, and that the teeth of these gears are of the Fellows stub-tooth standard. The lower gears in the apron run in an oil bath, and all the lower bearings are automatically lubricated.

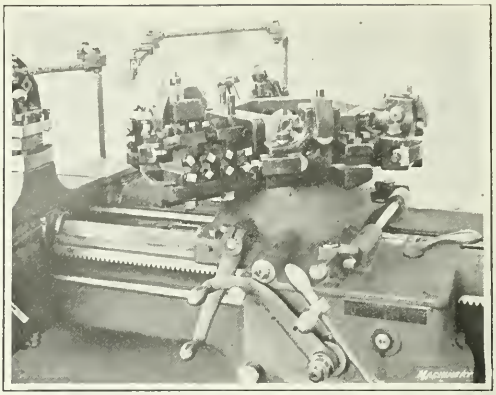


Fig. 3. Close View of Turret, showing Lever that controls Quick-traverse Mechanism

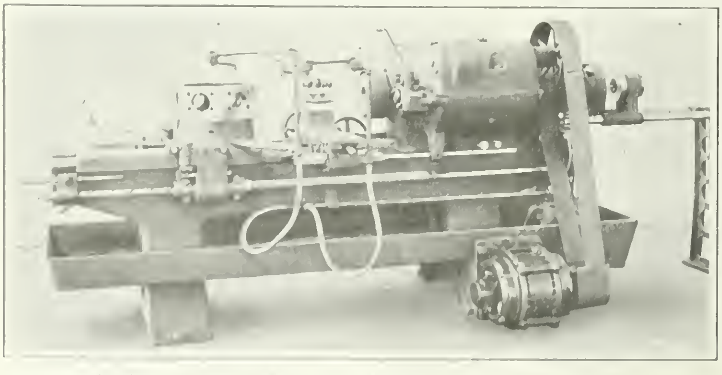


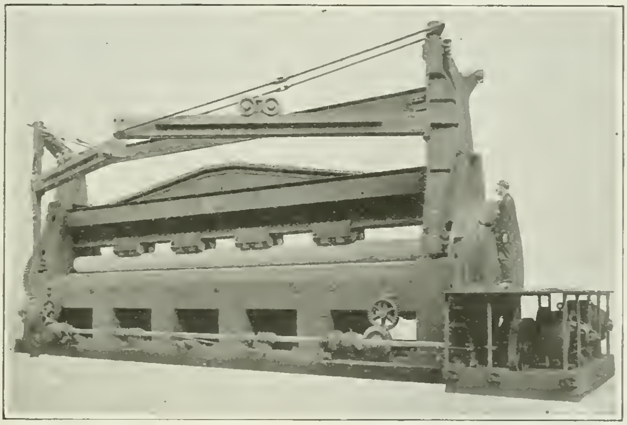
Fig. 2. Rear View of Machine, showing Arrangement of Quick-traverse Mechanism

Complete tool equipments for handling both bar and chucking work are designed for use on this machine, and Fig. 1 illustrates a lathe with chucking tools mounted on the hexagon turret. In Fig. 2, the machine is shown equipped for handling bar work. It will be apparent from the illustrations that this machine can be driven by either a countershaft or an individual electric motor, and in cases where electric motor drive is employed, the motor is usually mounted as shown in Fig. 2. The system of supplying a copious flow of coolant to the cutting tools has been carefully worked out. Equipped with an automatic chuck and bar feed for standard tools, the machine weighs about 5200 pounds.

NILES-BEMENT-POND HORIZONTAL PLATE-BENDING ROLLS

The accompanying illustration shows a large set of bending rolls recently built at the Niles Works of the Niles-Bement-Pond Co., 111 Broadway, New York City. This machine is of the "strongback" type and has a capacity to roll mild steel plates 1 inch thick by 36 feet long, and 1¼ inch thick by 30 feet long. It consists of two massive cast-iron housings, united at the top by two 20-inch I-beams and below by two heavy cast-iron side frames with bearings for eight pairs of steel rollers, four pairs on each side, to support the lower rolls. The three rolls are made of forged steel, one upper and two lower, each 36 feet 9 inches in length between the journals. The lower rolls are 16 inches in diameter. The rolls are driven by means of a 100-horsepower motor.

The top roll is 19 inches in diameter and reinforced by a heavy built-up steel girder, carrying on the under side four supporting roller bearings directly over those carried on the side frames. This girder and the roll are raised and lowered by means of steel screws, one at each end. The elevating screws are operated by a 75-horsepower motor through a mechanism so arranged that each end of the roll may be raised or lowered independently of the other or both ends together. The whole set of operating handles are grouped together in a convenient point at the motor end, so that the motor controllers and the reversing and clutch levers can be controlled by one operator without moving from his position on the operating platform. The machine is supplied with four top braced jib cranes, self-contained with the machine. The posts for the cranes are at the four corners of the machine.



Horizontal Plate-bending Rolls built at the Niles Works of the Niles-Bement-Pond Co.

BIGGS-WATTERSON THREAD MILLER

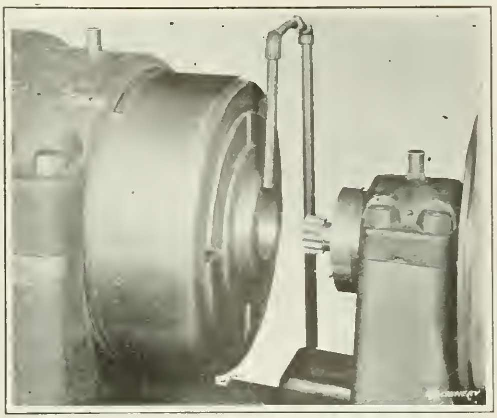


Fig. 3. Close View of Work and Thread Milling Cutter

For use in milling threads on high-explosive shells and other lines of commercial work, the Biggs-Watterson Co., 1235-1237 W. 9th St., Cleveland, Ohio, has recently placed on the market a machine which is shown in the illustrations accompanying the following description. It will be seen that the head and bed are cast integral and, with the oil-pan, are mounted on a pedestal, this design assuring great strength and rigidity. The work-spindle and lead-screw are both rotated from a single worm drive, which assures ample power as well as the required sensitiveness and accuracy. The work-spindle has a hole bored through its entire length, the diameter of which is sufficient to accommodate work of the maximum size that comes within the capacity of the machine, making it possible to introduce work from either end of the spindle as well as to hold pieces of any length. When so desired, the spindle can be equipped with an air chuck; and the work- and cutter-spindles are driven by a single pulley from the countershaft. Right-angle drive or direct motor drive can also be furnished for this machine.

The cutter-spindle is made of high-carbon steel and is carried in a bronze box with provision for efficient lubrication. When so desired, the machine may be equipped with a taper attachment for cutting threads on piping and similar work. A lead-screw provides for moving the carriage longitudinally on the bed, and this screw is engaged by a long nut, which is gripped at any predetermined point by a clamp attached to the carriage. When in a clamped position, the nut moves with the carriage and, when released, it returns automatically to the starting point. This return is effected by two coiled springs, one of which has a right-hand spiral and the other a left-hand

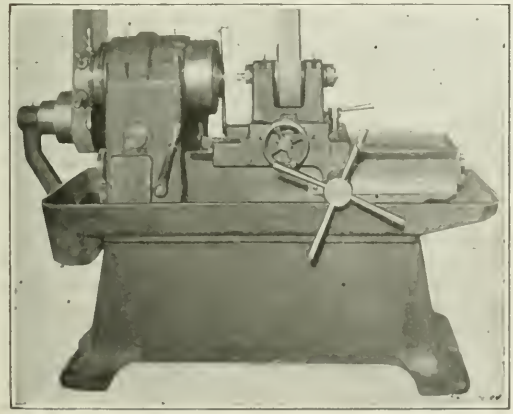


Fig. 1. Machine built by the Biggs-Watterson Co. for milling Threads on Shells and Other Commercial Work

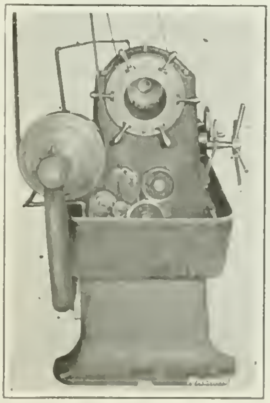


Fig. 2. End View of the Biggs-Watterson Thread Milling Machine

spiral. Provision is made for turning the lead-screw either to the right or to the left, to provide for cutting right- or left-hand threads. The screw is kept under tension at all times, which eliminates backlash. One end of each of the coiled springs is anchored into one end of the cylindrical nut, and at the opposite end, the spring is connected to an adjustable friction. This friction can be set at the proper tension, so that, should the springs be wound too tight, the friction will revolve around the lead-screw and prevent breaking.

A single lever control is provided on the machine, which consists of a camshaft in the front, with a lever at the side of the handwheel directly in front of the operator. This camshaft is connected to the work-spindle, clutch lever, and lead-screw clamp. When the spindle has made one complete revolution, it turns the clamp-shaft over, moves the cutter-spindle back, lifts the cutter out of the work, and disengages the clutch, stops the spindle, releases the clamp, and leaves the carriage free to move on the ways. When a new piece of work is chucked, it is only necessary for the operator to pull over the lever control, which brings the cutter into the work at the right depth, starts the spindle, and clamps the carriage to the lead-screw. The handwheel is only used for making sensitive adjustments of the cutter.

Provision can be made for cutting threads of any pitch, either English or metric, right- or left-hand, by simply changing two gears, no compounding of gears being necessary. An automatic knock-out is provided. At the present time, this machine is being built in 3- and 6-inch sizes. The 3-inch machine has a collet capacity of 3¼ inches; the cutter-spindle is bored No. 9 B. & S. taper; the floor space occupied by the machine is 76 by 36 inches; and the net weight is 3000 pounds. The 6-inch machine has a collet capacity of 6⅛ inches; the cutter-spindle is bored No. 10 B. & S. taper; the floor space occupied by the machine is 76 by 36 inches; and its weight is 3500 pounds.

NEWTON RAIL DRILLING MACHINE

One of the latest additions to the line of machine tools built by the Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa., is a multiple-spindle rail drilling machine intended for use in drilling three or four holes which are required in the ends of girders, rails, and similar pieces. All the spindles operate separately, and may be readily removed from the cross-rail when so desired. For drilling the main holes, the spindle speed is 125 revolutions per minute. The work-table is fitted with a slot in the top surface, which is used to assist in holding the rails in position while the drilling operation is being performed. All important bearings in the machine are bronze-bushed, and all the spindles, spindle gears, and rack pinions are made of nickel steel. All gears are enclosed, as is also the motor connecting belt. A pump, piping, and attachments for delivering coolant to the drills are included as part of the regular equipment.

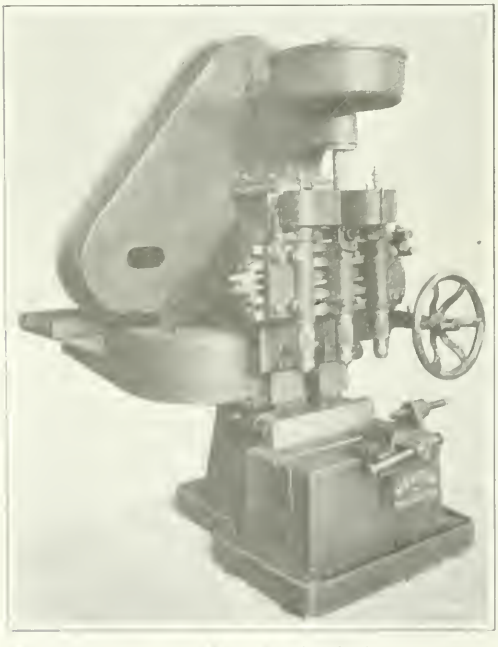


Fig. 1. Three-spindle Rail Drilling Machine built by the Newton Machine Tool Works

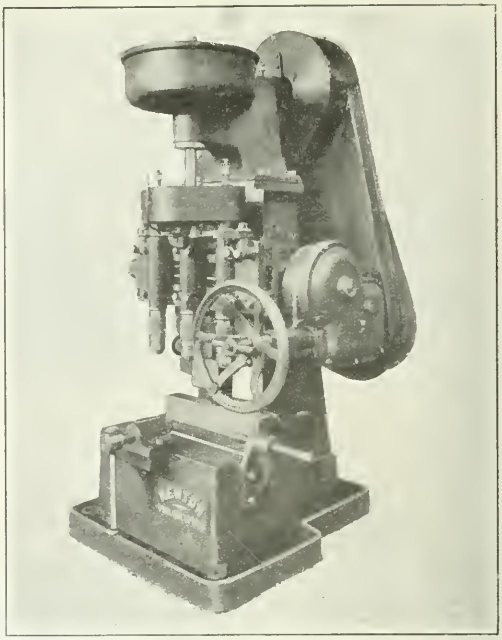


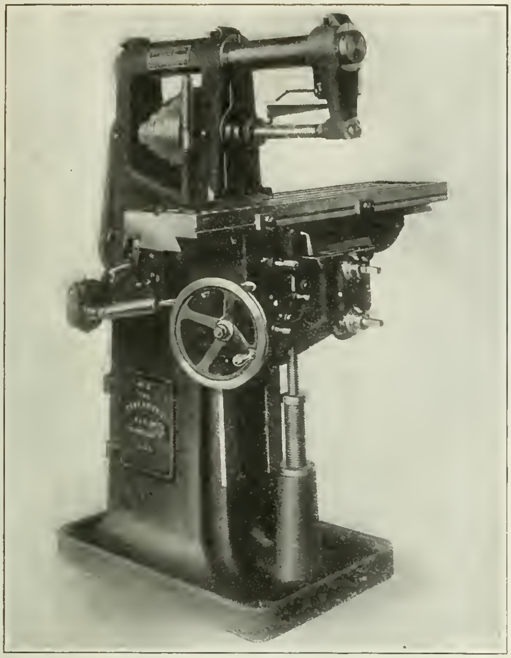
Fig. 2. Opposite Side of Newton Rail Drilling Machine shown in Fig. 1

As indicated in the illustrations, the motor is mounted on a bracket at the right-hand side of the machine and connected directly to the main driving pulleys by a belt which is completely enclosed. The drive is then transmitted through bevel and spur gears to the spindles at the top of the machine. Vertical feed and hand adjustment are provided for the saddle, which is counterweighted; there are two changes of feed, the available rates being 0.005 and 0.008 inch per revolution of the spindle. All three spindles are mounted on one saddle and feed in unison, and the machine is shown equipped with chucks for driving rail drills of special design. The base of the machine is surrounded with an oil-pan, and the lubricant tank is located in the base, the piping being arranged to provide for the usual continuous circulation.

The principal dimensions of this machine are as follows: diameter of spindles, 1⅞ inch; minimum distance between spindle centers, 3½ inches; maximum distance between spindle centers, 9 inches (the central spindle is held stationary and the two outside spindles are adjustable by hand-operated screws); maximum distance from top of table to end of spindles, 19½ inches; and size of work-table, 16 to 30 inches.

DAVENPORT NO. 2 MILLING MACHINE

The Davenport Mfg. Co., Meadville, Pa., is now building a No. 2 hand and power feed milling machine, which forms the subject of the following description. On this machine, hand feed to the table is obtained either through a hand lever, which gives a rapid movement of the table, or through a handwheel, which gives a slower and more sensitive feed. One full movement of the lever moves the table 5 inches, and each revolution of the handwheel effects a movement of 1/4 inch. The hand-lever is made of exceptional length, and may be set at the



No. 2 Hand and Power Feed Milling Machine built by the Davenport Mfg. Co.

point which is most convenient to the operator, or it may be entirely disengaged by a spring plunger. The handwheel is located at any angle with the apron.

Power feed for the table is obtained through a chain-driven feed-box in which six changes of feed are provided. The feed-change mechanism is contained in a single unit, which is assembled complete and placed in the column so that it becomes an integral part of the machine. All feed changes are effected by manipulating two levers, and changes of feed may be made at any time, even while the machine is running under a heavy cut. Reversal of feed is obtained through a push-rod on the feed-box, and all parts of the mechanism are oiled from one large reservoir, which may be easily filled through an opening in the column. When designing the feed-trip, special attention was given to facilitating rapid operation of the machine, and also to making the trips sufficiently sensitive. Automatic trips may be set to disengage the feeds at any point of the table movement and to leave either the hand-lever or the handwheel connected to the table motion.

Oiling of the spindle is accomplished through wicks which are supplied with oil from annular reservoirs cast around the spindle bearings, and glass indicators show the level of oil in these reservoirs at all times. The feed-screws for the transverse and vertical movements are fitted with adjustable graduated dials for gaging the depth of cut, and the elevating screw is made telescopic to overcome the necessity of cutting a hole through the floor. Ball bearings at the top of the elevating screw carry the thrust load and make the vertical movement of the table quite sensitive.

The principal dimensions of this machine are as follows: size of working surface of table, 36 by 9¼ inches; range of table movements, longitudinally, 22 inches, transversely, 6½ inches, and vertically, 19 inches; diameter of over-arm, 3¼ inches; distance from under side of over-arm to center of spindle, 6⅜ inches; size of arbor furnished with machine, 1 inch in diameter by 7½ inches between shoulder and nut; diameter of spindle in front bearing, 2½ inches; taper of spindle, No. 10 B. & S.; diameter of hole through spindle, 11/16 inch; dimensions of cone pulley, 5, 6¾, 8¾, and 10¼ inches in diameter by 2¼ inches face width; range of available spindle speeds, 65, 83, 105, 135, 176, 227, 285, and 367 revolutions per minute, all right-hand; available rates of power feed, 0.003, 0.005, 0.006, 0.008, 0.010, and 0.016 inch per revolution of the cutter; speeds of countershaft, 136 and 175 revolutions per minute; and net weight of machine, approximately 1800 pounds.

ADAMS SHORT-CUT LATHE

A large amount of work done on lathes in most manufacturing plants consists of machining pieces of short length and medium diameter. These are usually placed on the lathes of greater bed length and swing than is required, because the standard sizes made are such, and the power necessary to perform the work is not available on machines of smaller swing. To provide a lathe that will remove these objections, Ogden R. Adams, 159-161 St. Paul St., Rochester, N. Y., is now building a machine which is to be known as the "short-cut lathe." As the name indicates, this machine is a "short-cut" from raw stock to the finished piece, and it can be successfully used not only for roughing cuts equal to the power developed in a standard 16-inch lathe, but also for finishing cuts of extreme accuracy. This machine has a geared head providing six changes of speed through one operating lever and a sliding clutch. The operating lever is placed directly over the headstock where it is convenient for the operator, engaging two friction clutches by a forward or reverse motion, which provides two changes of speed. A sliding positive clutch over the spindle is arranged to give three changes of speed, which in connection with the operating lever makes the six changes always at hand, varying from 23 to 374 revolutions per minute in geometrical progression. All the gears in the headstock run in a bath of oil, insuring perfect lubrication and long life. On the front of the head there is a lock-bolt for holding the spindle from revolving while changing faceplates or chucks.

The spindle is made from a crucible steel forging, turned all over, ground to size, and scraped to a perfect bearing fit. It is bored out to take one-inch bar stock. The front bearing is 2 inches in diameter by 2¾ inches long; and the rear bearing is 1 9/16 inch in diameter by 2 inches long. The bearings are spaced 16½ inches apart; they are tapered with an adjustment for wear that can be taken up on the front of the headstock by one adjusting screw. The nose of the spindle is 2 inches in diameter with six threads, and it is bored to receive a No. 4 Morse taper. The carriage runs on ways usually found on lathes that swing 16 inches and have a bearing of 18 inches. It is gibbed front and back and provided with a locking bolt on the front way for holding the carriage when doing facing or forming work. The cross-slide is 7½ inches wide, and it is furnished with a taper gib to take up wear; it has a microm-

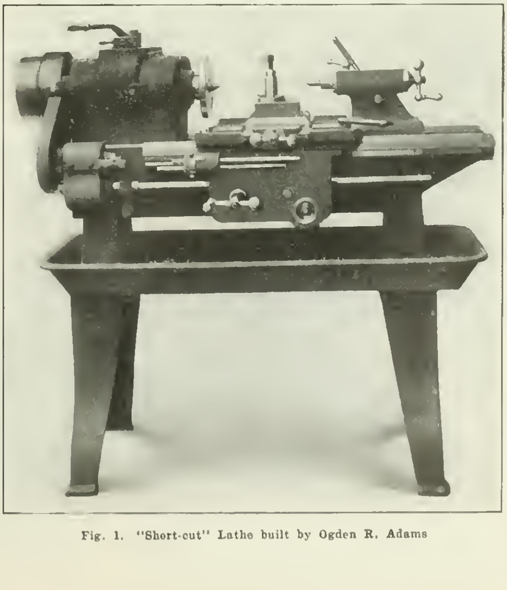


Fig. 1. "Short-cut" Lathe built by Ogden R. Adams

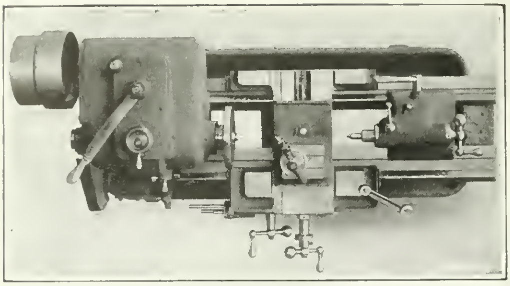


Fig. 2. Top View of the Adams "Short-cut" Lathe

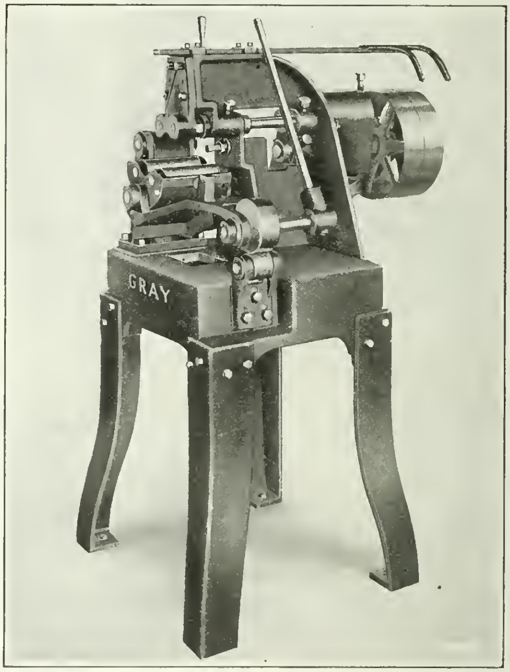
eter collar and carries a tool-block provided for 5/8- by 1½-inch tools. The tail-block is cut away to permit the use of the compound rest parallel with the bed; it is of very heavy design and is arranged to be locked to the bed by the slight movement of a lever and eccentric clamp of great power. The barrel is 1½ inch in diameter and 8½ inches long.

The feeds are positive and may be obtained instantly. They are three in number and vary from 0.007 to 0.020 inch per revolution of the spindle. Three more changes may be obtained by interchanging two slip gears and thereby doubling these feeds. The carriage will stop at any predetermined point by three stop-bars set on a rod, operated by a positive throw-out clutch, and a safety device is provided in the feed mechanism to prevent injury or breaking of the gears. Shoulder stops for various lengths make possible the production of duplicate parts. This lathe is always supplied with an oil-pan and short legs. One of the legs is made hollow and serves as a reservoir for holding cutting compound. This feature is only supplied on order. The lathe swings 12¼ inches over the ways and takes 19½ inches between centers. It weighs about 1200 pounds. It is regularly built with a plain rest, but can be supplied with a compound rest, heavy-duty back-forming rest, taper attachment, draw-in chuck and collets, thread-chasing device, and a two-speed countershaft.

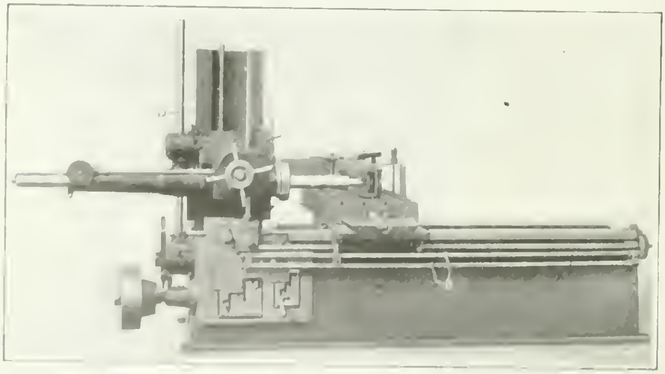
The principal dimensions of this lathe are as follows: swing over bed, 12¼ inches; capacity between centers, 19½ inches; length of bed, 48 inches; width of belt, 2 inches; diameter of hole through spindle, 1⅛ inch; maximum capacity of wire chuck, 3/4 inch; size of front bearing, 2¾ inches diameter by 2 inches long; rear bearing, 1 9/16 inch diameter by 2 inches long; available rates of feed, 0.007, 0.015, and 0.020 inch per revolution of the spindle without changing gear; length of carriage, 18½ inches; width of cross-slide, 7¼ inches; range of spindle speeds running pulley at 200 revolutions per minute, 23 to 374 revolutions per minute; size of tools used, 5/8 by 1½ inch; size of tailstock spindle, 1½ inch diameter by 7 inches long; length of machine, 48 inches; height to center of spindle, 42 inches; height to the top of machine, 48 inches; and width of machine, 30 inches.

GRAY KNURLING AND BOURRELET ROLLING MACHINE

In the accompanying illustration is shown a knurling and bourrelet rolling machine which is one of the recent products of the Gray Machine Tool Co., Inc., 2661 Main St., Buffalo, N. Y. This machine is intended for knurling the copper band groove on 3-inch and 75-millimeter shells, and it is shown equipped with two spindles and two knurls to provide for double- or cross-knurling, although the machine is ordinarily built with one heavy spindle for a single knurling tool. In operating this machine, a shell is placed on the two lower rollers with the base pushed up against a stop, after which the operation is completed by simply pulling a lever. It is stated that this machine will knurl shells as fast as they can be fed to it. For use in rolling the bourrelet, the rolling tool is placed on the spindle in place of the knurl, and a different set of rollers is used for supporting the shell. All tools and rollers used on this machine are made of cast steel and hardened. Power is transmitted to the machine from a line-shaft through a pair of tight and loose pulleys which are 12 inches in diameter by 3 inches face width, and run at 325 revolutions per minute. The machine weighs approximately 700 pounds.



Knurling and Bourrelet Rolling Machine built by the Gray Machine Tool Co.



Horizontal Boring Machine recently placed on the Market by the Lambert Machine & Engineering Co.

LAMBERT HORIZONTAL BORING MACHINE

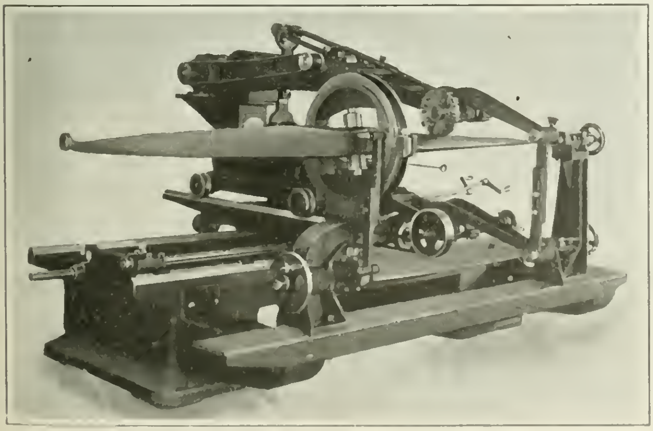
The Lambert Machine & Engineering Co., 1967 E. 55th St., Cleveland, Ohio, is now building a horizontal boring machine. On this machine, all bearings are provided with either ball bearings or bronze bushings, and all gearing is made of steel. The operation is facilitated by the provision of a start and stop mechanism for the feed movement and for the revolution of the boring-bar. It will be seen that two horizontal bars *A* run along the front of the bed on which two short levers *B* are mounted. One of these levers provides for starting, stopping, or reversing the feed movement, and the other provides for starting, stopping, or reversing the revolution of the boring-bar. These handles may be slid to any convenient position on the horizontal bars so that they are within easy reach of the operator. A patent has been applied for on this mechanism.

A vernier *C* is provided for making accurate vertical settings of the saddle and boring-bar; and shaft *D*, which transmits power to the saddle, is stationary so far as vertical movement is concerned. By having this shaft mounted in a fixed position instead of sliding up and down, no trouble is experienced through the necessity of having to cut a hole through the floor to accommodate the end of this shaft, when in its lower position. Gear guards are provided over the gears that are shown exposed at the end of the bed.

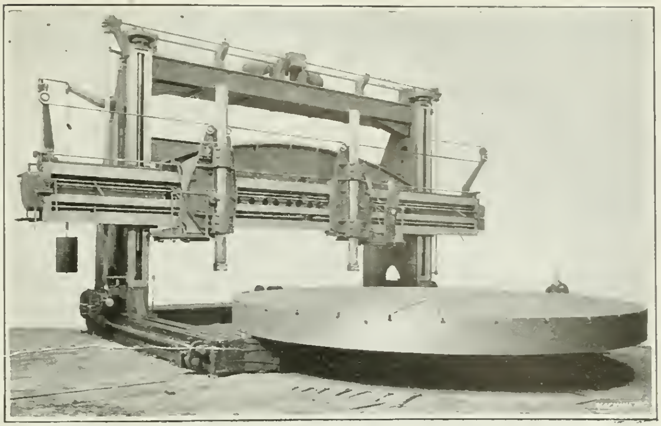
The principal dimensions of this boring machine are as follows: diameter of bar, 3 inches; taper hole in bar, No. 5 Morse; maximum longitudinal travel of bar, 24 inches; maximum distance from center of spindle to top of table, 30 inches; minimum distance from center of spindle to top of table, 1/2 inch; size of table, 20 by 48 inches; maximum cross-feed of table, 38 inches; maximum distance from face-plate to outer support, 72 inches; size of driving pulley, 14 inches in diameter by 4 inches face width; speed of driving pulley, 240 revolutions per minute; number of available spindle speeds, 12; number of available rates of feed in either direction, 16; range of feeds per revolution of the boring-bar, 0.005 to 11/32 inch; vertical travel of head (with vernier reading), 22 inches; vertical travel of head (with dial reading), 30 inches; and longitudinal power travel of table, 52 inches.

MATTISON PROPELLER SHAPING MACHINE

For use in forming airplane propellers, the C. Mattison Machine Works, Beloit, Wis., are now building a special shaping machine which forms the subject of the following description. This machine employs the pantoscope principle of copying, the propeller being held stationary while the cutter is reciprocated back and forth over it, shaping one side of the work at a time. It is claimed that this results in greater accuracy than can be accomplished where the propeller is revolved as on a copying lathe. Capacity is provided for shaping propellers up to 12 feet in length, and blades may be shaped up to 15 inches in width. This machine is adapted for making three- and four-bladed propellers, as well as propellers of the two-bladed type. A universal chuck is employed for clamping the hub of the propeller blade, and a special cutter-head has been developed which cuts with a shearing action.



Machine for shaping Airplane Propellers built by the C. Mattison Machine Works



Niles-Bement-Pond Extension Boring and Turning Mill with Housings back, giving 42-foot Swing

NILES-BEMENT-POND EXTENSION BORING AND TURNING MILL

In the accompanying illustration is shown an extension boring and turning mill recently built by the Niles-Bement-Pond Co., 111 Broadway, New York City, for arsenal work. This machine swings 28 feet 2 inches with the housings forward and 42 feet 4 inches with the housings back. The maximum height under the tool-holders is 10 feet and the bar travel is 84 inches. The table is driven by a 60-horsepower motor through a double pinion drive; a 25-horsepower motor is used for elevating the cross-rail and a 15-horsepower motor for fast traversing the bars and saddles. A separate 15-horsepower motor is used for traversing the housings. The cross-rail has two heads with octagon bars 10 inches across the flats. The cross-rail is 48 inches in width and 54 inches in depth from front to back. The table is designed to safely carry a load of 300,000 pounds in addition to its own weight. It is driven by two forged steel pinions, one located on each side of the table. The heads on the cross-rail are provided with platforms for the operator. Adjustment of the feeds and rapid traverse for the bars and saddles is controlled from the platforms. The main driving motor is also controlled from these platforms as well as from stations at each side of the machine. Push-button control is provided for all motors.

UNIVERSAL TAPPING MACHINE

F. Lowenstein, 397 Bridge St., Brooklyn, N. Y., is now manufacturing what is known as a "universal" tapping machine, because it is so constructed that adjustment may be made for using the spindle in a horizontal or vertical position or set at any angle which may be most convenient to meet the peculiar requirements of the work. This machine consists of three essential parts, namely, a base, swivel head, and frame which carries the spindle. It will be seen that the swivel head is provided with a circular slot to receive the clamping bolt which provides for securing the frame and spindle in any desired position. In Fig. 1 the machine is shown set up for operation horizontally, and Fig. 2 shows the same machine with the spindle swung through an angle of 90 degrees to bring it into a vertical position. It would be entirely practicable to operate the machine with the spindle in any intermediate position, or the spindle could be swung on to any desired position until it stood horizontal with the tap pointing in the opposite direction to that shown in Fig. 1.

The machine is shown equipped for belt drive from a countershaft, but where it is desired to use individual electric motor drive, a motor is bolted to the back of the base. The

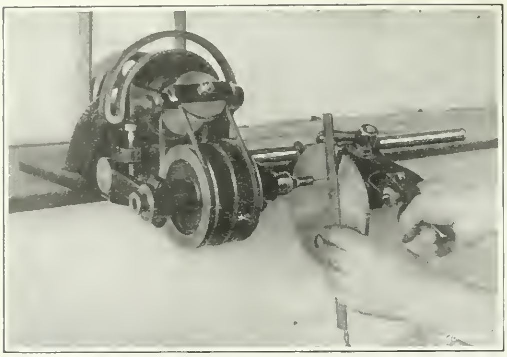


Fig. 1. Lowenstein Universal Tapping Machine with Spindle in Horizontal Position

illustrations make apparent the way in which a round belt runs over a pulley at the front of the driving shaft, thence over one pulley on the tapping spindle, and then around the idler pulley on the swivel head and back over the second pulley on the tapping spindle to the pulley on the driving shaft. In this way, the two pulleys on the spindle are running in opposite directions, which provides means of reversing the tap so as to back it out of the hole. In order to tighten the round driving belt, the spindle frame is hinged to the swivel head, and by means of a screw adjustment, the belt tension can be modified to any degree required for obtaining proper running conditions of the machine. Placed between the two pulleys on the spindle, there is a friction clutch consisting of a disk covered with leather pads. When the work is fed up to the tap, it causes the clutch to engage the "forward" pulley to drive the tap into the work; then, when the work is drawn away from the tap, the clutch is pulled over into engagement with the "reverse" pulley, which backs the tap out of the hole.

The spindle on this machine occupies a fixed position as regards longitudinal movement, and feeding is accomplished by moving the work up to the tap. When the machine is used with the spindle in a horizontal position, this feed movement is accomplished by a hand-lever, and with the spindle in a vertical position, feeding may be done either with the hand-lever or with a treadle connected to the chain shown in Fig. 2. This chain is adjustable in length to suit the location of the table and is connected to an extension back of the hand-feed lever. This lever is pivoted and connected with a yoke secured to the rod on which the work-table is carried. This rod is a sliding fit in its brackets, so that movement of the feed-lever causes the table and work to be advanced to the tap or withdrawn. The capacity of this machine is for tapping holes up to 1/4 inch in diameter in brass or soft alloys, and holes up to 3/16 inch in diameter can be tapped in steel. The forward and reverse clutches are engaged by the feed movement of the spindle.

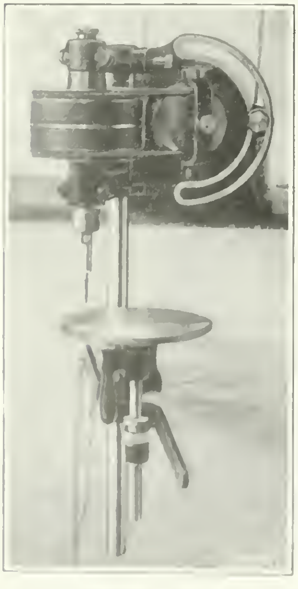
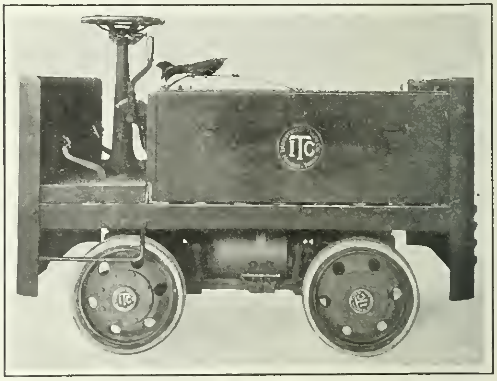


Fig. 2. Lowenstein Tapping Machine with Spindle set Vertical

INDUSTRIAL TRACTOR AND LOCOMOTIVE

The Industrial Truck Co., Holyoke, Mass., is now manufacturing four types of load-carrying trucks and two types of industrial tractors, one of which is equipped with end control and the other with central control, that is, machines where the operator sits at the center of the tractor and can, by changing his seat, operate in either direction without having to turn the tractor around. In driving a tractor through a narrow, congested aisle, this is often a very convenient feature. Both types of tractors steer on all four wheels and are built with either two- or four-wheel drive. The frame is built of commercial rolled channel-section steel, and the bumper plates are constructed of boiler plate bent on the corners and riveted to the frame. By making the coupler castings of the three-step type, accommodation is provided for different heights of trailers. The battery boxes are constructed with easily removable side doors for changing batteries, and hinged top plates to afford easy access for flushing or inspection. Any type of battery can be supplied up to a maximum of forty-two cells of the A8 Edison, or twenty-four cells of the 21 lead-plate type. The frame with the battery box can be lifted from the chassis by simply removing four nuts, leaving the entire driving mechanism accessible for inspection or the making of repairs.

Power is transmitted from the motor through a single reduction worm and gear down through the differential to the wheels, by means of a universal joint which is capable of operating at an angle of 43 degrees. This universal joint is enclosed in a dust- and oil-tight case, formed by the pivoting wheel knuckle and its supporting yoke. Ball bearings are provided in the wheels, and pivot bearings of a suitable size are provided, which makes the tractor easy to steer. Two separate brakes are furnished, one of which is operated by the left foot, which is an emergency brake, and one by the right foot, which is the regular service brake. The design of this tractor has been made as nearly fool-proof as possible. In order to operate it, the driver must be sitting in his seat with his left foot pressing the emergency brake pedal. Every time his foot is lifted from the pedal, the brake is applied, bringing the machine to a stop, and by means of a clutch on the controller shaft, throwing the controller handle out of gear and the controller to the neutral position. It is then impossible to start the tractor again without first releasing the emergency brake and bringing the controller handle back to the neutral position. The electric horn signal is operated by a push-button on the controller handle. An additional safety device is provided by locating the tilting steering wheel in such a way that the operator must move it before leaving his seat. This tilting wheel is interlocked with the controller shaft clutch, so that under no circumstances can the battery current be supplied until the wheel is back in the running position.



Storage Battery Electric Tractor built by the Industrial Truck Co.

The Industrial Truck Co. is also building an industrial locomotive adapted for any practical gage of track from 24 inches up to the standard gage of 56½ inches. Flanged wheels are substituted for rubber-tired wheels used on the tractor, but, aside from this difference and the fact that the differential, universal joint driving mechanism, and steering mechanism have been dispensed with, it is of essentially the same design as the tractor.

LANGELIER AUTOMATIC IGNITION TUBE DRILLING MACHINE

The machine shown in Figs. 1 and 2 was designed especially for drilling simultaneously and automatically the twenty-two holes in the ignition tube, Fig. 3. The machine produces an output of 20 tubes per minute or 12,000 for a day of ten hours. The equivalent in holes is 264,000. The tubes are made from drawn brass tubing 0.538 inch outside diameter, with a wall thickness of 0.035 inch, and are 4.158 inches in length. The size of the hole is 0.141 inch. Each tube has twenty-two holes. The only duty required of the operator is to keep the vertical magazine slide filled with tubes. All the other functions in the machine are performed automatically. The tubes are pushed one at a time from the bottom of the magazine into a jig in which are located the drill guide bushings. The jig has also an inner spring sleeve which squeezes the tube and holds it firmly while being drilled. The tubes are pushed one ahead of the other to the rear of the machine where they fall into a chute which leads into a receiving box at the side of the machine. The jig is provided with a chamber into which is led compressed air and a stream of oil which thoroughly lubricates the drills and also keeps the inside of the jig absolutely free from chips.

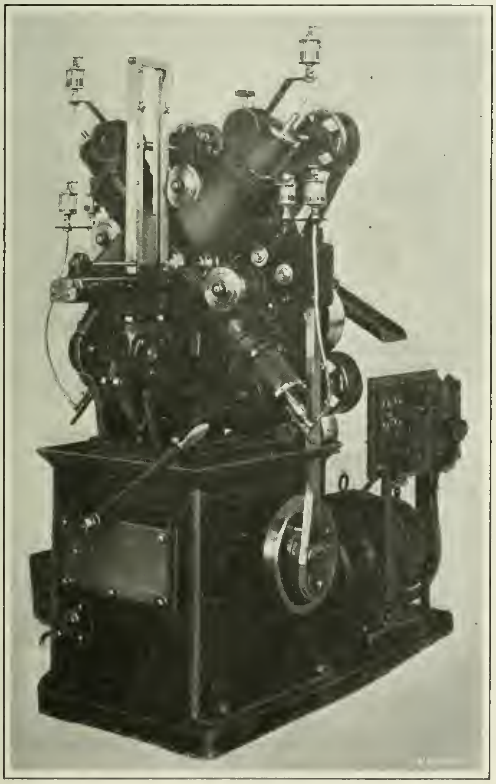


Fig. 1. Langelier Automatic Ignition Tube Drilling Machine

The tubes are fed into the drilling jig by a reciprocating plunger mounted in a dovetail slide, a segment gear and cam-bar, by a camshaft in the back of the machine. The cam-bar is provided with a collapsing arrangement so as to avoid breakage in case a tube should get jammed in any way, the possibility of which is very remote. The magazine slide is held in position by two quick removable belts, so that it can be quickly taken off, so as to facilitate the taking out and putting in of the drills when they are sharpened. The machine has four multiple drilling heads mounted radially, 90 degrees apart upon a faceplate that is trunnioned and fastened to the frame of the machine. Two of the heads that are diametrically opposite to each other have six spindles each and the other two, five spindles each. Each multiple drill head is mounted in a feed sleeve that is actuated through a double pinion by a ring gear located concentrically inside of the faceplate. The ring gear is connected by intermediate compound gears to a cam-bar that is operated by the camshaft in the base of the machine.

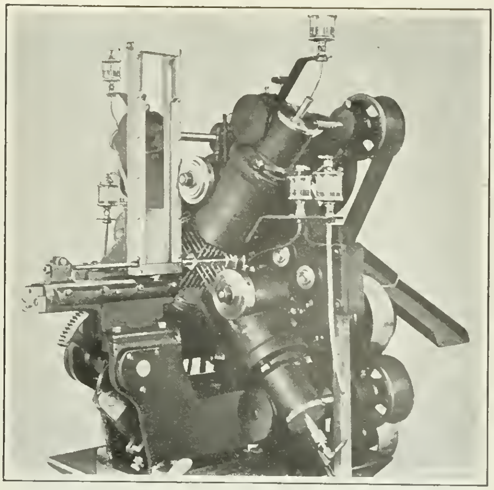


Fig. 2. Close View of Upper Part of Machine shown in Fig. 1

Each feed sleeve is provided with a cut-out that permits the drill heads to be adjusted individually to their proper drilling positions. The drilling head main spindles are mounted on ball bearings and are driven by spiral gears completely enclosed and running in oil. The spiral gear driving shafts are also mounted on ball bearings. They extend to the rear of the machine and are driven by an endless belt passing over the pulleys on their ends. Intermediate idler pulleys are used to obtain belt contact and the upper idler pulley is mounted with a screw adjustment so that the proper belt driving tension can be maintained. All idler pulleys are mounted on ball bearings. The endless belt combination of pulleys is driven by gears in couples by a belt from the motor.

The feeding mechanism of the machine is controlled by two face cams, one on the outside of the base for feeding the drill heads and the other on the inside for operating the feed plunger. The camshaft is driven by a worm and gear and the worm is geared in its proper ratio to the motor shaft. The camshaft is provided with a clutch that is operated by the hand-lever at the front of the base, so that the feeding mechanism can be stopped at any time by the operator. Sight-feed oilers with gravity feed are provided so as to insure a generous lubrication to the multiple drilling heads. The drilling spindles have a speed of 2800 revolutions per minute. An automatic oil-feed pump with filtering arrangement is belted to the motor shaft for supplying the cutting oil. The entire machine including the motor and appliances rests upon a heavy floor-

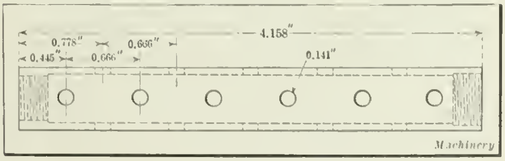
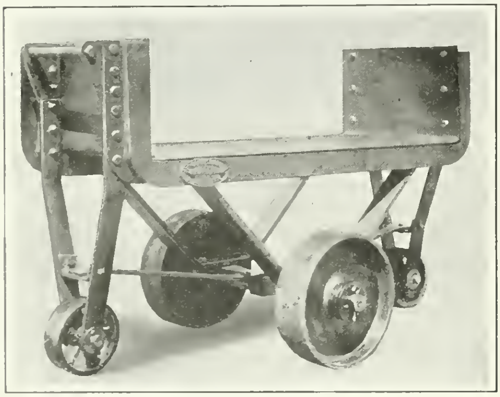


Fig. 3. Ignition Tube in which Twenty-two Holes are drilled

base. The machine is driven by a five-horsepower semi-enclosed, 110-volt, direct-current shunt-wound Westinghouse motor. The machine occupies a floor space of 30 inches wide by 60 inches long, and stands 68 inches high. The weight is 3500 pounds. This machine is a recent product of the Langelier Mfg. Co., Arlington, Cranston, R. I.

ORENSTEIN-ARTHUR KOPPEL HIGH-LEVEL TRUCK

Much time is lost and the efficiency of a machine operator is considerably reduced if he is required to stoop in transferring material from a truck to his machine, and vice versa. It was to eliminate this source of lost time that the high-level truck shown in the accompanying illustration was designed. This truck is so constructed that the whole load is balanced on the center axle, which is provided with large-diameter, wide-tire wheels, supported on roller bearings, which make the operation of the truck so easy that, although it is heavily constructed and has a rated capacity of two-thirds ton, the truck can be easily moved around when fully loaded. This truck is one of the recent products of the Orenstein-Arthur Koppel Co., Koppel, Pa.


"High-level" Industrial Truck manufactured by the Orenstein-Arthur Koppel Co.

NEW MACHINERY AND TOOLS NOTES

Toolpost Grinding Attachment: Gale-Sawyer Co., 33-37 Wormwood St., Boston, Mass. A toolpost grinding attachment furnished with a swiveling device which is graduated to provide for making accurate adjustments. This is said to be especially useful when sharpening cutters with end teeth and performing similar operations. Provision is made for driving the spindle at from 8000 to 12,000 revolutions per minute.

Bench Furnace: Johnson Gas Appliance Co., Cedar Rapids, Iowa. A No. 118 bench furnace which is suitable for use in machine shops and tool-rooms. Gas is used for fuel and it is claimed that temperatures from 1400 to 1800 degrees F. may be obtained without the use of a forced air blast. A removable melting pot may be placed on top of the furnace, and the opening into which this pot fits is filled by a cover plate when the pot is not required.

Motor-driven Trucks: Baker R. & L. Co., Cleveland, Ohio. A line of industrial trucks and tractors driven by storage batteries and electric motors, in which all parts have been carefully standardized. The work of standardization has been carried to a point where the different parts can be used on trucks of all models. Two- and four-wheel drive, four-wheel steer trucks, tractors, and elevating platform trucks are included in this line of industrial trucks.

Folding Blueprint Rack: National Co., 273-279 Congress St., Boston, Mass. A folding wall rack adapted for holding blueprints and other sheets of similar form. This rack is furnished with the "Presto" blueprint holder of this company's manufacture, which has been described in MACHINERY. The rack consists of a frame which hangs against the wall and supports a horizontal rack which projects out from the wall and carries the "Presto" blueprint holders.

Castellating Machine: Matthews Engineering Co., Sandusky, Ohio. (The machine is sold by the J. R. Stone Co., Detroit, Mich.) A machine especially designed for use in castellating nuts or other small parts which are suitable for chucking. The work is placed in a hopper and fed through a chute to the chucks. As each piece is chucked, it is carried around under the milling saws which feed downward and are then lifted automatically while the chuck table is indexed.

Shell-turning Attachment: Amalgamated Machinery Corporation, 72 W. Adams St., Chicago, Ill. An attachment devised by D. M. Derrom, works manager of the Winslow Bros. Co.'s shell plant in Chicago, to avoid trouble sometimes experienced through a constant change of the angle that the cutting edge of the tool presents to the work as it moves over the contour of the shell. Attachments of this kind are regularly furnished on Amalgamated lathes intended for use in shell turning.

Bench Grinding Machine: Temco Electric Motor Co., Leipsic, Ohio. A portable bench grinding machine provided with two emery wheels driven by an electric motor which is furnished with a cord for making connection with an ordinary lighting socket. The electric motor develops one-sixth horsepower, and the wheels which are 6 inches in diameter by 1/2-inch face width run at 3700 to 3800 revolutions per minute, depending upon whether connection is made with an alternating- or direct-current circuit.

Multiple-spindle Drilling Machine: Langelier Mfg. Co., Arlington, Cranston, R. I. A machine especially designed for use in drilling twenty-four holes 0.031 inch in diameter in the walls of primer ignition tubes. The machine is hand- and foot-operated and the drilling is done by six-spindle multiple heads located 90 degrees apart on a vertical faceplate. The spindles in one head are offset to a position midway between those in the opposite head, and drills carried by each head work diametrically through the walls of the tube.

Filing Machine: Advance Engineering Co., 848 Massachusetts Ave., Indianapolis, Ind. A bench type of die filing machine which is of compact construction, with moving parts carefully balanced and completely enclosed. All bearings and other wearing surfaces are made of bronze, and may be replaced if necessary. Provision is made for tilting the table to angles up to 10 degrees on either side of the central or vertical position, and the table may be turned around on the base to locate the driving pulleys at either side or at the rear of the machine.

Pressure Toggle: R. D. King, Monadnock Block, Chicago, Ill. A pressure toggle for use on presses to provide for regulating the pressure exerted on the work during the stroke of the press. Provision is made for adjusting the device so that the pressure will remain uniform during the entire stroke or so that it will either increase or decrease toward the latter end of the stroke. This pressure toggle is attached to the bolster plate with two rods and remains stationary while the plate supporting the drawing pins is moved up or down for adjustment by means of a handwheel.

Galvanizing Machine: E. L. Watrous, Des Moines, Iowa. A machine invented by Mr. Watrous and installed in the plant of the Hanlon-Gregory Galvanizing Co., Pittsburg, Pa. This apparatus is designed to handle small products such as nuts, bolts, nails, wood-screws, and similar articles. It is of simple design and the work to be galvanized is placed in a wire basket, from 50 to 100 pounds of work being treated at a time. The work is dipped into a kettle, and when sufficiently treated the basket is lifted out and transferred to the machine where excess zinc is removed by a centrifugal action.

Non-ferrous Melting Furnace: U. S. Smelting Furnace Co., Belleville, Ill. A melting furnace for non-ferrous metals, which is of the revolving tilting type. Either fuel oil or gas may be burned to produce the heat required for melting the metal. The material to be melted is put through the charging hole, and the burner which swings to one side in order to permit the furnace to be charged is then adjusted and lighted. The flame is projected through the center of the melting chamber, although it does not impinge upon the metal, reflected heat from the lining of the furnace being relied upon to bring the charge to the melting point.

Turret Toolpost: Craig & Coffman, 3714 Flora Ave., Kansas City, Mo. A turret toolpost which is made in two standard sizes, although larger sizes can be made to special order. On the larger sized standard equipment, the turret is 3½ inches square and carries three 3/8-inch square cutters and one 3/4-inch standard cutting-off plate. On the smaller size, which is adapted for use on bench lathes, the turret is 2½ inches square and carries three 1/4-inch square cutters and one 1/2-inch cutting-off plate. These turret toolposts provide a convenient method of using roughing, finishing, threading, and cutting-off tools in rapid sequence for the production of duplicate parts.

Circuit-breaker: Roller Smith Co., 233 Broadway, New York City. A line of self-timing circuit-breakers which are so designed that they always tend to trip instantaneously with the load for which adjustment has been made. Interposed in the path of its trip armature there is a pivoted, hook-shaped barrier, which is under two independent controls. One of these is thermal, so that expansion of a metal rod heated at the same rate the motor is heated by the passage of current retracts the barrier and allows the breaker armature to trip in case of excessive heating. The other control is electromagnetic and instantaneously retracts the barrier and allows the trip to operate in case a heavy overload occurs.

Tool-holder: Green Bay Drive Calk Co., Green Bay, Wis. A line of tool-holders which are made in five different sizes, of either straight, right-hand offset, or left-hand offset type. These tool-holders are furnished with a center piece, which is pivoted and provided with a tongue at one end and a set-screw at the opposite end. A tool steel bit of sufficient length is held by a double grip, but short pieces of steel are held under the tongue on the pivoted section and secured by pressure applied by tightening the set-screw against the body of the holder. Tool-holders of this type are made in sizes ranging from 1/2 by 1½ by 6 up to 1 by 2 by 11, and have capacity for holding square tool steel bits from 5/16 to 5/8 inch square.

Enclosed Electric Traveling Crane: Shepard Electric Crane & Hoist Co., Montour Falls, New York. A crane built for use in the Cuyahoga Works of the American Steel & Wire Co., in Cleveland, Ohio. The feature of especial interest in the design of this crane is that all parts of the mechanism have been completely enclosed in order to afford protection against damage from dust and other foreign matter which finds its way into the armatures, bearings, and other members. Where no protection is afforded, some plants find it necessary to clean the motors and other parts of their cranes as often as once or twice a week with compressed air, but this trouble has been completely overcome by the enclosed form of construction provided on the Shepard crane. It has a span of 76 feet 8 inches and a capacity for carrying ten tons. It is adapted for use in connection with electromagnets for lifting the load.

Electric Light Holder: Light Holder Mfg. Co., 79 E. 130th St., New York City. An adjustable electric light bracket which is known as the "New York Universal." This device makes it an easy matter to hold a light in the best position to enable a mechanic at the bench or machine to obtain a clear view of his work. Holders of this type are made in several styles which are designed to be supported from the floor, bench, overhead works of a machine tool, or in other convenient ways. Adjustment for length is provided by means of telescoping members of the bracket. and swivel joints provide movement in any direction. A lamp socket of ordinary form snaps into a spring yoke and no screws are required to hold it in place. All joints and movements of the bracket are held by friction under the tension of adjustable springs, so that to move the light from one position to another requires scarcely more than a movement of one hand, as the fixture moves easily and the light stays in whatever position it is placed.

* * *

A course of training for employment managers under the supervision of the Government has been opened at the University of Rochester, Rochester, N. Y. Twenty prospective employment managers sent to the university by manufacturers having war contracts are taking six weeks' intensive training in the practice and theory of employment management. Fifteen Rochester factories are providing the laboratory work and assisting the university in training these men. The course is given at the express request of the Industrial Service Sections of several of the departments at Washington. It is desired that manufacturers take a hand in the development of this movement and send students to the university on their own initiative. Those who wish to apply to send men to one of these courses should write to Employment Managers Division, 5207 New Interior Bldg., Washington, D. C. Courses will also be opened at Harvard University, Boston, Mass., in cooperation with the Massachusetts Institute of Technology. Applications for these courses may also be made immediately. The Government, having recognized the necessity for training men in the science of production and industrial management, should receive the fullest cooperation from all manufacturers who realize the need of training one or more young men as employment managers.

* * *

The War Trade Board, at Washington, D. C., has just published a complete list of all the firms in neutral countries listed in the Enemy Trading List and with whom citizens of the United States are not permitted to do business. The book may be obtained from the Government Printing Office, Washington, D. C. The publication is known as "Trading with the Enemy—Enemy Trading List Revised to March 15, 1918—No. 2."

TRAINING MECHANICS FOR ARMY SERVICE

Last February the Secretary of War appointed a Committee on Education and Special Training, to take charge of the training of 90,000 men of the National Army for technical and skilled work of various kinds. So rapidly has the committee proceeded that twenty-five schools are now under contract to take the men; fourteen have begun their work and 7500 National Army men are under instruction. The number of schools will be increased until 30,000 men can be instructed at one time. The courses are of eight weeks' duration, and the final number of 30,000 men (for army needs as now planned) will go to the schools September 1.

The institutions include engineering colleges, universities, and mechanics' institutes, while in one city the public school system is being used. Institutions that can accommodate at least 500 men are preferred, while one school expects to take 2500 men. The number of courses given at an institution depends on the number of students, character of school equipment, and location. Army officers will be placed at each school, and military drill will be carried along simultaneously with the technical instruction. The technical staff will be supplied by the institution. At present the following courses are arranged for: auto driving and repair, bench woodworking, general carpentry, electrical communication (telephone and telegraph work), electrical work, forging and blacksmithing, use of gas engines, machine-shop work, and sheet-metal work.

The men at the schools are National Army men who have volunteered for this special training and go to the schools directly from their homes. To insure proper assignment of schools, however, all men are sent first to "reservoir" schools, where they are tested by qualified men and then assigned to the proper schools. The aim is to push men along as fast as their abilities warrant; journeymen machinists, for example, will immediately be put on highly specialized work, such as airplane repairs.

* * *

MACHINISTS WANTED FOR GOVERNMENT WORK

The Watervliet Arsenal, Watervliet, N. Y., advises that it is in urgent need of machinists, and calls upon patriotic machinists who are not now engaged upon work necessary for the conduct of the war to apply to the Commanding Officer, Watervliet Arsenal, Watervliet, N. Y. It should be understood that men in plants and establishments manufacturing machine tools, munitions of war, or other material directly necessary for the successful conduct of the war are not wanted, but only skilled mechanics who are now engaged in industries that for the time being are not essential to the winning of the war. There must be thousands of men in this class who would be willing to put their services at the command of the Government for the successful winning of the war, at rates of pay which will prove satisfactory; details regarding this matter will be furnished by the Arsenal to those interested upon application.

* * *

MAY MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

At the May meeting of the New York Section of the American Society of Mechanical Engineers, the subject of labor turnover was discussed. A number of speakers representing the shipping, airplane, ordnance, and machine tool industries dealt with the subject in brief addresses. The machine tool industry was represented by L. D. Burlingame, industrial superintendent, Brown & Sharpe Mfg. Co., Providence, R. I., who spoke particularly on labor turnover in connection with the employment of women. The importance of training men and women for the work in machine shops and other factories was particularly emphasized. Several representatives of the Federal Government also spoke on the efforts made by the Government to regulate labor conditions, and information was given out indicating that the Government will shortly determine standard wages for various industries in order to prevent the shifting of labor from one shop to another, or from one locality to another.

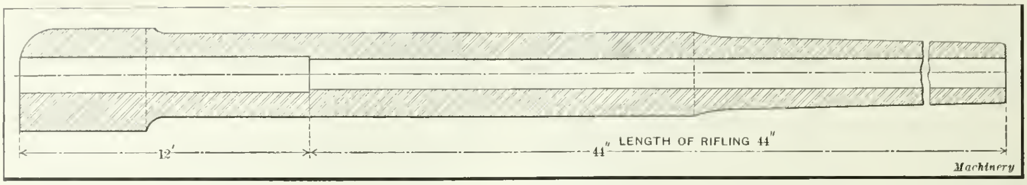


Fig. 1. Barrel of One-pounder Gun

BROACHING OPERATIONS ON ONE-POUNDER GUNS

BY FRANCIS J. LAPOINTE[1]

The broaching machine shown in Fig. 2 was developed by the J. N. Lapointe Co., New London, Conn., for broaching the breech opening and also the rifling grooves of one-pounder guns. Special tool equipments and fixtures are provided for each broaching operation so that it is possible to broach the breech opening and the rifling grooves on the same machine. The design of the fixtures is such that the change from one operation to the other can be made very quickly.

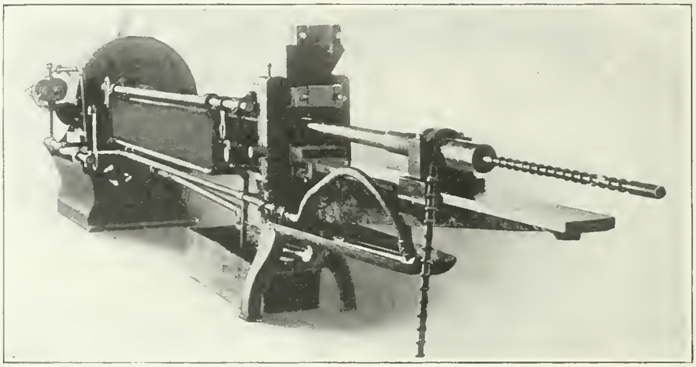


Fig. 2. Special Broaching Machine with Fixture and One-pounder Gun in Place Ready for broaching Rifling Grooves

In Fig. 2 the machine is shown with the fixture and a one-pounder gun mounted in place ready for broaching the rifling grooves in the barrel. The same fixture can also be adapted for broaching the breech opening. The broaching of the rifling grooves is done in two operations by the use of a roughing and a finishing broach. The actual length of rifling is 44 inches, as will be noted by referring to Fig. 1. Fig. 4 shows an enlarged section of the rifling grooves, which are approximately 0.015 inch deep and are twelve in number. The spiral formed by these grooves is right-hand and the lead is one turn in 40 inches. This rifling operation is accomplished by means of a master bar which gives the initial spiral to the cutting tool. The broaches used are also milled to correspond with the lead required. The master spiral bar is pulled by means of a roller thrust bearing and operates through a spiraling block that causes the bar to rotate. The gun is mounted on a carriage and clamped so as to hold it in perfect alignment and also prevent it from revolving. By referring to Fig. 2, it will be noted that there is a large flexible tube and pipe in the oil-pan under the front end of the machine. The pipe is slipped over the end of the broach and into the bore of the gun which at this end is large enough to admit the pipe. The broach is also provided with oil-channels so that every pocket between the cutting teeth of the broaches is filled with oil as it enters the work. The oil is constantly agitated by the high pressure under which it is forced. This results in a very smooth finish, as it prevents the chips from being cut dry and welding to the face of the teeth. The time required for broaching the rifling grooves is approximately fifteen minutes.

Fig. 3 shows the front end of the broaching machine with the fixtures and work mounted in position for broaching the breech opening. The work *D* rests on the bottom *F* of tilting head *A* and is held in place by clamps *B*. The tilting head *A* can be thrown forward or allowed to pivot on pin *I* to give the proper angle for broaching the tapered portion of the breech opening. The casting *G* is the fixture proper which is bolted to the end of the machine *C*. *H* is the broach carriage and *E* is a section of the broach.

Fig. 5 shows the eleven different operations required in finishing the breech opening, starting from a round hole

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[1] Address: Care of J. N. Lapointe Co., New London, Conn.

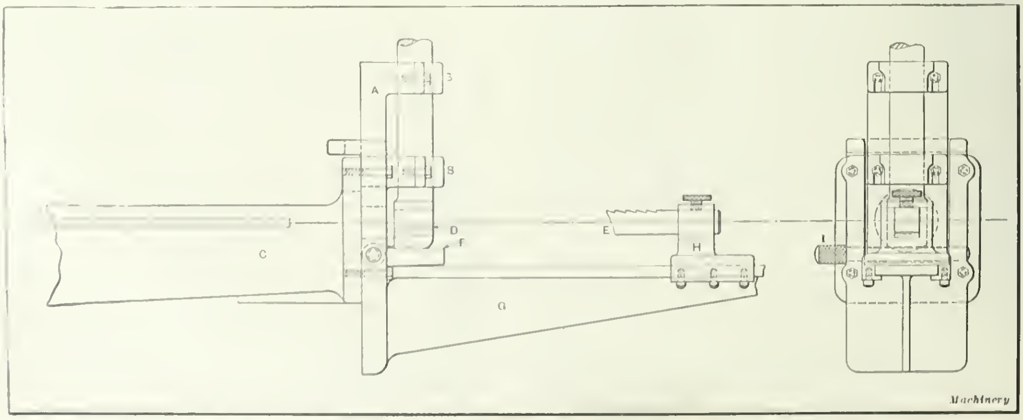

Fig. 3. Front End of Broaching Machine with Fixture and Gun-barrel mounted in Place for broaching Breech Opening

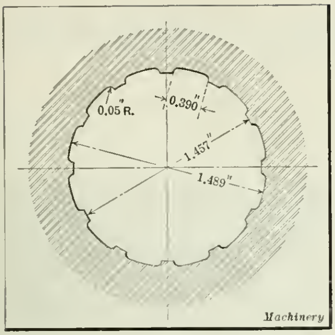

Fig. 4. Section of Gun-barrel which has Twelve Right-hand Spiral Grooves of Uniform Twist making One Turn in Forty Inches

2.5 inches in diameter. This hole is bored at an angle of approximately 5 degrees and the first nine operations are performed with the work held at this angle. The dimensions show the amount of material removed at each operation. It will be noted that on the first five operations the width of the rough-broached hole remains the same, namely 2.340 inches, and that the stock removed is all on the top and bottom. Operation 6 is a sizing operation finishing the width of the hole which represents the size between the two keys on the finished pieces. Operations 7, 8, and 9 are confined to removing material on the width of the hole stepping round the two solid keys, the ninth operation being a sizing operation which finishes the two keys. Operations 10 and 11 are accomplished by means of a T-shaped broach guided against a tapered block. Fig. 7 shows the eleven broaches employed. In this illustration is also shown a steel block that has been broached with this set of tools. The finished size of this broached hole is 2.756 by 2.857 inches. Fig. 6 shows the inside of a finished barrel as it appears when viewed from one end.

* * *

EFFECT OF COPPER IN MEDIUM-CARBON STEEL

In a paper by R. Hayward and A. B. Johnston, of the Massachusetts Institute of Technology, read before the American Institute of Mining Engineers, it was stated that copper increases the tensile strength and hardness, but lowers the elongation of the steel; in fact, copper steels closely resemble steels containing equivalent percentages of nickel as regards tensile strength, resistance to shock and corrosion, and hardness. Copper also lessens the brittleness of steel containing 1 per cent carbon.

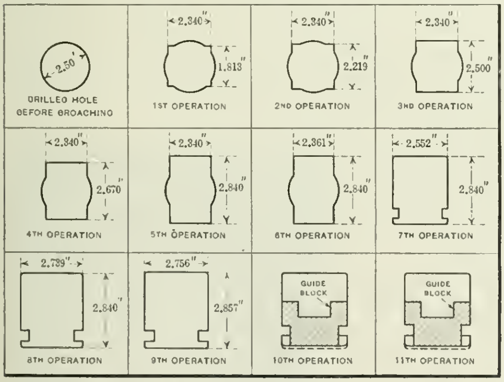

Fig. 5. Eleven Broaching Operations required in finishing Breech Opening

These conclusions were obtained from tests carried out on bars of steel having the following analysis: carbon, 0.38 per cent; phosphorus, 0.012 per cent; manganese, 0.57 per cent; sulphur, 0.03 per cent; and copper, 0.86 per cent. These steels, for the purpose of comparison, were termed high-copper steels. Tests were also conducted on bars containing 0.03 per cent copper, 0.048 per cent sulphur, 0.59 per cent manganese, 0.053 per cent phosphorus, and 0.365 per cent carbon, which were termed low-copper steels. Except for one set of bars, which was given a higher temperature through an error, all the bars were heated from 845 to 865 degrees C. and then cooled. One set was let cool in the furnace over night, another set was cooled in air, and the others were quenched in water, replaced in the furnace, and drawn to different temperatures.

The high-copper bars, as forged, had a yield point of 60,900 pounds per square inch, and the low-copper bars 46,600 pounds. The high-copper bars cooled in the furnace had a yield point of 52,900 pounds, and the low-copper bars a yield point of 45,800 pounds. The yield point of the bars was increased by the heat-treatment, reaching 136,900 pounds in the case of the high-copper bars that had been drawn to 455 degrees C. The ultimate strength of the bars was increased from 92,600 pounds to 190,800 pounds in the case of the high-copper bars drawn to 360 degrees C., and from 83,200 pounds to 136,300 pounds in the case of the low-copper bars. The ultimate strength of the bars cooled in the furnace, however, was lowered to 86,530 pounds and 78,130 pounds, respectively. The bars heated and cooled in the furnace also had a lower percentage of reduction than the forged bars; this reduction was increased in the case of the bars heated and drawn to 580 degrees, but was reduced in the case of all the others. The percentage of elongation was also increased by the heat-treatment, except in the case of the bars heated and drawn to 360 degrees C., when it was greatly reduced. The microscopic study showed that, for the same treatment, high-copper steel is finer grained than low-copper steel, and the quenched and drawn specimens of high-copper steel are slightly more martensitic. To what extent copper in steel will prove to be of importance in practical engineering is still problematical, but the investigations made are, nevertheless, of interest.

Fig. 6. Inside of Finished Barrel as it appears when viewed from One End

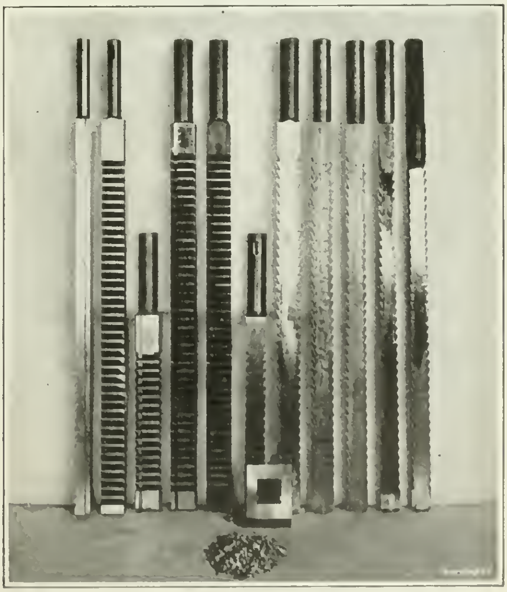

Fig. 7. Broaches employed in Eleven Broaching Operations

GRAPHIC USE OF LOGARITHMS

BY G. G. STEVENSON[1]

Logarithms are a valuable aid to engineers and draftsmen, but often they are not used to the greatest advantage. In the graphic solution of problems they are almost invaluable. A problem involving a number of variables can be drawn into chart form so that anyone can obtain correct results, although he may not understand the mathematical processes involved. Such charts are especially valuable for placing mechanical data in the hands of estimators, salesmen, etc. When more than two factors are involved, these charts are by far the most convenient method of solving a problem, or determining unknown factors. For instance, by means of the chart shown in Fig. 1, the capacity or lift of a pump or the horsepower of its motor may be readily found if two of these factors are known. As an example, suppose that it is required to find the horsepower of the motor that will drive a pump so that it will deliver 45 gallons a minute against a 95-foot head. By placing a straightedge, as shown by the dotted line, so as to intersect 45 on column *A* and 95 on column *C*, the point 4 on column *B*, where it is intersected by the straightedge is the horsepower required.

Probably the one thing that tends to discourage a more general use of these charts is the fact that they appear difficult to draw. This assumption, however, is wrong. Any convenient length may be taken for two of the columns, say *A* and *C*, which are then divided logarithmically. Several methods for doing this have been published but as a rule they are too complicated and roundabout to be practical. A simple and easy way where logarithmic paper is available is shown in Fig. 2. The logarithmic paper is placed at such an angle that the two extreme divisions desired just coincide with the horizontal extensions of the ends of the line to be divided; then with the T-square the points needed are projected to the line. If more convenient, a slide-rule may be used. This is done by multiplying the logarithm of each number to be located by the length of the whole line. In other words, the logarithms found are for a line one inch in length; then the points can be easily located by the use of a decimal scale.

Perhaps the easiest way to find the lateral location of the middle scale in this problem is to take, on the outside columns, two sets of numbers that can be conveniently used and the products of which are equal (for instance, 2 times 100 and 20 times 10). Join point 2 on one column *A* to 100 on the other column *C* and 20 on the first column *A* to 10 on the other column *C*. The position of the middle column *B* is at the intersection of these lines. Of course the scale of the line is determined by the efficiency of the machines, the factor of safety desired, etc. In the example given, the horsepower must be figured for both the maximum and the minimum requirements to determine the length of the center scale.

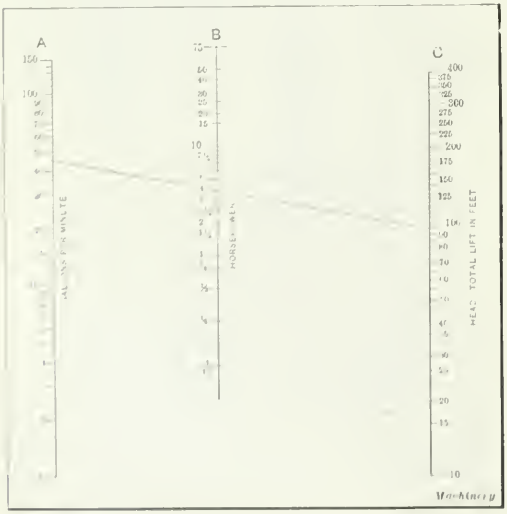

Fig. 1. Chart for finding Horsepower or Capacity of a No. 33A Pump

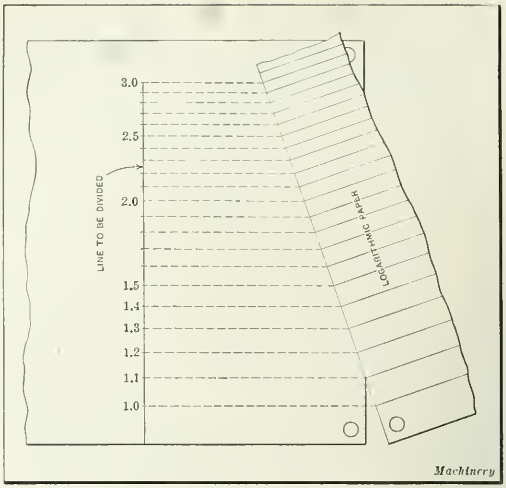

Fig. 2. Method of dividing a Line logarithmically

The chart shown in Fig. 1 represents a very simple case. Complications set in as soon as more factors are involved, but by applying a little reasoning almost any problem can be worked out by this method. The chart shown could, for instance, be drawn with several vertical or curved lines representing pumps of various efficiencies and horsepowers required for pumping different liquids, etc.

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[1] Address: 420 E. Main St., Evans Apts., Fort Wayne, Ind.

* * *

EFFECT OF FLANGES ON CAST-IRON CHANNELS

Tests made at the University of Wisconsin show that the flanges add little to the strength of cast-iron channels but have a marked effect on the stiffness of the section. All the channels tested were made of gray iron and had a tensile strength of 28,950 pounds per square inch. They had round ends, the centers of the ends coinciding with the centroidal axis of the section. The value of the polar moment of inertia was calculated with respect to this axis and, together with the area, was figured for the actual cross-section.

In the case of a channel with very small flanges, the ultimate twisting moment of which was 21,830 inch-pounds and the polar moment of inertia 18.6, the twisting moment when the first crack appeared was 19,690 inch-pounds. When it was assumed that only the 6-inch web was affected, the twisting moment was 18,940 inch-pounds; when the material in the flanges was included but was assumed to be revolved through 90 degrees, to form a deep narrow rectangular section, the twisting moment was 22,860 inch-pounds. In a channel with a 3¾-inch flange and a 6-inch web, which had an ultimate twisting moment of 31,070 inch-pounds and a polar moment of inertia of 53.92, the twisting moment when the first crack appeared was 31,070 inch-pounds. Assuming that only the web was affected, the twisting moment was 23,550 inch-pounds; when the material in the flanges was included but was assumed to be revolved through 90 degrees, to form a deep narrow rectangular section, the twisting moment was 44,500 inch-pounds.

* * *

A consular report states that tungsten ores have been exported from China to a considerable extent during recent months. When the trade in this ore began, its value was not realized by the sellers, who sold it as iron ore to the Japanese; at the present time the price is stated to be $32 per hundred pounds at Canton. Much of this ore comes from interior provinces, and in one case it is carried by men on the shoulders for a distance of sixty miles.

OBITUARIES

CLAYTON C. INGERSOLL

Lieutenant Clayton C. Ingersoll, a son of Winthrop Ingersoll, president of the Ingersoll Milling Machine Co., of Rockford, Ill., was killed in an airplane accident in France on April 26. Lieutenant Ingersoll was twenty-two years old, and his winning personality endeared him to a wide circle of friends. Educated at Lake Forest Academy and Cornell University, he received his military training at Fort Sheridan and at the aviation fields in Toronto, Canada, and Fort Worth, Texas. While he was stationed at Mineola, Long Island, before embarking for France last February, his engagement to Miss Mary Katherine Nelson, of Rockford, was announced. Lieutenant Ingersoll is survived by his parents, one brother, and two sisters.

Eben Boye, who was in the employ of Manning, Maxwell & Moore, 119 W. 40th St., New York City, for many years, died suddenly, after undergoing an operation, on May 13. He was associated with the company in Cleveland, Chicago, and Cincinnati, and for the last three or four years had been in the machinery department of the company in New York City.

EARL TRUMBULL WILLIAMS

Lieutenant Earl Trumbull Williams, of the 301st U. S. Field Artillery, and vice-president of J. H. Williams & Co., of Brooklyn, N. Y., was struck by a falling limb from a tree on May 6, while visiting friends in Northampton, Mass., and died the next day. Lieutenant Williams graduated from Yale University in 1910 and entered the business of J. H. Williams & Co., Brooklyn, N. Y., manufacturer of drop-forgings, which was founded by his father in 1883. When the company's plant at Buffalo, N. Y., began operation in 1914, Lieutenant Williams assumed charge as vice-president and was in active control until the summer of 1917, when he entered the officers' training camp at Fort Niagara. He received a commission as First Lieutenant in the 301st Field Artillery and was assigned to duty at Camp Devens, Ayer, Mass. Lieutenant Williams was an ex-member of Squadron A, New York, and a member of the Saturn and the Country Clubs of Buffalo. He is survived by his mother, brother, and sister.

FREDERICK REMSEN HUTTON

Frederick Remsen Hutton, for twenty-three years secretary of the American Society of Mechanical Engineers and president of the society in 1906, died May 14, aged sixty-five years. Professor Hutton was born in New York City, May 28, 1853. He graduated from Columbia College in 1873 with the degree of A.B., after which he entered the School of Mines, obtaining his degree in 1876. A year later he was appointed instructor in mechanical engineering in the university as an associate of the late Professor W. P. Trowbridge. Upon the death of Professor Trowbridge, in 1892, Professor Hutton was made head of the mechanical engineering department, which he continued to direct until 1907. At this time he resigned and was elected professor emeritus. For six years during his professorship he was dean of the Faculty of Applied Science. During Professor Hutton's association with the university he developed the mechanical laboratories until the equipment at present is the most complete of any technical school. Columbia conferred upon Professor Hutton in 1882 the degree of Ph.D., and on the occasion of its one hundred and fiftieth anniversary, in 1904, the degree of Sc.D.

Professor Hutton became secretary of the American Society of Mechanical Engineers in 1883, three years after its organization. He was appointed a member of the Conference and Building Committee of the United Engineering Society, which planned the Engineering Societies' building at 29 W. 39th St. He was also one of the Board of Trustees, which is the holding corporation for the United Engineering Society. In 1906, Professor Hutton was unanimously elected president of the American Society of Mechanical Engineers. At the close of Professor Hutton's administration as president of the society, he was appointed honorary secretary, as a token of appreciation of his unselfish and capable work in the society's interest—a recognition well deserved. In addition to his work for the society and at Columbia University, Professor Hutton has been an extensive contributor to scientific literature. His most important books, which have been widely accepted in the educational field in the United States and in England, are "The Mechanical Engineering of Steam Power Plants," "Heat and Heat Engines," and "The Gas Engine." He was the author of two of the most important monographs of the census of 1880, one covering machine tools and the other pumps and pumping engines. He was one of the collaborators in the preparation of the Century Dictionary, published in 1910, and the new International Encyclopedia of 1916. He has contributed extensively to the transactions of the society and has done considerable other literary work.

CAPTAIN RENÉ FENWICK

Captain René Fenwick, of the 31st Dragoons, French army, was killed at Locre, near Ypres, on the 28th of April, 1918, leaving a widow and three sons.

Captain Fenwick was the only son of Francis Fenwick, president of the Societe Anonyme des Etablissements Fenwick Frères & Cie., of Paris, a firm well known to all American machine tool manufacturers.

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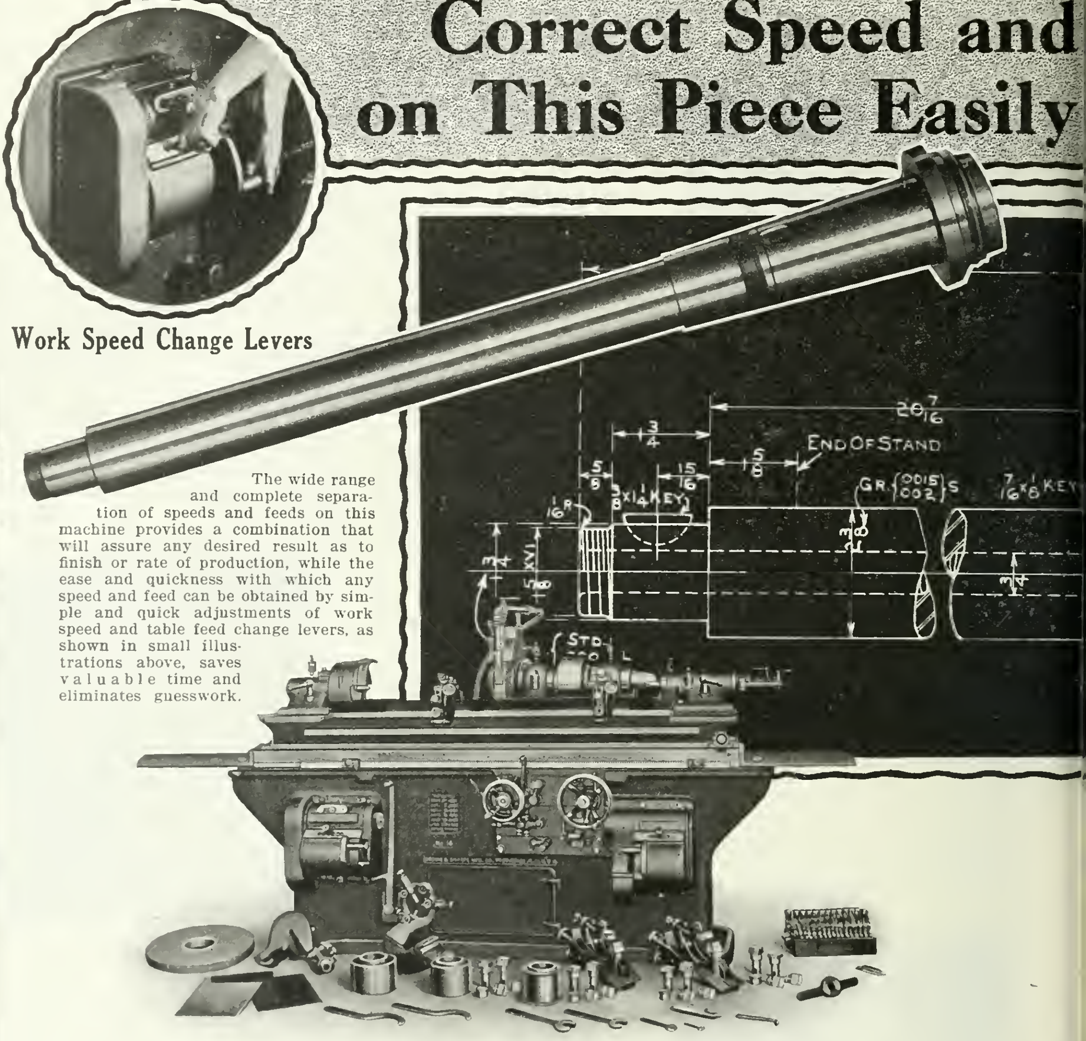

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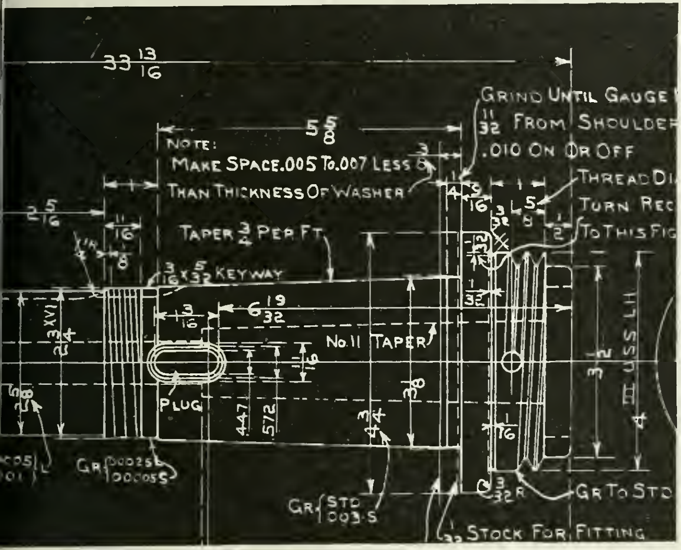


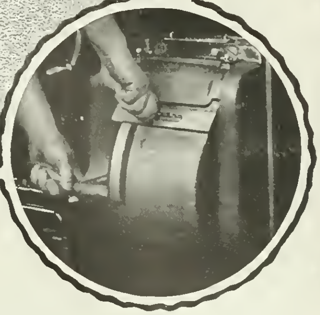
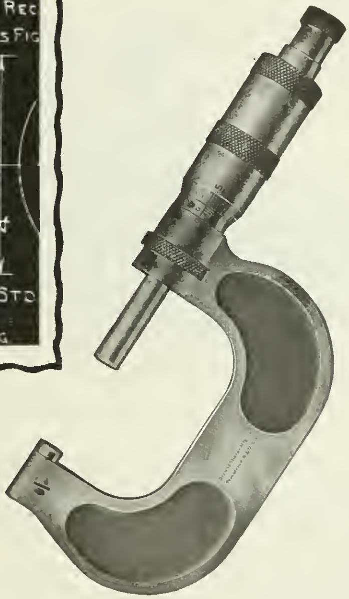


Table Feed Change Levers



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PERSONALS

C. L. Campbell, formerly with the C. A. Strelinger Co., Detroit, Mich., is now employed in the Machinery Sales Department of the Cadillac Tool Co., Detroit, Mich.

C. B. Leeds, formerly with the National Automatic Tool Co., Richmond, Ind., is now employed in the Machinery Sales Department of the Cadillac Tool Co., Detroit, Mich.

E. L. Steinle, who was eastern representative for the Steinle Turret Machine Co., is now associated with the Machine Tool Engineering Co., Inc., 149 Broadway, New York City.

V. P. Signorelli, who was formerly secretary and assistant treasurer of the Southwark Foundry & Machine Co., Philadelphia, Pa., is now office manager and auditor of the company.

R. W. Ellingham has resigned his position with the Bilton Machine Tool Co., Bridgeport, Conn., to enter the employ of the Heald Machine Co., Worcester, Mass., as works manager.

Charles Vickers has opened an office at 18 Dun Bldg., 110 Pearl St., Buffalo, N. Y., where he will carry on his business as consulting non-ferrous metallurgist and foundry adviser.

John G. Zummach, formerly chief of the Tool Designing Department with the Mitchell Motors Co., Racine, Wis., is now chief engineer and assistant factory manager with the Perfex Radiator Co., Racine, Wis.

A. P. C. Schramm, who has been chief engineer of the Klaxon Co., Newark, N. J., for the past five years, has opened an office as a consulting engineer at 276 Canal St., New York City. His specialty is electrical, industrial, and efficiency engineering.

D. M. Perrill, formerly advertising manager of the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, now has a similar position with the Lyon Metallic Mfg. Co., Aurora, Ill., and is in charge of this company's advertising and sales promotion work.

Howard J. Walls, son of T. P. Walls, president of the T. P. Walls Tool & Supply Co., Inc., 75-77 Walker St., New York City, who was one of the survivors of the *City of Athens*, which was sunk on April 30 by a collision with a French cruiser off Atlantic City, has enlisted in the Marine Corps.

J. M. Riordan, until recently sales engineer of the Grant Lees Gear Co., Cleveland, Ohio, and formerly a representative of the Fellows Gear Shaper Co., of Springfield, Vt., in the central states, is now connected with the sales organization of the Cleveland Milling Machine Co., Cleveland, Ohio.

Wendell P. Norton, works manager for the Hendey Machine Co., Torrington, Conn., and superintendent of the factory for twenty-eight years, has resigned his position, but has not yet announced his plans for the future. Mr. Norton is the inventor of the Norton lathe, manufactured by the Hendey Machine Co.

L. L. Newton, who has been for several years sales manager and secretary of the Luther Grinder Mfg. Co., Milwaukee, Wis., has resigned his position to become manager of the Stegeman Motor Car Co., of Milwaukee. Frank S. Hyland, for several years a member of the Luther sales force, will take Mr. Newton's place.

I. G. Stutsman has been appointed manager of the Milwaukee office of Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York City. Mr. Stutsman was for several years superintendent of the frog and switch shop of the Chicago, Milwaukee, and St. Paul Railroad at Tomah, Wis., and was more recently master mechanic for the Four Lakes Ordnance Co., Madison, Wis.

E. C. Peck, who has been in charge of the Cleveland Twist Drill Co., Cleveland, Ohio, for the past eighteen years as general superintendent, has been made Lieutenant-Colonel in the National Army, and is now chief of the Gage Section of the Engineering Bureau in the Ordnance Department, with headquarters at 451 Pennsylvania Ave., Washington, D. C. The Cleveland Twist Drill Co. has released Mr. Peck to the Government, for patriotic reasons, for the period of the war.

Howard Coonley, president of the Walworth Mfg. Co., Boston, Mass., was selected by Charles M. Schwab to be a vice-president of the Emergency Fleet Corporation and head of the Administration Department. Mr. Coonley is a graduate of Harvard University. In 1914, he accepted the presidency of the Walworth Mfg. Co., and in August, 1917, he reorganized the company and purchased the plant of the National Tube Co. at Kewanee, Ill., manufacturer of fittings, valves, and tools for water, steam, and gas work. Seventy-five heads of departments at the Boston works entertained him at an informal luncheon and presented him with a silver desk set as an expression of their respect and affection.

Charles A. Coffin, chairman of the board of directors of the General Electric Co., Schenectady, N. Y., and head of the Franco-American Clearing House in New York, has been presented with the cross of an officer of the Legion of Honor by the French Government. The presentation was made by the ex-assistant French war secretary, Justin Godart, in recognition of his work at the Franco-American Clearing House, which is now under the direction of the Red Cross, and for his efforts to develop a system of scholarship for Americans in French universities. He succeeded Judge Robert S. Lovett as the head of the committee on cooperation appointed by the Red Cross to negotiate with independent relief organizations. As head of the executive committee of the War Relief Clearing House, he has been very active in war service.

* * *

GASOLINE VAPORS

The danger of gasoline vapors is pointed out in an article in *Safety Engineering*. Unless an ample current of air at considerable velocity is passing, gasoline should not be used to clean an engine or other machinery. Even if there is sufficient air to sweep away the vapors as they are given off, open lights should always be kept at a safe distance, and on the intake side, so that the vapor cannot be carried to them. Many gasoline engines are built with cavities or enclosed spaces, which may be full of gasoline vapor; men using open lights when inspecting or repairing such engines have been severely burned by the ignition of these vapors. To guard against such accidents, all cavities should be blown out with compressed air or steam. If neither is available, the cover should be removed and the vapors fanned out.

Seemingly empty gasoline cans or tanks are probably more dangerous than those filled with gasoline. Usually all the gasoline is not drained off, so that which is left will vaporize, and as this vapor mixes with the air in the can, an explosive mixture may be formed. When a can is being filled, this mixture is forced out and may explode if a flame or spark is near the opening.

* * *

CONVENTION OF THE NATIONAL ASSOCIATION OF MANUFACTURERS

The twenty-third annual convention of the National Association of Manufacturers held at the Waldorf-Astoria Hotel, New York City, May 20-22, was devoted largely to subjects connected with the war. Many addresses indicated how manufacturers should promote the national war program. The conservation of man power, labor supply, mechanical reorganization, fuel, transportation, industrial housing, export trade developments, and many other subjects of vital importance were comprehensively treated with particular reference to the manufacturers' needs. Stephen C. Mason of the McConway & Torley Co., Pittsburg, Pa., was elected president to succeed the late Colonel George Pope. Contrary to the usual custom, the association held no annual banquet, the money usually spent for this purpose having been devoted to Liberty Loan subscriptions. An exhibition devoted to "Conservation of Man Power" was arranged in connection with the convention.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC. REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

of MACHINERY, published monthly on the 1st at New York, N. Y., for April 1, 1918.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the state and county aforesaid, personally appeared Matthew J. O'Neill, who, having been duly sworn according to law, deposes and says that he is the General Manager of MACHINERY and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, The Industrial Press	110-118 Lafayette St., New York
Editor, Erik Oberg	" " " " "
Managing Editor, None	
Business Managers { Alexander Luchars, President	" " " " "
Business Managers { Matthew J. O'Neill, Gen'l Manager	" " " " "

2. That the owners of 1 per cent or more of the total amount of stock are:

The Industrial Press	110-148 Lafayette St., New York
Alexander Luchars	" " " " "
Matthew J. O'Neill	" " " " "
Fred E. Rogers	" " " " "
Louis Pelletier	" " " " "
Erik Oberg	" " " " "
H. L. Ketchum	" " " " "
E. Y. Urban	" " " " "

3. That there are no bondholders, mortgagees, or other security holders.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 1st day of April, 1918.

THOMAS R. WILLIAMS,
(SEAL) Notary Public, Bronx County, No. 61.
Certificate Filed New York County, No. 419.
(My commission expires March 30, 1919.)

Cincinnati Gauging and Inspection Methods

Interchangeability of machine parts is a very flexible term. Even the parts of agricultural machinery are interchangeable, which shows that this word may mean much or little. In machinery construction it must be used in connection with stated or known accuracy limits. The limits to which parts of Cincinnati Millers are made vary from .001″ on some parts to .00025″ on others, and in many cases no tolerance is allowed. When such parts are made interchangeable, the gauging and inspection methods must be rigid.

Gauging Unit Mechanisms — Our unit system of construction demands different gauging methods from those usually employed. Figure 1 shows a set of gauges for testing the alignment of the splined shafts in milling machine knees. This is tested by two indicators, one reading on the top and the other on the side of a master shaft, inserted in the knee. Before making the test, these indicators are set to the master gauges, shown on top of case. This gives us a permanently accurate method of testing, which shows us more closely than any fixed or snap gauge can do whether a shaft is parallel and in its proper position, or in wind and out of position.

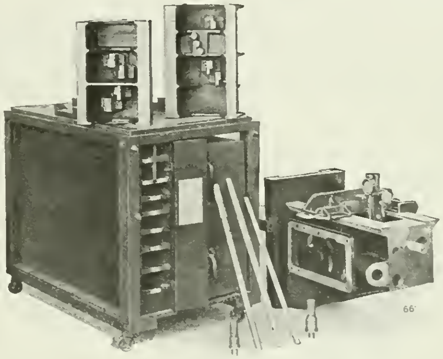

Fig. 1

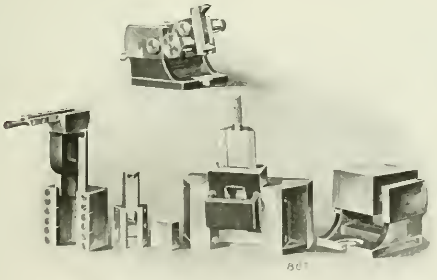

Fig. 2

The Testing Gauges for Our Dividing Head Tailstocks—These tailstocks consist of four parts, all of which slide into each other accurately. These parts are manufactured in lots of fifty. They are absolutely interchangeable in the machining stage, and can be pushed together without any hand work. The final scraping, which merely removes the loose iron, serves to give them a snug sliding fit.

These are only two examples out of many hundreds which we use. You are welcome to inspect these things in our factory at any time.

Let us send you our catalog showing the full line of Millers made by these methods.

THE CINCINNATI MILLING MACHINE CO.
CINCINNATI, OHIO, U. S. A.

COMING EVENTS

June 20-22—Fifth annual convention of the American Drop Forge Association held at the Iroquois Hotel, Buffalo, N. Y. E. B. Horne, "The American Drop Forger," 108 Smithfield St., Pittsburg, Pa., secretary.

June 25-28—Annual meeting of the American Society for Testing Materials, at the University of Pennsylvania, Philadelphia, Pa.

June 26-28—Annual meeting of the American Institute of Electrical Engineers, at Atlantic City. Secretary's address, 29 W. 39th St., New York City.

June 27—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

October 7-12—Joint convention of the American Foundrymen's Association and the American Institute of Metals in Milwaukee, Wis. Concurrent with these meetings there will be an exhibition of foundry equipment, machine tools, and accessories.

SOCIETIES, SCHOOLS AND COLLEGES

Clarkson College of Technology, Potsdam, N. Y. Catalogue for 1918, containing calendar and courses of study.

Northwestern University, Northwestern University Bldg., Chicago, Ill. Catalogue 1917-1918, containing calendar for 1918-1919, courses of study, and other information relating to the university.

Hebrew Technical Institute, Stuyvesant and Ninth Sts., New York City. Catalogue for 1918, containing calendar, courses of study, and other information relative to the work of the institute.

Massachusetts Institute of Technology, Cambridge, Mass. Catalogue for 1917-1918 containing a statement of the requirements for admission, description of the courses of instruction, and other general information about the institute and its educational activities.

Y. M. C. A. National War Work Council, 347 Madison Ave., New York City. Pamphlet entitled "The Association's Obligation in View of Industrial Conditions Created by the War," comprising the report of a conference held under the auspices of the Committee on Work in War Industries of the National War Work Council.

NEW BOOKS AND PAMPHLETS

Lime in 1916. By G. F. Loughlin. 29 pages, 6 by 9 inches. Published by the Department of the Interior, Washington, D. C.

A Study of the Heat Transmission of Building Materials. By A. C. Willard and L. C. Lichty. 60 pages, 6 by 9 inches; illustrated. Published by the Engineering Experiment Station of the University of Illinois, Urbana, Ill., as Bulletin No. 102.

Military Slide-rule. By J. J. Clark. 16 pages, 6 by 9 inches; 3 illustrations. Published by G. W. Richardson, 4210 W. 24th Place, Chicago, Ill. Price, 25 cents.

This book describes the operation of the military slide-rule for the solution of triangles in computing the range of the target.

Aircraft Mechanics Handbook. By Fred H. Colvin. 402 pages, 5 by 7¼ inches; 192 illustrations. Published by McGraw-Hill Book Co., Inc., 239 W. 39th St., New York City. Price, $3, net.

This book is designed to aid the thousands of mechanics who are needed to inspect, adjust, and repair the large air fleet being prepared in this country. The first six chapters are devoted to various phases of airplane construction, after which the various types of engines are described; the common troubles likely to arise are dealt with and their remedies are given. Then follow chapters on the training machines, instruments required, the Lewis machine gun, and British training methods. In the last two chapters are given tables, diagrams, and terms used in aeronautics.

Principles of Mechanism. By Walter H. James and M. C. Mackenzie. 242 pages, 5¼ by 7½ inches; 17 illustrations. Published by John Wiley & Sons, Inc., 432 Fourth Ave., New York City. Price, $1.50.

This book, which is one of the Wiley technical series, has been written especially for use in evening technical schools, trade schools, mechanic arts high schools, etc., where it is desired to teach the subject thoroughly without going into a highly mathematical treatment. Typical problems are solved throughout the text and at the end is an appendix of 22 pages, which contains 110 problems for the students to solve. The nine chapters into which the book is divided are headed as follows: General Definitions, Revolving and Oscillating Bodies; Transmission of Motion by Means of Cylinders, Cones, and Disks, Gears and Gear Teeth; Belts, Ropes, and Chains; Inclined Plane, Wedge, Screw, Worm, and Wheel, Cams, Simple Wheel Trains, and Links and Linkages.

Steel and Its Heat-treatment. By Denison K. Bullens. 483 pages, 6 by 9 inches, 285 illustrations. Published by John Wiley & Sons, Inc., 432 Fourth Ave., New York City. Price, $4.

This is the second edition of the author's work, which has been thoroughly revised and broadened to include additional information of a practical nature. The purpose of the book is to consider more completely the practical aspect of the heat-treatment of steel than has been done in many works in the past that have been written by theoretical metallurgists. The work covers a wide range of subjects, including the testing of steel; heat generation; heat application; forging; structure of steel; annealing; hardening; tempering; carburizing; casehardening; carbon steels; nickel steels; chromium steels; chromium nickel steels; vanadium steels; manganese steels; silicon steels; tungsten steels; molybdenum steels; high-speed steels; tool steel and tools; miscellaneous heat-treatments; pyrometers; and critical range determinations. The book may well be recommended to anyone who wants to study the heat-treatment of various kinds of steels, both from a theoretical and a practical point of view, but it might be mentioned that the work is by no means a primer on the subject, and that the theoretical side has been given quite extended consideration, so that the practical man should not attempt to study the work except with this idea in view.

Modern Locomotive Valves and Valve Gears. By Charles L. McShane. 340 pages, 4¾ by 7¼ inches; 113 illustrations. Published by Griffin & Winters, New York Life Bldg., Chicago, Ill. Price, $2.50.

This book covers the subject of valves and valve gears now in general use and contains much new, up-to-date, practical matter. The movements of the various types of valves and valve gears are explained so as to be as readily understood by the apprentice as by the experienced mechanic. For this reason, considerable space is devoted to definitions and elementary or fundamental principles. Balanced valves are then discussed, there being a description first of the valve and then of the different types, especial attention being paid to the more recent designs. Piston valves are discussed in the same manner, the advantages and disadvantages of the various types being shown. In the chapters dealing with valve gears, considerable space is given to the Walschaert gear, which is so extensively used at the present time. After the principles and construction have been carefully described, methods of handling the engine in case of accidents to the gear are given. Then follow descriptions of the Kingan-Ripkin valve gear device, designed to overcome the slow action of the combination lever, and of the Davis variable lead attachments. The closing chapters of the book deal with the Baker, Southern, and Young valve gears. A well-prepared index with cross-references adds to the value of the book by making it possible to find any item without loss of time.

Managing a Business in War Time. Two volumes; 402 pages, 5 by 8 inches; 81 illustrations; 5 tables. Published by A. W. Shaw Co., Chicago, Ill.

These timely volumes are divided into two parts each. Part I describes England's war-time experiences, each chapter being written by a man prominent in the British industrial world, who tells how he solved the problems he met. Part II was prepared by the editorial staff of "System" and gives hints from the experience war work gave England. Part III, which was obtained from various sources, describes methods by which American business may meet war-time conditions. Part IV deals with some problems that will have to be met after the war, as seen by men who have made a careful study of American industries. The books are full of methods by which all kinds of war-time problems may be solved; but no sales methods are given, the editors feeling that this subject should be avoided entirely. The titles of the various chapters are: Adjusting a Business to War-time Conditions; What American Business Men can Learn from British Experience; War-time Management Methods that have Won Success; How America can Meet War-time Business Conditions; How England is Meeting the Labor Problem; The Problem of Man-power in War Time; Running a Store in War Time; How England Met Six Important War-time Business Problems; Hints on Handling War-time Business; The Biggest War-time Tasks Facing American Business Men; Some Lessons the War Taught England; What can the Business Man Learn from the Soldier?; Pointers Gained Manufacturing Munitions; How Working Hours Affect Output; A Managerial By-product from Munition Work; Training the Boy Worker; The Six Most Important Factors in Meeting War-time Conditions; Food and the War Worker; Women and War Work; How will the War Affect Business?; The Probable Effect of the War upon Prices; How to Get the Most from the Farm; The Twenty Men Behind the Lines; Motor Trucks; A War-time Ally; A Short-cut in Financing; Our Flag: Its Laws and Customs; How to Sell to the Government; More Production with Fewer Men; Financing During the War; War-time Buying Problems; Munitions You can Make with the Equipment You Have; Where will European Competition Find Us Weakest?; What Chance has America after the War?; South American Trade Knocks at the Door; Preparing for the Trade Contest; What I Learned in Europe.

NEW CATALOGUES AND CIRCULARS

Pannier Bros. Stamp Co., Pittsburg, Pa. Catalogue of steel stamps for marking tools, dies, machines, etc.

Lewis M. Ellison, 211 W. Kinzie St., Chicago, Ill. Circular describing and giving price lists of Ellison draft gages.

American Pneumatic Chuck Co., Chicago, Ill. Circular illustrating and describing American air-operated chucks.

National X-Ray Reflector Co., Chicago, Ill. Circulars illustrating "X-ray" reflectors and other lighting devices.

Malm Engineering Co., Philadelphia, Pa. Circulars descriptive of rubber punching machines and gasket trimming machines.

Buffalo Forge Co., Buffalo, N. Y. Catalogue 100, descriptive of portable forges for toolmakers, machinists, boilermakers, blacksmiths, etc.

Electrolytic Oxy-Hydrogen Laboratories, 15 William St., New York City. Bulletin G, descriptive of the Levin oxygen and hydrogen generator.

Warner Elevator Mfg. Co., Cincinnati, Ohio. Bulletins 2850, 3100, and 3200, describing geared automobile elevators and traction elevators for freight service.

Ross Heater & Mfg. Co., 504 Mutual Life Bldg., Buffalo, N. Y. Circular of Ross crosshead-guided expansion joints, multi-head water heaters, and surface condensers.

Terkelsen & Wennberg, 326 A St., Boston, Mass. Circulars of the T. & W. semi-automatic machine presses for composition molding and T. & W. tire wrapping machine.

Boston Gear Works, Norfolk Downs, Quincy, Mass. Catalogue F-8 of spur gears, miter gears, worm-gears, spiral gears, sprockets and chains, universal joints, and ball bearings.

Pond-Robinson Metal Saw Co., Ltd., 1204 Howard St., San Francisco, Cal. Circular outlining the noteworthy features of Robinson's high-speed metal saw for cutting hard metals.

Griscom-Russell Co., 90 West St., New York City. Bulletin 901, illustrating and describing the construction of the "Multiwhirl" cooler for cooling lubricating and quenching oils.

D. A. Hinman & Co., Sandwich, Ill. Leaflet descriptive of bar benders and Sandwich pumping outfits which have been built with especial reference to the needs of the contractor and builder.

Gisholt Machine Co., Madison, Wis. Circular illustrating and describing Gisholt 16-inch simplified lathe for manufacturing operations, and Gisholt 25-inch special boring lathe, showing application for 6-inch shells.

Gisholt Machine Co., Madison, Wis. Circular entitled "Help Win the War by Keeping up Production," illustrating the Gisholt universal tool grinder, and listing the savings which can be effected through its use.

A. M. Byers Co., Pittsburg, Pa. Circular of Byers wrought-iron pipe, showing a photomicrograph of the pipe magnified sixty diameters, which indicates how the slag contained in the iron prevents the pipe from rusting.

Foster Machine Co., Elkhart, Ind. Folder of the H. & M. thread miller, manufactured under the Holden-Morgan patents, illustrating and briefly describing the machine and showing the classes of work for which it is adapted.

Baldwin Locomotive Works, Philadelphia, Pa. Record No. 90, containing an article entitled "The Problem of Motive Power under the National Administration of Railroads," by Alba B. Johnson, president of the Baldwin Locomotive Works.

Ulrich Planfiling Equipment Co., Jamestown, N. Y. Circular of the Ulrich index clip for rolled drawings, "Planfile" for large sheets of cloth or tissue, "Planfile" drawer units for small sized drawings, and steel shelving for filing field and note books.

Armstrong Cork & Insulation Co., Pittsburg, Pa. Pamphlet entitled "Satisfaction or—," treating of the subject of industrial drinking water systems and the application of "Nonpareil" cork covering for insulating pipe lines of drinking water systems.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Leaflet 250, illustrating and describing a light-weight, substantially built, hand magnet for the use of smelters and refiners, metal dealers, iron and brass foundries, machinists, and others in allied lines.

Western Machine Tool Works, Holland, Mich. (Hill, Clarke & Co., Inc., 156 Oliver St., Boston, Mass., agents). Catalogue 9, illustrating and describing in detail three lines of radial drilling machines in sizes from three to eight feet, inclusive.

Link-Belt Co., Chicago, Ill. Book 312, entitled "Link-Belt Silent Chain—the Efficient Drive for Machine Tools," describing the construction of Link-Belt silent chain and showing installations on various types of machine tools in a number of factories.

Evertite Nut Corporation, Detroit, Mich. Booklet describing the "Sta-lok" nut, a lock-nut which is so designed that it will lock onto the bolt more tightly the greater the strain placed upon it to unscrew it, unless a small nail is put into a keyhole provided for the purpose, to prevent a locking ball from acting.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin 1043, containing description and price list of Bachr flexible couplings, which are particularly suitable for use between a motor and the driven machinery, especially where the vibration of the machinery would have a damaging effect upon the motor insulation.

Walcott Lathe Co., Jackson, Mich. Circular of Walcott engine lathes, with quick-change gear-box, three-step cone, and double back-gears, in 14-, 16-, 18-, 20-, 26-, and 29-inch sizes; Walcott tool-room lathes; and improved taper attachment. The Walcott engine lathes are made with either English or metric lead-screws.

Wetmore Mechanical Laboratory Co., Milwaukee, Wis. Leaflet entitled "Wetmore Cutting Tools for Shell Manufacture," illustrating and describing special hand sizing taps, of both the solid and expanding types, for U. S. and British shells; expanding reamers for finish-sizing fuse holes of shells; and special lathe and boring tools.

Pennsylvania Engineering Works, Newcastle, Pa. Catalogue containing a series of views intended to convey in as brief a way as possible the class and

The LUCAS

(OF CLEVELAND)

"PRECISION"

BORING, DRILLING AND

MILLING MACHINE

ALWAYS GOOD

and as time goes on

ALWAYS BETTER

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF **CLEVELAND, O., U.S.A.**

scope of work in which this company specializes. Among the products illustrated are blast furnaces, hot metal mixers, converters, open-hearth furnaces, hot metal cars, and steel ladles.

Lewis-Shepard Co., 48 Binford St., Boston, Mass. Catalogue of the "Jicklift Master Truck," containing views of installations of this elevating truck in various factories, and specifications and dimensions of the different types. The catalogue is made the same size as a letter file folder and is provided with an index tab for convenience in filing.

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. Catalogue 43, illustrating and describing the H-P-M line of hydraulic valves and fittings. H-P-M hydraulic valves are divided into four classes, namely, operating, check, knock-out and safety. In addition to the standard line, a number of valves designed for special purposes are illustrated.

Benjamin Roman, solicitor of patents, 290 Broadway, New York City. Reference chart for machine designers, containing decimal equivalents of fractions of an inch, data relating to strength of materials, dimensions of standard machine screws, decimal equivalents of twist drill and steel wire gage, and formula for the solution of right-angled triangles.

Henry & Wright Mfg. Co., 760 Windsor St., Hartford, Conn. Catalogue of Henry & Wright drilling machines, illustrating and giving specifications for the various classes, which range from single-spindle machines to those having eight spindles. The catalogue also includes a chart of speeds and feeds for drilling, using both carbon steel and high-speed steel drills.

Fulflo Pump Co., 126 Opera Place, Cincinnati, Ohio. Booklet entitled "Scientific Lubrication of Cutting Tools," treating of the history of cutting tool lubrication, purpose of lubricating a cutting tool, volume of coolant necessary, water solutions as coolants, application of coolants, etc. It is claimed that the construction of the "Fulflo" lubricant pump is such that no clogging can occur and the pump cannot lose its prime.

Earle Gear & Machine Co., 4705 Stenton Ave., Philadelphia, Pa. Circular entitled "Economy in Cold-sawing," describing the "Len Simplex" cold metal saw. A summary of the features of design of this machine is given, and the four sizes of both belt- and motor-driven types are illustrated, complete specifications of each size also being given. Illustrations are included showing this tool in actual service on a wide variety of work, as well as views showing the machine adapted for multiple cutting.

Foster Machine Co., Elkhart, Ind. Descriptive catalogue of turret lathes, devoted primarily to a study of increased production on the modern turret lathe. Illustrations and specifications of the Foster 1-B turret lathe are given, and, in addition, a number of examples of correct tooling for different classes of work are given, indicating the possibilities of the machine for rapid and accurate production. The tooling lay-outs are shown in line engravings, and halftone illustrations show the work to be produced.

R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Catalogue of LeBlond lathes, including screw-cutting engine lathes, quick-change engine lathes, rapid-production lathes, automobile manufacturers' lathes, heavy-duty turret lathes, plain chucking lathes, gap lathes, motor-driven lathes, crankshaft lathes, and lathes for special purposes. The catalogue contains a complete description of the various parts and tables of specifications giving the dimensions, capacities, feeds, speeds, etc., of the different sizes and types of lathes.

Ready Tool Co., 650 Railroad Ave., Bridgeport, Conn. Quick-reference catalogue 16, illustrating and describing this company's chrome-nickel lathe tools with tool-steel bearings; shaper and planer tools; tool-holder for bench and watch lathes; boring-tool holders; boring-bars and internal threading tools; cutting-off tools; threading tools; side tools; vise hold-downs; lathe and milling machine dogs; high-speed steel cutters, etc. A price list of extra cutters is also given. The catalogue, which is of the vest-pocket size, will be sent free upon request.

Titanium Bronze Co., Inc., Niagara Falls, N. Y. Catalogue treating of high-conductivity copper castings, which are said to contain only three-tenths of 1 per cent of impurities, guaranteeing a minimum electrical conductivity of 75 per cent, which runs as high as 93 per cent. Photomicrographs are reproduced showing the relative amounts of impurities contained in electrolytic copper and titanium-treated copper, and the effect upon their conductivity. The catalogue also includes a table showing the effect of admixture of copper with specific quantities of various substances.

Rivett Lathe & Grinder Co., Brighton District, Boston, Mass. Catalogue illustrating and describing in detail the improved Rivett thread-cutting tool, an attachment for mounting on the toolpost block of the slide-rest of any standard engine lathe. This tool is adapted for cutting threads of six pitch and finer of any form excepting the square thread. The action of the cutter is clearly illustrated by the reproduction of views showing the development of a V thread. The catalogue is illustrated with numerous halftone engravings which show the construction of the tool very clearly.

Fellows Gear Shaper Co., Springfield, Vt. Catalogue comprising a treatise on the action of involute gearing. The subject has been treated in a simple way, without recourse to the use of higher mathematics, so as to be easily understood by the average shop man. The chapter heads are: Involute Spur Gearing and its Application; The Involute Curve and How it is Applied to Gear Teeth; Definitions of Gear Terms and Tooth Parts; Gear Tooth Systems and Advantages of Involute Gears; Generating Involute Gear Teeth and Interference in Involute Gears; The Gear Shaper Cutter as an Example of Correct Involute Action; Methods of Drawing Involute Tooth Curves; Tables of Gear Tooth Parts. This is the third edition, revised and enlarged, of this catalogue.

Ludlum Steel Co., Watervliet, N. Y. Catalogue of tool steel, 155 pages, 4¾ by 6¾ inches, comprising a treatise on the manufacture of steel and the use of various alloy elements. The book was compiled and written with the thought in mind that it is necessary for the user of tool steel and automobile steels to have a thorough understanding as to the uses of the various alloys used in the manufacture of steel, and the information given is the result of the company's extensive experience in the alloying of steels and comprises, in addition, a compilation of all the published information on the subject. An endeavor has been made to eliminate as far as possible the technical terms and explain the phenomena occurring in iron and steel in terms that the machinist will readily understand. The book deals with the effects of the alloys, change of properties, grain size, structure of steel, etc. A copy will be sent free upon request.

TRADE NOTES

Schoder & Lombard Stamp & Die Co., Inc., is now located in its new factory at 202-204 Center St., New York City.

Machine Tool Engineering Co., manufacturer of railway and machine shop tools and equipment, 149 Broadway, New York City, has been incorporated.

K. & Z. Automatic Screw Co., Defiance, Ohio, has opened a plant for the manufacture of screw machine products and is now in a position to undertake contract work.

Cincinnati Pulley Machinery Co., Cincinnati, Ohio, manufacturer of pulley lathes, is building a large addition to its shop, which will increase the present capacity to a considerable extent.

Wetmore Mechanical Laboratory Co., Milwaukee, Wis., manufacturer of special small tools, has removed its Canadian branch office from Toronto to the New Birks Bldg., Montreal, Canada.

Wadell & Bowen Co., Inc., 109 Tichenor St., Newark, N. J., is now being conducted under the firm name of G. F. Bowen Machine Co., George F. Bowen having acquired the interest of his co-partners in the business.

Bound Brook Oil-less Bearing Co., Bound Brook, N. J., has removed its western office from 308 Moffat Bldg., Detroit, Mich., to Room 1723, Ford Bldg., Detroit. The office is in charge of Harry J. Lindsley, western sales manager.

Defiance Screw Machine Products Co., Defiance, Ohio, has made plans for the erection of a three-story brick building which will be used as an office building, and also for a large two-story addition to the present factory.

Western Tool & Mfg. Co., Springfield, Ohio, has completed the erection of a one-story addition to its plant which will enable the company to take care of the increased demands for its vises, tools, hacksawing machines, and metal furniture.

Federal Machinery Sales Co., 12 N. Jefferson St., Chicago, Ill., has opened a branch office at Room 1320, Majestic Bldg., Milwaukee, Wis., under the supervision of H. L. Cole, who was for several years the Milwaukee manager for Manning, Maxwell & Moore, Inc.

Biggs-Watterson Co., 1235 W. 9th St., Cleveland, Ohio, has opened a store and office at 38 S. Jefferson Ave., Dayton, Ohio, where a line of machine tools and supplies is carried for the convenience of customers in the southern part of Ohio. The store is in charge of M. A. Wertman.

Jas. Clark, Jr., Electric Co., Inc., Louisville, Ky., manufacturer of "Willey" electrically driven tools, has removed its Chicago office from 31 N. Jefferson St. to 23-27 S. Jefferson St., where much larger quarters have been obtained. Oscar P. Wodack is district manager.

A. Gulowsen A.S., of Christiania, Norway, manufacturer of the "Grei" heavy oil engine, has incorporated the Gulowsen Grei Engine Co. at Seattle, Wash., and is erecting a large and modern factory where these engines will be manufactured for supplying the American trade.

American Graphite Co., a subsidiary of the Joseph Dixon Crucible Co., Jersey City, N. J., at its last annual meeting of stockholders, elected the following officers: George T. Smith, president; George E. Long, vice-president; J. H. Schermerhorn, treasurer; and Harry Dailey, secretary.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City, announce the removal of their Boston office from 201 Devonshire St. to 84 State St., Room 906. The St. Louis office of the company has been removed from the Chemical Bldg. to the Pierce Bldg., Room 1352.

Aborn Steel Co., Inc., 26 Clarke St., New York City, has opened a branch office at 520 Marine Bank Bldg., Buffalo, N. Y., in order to take care of its increasing business and provide better service. The Buffalo section is in charge of D. J. Mahoney as district manager for the Aborn Steel Co., Inc., and the Century Steel Works.

Joseph Dixon Crucible Co., Jersey City, N. J., at its last annual stockholders' meeting, elected the following officers: George T. Smith, president; George E. Long, vice president; J. H. Schermerhorn, vice president; Harry Dailey, secretary; William Koester, treasurer; and Albert Norris, assistant secretary and assistant treasurer.

Electric Tool Repair & Maintenance Co., which makes a specialty of repairing all makes of portable drills, grinders, fans, and small power motors, and buys and sells second-hand and rebuilt electric tools, has removed from 31 N. Jefferson St., Chicago, Ill., to larger quarters at 23-27 S. Jefferson St. The president of the concern is Oscar P. Wodack.

Malm Engineering Co., Philadelphia, Pa., has leased the exclusive rights to manufacture rotary punching machinery under patents belonging to the Malm Machine Co., Dayton, Ohio. The Malm Engineering Co. is in a position to offer these rotary punching machines for use in the rubber industry as well as in the metal blanking industry for delivery within sixty days after receipt of order.

Driver-Harris Co., Harrison, N. J., has elected the following officers: Frank L. Driver, president; Arlington Bensel, first vice-president; Leon O. Hart, second vice-president; Frank L. Driver, Jr., third vice-president; Percival E. Reeves, treasurer; Stanley M. Tracy, assistant treasurer; and M. C. Harris, secretary. Wilbur B. Driver, formerly vice-president, has retired from active participation in the business.

Young, Corley, & Dolan, Inc., engineers, contractors, and manufacturers' representatives, moved May 1 from their quarters on the eighth floor of the United States Realty Bldg., 115 Broadway, New York City, to much larger quarters on the tenth floor of the same building, where they occupy one-half of the entire floor. This change was made necessary by the rapid growth of their business, especially the machine and small tool divisions.

Brown Instrument Co., Philadelphia, Pa., has opened a new office at 2086 Railway Exchange Bldg., St. Louis, Mo., in charge of Paul H. Berggreen. The demand for Brown pyrometers and other instruments from the southwestern section of the country has been such that the company has felt it necessary to appoint a representative for that district in order to give more prompt attention to its customers in the vicinity of St. Louis.

Worthington Pump & Machinery Corporation, 115 Broadway, New York City, now operate the following works in the United States: Worthington Works, Harrison, N. J.; Blake & Knowles Works, East Cambridge, Mass.; Deane Works, Holyoke, Mass.; Snow-Holly Works, Buffalo, N. Y.; Power & Mining Machinery Works, Cudahy, Wis.; Laidlaw Works, Cincinnati, Ohio; Jeanesville Works, Hazleton, Pa.; International Gas Engine Works, Cudahy, Wis.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has erected a new factory at South Philadelphia, about nine miles from Philadelphia, which is being devoted entirely to the production of ship propulsion machinery for the Navy and the Merchant Fleet. Two steam railroads, an electric line, and the Delaware River, on which the plant is located, afford means of transportation. It is expected that this plant will eventually be of a size comparable with the East Pittsburg works, which now employ approximately 25,000 people and cover a floor space of over 100 acres.

DeMooy Machine Co., 706 Frankfort Ave., N.W., Cleveland, Ohio, manufacturer of high-speed ball bearing drilling machines, was reorganized in April under the name The Demco Machine Tool Co. The capitalization has been increased from $30,000 to $50,000. This firm now has a line of twenty-four styles of high-speed drilling machines, ranging in capacity up to 3/4 inch, and having from one to four spindles and speeds up to 12,000 revolutions per minute. The officers are Herbert O. Evans, president; Charles H. Loew, treasurer; and Arnold Ruetschi, general manager.

Walcott Lathe Co., Jackson, Mich., is erecting another addition to its plant which will add 75,000 square feet to the present floor space. The company is planning to bring out lathes in sizes of 26, 29, 33, and 36 inches, in addition to continuing its regular line. The Walcott Lathe Co. owns and operates the Jackson Machine Tool Co., manufacturer of die-sinking machines, and also the Jackson Shaper Co., manufacturer of Walcott high-duty crank shapers. Several large tracts of land adjoining the present property have been purchased, and further extensions are contemplated.

Syracuse Alloy Steel Co., Inc., Syracuse, N. Y., was formed some time ago, and is now manufacturing a high-speed steel, the object of which is to produce more work between grindings than ordinary high-speed steels. The officers are F. C. Raab, president; M. C. Warwick, first vice-president and general manager; J. E. Lynch, second vice-president; F. Hertrich, secretary; and C. A. Lawton, treasurer. Mr. Raab and Mr. Lynch have both been metallurgists with the Brown-Lipe-Chapin Co., of Syracuse, for some time, and Mr. Lynch has also had long experience in the production of tool steels. The steel manufactured is known as "Arab" steel, and is at present produced from high-speed steel scrap, chips, and certain proportions of new materials. Mr. Warwick, who acts as general manager, was formerly connected with the Brown-Lipe-Chapin Co. in an executive position.

Independent Pneumatic Tool Co., Chicago, Ill., and Aurora Automatic Machinery Co. have been reorganized and will be operated under one corporate name—the Independent Pneumatic Tool Co.—for convenience in handling business. The new company has been incorporated in the state of Delaware with a capitalization of $3,000,000. Both companies were owned by the same interests, the Independent Pneumatic Tool Co. representing the selling division for the "Thor" pneumatic and electric tools, and the Aurora Automatic Machinery Co. being the manufacturing department. The latter company also manufactures and sells "Thor" motorcycles and gasoline engines. The officers of the new company are John D. Hurley, president; Ralph S. Cooper, vice-president; Fletcher W. Buchanan, secretary; and Edward G. Gustafson, treasurer. The general offices of the company are in the Thor Bldg., 1307 S. Michigan Blvd., Chicago.

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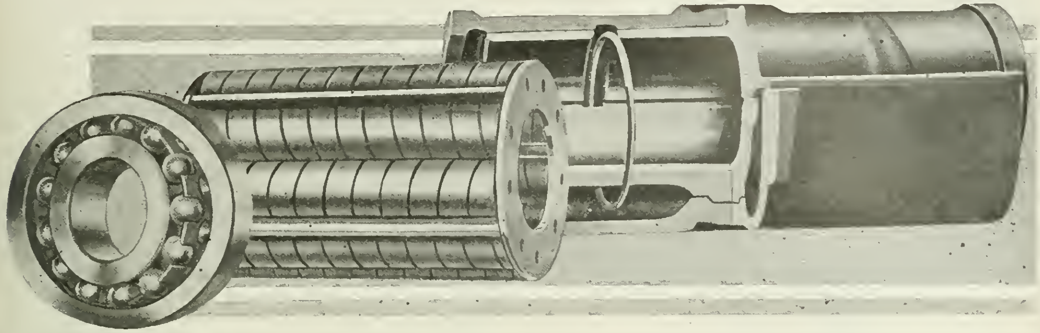

Bearings for Machine Shop Equipment

By Edward K. Hammond[1]

This is the first of a series of three articles dealing with the design of different forms of bearings used in machine shop equipment. Various forms of plain bearings which have demonstrated their ability to give satisfactory service will be illustrated and described in this installment. In the second article of this series, descriptions will be given of the different types of ball bearings and methods of designing mountings for these bearings to meet the requirements of various conditions of service under which ball bearings are used in machine shop equipment. The third and last article of the series will discuss the different types of roller bearings and explain conditions of service under which bearings of this type find successful application in the machine shop.

IN working out the design of journal bearings for use on any type of machine it is necessary for careful consideration to be given to the conditions of service under which each bearing will operate. This is particularly true in the case of bearings used on machine tools, because there is a great amount of variation in the conditions which machine tool bearings are required to fulfill. In bearings for driving shafts, provision made for the efficient transmission of power and freedom from wear are usually the two points of maximum importance; but in the main spindle bearings, these important points may only receive consideration after provision has been made in the design to assure obtaining a bearing which will be a tight running fit when new and in which means are provided to compensate for any wear that may develop after the machine is placed in service. Lost motion in a spindle bearing will show itself by the presence of chatter marks on the work and by difficulty experienced in holding dimensions of the work within the required limits of accuracy. On this account, the designer of machine tool spindle bearings must first consider the conditions under which the bearings are to operate with the idea of fulfilling these requirements without tendency for the bearings to wear excessively.

After this has been done, it is necessary to take steps to work out the design along such lines that convenient means are provided for readily taking up any small amount of wear which may develop in the bearings. Only after provision has been made for maintaining an accurate fit between the spindle and its bearings can the designer turn his attention to the question of transmission efficiency, although this condition must also be fulfilled. There are often special conditions which must be considered in designing bearings in order to assure satisfactory operation. For instance, on grinding machines, trouble would almost surely be experienced through abrasive dust from the wheel finding its way into the bearings and causing them to wear excessively, unless the housings were designed with special provision to exclude dust and other foreign matter from the bearings. This is one typical example of the special conditions which are likely to require careful consideration in working out the design of bearings capable of giving satisfactory service.

Types of Bearings Used in Machine Shops

In taking up this discussion of the different types of journal bearings used in machine shop equipment, there are three classes of bearings which will receive consideration. These are: (1) Plain bearings, which may be made of bronze, babbitt, cast iron, etc.; (2) ball bearings; and (3) roller bearings. Naturally, there are many variations in the design of each of these classes of bearings, which have been worked out by different manufacturers to meet the requirements of various conditions of service. After giving a general description of the different types of bearings and the peculiar advantages of each type for those especial classes of service in which it finds successful application, a description will be given of the modifications in design which have been worked out to meet the requirements of individual classes of service, and in connection with these detailed descriptions, information will be presented concerning various methods of mounting the different types of bearings in machine tools, countershafts, lineshaft hangers, etc., and of the means provided for excluding foreign matter which would tend to abrade the bearings if it found its way between the rubbing surfaces.

Characteristics of Plain Bearings

There are a great variety of plain bearings which have been developed to meet the requirements of different conditions of service under which shafts and spindles are required to operate. In all plain bearings there is surface contact between the shaft and the bearing, and in order to provide for the efficient transmission of power without excessive frictional resistance, wear, and tendency of the bearing to give trouble through heating, it is a matter of general knowledge that a constant supply of clean lubricating oil must be delivered to the bearing, and that this lubricant must be suitable for the conditions of bearing pressure, speed of rotation, etc. The effect of a lubricant is to prevent direct metal-to-metal contact, and some authorities explain this action by comparing the lubricant to the balls in a ball bearing. Where this comparison is made, it is justified on the basis that the lubricant consists of a multitude of small globules of oil which roll between the shaft and its bearing, thus preventing metal-to-metal contact and greatly reducing frictional resistance. In any case, this is the function of the oil film, although whether the globules of oil provide

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[1] Associate Editor of MACHINERY.

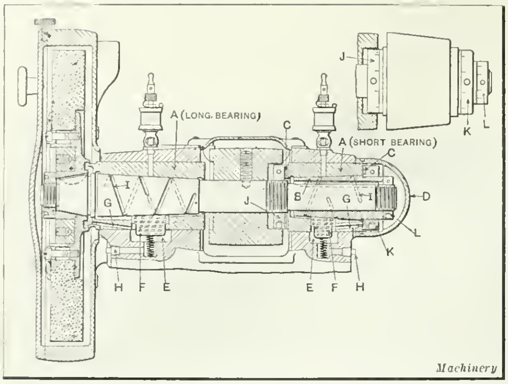


Fig. 1. Design of Spindle Bearings for External Grinding Machine, showing Provision made to compensate for Wear and Method of Lubrication

a true rolling action is largely a matter of hypothesis. Plain bearings are made in a great variety of designs, according to the conditions of service under which they operate; but, as a rule, when bearings of this type are used to support the spindles of machine tools, where the presence of any considerable amount of lost motion would result in inaccuracy of work produced by the machines, means of adjustment are provided to take up any lost motion that develops as a result of wear in the bearing. In the detailed descriptions of different types of plain bearings, which will be given in the following section of this article, an explanation will be presented of the manner in which designers have worked out means of compensating for wear.

Application of Ball Bearings

It was first demonstrated that ball bearings possessed features of practical value at the time that bicycle riding was the vogue. Ball bearings used in bicycles showed conclusively that they were the means of greatly reducing frictional resistance, thus making the operation of the machine far easier. These bearings were of what is commonly known as the "cup-and-cone" type, in which provision was made for adjusting the bearing to regulate the amount of space left between the races to receive the balls. The great weakness of this form of bearing design was that adjustment of the bearings on a bicycle was frequently made by men who had little knowledge of the actual requirements which had to be fulfilled, with the result that the bearings were either adjusted too tight or left too loose; and in either case this was likely to result in an excessive amount of wear, which soon destroyed the usefulness of the bearing. This tendency of the old style of "cup-and-cone" ball bearing used on bicycles to wear out, due to improper adjustment, created an impression among builders of machine tools that a comparatively short operating life was one of the serious limitations of ball bearings. Unfortunately, this impression was considerably strengthened through a similarly limited amount of service secured from ball bearings which were designed and made in the shops of machinery builders by men who had only a very limited knowledge of the requirements which must be fulfilled in order to obtain a ball bearing capable of standing up under the required service.

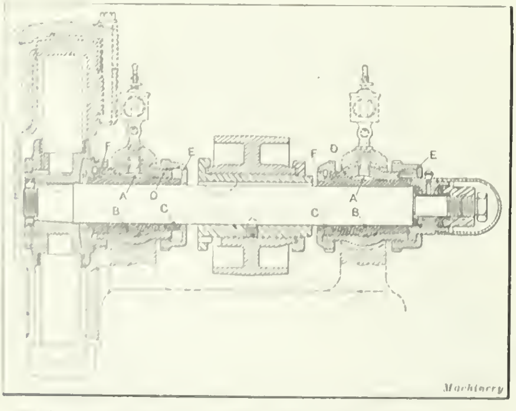


Fig. 2. Another Example of Grinding Machine Spindle Bearing Construction. These Bearings have Means of Compensation for Wear, and the Spherical Seats make them Self-aligning

It was generally conceded by those who experimented with the use of ball bearings that until the bearings started to wear their efficiency in the transmission of power was far in advance of that secured with any form of plain bearing. This high transmission efficiency is due to absence of friction, owing to the fact that, theoretically, there is point contact between the balls in the bearing and the races in which they run, so that the only frictional resistance is that resulting from the rubbing action of the balls on the retainer which distributes them uniformly in the bearing. As a matter of fact, this theory is not quite borne out in practice, because no material is inelastic, and although the steel from which the balls and races of a ball bearing are made is carefully heat-treated to give it the most desirable physical properties, the load on the bearing results in compressing the balls and pushing them slightly below the surface of the races surrounding the points of contact. As a result, there are small surfaces of contact between each ball and the inside and outside races, but these surfaces are very small, so that the balls can roll in the bearing with little frictional resistance.

When the automobile industry began to develop, there came a greatly increased demand for high-grade ball bearings, with the result that this matter was taken up by men of sufficient mechanical and scientific training to enable them to find out definitely the conditions which had to be fulfilled by a high-grade ball bearing in order to enable it to give efficient service over a long period of time. These men were so successful in their work of developing ball bearings to a point where they are of practical value that it is now a recognized fact that almost an absolute freedom from wear is a feature of ball bearings, which is of equal importance with their ability to transmit power with a high degree of efficiency. When it was demonstrated that ball bearings had been developed to a point where they were able to stand up under the conditions imposed upon them in automobile service, builders of machine tools began to see the desirability of applying bearings of this type in order to secure the double benefit of freedom from wear and high efficiency in power transmission.

Use of Ball Bearings in Machine Tools

It will be of interest to note that one of the first successful applications of ball bearings in machine tool construction was to support the thrust of drilling machine spindles. In this service they gave very satisfactory results, and now practically all high-grade drilling machines are furnished with ball bearings to carry the thrust load. Both radial and thrust ball bearings are employed in some cases for supporting the spindles of other types of machine tools besides drilling machines; and ball bearings are also quite generally used in machine tool gear-boxes, countershafts, lineshaft hangers, and in many other places in the machine shop. In order to give satisfactory service, these bearings must be made of the proper quality of steel, and the necessary care must be taken in their production so that the surfaces of both balls and races are free from even the slightest surface defects; the steel must also be of the proper quality and carefully heat-treated to give it the desired physical properties. Ball bearings must also be properly mounted in housings which are so designed that they exclude all dirt and grit from the bearing.

Last, although by no means least, the races and balls must be accurate to 0.0001 inch, because, if this degree of precision is not obtained, there will be a tendency for the load to concentrate on a few balls in the bearing, instead of having this load distributed over all the balls. When such a condition exists, it is quite natural that those balls subjected to an excessive load may start to wear—and the same is true of ball bearings where any surface defects may cause wear to start. Those who have had experience in the use of ball bearings accept it as a demonstrated fact that when wear once starts in a ball bearing, the bearing will deteriorate very rapidly to the point where it is no longer capable of giving efficient service. Accepting this fact, the machine tool builder who is about to adopt the use of ball bearings in his product should be very careful to investigate the quality of the bearings which he proposes using, in order to make sure that they come from a manufacturer who is able to turn out satisfactory bearings and who has the reputation of turning out a product of uniformly high quality. Such ball bearings will give an ample amount of service before showing any signs of wear.

Features of Roller Bearings

Roller bearings are made in various types, in some of which the rollers are straight, while in others they are tapered; also, some types of roller bearings have solid rollers, while in other cases the rollers are made of a piece of steel rolled up into a spiral form which somewhat resembles a helical spring. It is claimed for bearings with rollers of the latter type that, in the event of a sudden increase in load, the shock is absorbed by compressing the rollers without danger of damaging the bearing. Some types of roller bearings with tapered rollers are provided with means of compensating for wear of the rollers and races. Bearings with tapered rollers are also usually capable of carrying some thrust load in addition to the radial load. In any type of roller bearing, the higher transmission efficiency of a roller bearing, as compared with that of a plain bearing, is due to the fact that, theoretically, there are only two lines of contact between each roller and the inner and outer races, respectively, instead of a considerable amount of surface contact between the bearing and the shaft or spindle which rotates in it. Actually, there is a small surface contact between each roller and the races in which it runs, due to the fact that the steel is slightly compressed and distorted through application of the load; but as this distortion is very slight, the area of the surfaces in contact with each other, and the amount of frictional resistance, is considerably less than that which exists in a plain bearing, although the transmission efficiency of roller bearings is not usually as high as that of ball bearings.

Plain Adjustable Bearings for Machine Tool Spindles

In designing the bearings for carrying the spindles of machine tools, it is of absolute importance to develop a construction which will provide means of constantly maintaining a tight fit between the spindle and its bearing boxes, in order to effectually eliminate chatter and vibration. A very little thought will make it obvious that any lost motion in the bearings will result in seriously affecting the accuracy of work produced on the machine and the perfection of finish which it is possible to obtain on the work. Not only must the bearings be a perfect fit at the time the machine is new, but provision must also be made to readily compensate for any wear which develops after the machine is placed in service, so that it will continue to produce work of the required degree of accuracy. To meet the requirements of this service, some form of tapered bronze bearing has been quite generally adopted as a standard spindle bearing construction, although various modifications of this general form of design have been worked out by different machine tool builders to provide for making the adjustment for wear which becomes necessary from time to time. These modifications may be made to meet the requirements of different conditions of service for spindles which are mounted in a vertical or a horizontal position, or they may be worked out simply to meet the individual opinions of different designers. In the following discussion, there are presented descriptions and illustrations of different well-known forms of adjustable spindle bearing designs, which have been found to give satisfactory service.

Grinding Wheel Spindle Bearings

In order to give satisfactory service, the spindle of a grinding machine must rotate without an appreciable amount of vibration; otherwise chatter marks will appear on the work. It is, perhaps, safe to say that, in working out the design of the average grinding machine, more time is given by the designer in developing a satisfactory form of spindle bearing construction and in modifying this design to overcome trouble which is experienced when the first machine is placed in service than in producing satisfactory results in any other part of the mechanism. In Fig. 1 there is shown the standard type of grinding wheel spindle bearing which has been adopted for use on external grinding machines built by the Landis Tool Co., of Waynesboro, Pa. The bronze bushings *A* are assembled in the housings in such a way that expansion and contraction, due to changes in temperature, do not in any way affect the transmission efficiency of the bearings; and compensation for wear provided by the tapered form of the bushings enables all lost motion to be taken up, thus effectually eliminating vibration and enabling the grinding machine to produce perfectly accurate work. Attention is called to the fact that adjustment for wear in the front and rear spindle bearings is made independently, so that if only one bearing requires adjustment, this can be done without touching the other bearing. On these bearings, lubrication is provided by individual sight-feed oil-cups, from which a supply of oil is delivered to a reservoir *E* beneath each of the bearings. Felt wicks take oil from these reservoirs and carry it up to the bearings, the wicks *F* being held in contact with the bearings by means of compression springs. It will be seen that each reservoir is provided with a threaded plug *H*, which may be removed to drain out dirty oil and flush the bearing with kerosene before the plugs are replaced and a fresh supply of lubricating oil is delivered to the reservoir. Drains *G* are provided to prevent the possibility of reservoirs *E* overflowing and flooding the bearings. Oil-distributing grooves *I* are cut in the journals to facilitate the uniform distribution of oil. The way in which these spindle bearings are adjusted will doubtless be apparent from the illustration. Bronze bushings *A* are a press fit in the housings, and journal sleeve *B* is fitted over the back end of the spindle. The thrust load is carried by steel thrust washers *C*. When it is necessary to compensate for wear in the journal bearings, this is done by

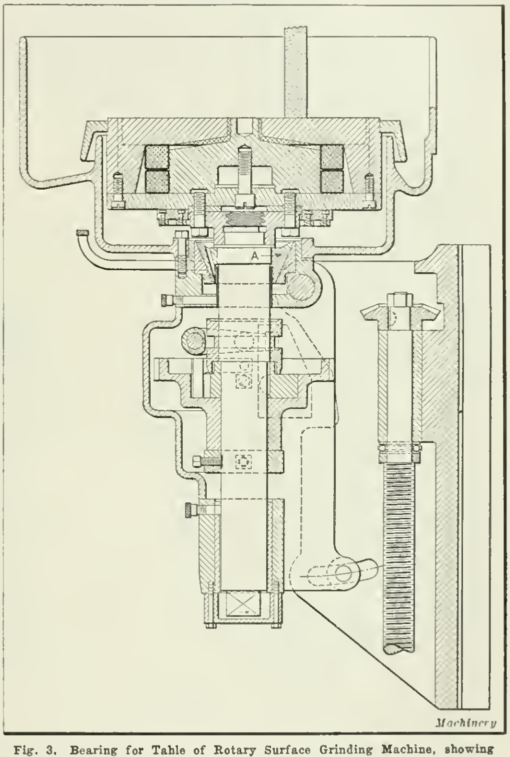


Fig. 3. Bearing for Table of Rotary Surface Grinding Machine, showing Method of automatically compensating for Wear

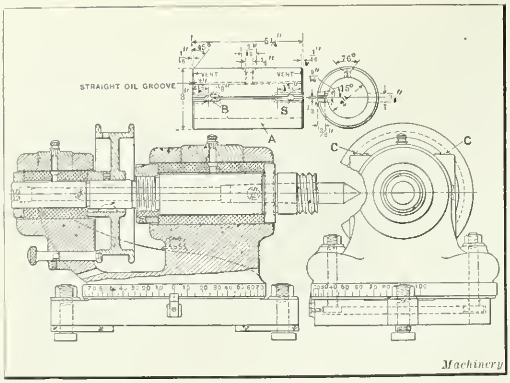


Fig. 4. Straight Cylindrical Spindle Bearings provided with Means of compensating for Wear

releasing collar *J* and tightening *L* to draw the front bearing into its box to take up lost motion; similarly, lost motion in the rear bearing is taken up by releasing collar *K* and tightening *L*, which forces sleeve *B* into the tapered bronze box. Each division on collars *J*, *K*, and *L* gives 0.00052 inch of adjustment on the diameter of the bearings.

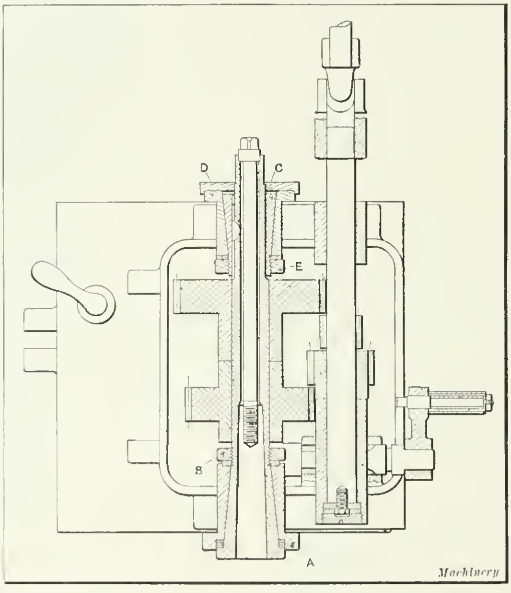


Fig. 5. Design of Adjustable Bearings for Vertical Milling Machine, showing Means of compensating for Wear

Self-aligning Spindle Bearings

Features of particular interest in connection with the design of bearings for the wheel-spindle of a Brown & Sharpe grinding machine, shown in Fig. 2, are the provisions made for lubrication and for the automatic alignment of the bearings with each other. It will be seen that a sight-feed oil-cup is provided at the top of each bearing housing, from which lubricant is delivered to the annular channel *A* cut in the inside of sleeves *D*. Oil runs around this channel and is absorbed by a felt packing or wick *B*, which is contained in a slot cut through the bronze bearing box on the under side of the shaft. This felt packing is kept constantly saturated with oil, and is held against the shaft by a flat spring. As the shaft revolves in the bearing box, the felt distributes a uniform film of oil over the shaft, thus efficiently lubricating the bearing.

In order to assure accurate alignment between the two bearings, it will be seen that each of the bronze boxes *C* is carried in a sleeve *D* that is machined to a spherical form on the outside in order to fit into a corresponding spherical seat in the bearing housing. When a straight shaft is put through bronze bearing boxes *C*, it will be apparent that the bearings will align themselves accurately on account of the ability of the spherical seated sleeves *D* to move as required in the bearing housings. It will be seen that the bronze bushings *C* in these bearings are tapered on the outside and bored straight on the inside; this is not quite so usual an arrangement as that of bronze boxes which are bored to fit a tapered journal on the shaft they are designed to carry. These boxes *C* are split, and in order to compensate for wear, it is necessary to push the tapered outside surface of the box into the tapered seat in sleeve *D*. The boxes and adjusting nuts have beveled ends to keep the bearings expanded in sleeves *D*. First nut *E* is loosened, and then nut *F* is tightened sufficiently to force the bronze box into sleeve *D* and cause it to contract in a way which is made possible by the split construction. After the desired adjustment has been obtained by tightening nut *F*, nut *E* is again tightened against the opposite end of the bearing box, thus locking the box securely against further end movement.

Self-adjusting Vertical Bearing

The upper bearing for the table or chuck of rotary surface grinders built by the Persons-Arter Machine Co., of Worcester, Mass., is provided with means of automatically taking up any wear in the bearing as fast as it develops. The way in which this is accomplished will be readily understood by reference to Fig. 3, where it will be seen that steel collar *A* is shrunk onto the upper end of the spindle and that this collar is tapered on the outside to fit a bronze bearing box of corresponding form. This steel collar *A* acts as a wedge in order to keep the bearing accurately centered, although the angle is such that the bearing runs quite freely and with very little friction. There is said to be absolutely no chance for side play in this spindle bearing which would cause the work-table or magnetic chuck to get out of alignment in any direction. Collar *A* and the bronze box in which it runs are arranged to form an oil reservoir from which a constant supply of lubricant is delivered to the bearing, lubrication being facilitated by spiral grooves in the taper collar which carry the lubricant and distribute it uniformly over the rubbing surfaces.

Adjustable Bearing Box of Straight Cylindrical Form

Still another form of adjustable spindle bearing box is shown in Fig. 4. This is another Brown & Sharpe construction, which has been designed for use in headstock spindle bearings. It will be seen that this box differs from any of the designs which will be shown in this article in that it is of straight cylindrical form on both the inside and outside. The method of making adjustment of the fit of this box on the spindle will be best understood by referring to the detailed view of the box shown at *A*, where it will be seen that a split extends all of the way along one side. Two dovetail slots *B* are machined in this split section to accommodate screws and beveled nuts or sleeves which may be tightened or loosened in order to expand the opening in the box or cause it to be contracted through pressure applied by the cap of the bearing housing. Reference to the end view will show that there are two

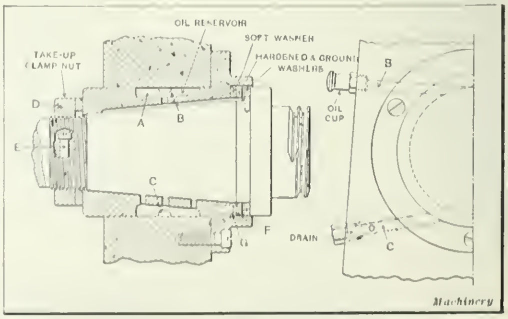


Fig. 6. Adjustable Bronze Spindle Bearing furnished with Means of compensating for Wear and Provision for Continuous Lubrication from a Reservoir

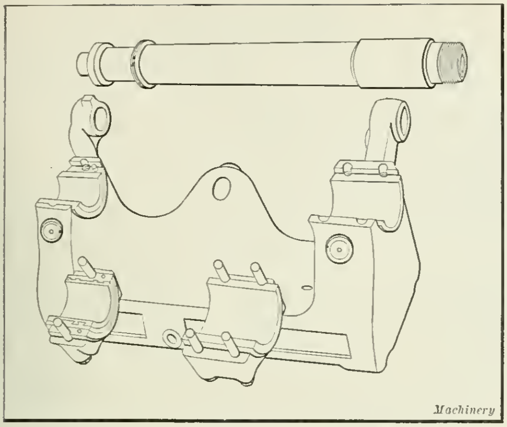


Fig. 7. Example of Spindle Construction used for Lathes, Milling Machines, and Cutter Grinders, where Front Bearing is of Chilled Cast Iron and Rear Bearing is lined with Babbitt

screws *C* which hold the cap of the bearing housing down on top of the bronze box, and when it is desired to secure a tighter fit of the box on the spindle, this result is accomplished by first backing away the screws in the sleeves in slots *B* and then tightening up the screws *C* on the cap of the bearing housing. In this way exactly the required fit for the bearing box may be obtained, and after the bearing has been in service, compensation for wear may be accomplished by further adjustment of screws *C* and the screws which adjust the sleeves fitting into slots *B*.

Examples of Milling Machine Spindle Bearing Design

For supporting the spindle of the vertical milling machine built by the Garvin Machine Co., Spring and Varick Sts., New York City, the following construction has been adopted: At the lower end of the spindle, Fig. 5, there is a bearing box *A* which is bored to a taper corresponding to the tapered journal on the spindle, in order to provide means of taking up any wear that may develop. It will be seen that the spindle is threaded along the straight portion immediately above the tapered journal to receive a threaded collar *B* which provides for holding the spindle up. When lost motion develops it is easily taken up by simply pulling the spindle up into the tapered bearing by tightening collar *B*. To provide for making this adjustment, it is necessary to face off the soft washer between bearing box *A* and the spindle flange. At the upper end, the spindle is straight and it is carried in a bushing *C* which is bored straight on the inside and turned to a taper on the outside, this bushing being secured to the spindle with a Woodruff key so that it is a tight fit. On the outside, bushing *C* is turned to a suitable taper to fit bearing box *D*, and bushing *C* is threaded at the lower end and furnished with a collar *E* which provides for maintaining a tight fit between bushing *C* and bearing box *D*. By screwing up collar *E*, provision is made for taking up any wear which develops in this bearing after the machine is put into service. It will be apparent that the use of bushing *C*, which is keyed to the spindle, is a substitute for having the journal made an integral part of the spindle, as it is at the lower end. The reason for having the upper journal in the form of a bushing keyed to the spindle is that this greatly facilitates the work of assembling the machine. Collars *B* and *E* are provided with split nuts to hold them in place after making the settings.

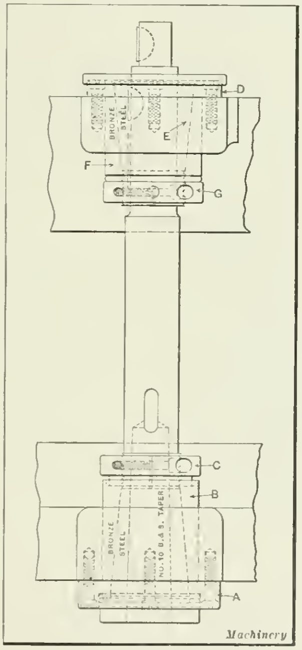


Fig. 8. Adjustable Bearings designed for Vertical Spindle Profiling Machine

Provision for Cleaning Bearings

Fig. 6 shows a form of spindle bearing construction which has been adopted as one of the standards in building machine tools made by the Garvin Machine Co. It will be apparent from the illustration that in working out this design provision has been made for supplying the bearing with lubricant from reservoir *A*, which extends around the outside of the bearing box. A supply of oil is delivered into this reservoir through tube *B* and finds its way from the reservoir to the bearing surface through holes which connect with oil-grooves cut on the inside of the bearing box. When it is desired to clean out the reservoir, this is accomplished by opening drain pipe *C* to allow the dirty oil to run out, after which the bearing is flushed with kerosene before closing drain *C* and filling the reservoir with a supply of fresh oil. It will be apparent from this illustration that the spindle is threaded on the straight portion directly to the left of the tapered journal, in order to provide for drawing the spindle into its tapered bearing box when it becomes necessary to compensate for wear. Before this adjustment can be made, soft washer *G* must be faced off. Collar *D*, by means of which this adjustment is made, is split at one side and furnished with a clamp screw *E*, so that when the bearing has been adjusted to obtain the desired fit, screw *E* is tightened to provide for clamping collar *D* firmly in the exact position to which it has been set. In most machine tool bearings, provision must be made for carrying a thrust load in addition to the normal radial load which comes on the bearing. In the present case, this result is obtained by designing the spindle with a flange at the large end of the taper. This flange bears against two hardened and ground washers *F* and a soft washer *G*, which are placed between the flange on the spindle and the end of the tapered bearing box, the thrust load being carried in this way without imposing an undue strain and unnecessary amount of wear on the bearing.

In Fig. 8 there is shown the form of adjustable bronze bearings which are used for carrying the vertical spindle of the Nos. 2 and 4 profiling machines built by the Garvin Machine Co. As in the case of the bearing design shown in the preceding illustration, it will be seen that provision is made for carrying the thrust load by having a flange at the lower end of the spindle which bears against an arrangement of thrust washers. These washers serve the double purpose of taking the thrust of the spindle and providing means of compensating for any wear and lost motion which may develop in the lower spindle bearing.

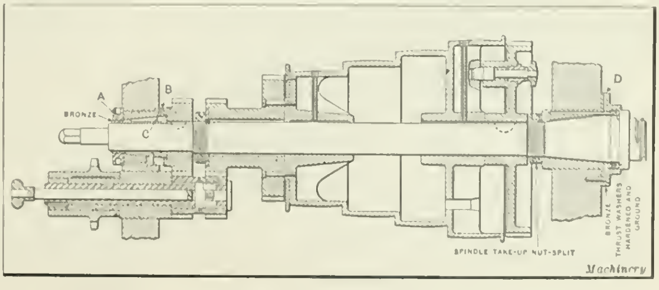


Fig. 9. Example of Bearing Design where Compensation for Wear is accomplished by compressing the Bronze Bearing Box

When wear in the bearing must be compensated for, this is done by facing off the soft thrust washer and tightening collar *C*, which is carried on the threaded section of the spindle, the result being that the spindle is drawn up into the tapered bearing box. At the upper end of the spindle there is a tapered steel bushing *E* which is keyed to the straight end of the spindle with a Woodruff key. On the outside, bushing *E* is machined to a taper to accurately fit bronze bearing box *F*, and when it is necessary to make adjustment to compensate for wear, this result is obtained by tightening threaded collar *G*. It will be apparent that both collars *C* and *G* are split on one side and furnished with binding screws to provide for securing the collars in the desired positions after the required adjustment has been made.

Compensation for Wear by Compressing Bearing Box

In Fig. 9 there is shown a different method of providing compensation for wear in a tapered bronze spindle bearing box. This construction is used on the Garvin No. 2 universal milling machines. At the front end, the spindle is furnished with a bearing box of the same general design as those which have already been described, but at the rear end, as will be seen, the bronze box is split and fitted to the straight end of the spindle, this box being tapered on the outside to engage a bushing in the machine frame with which it remains in fixed contact. Obviously, this necessitates an entirely different method of adjusting the box to afford compensation for wear, and such adjustment is obtained by tightening threaded collar *A* to provide for pulling the tapered bearing box into the bushing in the machine frame. When this collar is tightened to pull the bearing box into the tapered bushing, the bronze box is compressed against the straight journal on the spindle, thus taking up any wear which may have developed. Attention is also called to oil-hole *B*, which delivers a supply of oil into reservoir *C*, formed in this bearing box to provide a liberal supply of oil; the oil flows from the reservoir through oil-holes connecting with grooves machined in the bearing surface of the box to provide for distribution of lubricant over the bearing. The same arrangement of an oil-hole *D* and oil reservoir in the bearing box is provided at the front end of the spindle.

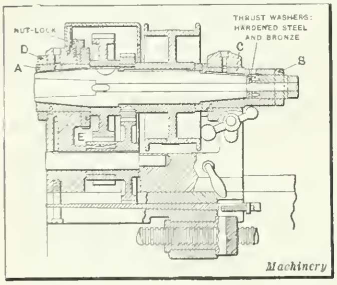


Fig. 10. Bearings designed so that Compensation for Wear is accomplished by drawing Spindle into Tapered Box

Compensation for Wear by Drawing Spindle into Tapered Box

Fig. 10 shows an example of the design of bearings for a machine tool spindle, where the journals are directly supported by tapered bronze boxes at both ends. In order to take up wear which develops in these boxes, the method of procedure is as follows: It will be seen that at the front end of the spindle (which is the left-hand end in this case) a tapered bronze box *A* is provided which is threaded on the outside at both ends. To compensate for wear which may develop in these bearing boxes, the method of procedure is as follows: Threaded collar *B*, carried at the right-hand end of the spindle, is tightened to draw the entire spindle, and hence the tapered bearing at this end of the spindle, back into box *C* to compensate for any lost motion which may have developed as the result of wear. When this result has been obtained, a corresponding adjustment must be made on box *A*, the procedure being as follows: Jam nut *B* is loosened and the rear step plug behind the nut is slacked away, after which threaded collar *D* at the front end of the spindle is loosened and collar *E* is then tightened to draw the front tapered bearing box up to a snug fit on the journal; this also pushes the entire spindle back into the rear tapered bearing *C*. When this result has been obtained, collar *D* is tightened to provide for holding the box in exactly the position in which it has been set. Then the rear step plug is carefully adjusted against the rear end of the spindle and locked by a jam nut *B*. This is another bearing design used by the Garvin Machine Co.

TABLE 1. COMPOSITION OF ALLOYS USED FOR BEARING METALS

Alloys	Lead	Tin	Antimony	Copper	Zinc	Other Constituents
Babbitt 1	80.0	20.0	....	....	....	......
Babbitt 2	72.0	21.0	7.0	....	....	......
Babbitt 3	70.0	10.0	20.0	....	....	......
Babbitt 4	80.5	11.5	7.5	0.5	....	......
Babbitt 5	0.5	68.0	....	1.0	30.5	......
Babbitt 6	....	20.0	....	....	80.0	......
Babbitt 7	....	86.0	10.0	4.0	....	......
White metal 1	82.0	....	12.0	6.0	....	......
White metal 2	3.0	7.6	3.8	2.3	83.3	......
White brass	....	64.0	....	2.0	34.0	......
Bronze 1	11.5	11.5	....	77.0	....	......
Bronze 2	15.0	8.0	....	76.2	....	P = 0.80
Bronze 3	9.5	10.0	....	80.5	....	......
Bronze 4	....	3.0	....	97.0	....	......
Bronze 5	....	15.0	....	85.0	....	......
Bronze 6	15.0	7.0	....	78.0	....	......

Machinery

Note: P indicates phosphorus.

Cast-iron and Babbitt Spindle Bearings

Experience has shown that very satisfactory service is obtained from a hard steel journal running in a cast-iron bearing. With such a combination, it is found that the cast iron has a tendency to become glazed on the surface in such a way that the coefficient of friction between the bearing and its journal is very small, thus making the transmission efficiency of the bearing correspondingly high; also a bearing of this kind is so hard that wear becomes almost a negligible quantity. In Fig. 7 there is shown a type of spindle bearing construction which has been adopted as a standard by the R. K. LeBlond Machine Tool Co., of Cincinnati, Ohio, in building lathes, milling machines, and cutter grinders. This consists of a cast-iron box at the front end and a babbitted box at the rear end of the spindle, and the results obtained by this combination have proved so satisfactory in practice that a detailed description will be of interest.

The spindle is made of 50-point carbon steel, and over this there is pressed at the front end a hardened steel bushing made of Shelby seamless tubing. In making this bushing, the blank is cut off and annealed, after which it is bored, turned, and carburized; then it is necessary to round up the bushing to remove any distortion which has been produced during the heat-treatment, after which it is reheated and quenched in water to make it glass-hard. After hardening, the bushing must show a scleroscope hardness of 80 degrees, and those which fall to fulfill this test are heat-treated again. The hardened bushings are ground on the inside and rough-ground on the outside, after which they are again tested for hardness before being pressed onto the spindle. The fit of the bushing on the spindle is so adjusted that from seven to ten tons' hydraulic pressure is required to push it into place, after which the bushing is ground to standard size. The cast iron for the bearing is cast against a chill to make the metal dense and close-grained. Mention has already been made of the fact that this hardened steel journal is carried in a cast-iron bearing box which is an integral part of the main headstock casting. This eliminates an extra joint between the bronze box or a babbitt-lined bearing, and affords a more rigid construc-

TABLE 2. ALLOWANCE FOR OIL BETWEEN SHAFT AND JOURNAL IN MEDIUM AND HIGH-SPEED BEARINGS

Diameter of Journal	Allowance	Diameter of Journal	Allowance	Diameter of Journal	Allowance
¾ to 1	0.002	3⅝ to 4½	0.005	6	0.009
1⅛ to 2½	0.003	5	0.006	7	0.011
2⅝ to 3½	0.004	5½	0.007	8	0.012

Machinery

tion, although the work of scraping the cast-iron spindle bearing to an accurate fit and perfect alignment is a difficult job, calling for the services of an experienced mechanic. A cast-iron bearing of this type must be more accurately finished than either a babbitted or a bronze-bushed bearing, because no dependence can be placed upon the spindle wearing itself to a satisfactory fit after the machine is placed in service; the bearing must fit properly before the machine is started. Several years ago the R. K. LeBlond Machine Tool Co. built four trial headstocks equipped with the following combinations of journals and bearings: (1) Cast-iron bearings and soft steel spindle; (2) bronze bearings and soft steel spindle; (3) babbitted bearings and soft steel spindle; and (4) cast-iron bearings and hardened steel spindle.

Lathes with spindles of these types were kept in constant use on work of the same general character, and when examined, the condition of the hardened steel journal running in a cast-iron box was found to be the best, neither the spindle nor the box being worn to an appreciable extent and the grinder and scraper marks still being visible. The combination of a soft steel journal and bronze box was in good condition, but the journal was slightly ridged in the center. The soft steel spindle in a cast-iron box was appreciably worn, but the soft steel spindle in a babbitt box was in first-class condition. There are lathes in the LeBlond shops at the present time in which hardened steel spindles have been running in cast-iron boxes for about twelve years without any adjustment having been necessary. The wear is so slight that it can scarcely be measured with the most delicate instruments. It is very important, however, to have the combination of a hardened steel spindle and cast-iron box, because a soft steel spindle and a cast-iron box is much less satisfactory than a soft steel spindle running in either a bronze-bushed or babbitted bearing.

At the rear end, the spindle of LeBlond lathes milling machines, or cutter grinders is supported in a babbitted bearing. It will be seen that the seat for this babbitted bearing is dovetailed and the babbitt is poured, after which the bearing is bored in position. No attempt is made to peen the metal. Experience has shown that wear on the back bearing in a headstock of this construction is proportionate to the wear of the front box with its hardened steel journal running in a cast-iron bearing. Practically no attention is required by bearings of this form after the front bearing has run for a sufficient time to enable the cast iron to become glazed. The metal becomes so hard on the surface that it can scarcely be "touched" with a scraper.

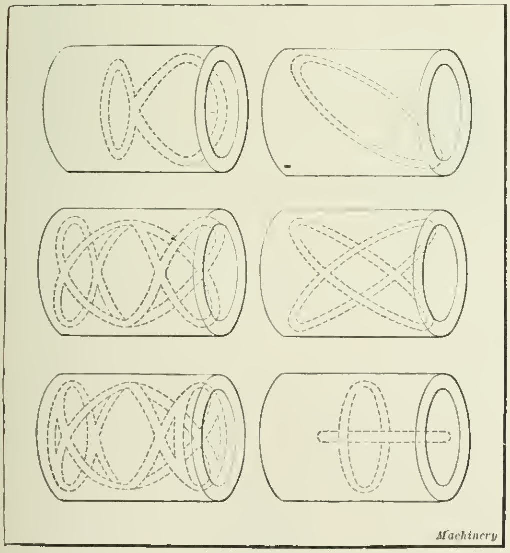


Fig. 11. Examples of Bronze Bearing Bushings showing Different Forms of Oil-grooves

Composition of Metal Alloys Used in Bearing Boxes

Various materials are used for lining plain bearings, among the more common of which are bronze, babbitt, and brass. The principal qualities required of a good bearing metal are that the coefficient of friction between the bearing surface and the steel journal shall be as low as possible, in order to provide for the efficient transmission of power and freedom from both wear and the tendency of the bearing to become heated while in service; also, the metal must possess sufficient compressive strength so that the bearing will not be distorted, due to pressure of the shaft, or broken when subjected to sudden shocks. Bronze is usually understood to be the name given to an alloy of copper and tin as distinguished from brass, which is an alloy of copper and zinc. A bronze is usually understood to have more copper than tin, and the properties of the metal differ widely according to the percentages of these constituents which are present. In general, the alloy tends to harden when tin is present up to 30 per cent, but when this limit is exceeded, the alloy takes on more and more the nature of pure tin. Bronze mixtures commonly used for bearings contain from 3 to 15 per cent of tin and 85 to 97 per cent of copper. Bronze containing over 15 per cent of tin has been recommended in some cases, but, owing to its hardness, such a bearing must be of perfect form before it is placed in service and must be very carefully lubricated. Alloys of copper and tin were originally understood to be true bronzes, and today the term "bronze composition" is used quite commonly to designate alloys of copper, tin, and lead which are used for making bearing boxes. A bearing lined with bronze containing lead is less liable to heat under the same conditions of lubrication, and the rate of wear is also much less. A further advantage is found in the fact that lead is cheaper than tin, so that it is desirable, from a commercial viewpoint, to use an alloy containing as much lead as possible. One bearing bronze of this character contains 78 per cent of copper, 15 per cent of lead, and 7 per cent of tin. By adding from ½ to 1 per cent of nickel to the alloy, more lead may be used.

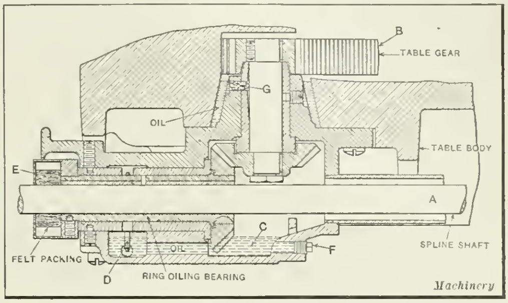


Fig. 12. Method of lubricating Table Gear Bracket of Vertical Surface Grinding Machine

The commonly used babbitt metals consist of alloys of lead, antimony, copper, zinc, and tin in various proportions. Two or more of these constituents may be present. Alloys containing a high percentage of antimony are suitable for use in heavy-duty machinery, as they are harder, while alloys containing a low percentage of antimony are adapted for use in high-speed machinery. Soft babbitts have not sufficient strength to sustain the weight and shock of heavy-duty machinery bearings and can only be used as a liner; even so, the babbitt must be of the proper type, or trouble is likely to be experienced from distortion of the babbitt allowing the shaft to drop and the babbitt metal to be displaced to a position above the shaft, thus throwing machine members out of alignment. Frictional resistance becomes less in alloys containing higher percentages of antimony than is the case where this constituent is present in smaller quantities, and the temperature of the bearing is likewise diminished when running under normal conditions of speed, pressure, and lubrication. In Table 1 is given the composition of various alloys which are commonly used for bearing boxes, and in this connection it will be of interest to note the normal market price of various metals which are constituents of these alloys. They are as follows: Lead, 4 cents per pound; zinc, 5 cents per pound; antimony, 9 cents per pound; copper, 15 cents per pound; and tin, 30 cents per pound. It will, of course, be apparent that these prices are far below those which exist in the present war-time markets.

Clearance between Journals and Bearing Boxes

In designing journals and the bearing boxes in which they are to run, care must be taken to so proportion the sizes of the journal and its box that just a sufficient amount of clearance will be left to provide the necessary space for a film of oil which is required in the bearing. This amount of clearance varies with the diameter of the shaft, and in Table 2 there is given the average amount of clearance which should be left for shafts of different sizes. In order to provide for uniform distribution of oil over the entire surface of a journal bearing, it is common practice to cut what are termed "oil-grooves" in the surface of either the journal or its box. These grooves are usually made in the form of a spiral or some kind of an endless curve, as shown in Fig. 11, which illustrates bearing boxes made by the Bunting Brass & Bronze Co., 748 Spencer St., Toledo, Ohio. Special machines are made for cutting oil-grooves, which provide for handling this work in a more expeditious manner than is possible with hand tools or on machine tools of standard design. There are several reasons for cutting oil-grooves in the form of spirals or other curved shapes, instead of adopting the practice of cutting straight grooves parallel to the axis of the journal. If such a practice were followed, there would be a tendency for oil to gather in the grooves near the bottom of the box, while those on the sides and top would remain empty. With oil-grooves of spiral or similar form, however, this trouble is not experienced and rotation of the journal has the further tendency of circulating the oil through these curved grooves, thus greatly facilitating distribution of the lubricant.

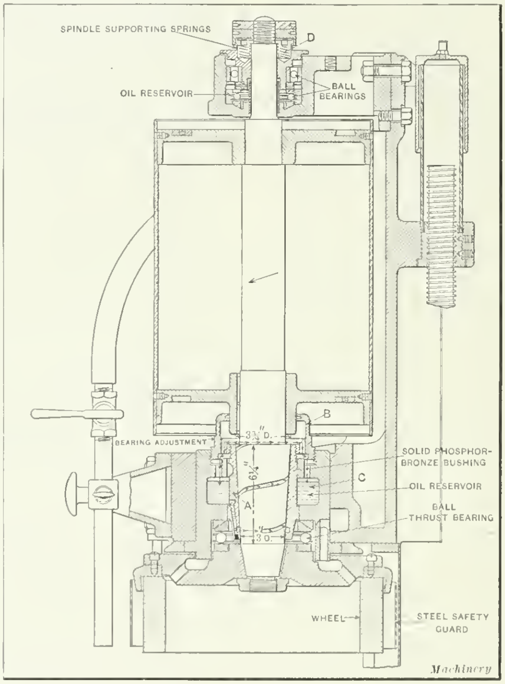


Fig. 13. Provision made for Lubrication of Spindle Bearings of Vertical Surface Grinding Machine

Lubrication of Plain Machine Tool Bearings

The ideal method of lubrication for the bearings in gear-boxes on machine tools and other bearings, where such an arrangement is possible, is to have the gears run in a reservoir filled with oil. This not only avoids wear of the gear teeth, but it also provides for lubrication of the bearings by the well-known splash system of lubrication. Oil-holes are provided at the top of the bearings, so that oil thrown from the gears drops into these holes and provides a continuous flow of lubricant through the bearings. Where this arrangement is employed, an ample amount of lubricant can be put into the reservoir to last for several weeks, the length of time being governed by the conditions of service. A gage-glass is furnished on each reservoir, which shows the level of the oil, and at infrequent intervals it is merely necessary to replenish the supply of oil. When gears are running in mesh, or when a shaft is rotating in its bearing, the effect of friction is to tear off very fine fragments of metal which collect in the oil in such a reservoir; also, there is a tendency for a "muck" to collect in the bottom of the reservoir, due to oxidation of the oil. For these two reasons, and also owing to certain other causes, it is necessary to clean out the oil reservoirs at intervals of about six months. To facilitate this cleaning process, a drain plug should always be provided at the bottom of the reservoir which can be screwed out in order to drain off the dirty oil. The reservoir should then be flushed out with kerosene to clean away all accumulations of metal particles and oxidized oil, after which the drain plug is replaced and the reservoir refilled with clean oil. The same method of lubrication may be employed in the case of lubricant and oil-pumps, table traverse mechanisms, etc.

In the headstocks of "Filsmith" lathes built by the Philip Smith Mfg. Co., of Sidney, Ohio, all bearings are lubricated by the splash system with the exception of the main spindle bearings, which are oiled by sight-feed oil-cups. The reason for this is that it is felt that oil used in a geared headstock is bound to be contaminated with particles of metal abraded from the gear teeth and bearings, and that such impurities should not be allowed to enter the spindle bearings which are directly responsible for the accuracy of work produced on the lathe. This is, of course, a subject upon which there could be considerable discussion. In any case, where headstocks are lubricated by the splash system of oiling, all the oil should be drained from the head occasionally and the head should be thoroughly flushed with kerosene, benzine, or naphtha to clean all residue from the gears, bearings, and inside of the gear-case before a fresh supply of oil is added.

Lubrication of Bearings in Grinding Machines

An example of this method of lubrication is shown in Fig. 12, which illustrates the table gear bracket of the vertical surface grinding machine built by the Blanchard Machine Co., 64 State St., Cambridge, Mass. By building this mechanism as an independent unit, the process of manufacture is simplified, in addition to making provision for the efficient lubrication of the gears and bearings by application of the splash system of oiling. Referring to this illustration, it will be seen that the drive is transmitted through a spline shaft *A* and bevel gears to the table gear *B*. Oil is retained in reservoir *C* at the level indicated by shaded lines, and the bearing of the spline shaft is lubricated by the ring-oiling principle, which will be more fully discussed in connection with another example of bearing design. By this method, ring *D* runs over the bearing to be lubricated and its lower side dips into the oil carried in reservoir *C*. Rotation of the shaft results in continuously turning ring *D*, with the result that oil is carried up by the ring and deposited at the top of the bearing, thus delivering a constant supply of lubricant to the bearing. A felt packing *E* is employed to exclude abrasive dust, which would soon wear out the bearing if special precautions were not taken to prevent it from getting between the rubbing surfaces; and telescopic tubes form an effective seal at the right-hand end of the shaft. When it is required to clean out reservoir *C* by the method which has already been explained, drain plug *F* is withdrawn in order to provide for the escape of dirty oil from the reservoir and the flushing out of the reservoir with kerosene so as to remove all accumulated foreign matter before a fresh supply of lubricant is added.

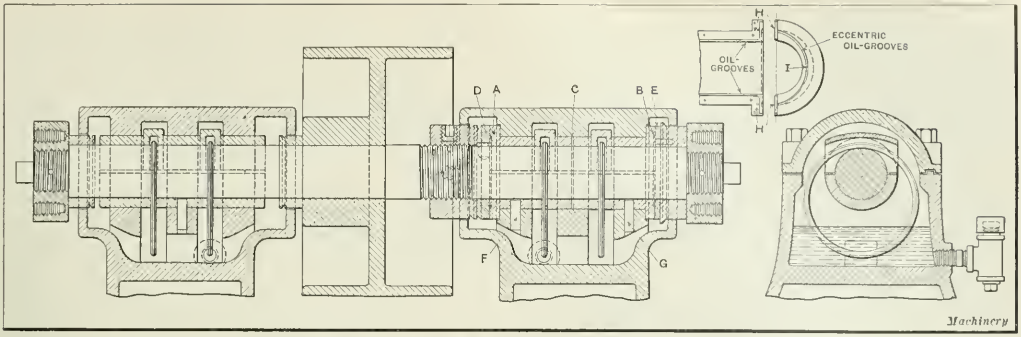


Fig. 14. Application of Ring-oiling Principle for lubricating Combination Radial and Thrust Bearings on Disk Grinding Machine

To provide for lubricating the bearing of the vertical shaft carrying gear *B*, oil is delivered through channels communicating with a felt packing *G* which is in contact with the bearing of the vertical shaft. This packing serves the double purpose of carrying a continuous supply of oil to the bearing and filtering out any foreign matter with which the oil may have become contaminated. Any excess oil which passes through this bearing is caught in the lower reservoir and replenishes the supply of oil for lubricating the gears and the ring-oiled bearing of the horizontal shaft. Felt packings are very generally used in this way to provide for delivering clean oil to bearings of grinding machines and similar equipments where the bearings are so situated that it is difficult to exclude abrasive dust and other substances that would rapidly score and wear out the bearings if they came in contact with the rubbing surfaces.

Provision for Lubricating Vertical Grinding Wheel Spindle Bearing

In Fig. 13 there is shown a cross-sectional view of the wheel-head of a Blanchard belt-driven vertical surface grinding machine; and the design of the bearings for carrying the wheel-spindle, together with the means provided for assuring efficient lubrication, will undoubtedly prove of interest. This entire wheel-head is carried on a vertical slide, so that alignment of the spindle bearings is made entirely independent of the slide. It will be apparent from the illustration that there are ball thrust bearings at both the lower and upper ends of this spindle; and for carrying the radial load there is a bronze bearing at the lower end of the spindle and a radial ball bearing at the upper end. The great advantage of ball bearings in such a case is that they may be packed with grease and housed in such a way that the grease is kept in the bearing and adequate protection is afforded against the entrance of grit and other foreign matter, which would abrade the bearings. With such an arrangement, the bearings require practically no attention, provided they are furnished with the proper kind of lubricant which is chemically neutral; that is to say, free from both acid and alkali. The mounting of these radial and thrust ball bearings conforms with a standard practice, of which a detailed description will be given in a later section of this article, but the reader's attention is called to the hemispherical seats on the races of the ball thrust bearings which fit corresponding surfaces machined to receive them. It is the purpose of this arrangement to have the hemispherical surface on the race adjust itself for slight inaccuracies in alignment or to compensate for slight strains which develop in the wheel-head, thus enabling the bearing to distribute the thrust load over all of the balls and assuring efficient transmission of power.

At the lower end of the spindle there is a tapered bearing which is arranged with the large end of the taper at the top, so that it is impossible to transmit any of the wheel thrust to this bearing. Tapered bronze bushing *A* can be easily raised by turning the threaded ring *B* to provide for taking up any wear which develops between the spindle bearing and its bronze box. This adjusting ring *B* is turned by a spanner wrench and the bronze bushing is not split. The provision of means for delivering lubricant to this tapered spindle bearing is particularly interesting. Lubricant is delivered to an oil reservoir *C*, from which it flows down through a channel cut in the bronze bushing at the left-hand side of the spindle to gain access to the spiral oil-groove which is cut in the journal. Oil is carried up through this groove, and in this way a liberal supply of lubricant is always distributed over the bearing. Upon reaching the top of the bearing, excess oil finds its way into channels at each side of the spindle and flows down through these channels into reservoir *C*, where it is available for subsequent use. By studying the direction of flow, which is indicated by arrows shown in this illustration, the reader will easily obtain a perfectly clear idea of the way in which oil circulates through this bearing.

The upper end of the spindle carries a threaded collar with springs *D* beneath, which press up against it with a force exceeding the weight of the revolving parts by at least five hundred pounds. By this means, the thrust bearing at the lower end, on which depends the accuracy of the grinding, is always kept tight. All backlash in the spindle is eliminated and variations of spindle length with temperature are automatically corrected. The downward reaction of the springs is carried on a ball thrust bearing in the upper box, and side pull at that point, due to the belt, is taken on a radial ball bearing.

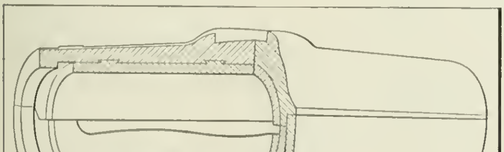


Fig. 15. Self-oiling Type of Bearing where Lubrication is effected by Capillary Action

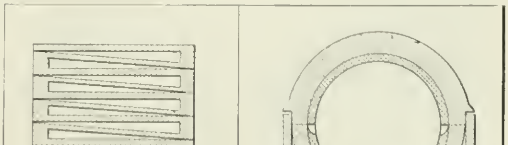


Fig. 16. Diagram illustrating Principle governing Operation of Capillary Bearing

Ring-oiling System of Bearing Lubrication

Another method of providing for automatically delivering oil to a bearing is to furnish one or more rings which are hung over the top of each journal and extend down sufficiently below the journal at the under side so that they dip into a reservoir filled with oil. As the journal rotates, it carries the rings around, thus bringing the portion of each ring which was formerly immersed in the oil up into contact with the top of the journal. The ring carries a considerable amount of oil with it, and in this way a constant supply of oil is deposited on the journal, which assures its efficient lubrication. A good example of the application of ring-oiled bearings in machine tool design is shown in Fig. 14, which illustrates the spindle construction of a disk grinder built by Charles H. Besly & Co., 120 B N. Clinton St., Chicago, Ill. The bearings are so constructed that they are dustproof, which is an important feature on the bearings of any grinding machine, and, in addition to the ring-oiled radial bearings, thrust bearings are provided to support the load which is applied in an endwise direction. This combination radial and double end thrust bearing is automatically oiled.

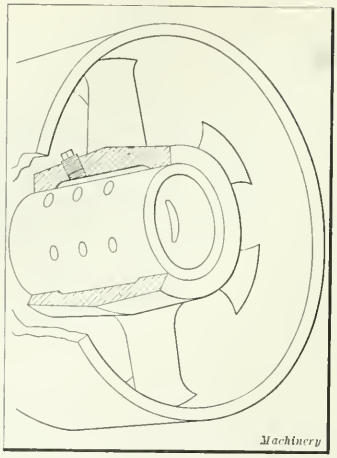


Fig. 17. Bronze Bushing provided with Means of automatically drawing Oil from Supply Reservoir

It is claimed that this ring-oiling device is so efficient in operation that the spindle literally floats on an oil film, thus greatly reducing the amount of power required to drive the machine. Tests which have been conducted to determine the transmission efficiency of these ring-oiling bearings are said to have shown that it is within 2 per cent of the efficiency of ball bearings. In the operation of ring-oiled bearings of this type, the oil should be drawn off about every six months, the exact length of time depending upon the conditions of service under which the bearings are operated. The oil wells have ample capacity; for instance, on the No. 17 Besly disk grinder, with a spindle 2½ inches in diameter, the oil wells are 7 inches deep. Two solid steel rings are provided for each bearing, which operate through channels cut in the bearing bushings in such a way that it is impossible for a ring to be displaced and fail to operate properly. The bearing boxes are split to facilitate assembly, and the housings in which these boxes are inserted are so arranged that replacement of the boxes is an easy matter when this becomes necessary. A special grade of phosphor-bronze is used for the boxes, and they are designed with ample bearing surface so that there is very little wear.

On disk grinding machines, considerable end thrust is set up when work is forced against the grinding wheel, and this is particularly true in the case of machines furnished with a lever feeding mechanism for the work-table. On single-spindle Besly disk grinding machines a grinding wheel is mounted at both ends of the spindle, which makes it necessary to design the bearings in such a way that provision is made for supporting the thrust load which is applied in both directions. It is also important to work out the design in such a way that there will be no end motion of the spindle while a grinding operation is being performed, because this would prevent the work from being ground accurately to size and would make it impossible to produce duplicate parts. End play is taken up by adjusting collars threaded onto the spindle under the flange of the driving pulley. The machine can be safely operated without any end play in the spindle. In Fig. 14 it will be seen that end thrust is supported by flanges *A* and *B* of the right-hand bearing bushing. Attention is called to the fact that this bushing is made in two parts, which are separated at *C* with sufficient clearance space, so that in the event of any longitudinal expansion of the bushing, due to a rise in temperature during operation of the bearing, such expansion is taken up in the clearance space without affecting the lateral adjustment of the spindle; also, there will be no tendency for the bushing to swell outward along the spindle and bind against the thrust collars *D* and *E*, which are located at opposite ends of the radial bearing bushing. Attention is called to the fact that the bushing is anchored in the head of the grinding machine by means of two pins *F* and *G*, which fit into holes that are slightly elongated to permit expansion or contraction of the bushing without causing any unnecessary strain. There are no holes through the caps which cover each of the bearings on this machine, so that it is impossible for grit or dirt to find its way into the bearings.

In working out this design, an interesting method has been provided for lubricating both the thrust and radial bearings. Referring first to the detail view of a part of the bushing which is shown separately, it will be seen that the liner *H* is set back in order to form an oil-groove along the radial bearing at both sides of the spindle. These oil-grooves extend to the end of the bushing and then in an outward direction almost to the periphery of the flanges on the radial bearing which engage the thrust collars. The thrust faces of both flanged ends of the right-hand bearing bushing are grooved, as shown at *I*, and carry oil to all parts of the thrust bearing. The groove is circular in form, but eccentric with the spindle and it is made of such diameter that all portions of the face of each hardened thrust collar which bears against the flange on the radial bearing pass over the oil-groove during one revolution of the spindle, which insures oil reaching all parts of the thrust bearing. Oil is also delivered to this groove from the oil-grooves formed by the bushing liners *H*, to which reference has already been made. As the oil-grooves in the thrust bearings are circular in form. an eccentric with the spindle rotary motion of the thrust collars against the oil in the grooves tends to circulate this oil and provide a copious flow of lubricant. After this type of disk grinder spindle bearing was adopted, it was found practicable to increase the speed 75 per cent where such an increase was desirable.

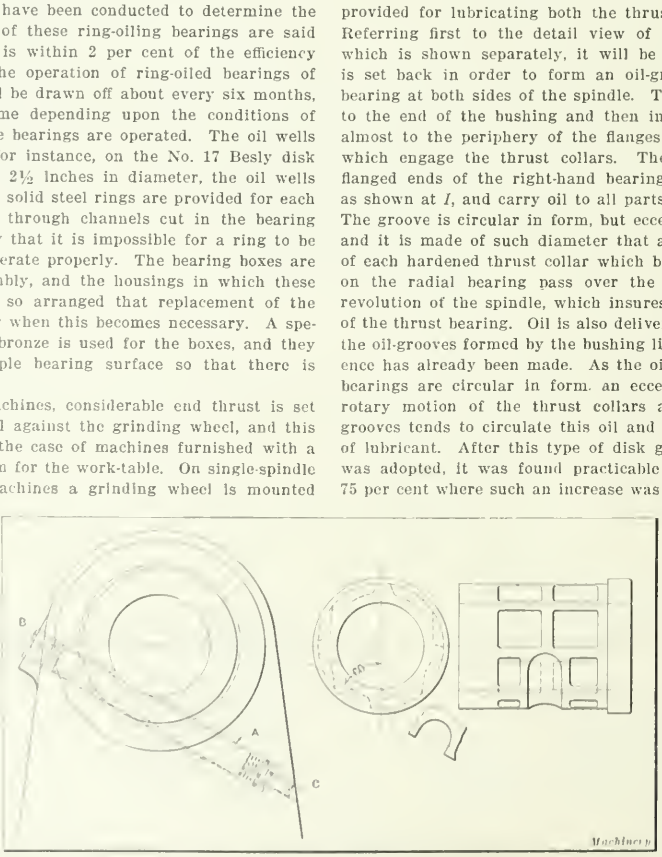


Fig. 18. Provision for lubricating Bearing by holding Oil-soaked Felt Packing in Contact with Bearing by Spring Pressure

Oiling Lineshaft Hanger Bearings

In shops where the equipment is quite congested, it is likely to be found that there is danger of accidents to men whose duty it is to oil the bearings of lineshaft hangers, countershafts, and similar equipment where the bearings are placed in somewhat inaccessible positions. A little time given to the subject of devising meth-

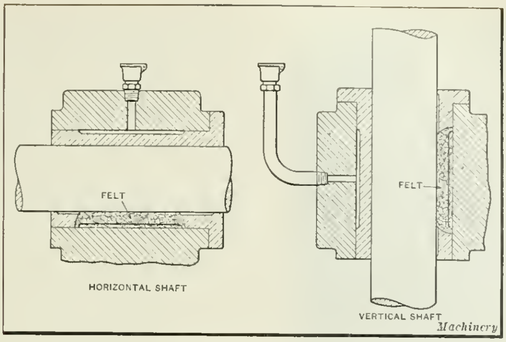


Fig. 19. Method of lubricating Horizontal and Vertical Machine Tool Driving Shafts

ods of lubrication may often be the means of saving serious accidents and consequent litigation over employer's liability. Observation of the following points will often result in saving trouble: Wherever possible, the work of oiling bearings in lineshaft hangers and countershafts should be done while the machinery is not running. A better plan is to equip such bearings with automatic lubricators which only need to be filled at infrequent intervals; with bearings of this type, it is always feasible to arrange to replenish the supply of lubricant at some time when the machines are at rest. It will always happen, however, that certain conditions will arise, making it necessary for shafting to require attention while the machines are running, and to meet such contingencies, safe means of access must be provided, among which mention is made of the following:

Where ladders are used to reach lineshafts and countershafts, they should be provided with hooks or hangers to fit over the shaft at the upper end and spurs at the lower end, which will insure obtaining a secure grip on the floor. With such provision, there is no likelihood of a ladder slipping and causing the workman to be thrown into moving parts of a machine. In big shops it will sometimes be found feasible to have a service platform or "runway" provided with guard rails and toe-boards running parallel to lineshafts, so that any point on the shaft is readily accessible. Moving parts of machinery should not be allowed to project over such a runway, but if such a condition is unavoidable, the moving part should be completely enclosed. In some plants, use is made of a car hung from an I-beam running parallel to the lineshaft, and with such an equipment the oiler can readily move along the shaft to reach all of the bearings. The use of such a car or of the service platform is naturally restricted to quite large shops. Some shops have their men use forced-feed oil-cans of sufficient length so that they can be operated from the floor.

Where men are employed to look after the work of inspecting and oiling shafting and other equipment before the regular starting time of the plant, accidents sometimes happen through the engineer's starting up the machinery before these men have finished their work. This source of danger can be overcome by providing disconnecting appliances which make it possible to cut out any section of the equipment until the work of oiling bearings has been completed. Switches used for this purpose should be provided with padlocks, so that they can be locked in either the open or closed position. If such appliances are not installed, it is a good practice to require a man employed in oiling equipment to report personally to the engineer of the plant that he is going to oil certain machinery. Probably the best safeguard in the lubrication of bearings used in all inaccessible equipment is to adopt the use of one of the so-called "self-oiling" types of bearings which can be furnished with a supply of lubricant that is adequate for a considerable period of time. Bearings of this type are furnished with means of drawing oil from the reservoir and delivering it to the bearing surface, so that constant and efficient lubrication is assured. The features of various bearings of this type are described in the following paragraphs.

Types of Self-oiling Bearings

The so-called "self-oiling" type of bearings may work on either of two principles; oil may be taken from a reservoir and carried up to the bearing by any suitable means, or the bearing box which surrounds the journal may be impregnated with some form of lubricant. The latter type of bearing is often referred to as an "oilless bearing," although in many cases it is found desirable to give bearings of this type perhaps 25 per cent of the quantity of oil which would be required for the efficient operation of a bearing of standard design. The great advantage of self-oiling or oilless bearings is that they do not require as much attention as the ordinary type, and in the event of neglect to supply such bearings with the quantity of lubricant which they are expected to receive, they are capable of operating for a considerable length of time without serious damage.

Dodge Capillary Self-oiling Bearing

In Fig. 15 there is shown what is known as a capillary type of self-oiling bearing, which is suitable for use in lineshaft hangers and similar types of equipment. This bearing is made by the Dodge Mfg. Co., of Mishawaka, Ind. The bearing box has been designed with an opening at the bottom, in which there is inserted a wooden block that extends down through the box for a sufficient distance so that the lower side of the block can dip into an oil reservoir provided in the bearing housing. The block is held against the shaft by a spiral spring, and it has a series of slots sawed in it which come to a sharp angle at one end. It is the tendency of the oil to rise in the narrow end of these slots in the wooden block, as a result of capillary action, which is responsible for carrying oil up to the bearing.

Perhaps a better idea of the arrangement will be secured after referring to Fig. 16, which shows a cross-sectional view of the wooden block, illustrating the way in which it is slotted, and a cross sectional view through the bearing showing how the oil is drawn up in the narrow side of these slots in the wooden block, due to the capillary action which has just been mentioned. A uniform film of oil is maintained on the shaft in this way, and oil-grooves are cut in the bearing box in order that these grooves may be kept full of oil, thus facilitating lubrication of the bearing. As there is no mechanical agitation of the oil contained in the reservoir in this bearing, any foreign matter which is present in the oil is allowed to settle to the bottom, so that only pure oil is admitted to the bearing and no trouble is experienced through grit or other foreign materials rapidly wearing the bearing surfaces. The reservoir in this bearing has sufficient capacity to contain a supply of oil

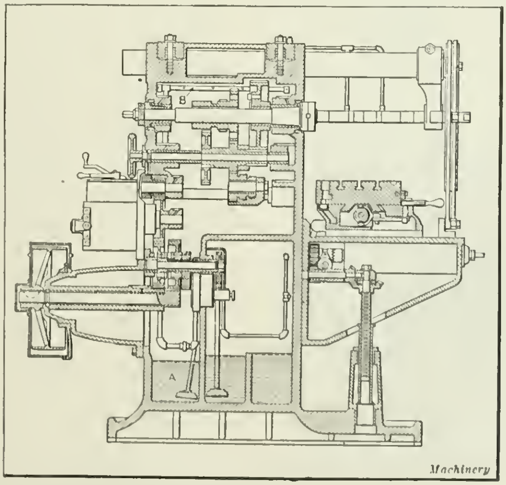


Fig. 20. Provision for delivering Continuous Stream of Oil to All Bearings and Gears in Milling Machine Drive

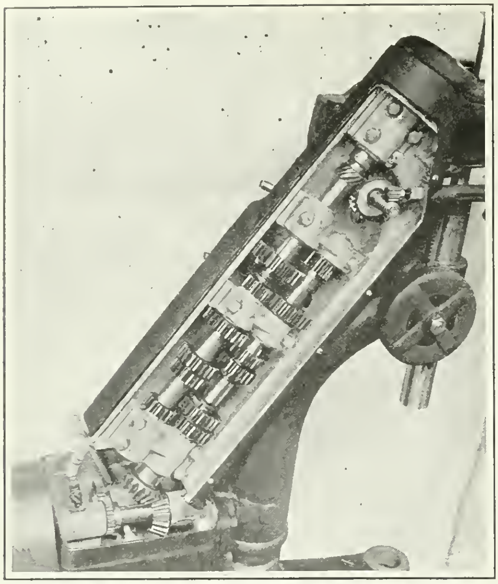


Fig. 21. Provision for Continuous Lubrication of Gears and Bearings on Vertical Drilling Machine

which is adequate to keep the bearing efficiently lubricated for a period of six months. Before replenishing the supply of oil, the bearing should be thoroughly cleaned, and this result is easily accomplished by removing the drain plug at the bottom of the reservoir and flushing the entire bearing with kerosene, after which the plug is replaced and a fresh supply of oil placed in the bearing.

Moccasin Bronze Bushing with Provision for Automatic Lubrication

Another type of self-oiling bearing is shown in Fig. 17, which is especially adapted for use in loose pulleys and similar installations where it is desirable to have the combination of a bronze bearing box and provision for automatic lubrication. This bearing is made by the Moccasin Bushing Co., of Chattanooga, Tenn. It will be seen in the illustration, which shows the method of mounting this bearing, that an oil reservoir is provided in the hub of the loose pulley, and the principle by which lubrication is effected is quite similar to that of the bearing furnished with a wick, through which oil is drawn by capillary action. Moccasin bushings can be used in any type of machine member furnished with an oil cavity from which lubricant can be drawn by the capillary oil-feeders which are contained in holes that pass transversely through the bushing so that they come into contact with the bearing surface in the manner shown on the inside of the bushing. They deliver a continuous supply of oil to the bearing, and are so prepared that they cannot glaze or clog. It is claimed that these bearings prevent the waste of oil, in addition to supplying the bearing with exactly the desired volume of oil which is required for its efficient operation.

Oilless Bearings

The Bound Brook Oilless Bearing Co., of Bound Brook, N. J., manufactures two types of the so-called "oilless" bearings. On the bearing surface, there are cast symmetrical grooves of various designs, depending upon the service for which the bushing is intended. These grooves are packed solid by means of hydraulic pressure with a special hard graphite lubricant. When the bushings are once installed and in use, fine particles of the graphite lubricant are distributed over the entire bearing surface of the bushing. Ample lubrication is provided for almost any form of bearing contact, whether the movement be oscillating, vertical, horizontal, or full revolution. Owing to the scientific design of the graphite grooves which fits them for the particular service required, wear is reduced to a minimum. The design of the graphite-packed grooves varies in different bushings because some bushings are subjected to different kinds of contact from others. These bushings are suitable for use in machine tools, countershafts, lineshaft hangers, electric motors, etc., but, although they are styled "oilless" bearings, it is recommended that about 25 per cent of the volume of oil which would be required to efficiently operate an ordinary plain bearing of the same size should be applied to these Bound Brook oilless bearings. However, in the event of failure on the part of the attendant to give the bearing the required oil, this lack of attention is not so likely to result disastrously, as would be the case with an ordinary bronze-bushed bearing.

The other type of oilless bearing made by the Bound Brook Oilless Bearing Co. consists of a bushing made of either hard maple or iron wood, which is thoroughly impregnated with a mixture of graphite and other lubricant by a special treatment. These are more truly "oilless" bearings than the type that has graphite inserts, because when the bearing is in operation a slight increase in temperature resulting from friction causes the bearing to exude some of the lubricant with which it has been impregnated, thus providing for efficient transmission of power. These bearings are especially adapted for use in loose pulleys; and in many cases they are run without any provision for lubrication. Some users prefer to drill the usual oil-hole in the hub of the pulley and in the bushing, so that a little oil can be added from a squirt can, and very satisfactory results were obtained where the bushings were used in this way. They must be properly supported to prevent splitting, although with sufficient support these wooden bushings have ample strength to resist any crushing load to which they will be subjected when used in loose pulleys and similar positions.

Another type of oilless bearing is made by the Graphite Metallizing Corporation of Yonkers, N. Y. In the manufacture of these bearings, graphite bushings are made of the required sizes, and these are impregnated with white metal or bronze to produce what is known as "graphalloy." In the March number of MACHINERY an article entitled "Manufacture of a Self-lubricating Bearing Material" was published, in which there was given a complete description of the process of manufacturing oilless bearings of this type. Speaking generally, these oilless bearings are adapted for use in light-duty machinery operating at high speed, and for heavier service where the speeds are comparatively low; their use is particularly to be recommended in cases where the application of oil is either objectionable, difficult, or likely to be neglected. In the machine shop, oilless bearings find application chiefly in loose pulleys and conveyor systems, and for supporting shafts which are mounted in a vertical position. As a general rule, the bearing pressure per square inch of projected area should not exceed fifty pounds. When placed in service, the surface of a graphalloy bearing soon becomes coated with graphite which is smooth and very hard.

The Aurora Tool Works, of Aurora, Ind., are using oilless bearings made by the Arguto Oilless Bearing Co., 145 Berkley St., Wayne Junction, Pa., to support the loose pulley on a new drilling machine they have recently placed upon the market, which was illustrated and described in the May number of MACHINERY. The use of this type of bearing was adopted because flooded and splash lubrication is used at other points on the machine, and the oilless bearing avoids danger of lubrication of the loose pulley bearing being neglected. This type of bearing has been found to give very satisfactory results for carrying the loose pulley on this drilling machine.

Lubricating Device for Machine Tool Bearings

There are many different methods in use for applying lubricants to the bearing of machine tools. In Fig. 18 there is shown one method worked out by the Garvin Machine Co. which has given very satisfactory results. Where this method is employed, the bearing box is cut away to receive a metal tube *A* which runs diagonally across the under side of the bearing box, the tube and bearing box being fitted together as indicated. This tube *A* carries a compression spring in its lower end, and at the upper end there is a threaded cap *B* which may be removed to provide for replenishing the supply of lubricant when desired. The tube is filled with felt, and when oil is introduced into the upper end of the tube by removing cap *B*, this felt becomes thoroughly saturated. By means of the compression spring at the lower end of the tube, the felt wiper is always held in contact with the shaft by entering through the section of the bearing box which is cut away for that purpose, with the result that a supply of oil sufficient for the requirements of effective lubrication is continually being applied to the shaft, as it rotates in contact with the oil-soaked felt wiper. This method of lubrication has been found very efficient. At certain intervals, it is found necessary to clean out this tube and to provide for so doing there is a threaded plug *C* carried at the lower end of the tube. This plug is removed and the tube is then drained and flushed with kerosene, after which plug *C* is replaced and a further supply of lubricating oil is poured in at the upper end of the tube.

Method of Lubricating Bronze-bushed Shaft Bearing

In Fig. 19 there is shown a standard form of construction which has been adopted for bearings used to support horizontal and vertical driving shafts on machine tools built by the Morris Machine Tool Co., of Cincinnati, Ohio. Simplicity is the important feature of this construction. Oil is delivered through a tube which carries it into an annular space machined in the outside of the bronze bearing box, and the oil flows around through this space to the opposite side of the box from the point at which the delivery tube is connected. Here there is a slot cut through the box to communicate with the inside or bearing surface, this slot being filled with felt. The oil flows through the felt to the bearing, and the felt serves the double purpose of filtering impurities from the oil and acting as a wiper which distributes the oil evenly over the surface of the bearing which it is required to lubricate.

System of Automatic Flooded Lubrication on Machine Tools

When geared feed-boxes were first developed for use on "Milwaukee" milling machines built by the Kearney & Trecker Co., Milwaukee, Wis., an important step was made in advancing practice in the design of machine tools of this type. It soon became apparent, however, that in order to give efficient service, the gear-boxes would have to be provided with some means of continuous lubrication. After studying the merits of various methods, the design finally adopted consisted in constructing oil-tight boxes, so that the gears dipped into the oil. This result proved so satisfactory that attention was turned to the idea of adopting a geared spindle drive, but to accomplish this result the gears had to be placed one above the other, thus precluding the possibility of having all of the gears dip into an oil bath. Finally, provision was made for lubrication by having the gears placed one above the other and delivering oil to the top gear by means of a pump drawing its supply from a reservoir, as shown in Fig. 20 at *A*, and delivering the oil through holes in pipe *B*. While in operation, a gallon of oil per minute floods down over the gears and bearings. It will be apparent that at the top of each bearing there is a cup which catches part of the oil thrown by the gears and allows it to run down through a duct to the bearings. In this way, both the gears and bearings are kept thoroughly lubricated, so that efficient transmission of power is obtained and wear is reduced to practically the absolute minimum. In ordinary practice, the oil-grooves are closed at the ends to prevent the escape of oil from the bearings, but in the present case the grooves are cut right through to provide for a free circulation of oil and the washing away of all foreign substances from the bearings.

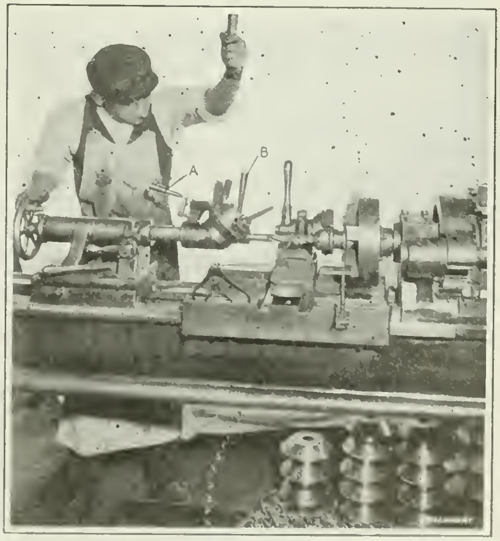
On 20-inch all-geared drilling machines built by the Barnes Drill Co., 814 Chestnut St., Rockford, Ill., all bearings, with the exception of the spindle sleeve and cross-spindles, are continuously oiled by an automatic lubrication system. Oil is delivered by a geared pump in the reservoir of the machine and distributed constantly to all gears and bearings, including the crown gears and feed-box. This automatic lubrication system is manufactured under license from the Kearney & Trecker Co. A close view of the mechanism of one of the Barnes drilling machines is shown in Fig. 21, and the geared pump, which is driven by the constant-speed driving shaft, will be seen at the bottom of the oil reservoir. Oil is drawn into this pump through a strainer, which is also located at the bottom of the reservoir, although it is not shown in the illustration. There is a valve which can be set with just enough resistance to lift the required volume of oil to the crown gear bearings, while the remainder of the oil overflows directly into the oil-hole for the rear bearing. The pipe which will be seen just underneath the "backbone" of the machine, leading up to the crown gears, has small holes drilled in it just above each of the bearings in order that oil may escape to provide for the constant lubrication of bearings on both of the diagonal shafts. A groove is cut inside of each double bearing which leads the oil across to the lower diagonal shaft. A sufficient volume of oil is delivered to the crown gear housing so that the overflow runs into the feed-box, from which it works down through the worm-shaft bearing, and in so doing oils the worm and worm-wheel, after which it is led back into the frame of the machine and cascades back to the original reservoir. In this way, every bearing, aside from the spindle sleeve and cross-spindle bearings, is automatically supplied with a constant stream of oil.

* * *

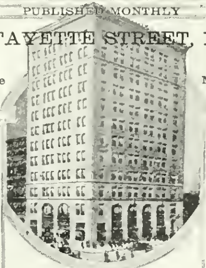
TURRET ATTACHMENT FOR LATHE

In shops where it is occasionally necessary to handle a lathe job requiring the performance of a sequence of operations at a single setting of the work, but where there is not enough work of this kind to warrant the installation of a turret lathe, good results can be obtained with a turret attachment of the kind shown in the accompanying illustration. Here it will be seen that the turret is provided with five holes so that provision is made for handling work where any number of tools from one to five, inclusive, are necessary to perform the required machining operations. To index the turret, lever *A* is pushed down to release the locking pin; the turret is then turned by hand to bring the next tool into the operating position, after which the turret is locked in this position by turning lever *B* which actuates a clamp. The tool in the operating position is the only one in the group which revolves, and feeding of this tool to the work is accomplished by means of the handwheel which traverses the tailstock spindle. It will, of course, be apparent that the attachment is secured to the tailstock spindle by means of a bushing which is clamped over this spindle. This turret attachment, which is made by the Newman Mfg. Co. of Cincinnati, Ohio, provides means for converting an engine lathe into the equivalent of a turret lathe for handling those classes of work which come within its range.

E. K. H.



Lathe equipped with Turret Attachment made by Newman Mfg. Co.



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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

RAILWAY MACHINE TOOL REQUIREMENTS

The needs of our railways for machine tools during and after the war will be considerable; and if recognition of these needs takes the form of orders they will go far toward replacing the lessening demands of munition plants. It is stated that during the years immediately preceding the war the expenditure for machine tools and shop equipment for all the railroads in the United States averaged about $12,000,000 annually. During the last four years, however, that average probably dropped to about $7,000,000; and, because of the increase in prices for machine tools, we may estimate that only about one-third the number of machines was annually purchased during the war. The increased freight and passenger rates should insure a margin of net earnings which our railways have not enjoyed for many years, and the requirements of railroad shops for machine tools are likely to run into millions of dollars annually for a period of years.

* * *

SOME KNOTTY LABOR PROBLEMS

The small manufacturer is facing a difficult problem caused by the high wages paid both skilled and unskilled labor in the munition, shipbuilding, and other industries that have become abnormally active as a consequence of the war. The machine tool industry particularly has lost many good mechanics; because, although it has been prosperous during the past few years, manufacturers are unable to meet the competition of war industries which offer wages more than double those ordinarily paid in the machine tool trade. Another difficulty is the loss of time and decrease in efficiency caused by men "laying off" a day every now and then to look for other jobs with higher wages. One manufacturer says that recently his men averaged only 80 per cent of the full quota of working hours on account of taking time off to find better paying jobs. This, of course, reduced the efficiency of the entire plant 20 per cent; and as these conditions are prevalent in many parts of the country, a marked decrease in efficiency is noticeable. Owing to such circumstances, over which they have no control, manufacturers are unable to meet the delivery dates for war material at a time when there is urgent need for our maximum output

It may be practicable for the Government to take some action to remedy this condition through the new board which is to regulate the relations between employers and labor. There should be some kind of central labor bureau, with the power to decide whether a worker should be permitted to pass from the employ of one concern to another. This would be a better method of handling the problem than the actual conscription of labor, which has been advocated in some quarters. In England one solution of the problem is presented by the Central Labor Bureau and the Volunteer Corps of Mechanics, whose members have agreed to perform mechanical work for the duration of the war wherever the Government needs them.

* * *

THE SALVAGING OF MACHINE TOOLS

Salvaging machinery and tools is a business well worthy of careful study both by users and makers; it promises to become, moreover, an important part of the machine tool industry. The salvaging of such tools as drills, reamers, and milling cutters involves, in general, principles easily understood by the average machinist, but when it comes to the salvaging or rebuilding of machine tools, he is confronted with a more complex proposition; one, in fact, that would make most good machinists pause. They are familiar, in the main, with methods of manufacture which, for the most part, involve the removal of metal in order to form a piece to the desired shape. Manufacture consists, roughly, in cutting away material where it is not needed; but to restore a worn machine tool to first-class condition, it is necessary to resort to various expedients out of the ordinary in machine tool manufacture.

Take, for instance, the case of a pair of worn gears; one, say, is a gear of 80 teeth, 4 diametral pitch, which engages a pinion of 16 teeth. These gears are found to be so badly worn that they must be renewed or restored to a condition as good as new. The large gear is rehobbed to a pitch circle corresponding to 79 teeth, thus producing a slightly thinner tooth than when new. A new pinion gear is hobbed with 17 teeth; and in this way the gearing is restored to a condition as good as new by recutting the large gear and renewing the small and comparatively inexpensive pinion.

The worn slides, especially the ways of lathes, must be replaned, scraped and fitted as if they were new. It is impossible to refit the worn ways by hand methods until the hardened shell formed by the sliding carriage has been removed with the planer tool. The lowering of the saddle requires readjusting of the apron so that engagement of the split nut and the splined feed-shaft will be right. In the case of planers, it is necessary to replane the ways and vees on the table and to cut out a corresponding amount from the rack seat in order to compensate for the metal removed from the ways and vees. Each machine is a study in itself; experience and good judgment are needed in order to obtain a satisfactory remanufactured product at a reasonable cost.

* * *

WEAK HANGER CONSTRUCTION

If safe working conditions are desired in factories, attention must be paid to the construction of shaft hangers, as they are often defective. In one shop recently visited, where a certain kind of hanger had been discontinued on account of its flimsiness, the manager mentioned that the boxes had been suspended between two half-inch screws projecting from two to three inches beyond their supports; in other words, the box had been virtually suspended in mid-air and held only by these small screws against the pull of a four-inch belt. Hangers are not conspicuous and, when once installed, the defects in their construction are not easily observed, which is all the more reason why factory inspectors should give close attention to hanger construction. Workers may easily lose their lives or be crippled as a result of the weakness of a supporting screw that might have been made fifty per cent stronger at an increased cost of not more than five cents. The safety-first campaign has eliminated most of the dangers in machine shops, yet many small details seem to have escaped attention. Weak hanger construction is one of these.

SPEED UP *for* VICTORY

THIS war will be won, not alone by men with bayonets, but by the concentrated efforts of all the men and women of the nation. In these pregnant words, Lieutenant André Morize, of the French Army, concluding his address before the American Society of Mechanical Engineers at the convention in Worcester, summarized in a single sentence the immensity of our task and the great essential to success in the world war for democracy. This telling declaration points the sure and only road to Victory.

We must not only win this war, we must win it soon; and we must avoid anything and everything likely to delay our plans or hamper the production of essential materials. Modern wars are won not merely by men in arms, but also by machinery and material; and the men who produce the machinery and material are as necessary to success as the brave fellows fighting in the trenches. This truth should be brought home to every mechanical man in America—that upon *his* work Victory depends.

Three factors must be coordinated in the drive for Victory: The Ordnance Department that plans the work, the Manufacturer who provides the organization and machinery, and the Toolmakers and Machinists of America upon whose skill and toil the production of war materials must finally depend. If one link in this great chain fails, the whole structure collapses. If we are to have all the rifles, machine guns, heavy artillery, airplanes, tanks, and ammunition required, these three—the Ordnance Department, the Manufacturer, and the Workman—must cooperate intelligently, unselfishly, faithfully.

The Ordnance Department must Speed up for Victory. Work must not be held up pending decisions on petty details by high officials in Washington, when any intelligent mechanic can give the correct answer. The trained judgment of the experienced manufacturer can be trusted in minor details, and his practical advice and cooperation should be enlisted. He wants to help. The constant changing of designs must cease. We must begin to produce, and must learn to let good enough alone. We must profit by the experience of our allies, and not aim at too great originality in our endeavors. The enemy will not wait until the Ordnance Department is ready; the Department must be ready for the enemy. If the reorganization of a department is necessary, speed up the reorganization! Let us lose no more time. We must Speed up for Victory!

The manufacturer must do his share in the speeding up. It may mean smaller profits, but this is no time to think of profits. Criticism of the Government and its policies should cease, except when constructive. Faultfinding—without suggestions that are constructive, practical, and based on knowledge of the facts—is worse than useless. Controversies, either with the Government or with labor, that involve nothing but personal prejudices or opinions, cannot be tolerated now. New methods of training men must be adopted, and the practice of taking trained men from other manufacturers who also work on materials necessary for Victory must cease. To win this war, we must cooperate, not compete.

The third link in the chain is labor. Every man at machine or work-bench must realize that *he* is a soldier in the great war; that *his* efforts are absolutely essential to Victory—to Democracy. The occasional day needlessly lost may mean a life lost at the front. Delay in the completion of a gage may mean delay in the making of a gun that would have held the desperate enemy at a salient in the fields of France. The toolmakers and machinists of America are, in the final analysis, the men who will win or lose this war. They should forget any grievances for the time being, for these weigh nothing in the balance that holds the fate of a nation.

Put in full time! Give the best that is in you! Remember that your work is as important as is the fighting of the boys in the trenches. Will you do your share as they do theirs? It is up to you. Speed up for Victory!

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HOW AMERICAN MECHANICS CAN WIN THE WAR

BY PRODUCING WAR MATERIALS, TOOLMAKERS AND MACHINISTS CAN DO AS MUCH AS MEN IN TRENCHES TOWARD WINNING THE WAR QUICKLY

BY B. M. W. HANSON[1]

WHAT is the most important thing that can be done to facilitate the production of war materials? To that question there is but one answer: Impress the toolmakers, machinists, and machine operators with the importance of the part that they play in the winning of the war; induce them to give their full time and maximum production; tell them to stick to their job, and not change from place to place, wasting the time that we cannot afford to waste; and make them understand that their interests are best served when they, in turn, faithfully serve the nation.

This is a war primarily of materials, not of men. The Allies, with Russia still fighting, were superior in man-power; yet, because of inferior materials, they could not overcome the enemy. Men cannot overcome materials; the partial successes of the last two German drives are proofs of this statement. Hence, to win the war we must create a superiority in materials; and to create this superiority the patriotism and loyalty of every mechanic in America must be aroused as it has never been before. Our men in France have already shown that they are going to do their part, and do it brilliantly. If the mechanics at home will do theirs equally well, there will be a superiority in war materials that will end the war in a fraction of the time that would otherwise be required.

This is No Time for Internal Strife

Labor is now earning higher wages than ever before. Hence, there is no reason for stirring up strife and discontent at this time. To do so at a moment when the country requires the faithful work of every man is to act the part of a traitor. Loyalty and cooperation are now the most necessary qualities required of American mechanics, if we are to be successful in quickly winning the war. Labor, in America, has an opportunity to do what in the past only armies could accomplish. Will labor do its part?

The unrest of labor has been due partly to a belief that the profits of the manufacturers of war materials have been unreasonably large and partly to an effort of men more unscrupulous than patriotic to take advantage of the situation to raise wages abnormally. In so doing, however, they have not held up merely the manufacturer—they have held up the nation itself. As to war profits, it is undoubtedly true that two or three years ago, before our own country was involved, there were many cases of huge profits; but as time has passed, the rising cost of materials, the higher level of wages, and the increased taxation have largely absorbed these profits, and today there are few manufacturers of actual war materials who are getting anything more than a normal and necessary return, and there are some who are not able to obtain even that. The Government is carefully scaling down prices, and this, in combination with rising costs of all kinds, has made excessive profits the exception rather than the rule.

Of course there are cases of profiteering, but these are less frequent in the direct production of war materials than in other lines of manufacture. In one instance, for example, a machine that is being built for $2000—labor, materials, and overhead included—is being sold for $7200. This machine has to be bought by the makers of war materials, so instead of profiteering, many of these manufacturers are themselves subjected to the unscrupulous actions of the profiteer. This sort of thing must stop. We want no more profiteering.

Labor's Opportunity

Labor, again, is paid better in the war manufacturing industries than in any other industry, and has generally shorter working hours. It is, therefore, to be hoped that our machinists and machine operators will realize their duty as Americans and will put into their work the full effort of which they are capable. We cannot afford to move leisurely if we are to win a victory over the still powerful enemy. American mechanics must rise to the occasion with determined loyalty and do their work as English and French mechanics are doing theirs. There are no strikes in France. There is no thought of jeopardizing the armies at the front by men and women at home refusing to work long hours. They know that there is but one way to hold back the enemy: "War materials! More war materials!"

It is to be expected that American mechanics will come forward voluntarily and do all in their power to cooperate with the men who offer their lives in France. The task of those that stay at home is easy. They receive better wages than ever for their work, and they have all the comforts that the American standard of living provides. All that their country asks of them is: "Stay on the job, and do your work to the best of your ability." Surely, American mechanics are not going to refuse to respond to that appeal.

Duty of the Trade and Technical Press

The engineering and technical journals of the United States can do no better service to the country, the industries, and themselves than by voicing this appeal. They reach tens of thousands of intelligent mechanics all over the country, and these men, when they fully understand the situation, will exert their influence on their fellow-workmen so as to counteract any influences that may be at work to destroy the loyalty of the great mechanical army of the nation. German propaganda is working over-time in our factories. It now clothes itself in the guise of the friend of labor, to instill in the minds of toolmakers and machinists the idea that they are exploited by the makers of munitions; when, as a matter of fact, the nation gives to the workers at this time a greater return than ever, and assures the conscientious mechanic opportunities that were never before within his reach.

To do One's Duty is Not a Sacrifice

The country asks for no sacrifice of the mechanic, as it does of the soldier. There is no sacrifice in working for reasonable hours at good wages or in investing in Liberty Bonds and War Savings Stamps on which a good interest is paid. The American workmen in the machine industries today are making absolutely no sacrifice. It is not a sacrifice to do one's duty. On the other hand, there are many manufacturers who, in order to increase production of war materials, are increasing their plants to such an enormous extent that it is inconceivable that they will ever be able to get full returns on their investment. Yet in the final analysis even these men are not making any sacrifice—they are only doing their duty. But, in addition to not making the sacrifices that are required of a great many other citizens, there is, for the machinist who thinks, and who realizes that he has a stake in the country, this remarkable advantage: He is called upon to serve as a skilled member of the one trade that more than any other will win the war; because to win or not to win is in the hands of the machinists of America. They have the greatest opportunity to prove the importance of their trade that has ever come to any trade or profession. When the war is over, the returning soldiers will tell how they would have been helpless in the face of the German armaments had it not been for the work of the machinists at home who provided the guns and the ammunition that ultimately crushed the enemy.

To combat German propaganda, to tell the mechanics of America that they should be careful of the influence of this secret force, to ask them to stay on the job and to grasp that opportunity that is theirs to go on record as being the most loyal and faithful mainstay of the armies in France, would appear to be the greatest service that journals like MACHINERY can render at this time.

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[1] Superintendent [illegible] General Machine [illegible], Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.

MECHANICAL DATA IN CATALOGUES

VALUE IN DESIGNING FIXTURES

BY ALBERT A. DOWD[1]

Very few machine tool catalogues give sufficient information from the mechanical engineer's standpoint. The selling points of the machine and various features of interest or importance in the construction are carefully mentioned and illustrated, but this is done more to show the superiority of one particular type of machine over another than for any other reason. Yet is selling the machine the sole function of a catalogue? It does not seem to the writer that the sales department should dictate or specify the mechanical data to be contained in a catalogue. A machine tool is seldom sold directly on the strength of the talking points noted in a catalogue; usually a salesman must give some additional information before he can make a sale. When a machine tool is purchased, it is natural to assume that the mechanical features have been carefully considered by the chief engineer of the factory or by some other mechanical man familiar with the requirements; to this man the various mechanical features that pertain to the rapid handling of work are of supreme importance. In addition, the qualities of the machine and the way in which it is built will be considered with the greatest care.

Object of Mechanical Data in Catalogues

Suppose that it is desired to make a special tool equipment for a certain operation on work to be handled on a new machine and that the purchaser will not have the machine in his shop for some time. It is obvious that he will desire sufficient information about the machine to enable him to design the tools or fixtures to use with the machine, without having to write to the makers for it. The time required to obtain this information by writing for it, in many cases, will entail a serious delay, especially if the purchaser is in a foreign country. But if the catalogue were made up more carefully, from a mechanical engineer's point of view, a reference to it would give the purchaser all the mechanical data he would need. Within the last year, the writer had occasion to supervise the design of tools, jigs, fixtures, and gages for a foreign motor car, the machine tools for the manufacture of which were purchased in this country and shipped abroad. As the work was done in New York, it was frequently necessary to write to the various manufacturers of machine tools for the information needed to design the tools properly. In many cases there was a delay in obtaining the information and sometimes more than one letter was necessary. Nearly all the information requested would have been contained in the catalogues had they been properly prepared, and then it would have been easy to have designed the tools without taking up any matters with the manufacturers.

Important Information that is Not Given

In the case of a milling machine of the manufacturing type, one of the first things the tool designer needs to know is the width of the table and the dimensions of the T-slot in the table; a careful examination of a number of catalogues showed that nearly all the manufacturers give the width of the table, but very few give the dimensions of the T-slot. This is a small matter, but one that causes trouble in the design of tools. Also, in the case of vises and other tools used in connection with a milling machine, there are not sufficient dimensions given to enable a tool designer to design any part that will be used in connection with them. In the case of a set of vise jaws for a milling machine, the depth, width, length, and the distance between screw holes should be given in diagrammatic form. One catalogue contains a sectional view through a vise in which all the parts are distinctly shown; undoubtedly they are drawn to scale, as the drawing is a carefully made sectional line drawing, and yet not one dimension is given. While a table is given in connection with the illustration, this table gives no information of any importance to a mechanical engineer interested in the design of tools.

In drilling machines of the vertical type, the swing of the machine is frequently given in a misleading fashion. The overhang of the spindle from the column may be given as 9 inches, and yet, due to the offset of the ways from the column, it may not be possible to drill to the center of an 18-inch circle, although it would be assumed that such an operation could be performed.

Perhaps one of the most difficult machines on which to collect sufficient mechanical data is a turret lathe or chucking machine. On these machines there are a number of dimensions that are seldom given in the catalogue, and if any special tooling is to be applied, there is considerable difficulty in obtaining the necessary data unless the machine itself is accessible. If a faceplate of special form is to be applied to a turret lathe for holding a particular piece of work, it is necessary to know the dimensions at the end of the spindle so that the faceplate can be screwed into position; but the writer knows of no catalogue that gives this information. Also, if any special tools are to be applied to the cross-slide, it will be found that there is not sufficient information to allow a drawing to be made and at the same time be sure that the special tool-block will be properly supported. Besides, it is necessary to know the dimensions of special tools and the method of fastening them to the turret face. The amount of clearance over the turret-slide from the center of the turret hole should be given, so that if a tool is designed with a low-hanging part it can be positively decided whether or not this will swing clear as the turret is indexed. In addition, the dimensions between the ways of the machine and the distance from the center of the spindle to the ways should be shown. As a matter of fact, a view looking toward the headstock, showing the various parts in outline, with a few general dimensions, will be of the greatest value in many cases.

Need of Data Concerning Special Tools

In addition to this lack of data, special tools designed for turning various diameters, recessing, boring, and the like are frequently specified in the catalogues, but usually no dimensions are given, so that it is difficult for a tool designer to determine just what work he can do with them without going out into the shop and setting up the machine. If all tools of a special nature were shown as line drawings, properly dimensioned, it would be a great advantage to the tool designer.

At least one well-known manufacturer of machine tools in this country has come to an appreciation of this matter and is seriously considering the preparation of a catalogue based on the facts needed by a mechanical engineer in making up tool equipment for the machine. He believes that there is nothing to conceal in the mechanism of his machine and that the dissemination of a little more information about the construction will not do him any harm. If the machine tool builder will consider his machine from the viewpoint of the mechanical engineer in search of information, he will readily see what information his catalogue lacks. The average machine tool must be considered in conjunction with its tool equipment, and unless this equipment can be properly arranged to produce the work to the best advantage, the machine tool itself is a failure. Therefore, it behooves every manufacturer to give this matter the most serious consideration. If necessary, he should find from his tool department exactly what information it has access to when designing special tool equipment for the machine. It is natural to assume that any information this department may have is complete.

* * *

The National War Labor Board has announced its plans for the settlement of local industrial disputes that might interfere with war work. These plans provide for the appointment of local arbitration committees in industrial cities and subcommittees of the board to act in disputes that local committees fail to settle. The War Labor Board will hear cases only when the subcommittees of the local committees fail or on appeal from their decisions. Appeals will be heard in the following cases: Where the principles established by the President's proclamation have been violated; where an award made by a board has not been put into effect, or where employes have refused to accept or abide by the award; and where there are questions of jurisdiction, as between government boards.

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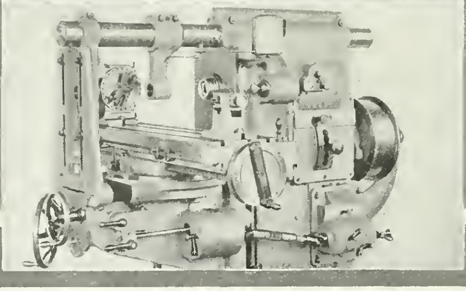
[1] Address: 25 Church St., New York City.

Supports for Milling Machine Arbors

Historical Review Showing Early Designs



Development of Types Now Used

By Luther D. Burlingame[1]

ONE hundred years ago, when Eli Whitney made what was perhaps the first milling machine, it was elementary in character and naturally did not have any means for supporting the outer end of the arbor. About twenty years later, however, as the art of milling developed and became a well-established shop operation, one of the early improvements was to provide such means, first by the use of an overhanging arm combining the center head in the same casting, later by the use of an outer support without an overhanging arm, and finally by the combination of the two. These supports have taken many forms to adapt them to the needs of convenience, stiffness, ease of manufacture, etc., and have expressed the individuality of many designers.

The first known application of an outer support for the arbor of a milling machine had its origin in that pioneer shop in North Chelmsford, Mass., where Gay and Silver evolved so many of the features which have since proved fundamental in the development of machine tools. A Gay and Silver machine having an outer support (Fig. 1) was probably built as early as 1835, and the records show that machines of this design were regularly sold as early as 1841. This machine, which might be classed as of the "manufacturing type," had the overhanging arm cast as a part of the spindle head, and apparently a center carried by this arm was used to support the outer end of the arbor.

"Manufacturing machines" suggesting the Lincoln type of miller, which have since become so well known, were in use as early as Eli Whitney's time, but apparently none of the early designs had any provision for supporting the arbor. The first one found having this feature is accredited to Frederick W. Howe, the support being designed by him while he was with the Robbins & Lawrence Co., of Windsor, Vt., about 1850. This support is shown in Fig. 2 and illustrates not only the first known application of a support to the Lincoln type of milling machine, but also the first application of an outer support carried by the bed of the machine instead of by an overhanging arm.

The cylindrical overhanging arm next appeared, and it also seems to have been first applied to the Lincoln type of machine this being the Root machine, designed about 1854 at Colt's Armory, Hartford, Conn. In this case the arm appears to have been attached to the face of the spindle head rather than extending through it, as in later designs of this type of machine, such as that since made by the Kempsmith Mfg. Co. A center was provided for the outer end of the arbor.

In 1857, Mr. Howe, already referred to in connection with the design of an arbor support, brought out a design of milling machine, while with the Newark Machine Co., which he called a "universal milling machine" and which showed the first application found of an intermediate support carried by an overhanging arm. Fig. 3 shows the arm used by Mr. Howe in this machine. It is of novel design, being a double arm, with each section made rectangular in form. The center head for supporting the end of the arbor was clamped in the space between the two arms and carried a center. The intermediate support engaged the end of the spindle, which, on account of the design of the machine, projected some distance from its front bearing.

Perhaps the earliest use of a cylindrical arm made solid with the spindle head is found in the unusual design brought out by Bement & Dougherty, of Philadelphia, shown by a drawing dated 1861, which is now in the possession of the Brown & Sharpe Mfg. Co. The rights were secured and the manufacture of these machines was undertaken by the latter company in what was for many years well known as their No. 13 plain milling machine. (See Fig. 5.)

Professor John E. Sweet proved a pioneer in many lines of mechanical development and put his impress on milling machine design in 1864 by bringing out a machine at the works of the Sweet & Barnes Co., at Syracuse, N. Y., which seems to be the first of the knee type of machine to have an outer support for the cutter-arbor. Professor Sweet showed himself to be well ahead of the times by his appreciation of the need of a rigid support. He made his support reach from the baseplate to the level of the spindle, with means for clamping to the knee and apparently with an outer bearing instead of merely a center to support the arbor. If this is the case, it is perhaps the first use of such an outer bearing. In a letter from Professor Sweet to the writer in 1914, enclosing a photograph of this machine, he said that he was keeping the machine for some museum, and it is to be hoped that if it has not already found a suitable resting place where it will be preserved, it soon may, as its historic value as a step in the development of the art of milling will increase as time goes on. It would seem that

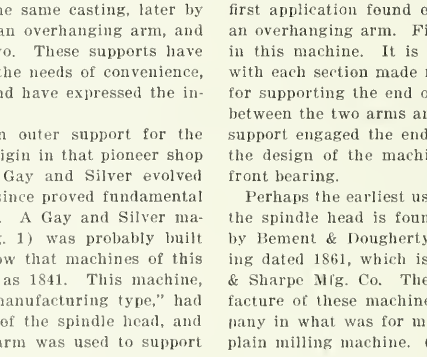


Fig. 1. Gay & Silver Milling Machine having Overhanging Arm or Arbor Support which is Integral with Spindle Head

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[1] Industrial Superintendent, Brown & Sharpe Mfg. Co., Providence, R. I.

Cornell University, the scene of some of Professor Sweet's effective work when in his prime, would be the ideal place for this machine to be preserved. Since the time when the Sweet design was brought out, the feature of supporting the knee and arbor from the base of the machine in cases where special rigidity is required has been used not only in American but also in European practice.

During all these years no example is found of the combination of a brace for the overhanging arm as well as for the cutter-arbor. The earliest application of this kind seems to have been made by the Brown & Sharpe Mfg. Co. in 1873, in order to adapt its No. 1 universal milling machine for use in gear-cutting. This is shown in Fig. 4. A steel bar was bolted to the top of the frame, and this bar was provided with a square thread to allow for adjustment of the arm brace by means of nuts engaging the threads. It also had a keyway at the top to receive the points of two set-screws for clamping in place—a practice which has since been followed for the purpose of holding the center head in alignment, a modification being to provide a flattened spot on the cylindrical arm.

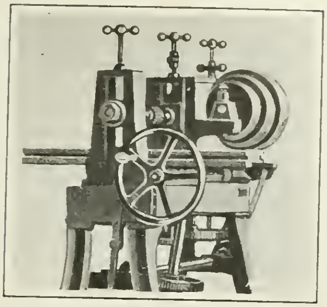

Fig. 2. Howe Milling Machine, designed about 1850, equipped with Arbor Support

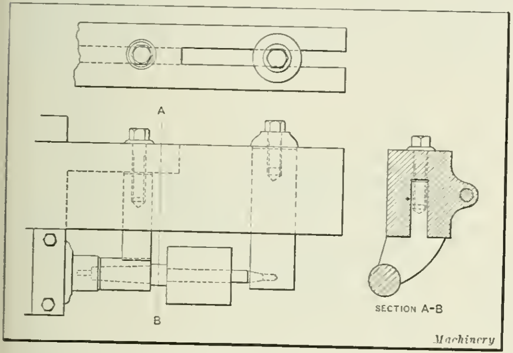

Fig. 3. First Application of Intermediate Support carried by Overhanging Arm; designed by F. W. Howe in 1857

The first regular application of an overhanging arm to a universal milling machine was in 1876, when the large size machine of that type was brought out by the Brown & Sharpe Mfg. Co., having a cast-iron arm as shown in Fig. 6. Up to this time the development in the style of overhanging arms seems to have been along two well-defined lines, one including the use of cylindrical arms, and the other the use of arms with flat or angular ways. In both designs the arms were either made solid with the frame or spindle head, as the case might be, or were bolted in place.

While the double rectangular arms of the Howe design (Fig. 3) were not repeated, many forms of arms other than cylindrical were brought out. Those with angular ways were most common, examples being found on machines made in America, France, and England. A typical one, made by William Muir & Co., of Manchester, England, is shown in Fig. 7, and one of Bariquand & Marre, Paris, France, in Fig. 8. The combination boring and milling machine shown in Fig. 9 was patented by Albert D. Pentz, of Elizabeth, N. J., in 1889, and has flat ways on the overhanging arm and a rack and pinion adjustment for the center head. None of the overhanging arms of either type had been made adjustable in the frames of the machines prior to 1883, and the next step in advance was to make them adjustable so that they could be readily pushed back out of the way or removed. Lawrence Cosgrove, of Baltimore, Md., was the pioneer in this improvement, and machines having solid steel arms, as shown in Fig. 10, were first manufactured by Pedrick & Ayer under the Cosgrove patent. At about the same time, Charles E. Lipe, of Syracuse, N. Y., brought out a novel type of milling machine, which also had an arm sliding in the head. Both the Cosgrove and Lipe patents were purchased by the Brown & Sharpe Mfg. Co., and this and some of the other features of these patents were adopted in its regular line of machines.

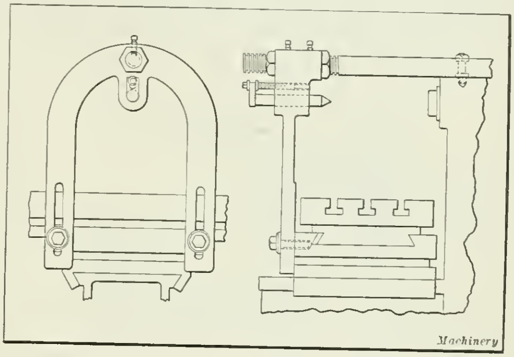

Fig. 4. Combination Brace for Overhanging Arm and Cutter-arbor; designed by Brown & Sharpe Mfg. Co. in 1873

The invention of the double arm brace (Fig. 11) by Charles H. Phillips, of the Brown & Sharpe Mfg. Co., in 1892, added materially to the progress in devising methods of rigidly supporting the outer end of the arbor. This was an important improvement, because at that time there began to be a growing demand for milling machines capable of taking heavy cuts. In the "Wanderer" milling machine, which is of German manufacture, is a combination of the Phillips double arm brace and Professor Sweet's idea of supporting the knee and arbor from the base of the machine. Such a support from the base

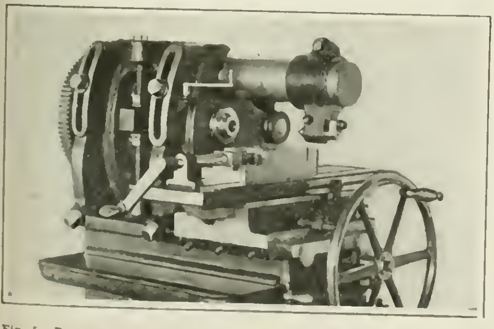

Fig. 5. Brown & Sharpe Machine provided with Cylindrical Arm which is Solid with Spindle Head

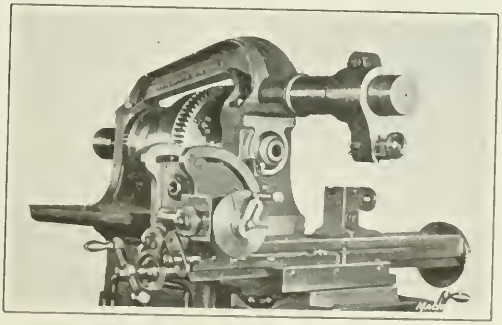

Fig. 6. First Regular Application of Overhanging Arm on Universal Milling Machine

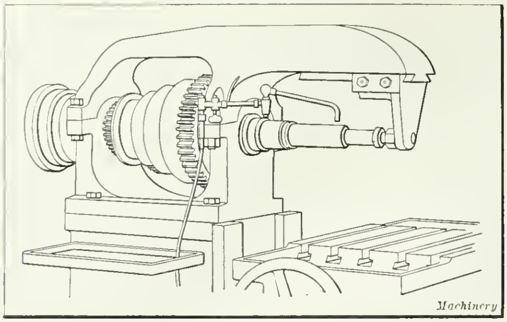

Fig. 7. Overhanging Arm having Angular Ways for Arbor Support

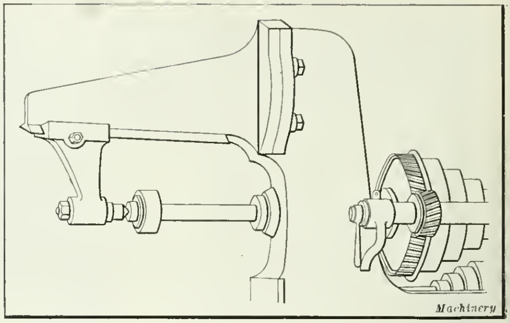

Fig. 8. Removable Overhanging Arm provided with Angular Ways

was also applied to the Muir machine of English manufacture (Fig. 12); the overhanging arm of this machine has angular ways for the arbor support.

Steps for increasing the rigidity of the arbor support in "manufacturing milling machines" showed a development along independent lines. Attention has already been drawn to the double outer support of the Howe machine (Fig. 2). At a later date tie-rods were added, fastened in the head and having a sliding fit in holes in the outer support, with means for clamping after adjustment. Such a construction is shown in an old Cox & Prentice catalogue prior to 1881, and has also been used by Pratt & Whitney in some designs of their Lincoln millers. A further development of this type of double support is shown in the Reinecker machine of 1900, which has two bars or arms sliding in the frame and in the outer support, so that they can be adjusted to any position or readily removed, as desired.

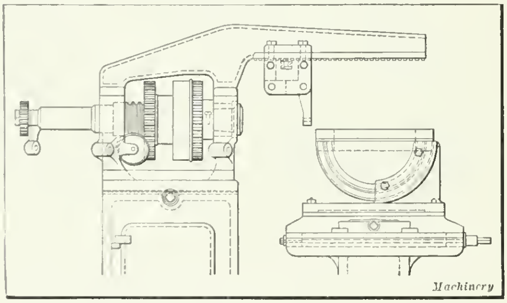

Fig. 9. Combination Boring and Milling Machine equipped with Overhanging Arm having Flat Ways

Mention has already been made of some of the steps taken to hold the cylindrical overhanging arm and its center head more rigidly in position by means of keys, flattened spots, etc. One method of securing this end was devised by Charles H. Norton, in 1892, when with the Leland, Faulconer & Norton Co., of Detroit, Mich. The arm was of square cross-section (see Fig. 13), and one of its "diagonal diameters" coincided with a plane intersecting the axis of the cutter-spindle. It was also claimed that this arm provided improved means for attaining and maintaining accuracy of alignment. Still other methods of obtaining rigidity were originated at about the same time that the Norton machine was designed. Pratt & Whitney brought out a double-spindle milling machine with double arms tied together at the outer end, as shown in Fig. 14. This same feature was applied to a duplex milling machine having two work-carrying heads, built by the Brown & Sharpe Mfg. Co. a little later, in which the center heads for the work-spindles were carried by separate arms tied together by a single arm brace (Fig. 18).

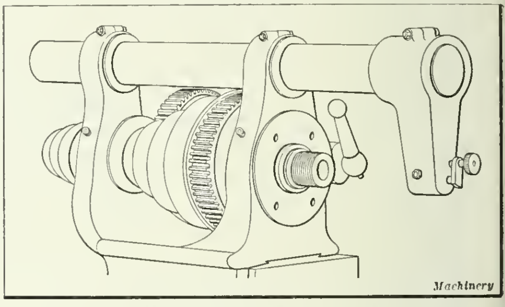

Fig. 10. Pedrick & Ayer Universal Milling Machine provided with Adjustable Overhanging Arm

At least as early as 1904 a French manufacturer (A. Vautier & Co., of Maubeuge) brought out a combined vertical and horizontal spindle milling machine, with double overhanging arms carrying an outer support for the cutter-arbor, as shown in Fig. 15, the double arms being evidently used for the purpose of supporting the arbor rigidly without an arm brace and in order to avoid interference with the vertical spindle of the machine. Further developments along the lines of using double overhanging arms were made by the Kearney & Trecker Co., of Milwaukee, Wis., and Potter & Johnston Co., of Pawtucket, R. I., in 1913. The Kearney & Trecker over-arm construction consists of two arms arranged so that both fit the arbor supports. The two arms are of the same size and are located some little distance apart, with the axes in a horizontal

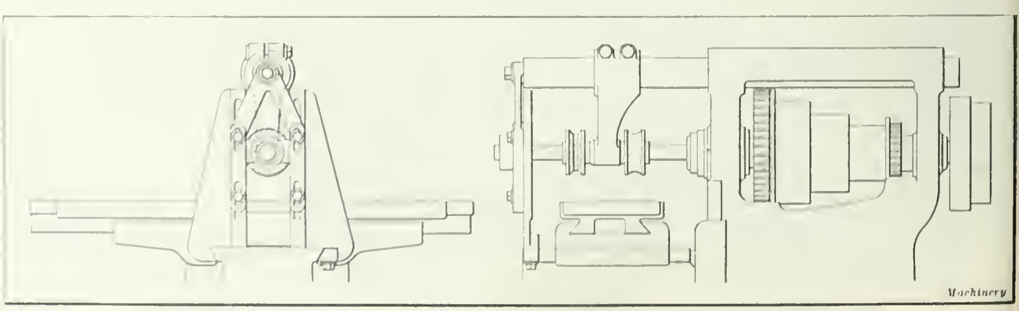

Fig. 11. Double Arm Brace applied to Brown & Sharpe Milling Machine in 1892

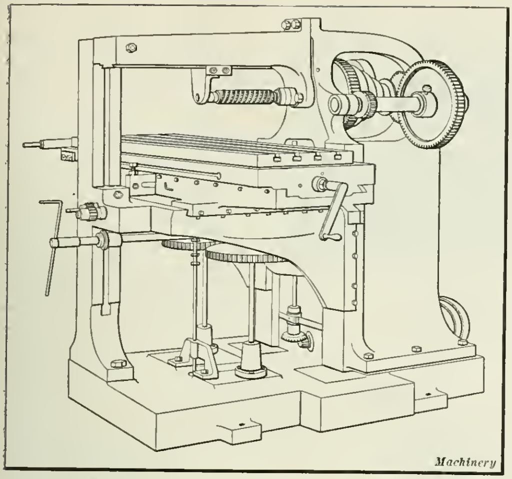

Fig. 12. Milling Machine of English Manufacture having Support for Overhanging Arm and Knee

plane, so that the connections between the arms and the arbor form the outline of a triangle. The Potter & Johnston Co.'s machine had one arm located vertically above the other (Fig. 16), the idea being to so tie the two arms together that no arm brace would be required, as the method of operating the machine makes the use of an arm brace impracticable.

While the cylindrical arm appears to have been made adjustable in the head or frame of milling machines at an earlier date than the arms having angular ways, the provision for such adjustment in arms of the latter design soon followed. In the earlier designs of both types where there was no adjustment, the arms were often bolted in place so that they could be removed if the work was such that they would be in the way. (See Figs. 7, 8, and 9.)

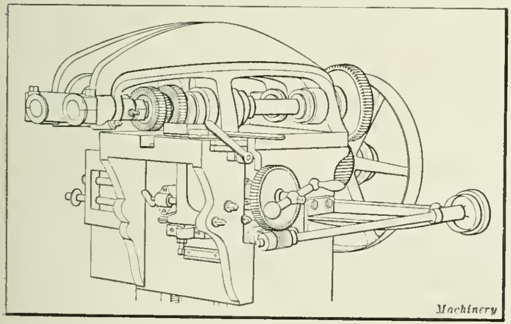

Fig. 14. Double-spindle Milling Machine having Double Arms tied together at Outer End, as designed by the Pratt & Whitney Co.

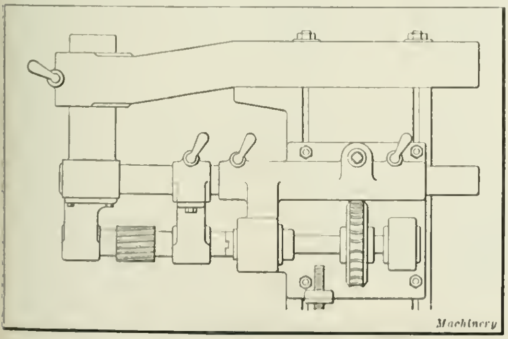

Fig. 16. Double Overhanging Arms located one above the other

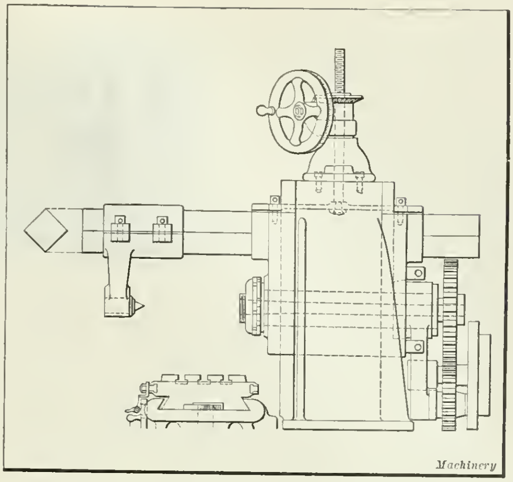

Fig. 13. Overhanging Arm of Square Cross-section designed to provide Rigid Support and Accuracy of Alignment

The earliest application of an adjustable angular arm so far found in a milling machine was in a duplex machine made by the Brown & Sharpe Mfg. Co.; this arm was applied to the machine in 1894. It provides widely separated ways to give rigidity to the structure and carries an intermediate support having a fine adjustment by means of a set-screw.

In milling machines of the planer type the natural evolution has been to secure rigid supports not only at the end of the arbor, but at intermediate points as well, by attaching such supports to the cross-rail—a construction which also has the advantage of having widely separated ways.

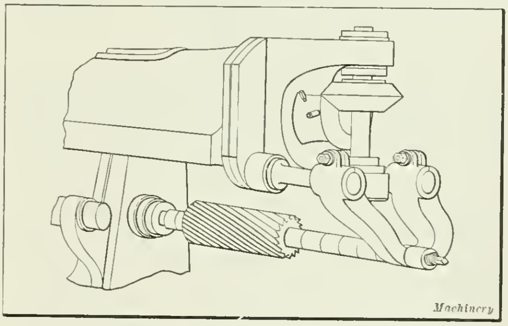

Fig. 15. Combined Vertical and Horizontal Spindle Machine of French Manufacture with Double Overhanging Arms

An early use of an adjustable overhanging arm with guideways is found in the Mergenthaler machine brought out in 1899 (Fig. 17). In this case the arm is adjusted in the head

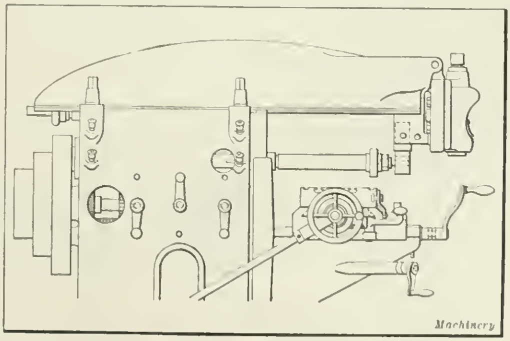

Fig. 17. Adjustable Overhanging Arm mounted in Guideway

by means of a worm engaging a rack. A still more complete disclosure of an adjustable overhanging arm with angular ways, having an adjustable center head and double-arm brace, is shown in the Sowden patent of July 28, 1903 (Fig. 19).

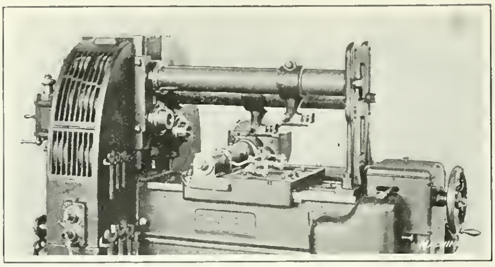
Fig. 18. Duplex Milling Machine having Separate Arms tied together by a Brace connecting with Machine Bed

In manufacturing milling machines, illustrated by the Lincoln type, the tendency, in order to secure greater rigidity, seems to be toward the use of a heavy outer support with stiffening arms acting more in the nature of tie-rods to bind the structure together for stiffness. In the case of the knee type of milling machine, this tendency lies along two lines: one, the use of a rigid overhanging arm of steel with heavy arm braces tying it to the knee, or even to the base; the other, the use of double cylindrical or widened angular arms of sufficient rigidity to support the arbor by depending principally upon the strength and stiffness of the overhanging arms, the arm brace being comparatively light or entirely absent, and, when used, serving primarily as a brace rather than as the main support.

The steps of development here outlined give another illustration of the gradual step-by-step evolution in mechanical design through many years from the first crude beginnings to a state of the art suited to modern needs.

* * *

NEW METHOD OF SOLVING TORSION PROBLEMS

BY MARK MEREDITH[1]

The determination of the distribution of stresses in members subjected to torsion has occupied many mathematicians and physicists. Without a knowledge of how such stresses are distributed, it is impossible to determine the local weaknesses of members of irregular section when under torsion, and therefore to modify the contour so as to secure the greatest strength within the limits of contour modifications laid down by the kind of duty the member is required to perform. Certain simple sections, like the circle, ellipse, rectangle, and equilateral triangle, for example, yield more or less readily to mathematical analysis, and a torsional-stress-distribution diagram of these sections can be constructed. But in the more irregular sections, the mathematical process becomes too complex and the designer of mechanisms comprising parts of irregular section subjected to torsional stresses has had to work in the dark.

The aircraft propeller blade is subjected to a particularly complex combination of stresses, among which is the torsional stress set up by the greater air pressure on the following than on the leading part of the curved face of the blade. The shape and dimensions of the blade section at any point are determined, within limits, by the requirements of stream-line and propulsive efficiency contour, and by resistance to bending, but there is a certain latitude within which modifications can be made to secure the maximum resistance to torsion. It is of extreme importance that the design should take cognizance of this factor, not so much because risk of fracture is thereby diminished as because, unless the distribution of the torsional stresses is known, it is impossible to forecast how the blade will deform in use, and consequently impossible so to shape the blade in its unstressed condition that it will present the desired features when under working stress. About a year ago the design department of the British royal aircraft factory at South Farnborough tried to determine the torsional stresses by working on the theory that the equations for the torsion of an elastic bar are of exactly the same form as those for the displacement, under evenly distributed pressure, of an elastic membrane, the shape of which corresponds to the cross-section of the bar. The calibrating instrument devised consists of a thin metal plate out of which a section corresponding to the cross-section of the blade is cut, and a thin membrane stretched across the opening. A slight excess air pressure is provided on one side of the film, and finally a means of registering the contour of the surface of the bulged film is employed. The first requirement was easily satisfied. For the second, a soap film stretched across the opening was used. The pressure on one side of the soap film was produced by clamping the plate over a box within which the air pressure could be delicately adjusted. The reflection in the film of a suitably placed single electric lamp filament shows the inclination of the film to the plane of the plate at any given point for the determination of stresses, and a steel needle pointing down toward the film, and adjustable as to depth by a micrometer, traces the contour lines of the film and records them by pinpricks on a sheet of paper. By cutting in the plate, beside the slot of the section it is desired to investigate, a circular hole of the same cross-sectional area, it is possible not only to ascertain the distribution of stresses in the irregular member, but to determine, by comparison with the known stresses in the circular bar represented by the round hole, their actual value.

* * *

MACHINISTS AND TOOLMAKERS FOR ARSENAL WORK

The Watervliet Arsenal, Watervliet, N. Y., is making the guns that will pound into the German mind the fact that there is such a thing as an undying belief in the ideal of justice in this world; and the arsenal needs skilled men in the making of these guns. Large additions are being built to the arsenal and these must be manned. A great number of toolmakers and machinists are needed for this work. Every mechanic, therefore, who is engaged on any work which is not necessary for the winning of the war should be willing to do his share by going to work for the Government. All the workers are directly under the Federal Civil Service and the Federal Compensation Law, and the wages are good. A special housing bureau devotes its entire time to getting homes for the new workmen, and no effort is spared to make them feel at home. Applicants, however, should not come to the arsenal without first writing to the Commanding Officer, Watervliet Arsenal, Watervliet, N. Y. No men who are now engaged in work for the Government or in the building of machines that are to be used for work on government contracts will be hired, but, with this exception, any American between the ages of eighteen and fifty-four who feels that he really wants to do his share in the great crisis through which the world is passing may apply for work at the arsenal and feel that he is doing his duty toward his country.

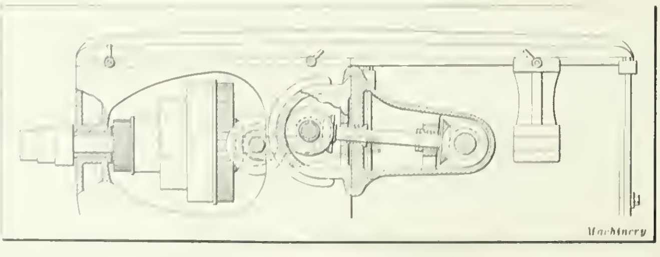

Fig. 19. Another Design of Adjustable Overhanging Arm

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[1] Address: 67 Dale St., Liverpool, England.

BLUING STEEL

MATERIALS, ARRANGEMENTS, AND METHODS USED ON LIGHT SHEET-STEEL WORK

BY W. B. GREENLEAF [1]

FOR bluing steel by the saltpeter process, the outfit necessary consists of a cast-iron kettle for melting the saltpeter mixture and tanks for the water and oil. The melting kettle may be heated by gas or oil; with kerosene oil at nine cents a gallon and gas at ninety cents a thousand cubic feet, the gas is about 60 per cent more expensive but is less trouble. The water tank should be connected to a steam or gas supply so that the water may be kept boiling hot; it should also have a fresh-water connection. Both the oil and the water tank should have waste cocks at the bottom. The writer uses a fifty-gallon round galvanized tank for the water and a thirty-gallon rectangular tank for the oil. Considerable heat is necessary for melting the mixture, but after it is melted the flame must be turned down to 20 or 30 per cent of full size, or the solution will get too hot and eat through the kettle.

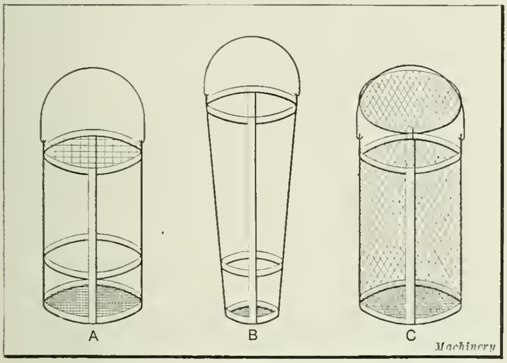

Fig. 1. Baskets for holding Work when bluing

The saltpeter mixture consists of nine parts, by weight, of saltpeter and one of black oxide of manganese, or pyrolusite, melted together. Either nitrate of soda or nitrate of potash may be used; but only the best quality should be used, for the cheaper grades are adulterated with common salt which interferes with the work. The writer has found "Aqualine" the cheapest satisfactory oil, but the Standard Oil Co.'s flat wire oil is good, and a mixture containing one part of lard oil and two or three parts of paraffine oil is all right. Paraffine oil by itself is not satisfactory, as it evaporates and leaves a coating of saltpeter on the work.

The work the writer has handled is stamped from sheet steel and is used for cap pistols and air rifles; heavier material may require a little different treatment to that described here. Cup-shaped articles must be hung on hooks or placed in racks so that they will drain; all other work is handled best in baskets. Large pieces should have special baskets to suit the individual shapes. All baskets should hang at least 1½ inch from the sides and 5 or 6 inches from the bottom of the kettle; Fig. 1 shows the types in daily use. Small parts may be thrown in loose, the only limitation being that the mass of metal must not be so great that the heat will not reach those in the center before the outside is too hot. In other words, where the parts are of such shape that they will pack closely together, the basket must be filled only two or three inches deep; curved or hollow shapes of thin metal, which pack so as to allow the solution to circulate rapidly all around them, may fill baskets as large as the kettle will take. Baskets for light material must have tight covers that are hinged and fastened; otherwise the parts will be thrown out when they are dipped into the water. Large or small pieces with curved surfaces may be packed close together, but large, flat, smooth surfaces must be kept a slight distance apart. A convenient basket for handling such parts is shown at *A*, Fig. 1.

All baskets should be made as light as possible. There are firms who will make better wire baskets than could be made in a shop; but if a homemade one is desired, it will be found better to use 1/2- by 1/16-inch strips, with electric welded joints, for the frames. For small pieces, the frames, sides, and bottom of the basket should be lined with 1/4-inch mesh galvanized wire netting, fastened in place by lacing with stovepipe wire, as shown at *C*. For larger pieces, the netting on the sides is unnecessary but an extra hoop should be placed a quarter of the way from the bottom, as shown at *B*. For the bottom of some of these baskets, 1/4- by 3/32-inch strips may be used, but 1/2-inch mesh netting is most commonly used. The covers for small work may be formed of 1/4-inch mesh netting, wired to a hoop made of a 1/2- by 1/16-inch strip. Each basket should have a handle.

A scraper should be provided for the melting kettle. A convenient form is made of 1/2-inch rod about 3 feet long, with a loop at one end and an oval-shaped piece of heavy sheet iron, about 3 by 5 inches, securely riveted to the other. This scraper is used to stir the solution and to scrape the sediment from the bottom of the kettle.

Convenient Arrangement of Outfit

The proper arrangement of the outfit is, of course, essential to quick and easy handling of the work. A satisfactory layout is shown in Fig. 2, where the kettle and the two tanks are set in a quarter-circle close together. The outlet cocks and steam and water pipes are placed close against the outer edges of the tanks. A lever, about eight feet long, is hung at the center of the tank circle by a swivel yoke and chain from the ceiling. The chain is guyed by wires just above the joint, to keep it from swaying. This lever is free to tip up and down and to swing in a circle. It may be made from one-inch pipe, but should have a short piece of chain at one end and a longer piece at the other. The shorter piece should be passed through the ring of a large swivel harness snap and looped up to an S hook for adjustment; the longer piece should have a handle or ring at the end. To fasten the chains, the ends of the lever should be threaded for caps, each of which is drilled to take a link of the chain, which is held by a pin fitting tight inside the cap. The oil tank should be provided with a drip flange at the back and should have a row of hooks suspended from a bar above it.

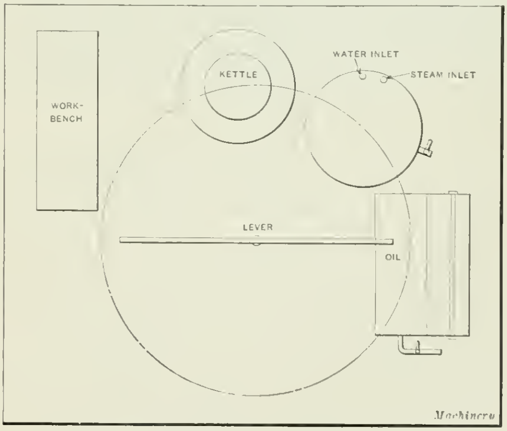

Fig. 2. Convenient Arrangement of Tanks for Bluing Process

The floor under and around the outfit should be of cement and pitched to a large drain just back of the tanks; the walls should be of brick, cement, or tile. The work gives off much flame, smoke, and steam, unless the roof is high and ventilated like a foundry; the kettle and water tank should have heavy sheet-iron hoods with a direct outlet, not less than 20 inches in diameter, and forced draft if possible.

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[1] Address: Care of Kohler Die & Specialty Co., De Kalb, Ill.

A low bench should be placed opposite the tanks at the other end of the lever, or to one side, for filling the baskets, and should have space enough to hold material for at least one day's work. There should also be hooks or nails on the bench, or special uprights opposite the kettle and the oil tank, to support the lever while the work is bluing and while the baskets are being changed. One man can handle this work with this outfit, as the articles have to stay in the solution long enough to load and unload the baskets. A helper does not increase the speed more than 10 or 15 per cent.

Method of Performing Work

To start the work, the kettle should be heaping full of the saltpeter mixture and the heat turned on full. As the mixture melts, more should be added so that when it is all melted, the solution is within two or three inches of the top of the kettle. The kettle should be kept covered until the material is entirely melted, especially after the first melting, for the hot solution spurts through the crust, and melted saltpeter burns badly.

A pailful of saltpeter and the black oxide should be mixed in the proper proportions, and between each heat a handful should be stirred in until it melts. In this way the level of the solution in the kettle will be kept uniform and the mixture will work much better than if the kettle is allowed to get low and is filled once in a while. The solution should be stirred from the bottom each time, during which operation the workman should wear canvas gloves. After the first time the mixture is melted, each time the kettle is started, before stirring, some of the sediment at the very bottom should be scraped out.

When all the mixture is melted, the solution clears up on top and begins to boil. It should then be tested by throwing on a pinch of fine dry sawdust; if this floats around and burns slowly the mixture is not ready; when the sawdust bursts into flame the moment it reaches the surface, the bluing process can be started.

The most essential and only difficult point in the process is maintaining the right heat. The writer has not used a pyrometer, which would undoubtedly be a great help. A test, which he has found entirely reliable, is the formation of scum by the burning oil on the surface; this should be entirely burned off at about the second minute. If there is scum on the surface at the end of the third minute, the work should be left in the mixture for fifteen seconds after the scum has disappeared and the heat increased; if the scum is gone by the end of the first minute, the heat should be reduced. Maintaining the proper temperature is vitally important to the production of good work. If the heat is a very little too low, the color is good though a little light, but it has dark spots, like the brown with purple spots in the tempering scale of steel. On the other hand, if the solution gets too hot, the work comes out very dark and mottled with dark streaks and spots. In the first stages of overheat, the effect is quite similar to underheat, but the whole tone is much darker; however the formation of scum has been found to be a sure temperature test. It is possible, by watching when the scum disappears from heat to heat, and adjusting the fire a very little at a time, to obtain a correct temperature. The writer has held it on the spot for three or four hours at a time without further regulating. However, the bad effects from both underheating and overheating can be entirely removed by running the material through again at the right temperature.

There is another serious danger from overheating. At the same point that the work shows bad, the kettle begins to turn red. As the chemicals attack the cast iron at red heat, they will eat into the kettle as long as it stays red, and will eat through the iron in a short time. As can easily be imagined, boiling saltpeter is not pleasant to have flowing around on the floor, and it is very hard to dig out of the furnace and pipes after it cools. If the kettle begins to show the least red, the only safe way, is to turn out the fire and light it again when the heat is reduced to the proper point.

In operation, the full basket is hung on the snap at one end of the lever and lowered into the solution by means of the chain at the other end. This chain is hooked so that the articles will be about two inches below the surface. As the articles are usually covered with oil and the baskets always are, this oil catches fire and flames, burning and smoking until it is all burned off. There is always more or less spattering of the solution so that the operator should keep the full length of the lever away from the kettle. The writer dips the work without cleaning off the grease from the presses and buff wheels; work that has been thoroughly cleaned with gasoline does not seem to be any better. There must be no rust on the work, however. For the work done in the writer's plant, three minute's is the proper time for the articles to remain in the solution; they will color in less time than that but the additional time gives a better tone and a stronger and more lasting coat. The time can be kept with an ordinary watch, but a stop-watch is much handier.

When the time is up, the basket should be slowly lifted from the solution and held over the kettle until the surplus solution drains off. Baskets of small pieces should be shaken. Then the basket should be dipped into the hot-water tank as quickly as possible without sloping over, as the steam helps to clean off the solution. The basket should be shaken enough in the water to clean the work thoroughly. The articles should be examined carefully as the baskets are emptied; if there is any solution (black mud) clinging to them the washing is at fault. After the surplus water is drained off, the work is dipped into the oil and taken out again as quickly as possible. The operator, of course, handles the basket all this time by means of the lever. The chain at the operator's end of the lever is then fastened so that the basket hangs over the oil while he adds his saltpeter mixture and stirs the solution in the melting kettle. He then hangs the finished basket on the rack to drain, puts on a fresh basket, and starts over. While the lot is bluing, he takes from the rack a basket that has drained, empties and refills it, and places it near the oil tank; he will have time left to watch his time and heat. At least four baskets should be kept going at once; one in the kettle, one being filled, and two draining.

There is time while the kettle is heating in the morning, which requires one or two hours, to move the previous day's work into the next department and to get a fresh supply. Of course the work of heating the water should be started at the same time as the kettle is started. The water tank should be drained and cleaned out every two or three days. The water and soft soap that settle under the oil should also be drawn off every morning and fresh oil added; and the sediment should be scooped out of the bottom of the oil tank.

* * *

CARBURIZE AND CARBONIZE

The two words "carburize" and "carbonize" are frequently used interchangeably in mechanical literature to designate the process of impregnating the surface of steel with carbon in order to raise the carbon content of low-carbon steel so that it may be hardened by heating to the hardening temperature and quenching in oil, brine, or water. "Carburize," however, is the correct term to use, and while the other term has been so generally employed that it has become recognized by dictionaries as an allowable word, its use should be discouraged. Webster's New International Dictionary defines carburize as "to combine or impregnate with carbon; as, to carburize iron by cementation." The word "carbonize," again, is defined as "to convert into a residue of carbon by the action of fire or some corrosive agent; to char." As a secondary definition, it is given as equivalent to "carburize." The proper meaning of carbonize, however, refers to the converting of a substance into carbon, as, for example, when a carbon lamp filament is carbonized, when the fiber from which it is made is charred. The Century Dictionary, therefore, defines a carbonizing furnace as a "gas furnace used for carbonizing the filaments of electric lamps," or as "an apparatus for carbonizing wood, disintegrating rocks, etc." A furnace used for increasing the carbon content on the surface of steel is not a carbonizing furnace, but a carburizing furnace.

FACTORY MOVING

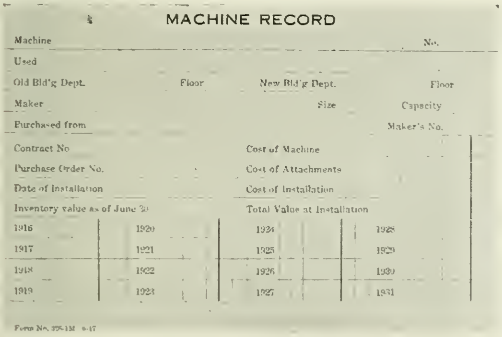
METHODS OF EFFICIENTLY SOLVING THE PROBLEMS ARISING WHEN MOVING MACHINERY INTO A NEW FACTORY

BY L. J. HENGESBACH[1]

THE ordinary person regards the moving of a factory as about the same thing as the moving of household effects; but, as a matter of fact, it is a very different proposition. The moving of any factory has several drawbacks, the most important of which is the interruption of work, with the resulting loss of business due to failure to make promised deliveries. Another bad effect is the disruption of the organization.

The labor involved depends on the extent of the move. If a factory is to be moved by rail from one town to another, it is necessary to crate and pack all the machinery, which involves the taking apart of many of the larger machines. All dies, tools, fixtures, etc., must also be carefully packed and the boxes marked so that the tools or other equipment for any machine may be readily found when the machines are being set up again. This is the most difficult kind of move to engineer. The easiest is that caused by the remodeling of a plant, when the machinery does not leave the factory, so that there is no chance of losing parts in transit. Between these classes is the moving of a factory to another location in the same town.

The size of the plant and the number of machines will determine whether or not it will pay to employ an engineer to manage the moving. Generally some member of the organization, who is well acquainted with all the machinery, is given control of this work. If the move is not great, this may prove to be the better plan, but, as a general rule, the men in the organization are not experienced in moving and their other work must be neglected. The number of engineers experienced in moving factories is limited. To be successful in this work, a man should be a mechanical draftsman, familiar with the forms and terms of architectural drawing, and have had practical experience in production along the same line as the factory to be moved in order to adjust and locate the machines so as to get the best results. He should also have had experience as head millwright or master mechanic, so as to be entirely familiar with all kinds of overhead construction, motors, lineshafts, countershafts, etc.; he must have the faculty of getting along with everyone with whom he comes into contact, and must be willing to accept suggestions from everybody, even from a laborer. In case a man with no previous experience in moving is employed, it may be profitable to employ an experienced man in a consulting capacity, if for only a single interview.



MACHINE RECORD

Machine No.

Used

Old Bld'g Dept. Floor New Bld'g Dept. Floor

Maker Size Capacity

Purchased from Maker's No.

Contract No Cost of Machine

Purchase Order No. Cost of Attachments

Date of Installation Cost of Installation

Inventory value as of June 30 Total Value at Installation

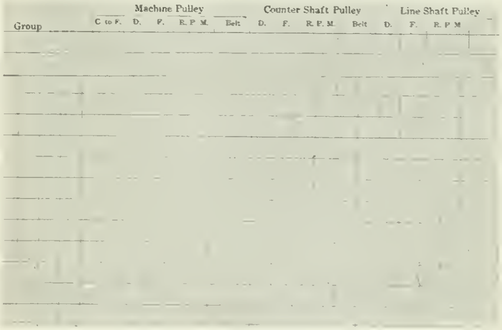
1916	1920	1924	1928
1917	1921	1925	1929
1918	1922	1926	1930
1919	1923	1927	1931

Form No. 375-1M 9-17

Fig. 1. Machine Record Card

Planning the Moving

The best time to start planning the moving is before the plans or drawings of the building are finished, in order that the machinery may be laid out to give the best results of production. In one case, where the plans of a factory, approximately fifty by two hundred feet, were completed and the building was being constructed before an engineer was employed to take charge of the moving, it was found that the most economical location for the screw machine department was in the rear of the building. After laying out these machines on paper, the engineer discovered that they would require about five bays of the building; but the architect, in laying out the building, had located a large sliding door in the fifth bay, thus making it necessary to separate the screw machine department into two groups, one on each side of the large door. As they were bar machines, it was necessary to locate the first about ten feet to the right of the door, so that the long bars of stock would not project into the space directly in front of the door. Had the machinery lay-out been made before the architect had completed the plan of the building, he could easily have placed this door one or two bays nearer the center of the building. In another case, the architect located three vent pipes at approximately equal distances from each other in a floor to be used for laying out and cutting large patterns of heavy cloth and canvas. As these pipes interfered with the placing of the large tables upon which the material was to be laid while marking out, it was necessary to change their location, which involved a costly change in the plumbing. This expense and trouble would have been entirely avoided had this department been laid out before the building drawings were made.



Group	Machine Pulley				Belt	Counter Shaft Pulley			Belt	Line Shaft Pulley		
	C to F.	D.	F.	R. P. M.		D.	F.	R. P. M.		D.	F.	R. P. M.

Fig. 2. Back of Machine Record Card

When an engineer enters upon his duties, the manager or someone else in authority should introduce him to all superintendents, foremen, and other heads of departments, so as to eliminate all chance of friction and to secure the complete cooperation of everyone during the moving. The engineer should then make himself familiar with the entire organization and all of its systems, as well as with methods of machining and routing of material, in order to do his own planning. Too much stress cannot be laid on this point, for it is during these days, while the engineer is becoming acquainted with the different heads of departments, that he lays the foundation for the cooperation he must receive during the moving if his work is to be a success. He must become familiar with all the details of the new building, by a careful study of the plans, and should visit as many other factories as is possible, to study the latest ideas in factory lay-out, overhead construction, machine drives, piping arrangements, lighting in special cases, methods of handling stock, etc.

At this time it must also be decided how much planning is to be done, whether only the location of the machines and lineshafting are to be considered, or whether the location of the countershafts and motors are also to be fixed. The first way is the quicker and cheaper from the planning standpoint, but costs more later, because the millwrights erecting the machines must plan the arrangement of the countershafts and

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[1] Superintendent, Van Dorn Electric Tool Co., Cleveland, Ohio.

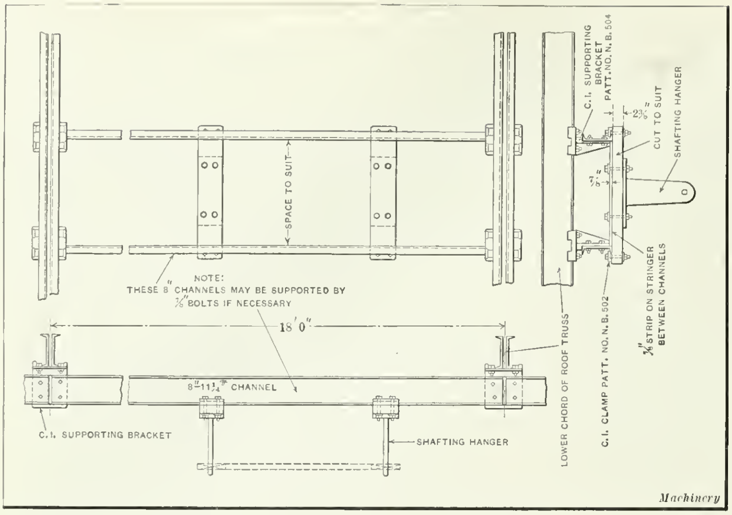
SPACE TO SUIT
NOTE: THESE 8" CHANNELS MAY BE SUPPORTED BY ⅞" BOLTS IF NECESSARY
18' 0"
8"-11¼# CHANNEL
C.I. SUPPORTING BRACKET
SHAFTING HANGER
C.I. SUPPORTING BRACKET PATT. NO. N. B. 504
2⅜"
CUT TO SUIT
SHAFTING HANGER
7⅛"
LOWER CHORD OF ROOF TRUSS
C.I. CLAMP PATT. NO. N. B. 502
⅞" STRIP ON STRINGER BETWEEN CHANNELS
Machinery

Fig. 3. Supports for Lineshafts and Countershafts

motors. This method not only requires a better class of millwrights but it retards the progress of the moving and frequently results in overhead interference that cannot be overcome and thus causes a change in the plans. The second way costs more when the plans are being made, but is much cheaper later, and reduces to a minimum all interference with overhead work, wiring, piping, etc. As a general rule, when the millwrights encounter difficulty with the overhead construction, all work must stop until the point in question is settled. Besides, it is frequently necessary to move some of the machines already permanently located in order to overcome the difficulty. Sometimes the loss entailed by one interruption of this kind will more than pay for the planning of all the overhead construction.

Moving a Plant to Another Location in Same City

The following is a description of the method used when moving a plant from one location to another 1.3 mile away. The factory contained over 600 machines, ranging in size from a sensitive drilling machine to a 100-inch vertical boring mill, and owing to the nature of the contracts in force, it was necessary to keep up the production while the move was being made. First, a complete set of floor plans was made to a scale of one-half inch equals one foot. These plans showed the outline of the walls with windows, doors, and columns, and all fixtures such as elevators, stairways, drinking fountains, etc. Then sketches were made of all the machines, both power- and hand-operated. These sketches showed the outline of the machines and the exact location and the rotating direction of drive pulleys. They also contained notes covering all items of special interest, such as sewers required for pits for shavings or turnings, pits for clearances for machine parts, water pipes, electric wire connections, air systems, and individual cranes. In case the machine was driven by an individual motor, a note of the location of the switch or controller was made; a note was also made of any special space required around the machine on account of the stock condition Frequently when one machine in a progressive group is slower than any of the others in the chain, there is a congestion of material at this place. A memorandum was also made of any special feature that the foreman or operator thought would increase production or make operations easier for the operator; the handiest spot where the tool trays could be located was noted, and a cross was placed to show where the operator usually stood.

When these sketches were completed, sketches were made of the countershafts of all the machines. These sketches contained only enough dimensions to locate the shafts in the proper relation to their respective machines. The essential dimensions, of course, vary on different types, but usually they are the over-all dimensions, the drop of the hanger, and the relation of the cone pulleys or any keyway pulley to the end of the shaft. As the sketches of the machines and countershafts formed the basis of all plans, practical millwrights did all the measuring in order to have the measurements as accurate as possible. One of these millwrights was to have charge of all the erecting in the new factories; in this way he became familiar with the special features as they were installed in the old factories.

The value of the information collected by a planning engineer depends largely on its arrangement and the ease with which it may be referred to. Fig. 1 shows the front and Fig. 2 the back of a machine record card, upon which can be placed all the information pertaining to any machine. This card is self-explanatory, with the exception of the second column on the back; the heading C to F means distance from center of drive pulley to floor, which is a very important dimension when planning overhead construction, as it determines the angle of the belt from the machine to the countershaft. The rest of this side may be used for sketches of the machine and countershaft and other information. This card may be used as a permanent inventory card and in the superintendent's office as a reference card; it is very helpful when ordering repair parts for any machine.

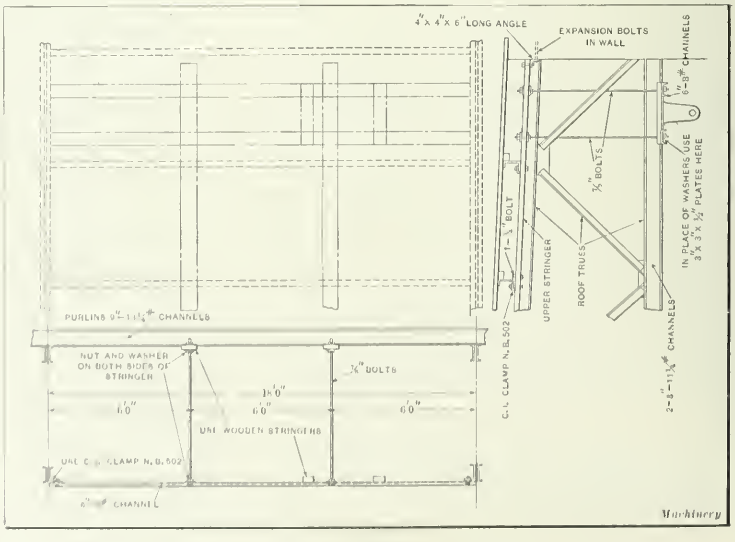

Fig. 4 Supports for Lineshafts and Countershafts running Lengthwise of Middle Span

TABLE 1. MOTOR DATA

Location in New Plant	Motor Required, Horsepower	Motor Used: Horsepower	Motor Used: Serial Number	Motor Used: Shop Number	Taken from
Mill gear basement, west end of building....	10	10	1,831,575	628	Stock
Rear of mill gear, northeast of Column 12, south, center........	10	10	455,799	604	Stock
Rear of mill gear, grinding room...........	5	5	....	...	Stock
Mill gear, running machine No. 83, northeast of Column 11, south, center..............	10	10	716,055	606	Running machine No. 83 at present
Mill gear, grinding department.............	10	10	736,510	612	Running machine No. 43 at present
First floor, grinding department, southwest of Column 9, north.....................	10	20	1,839,576	639	Stock
Second floor, spur gear department, north of Column 1, north........................	10	10	1,034,571	611	Turning lineshaft in spur gear cutting department
Second floor, Fellows gear shaper department, north of Column 1, south..........	15	20	19,662	623	Turning lineshaft in Fellows gear shaper department
First floor, tool-room, northwest of Column 1, south	5	5	170,918	613	Driving machine No. 233
Second floor, tool-room, southeast of Column 5, south..........................	5	5	468,884	616	Running lineshaft in tool-room

Machinery

Next, templets of white cardboard, 1/32 inch thick, were made of all the machines and countershafts, to a scale of one-half inch equals one foot, and all the information noted was transferred to them. The idea was to have all information before the planning engineer at all times.

General Lay-out of New Plant

A general lay-out was next made of the various departments as they should be located in the new plant so as to get the best results in the production and routing of material. This lay-out was submitted to the persons in charge of the various departments, and all their criticisms were considered before any actual laying out of the machines was begun. Afterward the machines, countershafts, lineshafts, motors, etc., were located, each machine being considered by itself. By this plan a much better lay-out is obtained, because the machines have so many things in common that must be considered in order to get better results before starting the actual locating of the machines. Some of these are the general location of lineshafts, number of revolutions per minute of lineshafts and countershafts, type of hanger, whether ball, roller, etc., belt speeds, and maximum and minimum pulley diameters. As soon as the locations of the lineshafts and their motors were determined, they were drawn on the lay-out plans with pencil. The final lay-out of all machines was accomplished by moving the cardboard templets of the machines and countershafts around on the drawing-board, the templets being held in place on the board by small tacks. After what was considered the best possible lay-out was obtained, it was submitted to all persons concerned for their approval. The embodiment of the suggestions thus obtained greatly improved the lay-out. In most departments it was necessary to make many changes in the original plans before everyone concerned was satisfied. When the plans were finally approved, the machines, motors, countershafts, lineshafts, pulleys, couplings, and shaft collars were drawn in.

Next the exact design of the overhead construction for holding or bolting the lineshafting, countershafts, motors, pulleys, etc., to the ceiling was planned, as shown in Figs. 3 and 4. This was done in a general way before the building was erected. Each type or style of overhead construction was called a case and was designated by a letter; each construction print had a note specifying which case was to be used. From the complete floor lay-out, the millwrights were able to get all the necessary information regarding the location of machines, motors, countershafts, lineshafting, and size of pulleys. Data on the motors

TABLE 2. DATA OF LINESHAFTING, HANGERS, COUPLINGS, AND COLLARS

Location in New Plant	Lineshafting: Diameter, Inches	Lineshafting: Length, Feet	Lineshafting: Length, Inches	Lineshafting: Remarks	Hangers: Number	Hangers: Drop, Inches	Hangers: Remarks	Couplings: Number	Couplings: Remarks	Collars: Number	Collars: Remarks
First floor, grinding department, north of Columns 8, 9, 10....................	$2\frac{7}{16}$ $2\frac{7}{16}$ $2\frac{7}{16}$	24 16 20	0 0 0	New .... New .... New	8	14	New	2	New	2	New
First floor, bevel gear testing department, north of Colums 4 and 5.............	$2\frac{7}{16}$	14	6	Use 18-foot length of new shafting	3	12	From street railway department	0	....	2	New
First floor, burring department, north of Columns 6 and 7....................	$2\frac{7}{16}$	20	0	First floor, street railway department, north of center aisle	3	12	From west end of building	0	....	2	New
Second floor, screw machine department, south of Columns 6, 7, and 8, north...	$2\frac{7}{16}$ $2\frac{7}{16}$	20 16	0 0	First floor, east end, motor gear department, 20 feet 5 Inches length.......... Second floor, Fellows gear shaper department........	6	19	New	1	New	2	New
Second floor, screw machine department, south of Columns 9 and 10, north.....	$2\frac{7}{16}$ $2\frac{7}{16}$ $2\frac{7}{16}$	24 14 10	0 0 0	Second floor, Fellows gear shaper department........ New .... New	7	19	New	2	New	2	New

Machinery

were tabulated as shown in Table 1, and all data on lineshafting, couplings, and collars were arranged as shown in Table 2.

Organization for Handling the Moving

In the present instance, the engineer was responsible for the entire move, but an assistant had charge of the draftsmen who made the drawings, sketches, etc. The assistant also made out most of the requisitions for material and looked after the material tracers. On a move of any size, the tracing of material requires a man of action and experience, for unless the material arrives according to schedule, the plans made beforehand will miscarry.

At the old plant there was a dismantling and a moving gang. The dismantling gang prepared all machinery for moving. As a machine was dismantled, there was fastened to all loose parts a tag upon which was written the number of the machine, and all these parts were placed in boxes, one box for each machine. These boxes varied from 2 feet wide, 4 feet long, and 18 inches deep to 3 feet wide, 10 feet long, and 2 feet deep. The top board on each long side extended beyond the box about two feet, making the boxes easier to carry and making it possible for the heavier ones to be handled with a crane. It was the duty of one man in the dismantling gang to see that each and every part that went into these boxes was tagged.

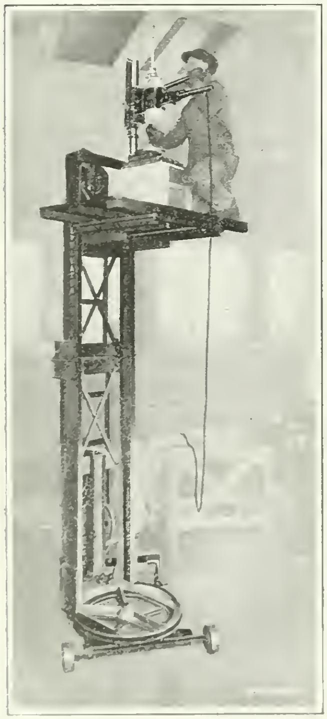

Fig. 5. Use of a Revolvator for drilling Holes in Ceiling to install an Overhead Motor

The moving gang was obtained from a regular machinery moving company, which supplied the men and the auto trucks. It was the work of this gang to place the machinery on the trucks and haul it to the new factory. This machinery was received at the new plant by a gang whose duty it was to unload as rapidly as possible, thus keeping the trucks on the road all the time. The dismantling, moving, and receiving gangs had lists of machines and the order of moving each day, so that the gang bosses would have the proper trucks ready for the machinery.

All machinery was taken from the receiving gang by the locating gang, who took it to its permanent location. This gang had blueprints showing the permanent location of all machines. This gang also removed all parts of each machine from the boxes and placed them at their respective machines.

The erecting gang comprised three groups: a lineshaft and overhead construction gang, a countershaft gang, and a machine leveling gang. The lineshaft and overhead construction gang erected all overhead construction except the countershafts, which were erected by the countershaft gang. The machine leveling gang located machines as called for by the blueprints and secured them to the floor or foundation. All belts were installed by one man and two helpers.

It should be the aim of every man in charge of a move to obtain as much speed as is possible. He must, therefore, devise and use every short-cut and appliance that will speed up the work in any way. Every move brings out several new ideas, as well as improvements on the old methods. The greatest time-saver used in the case described was an appliance called a revolvator, made by the Revolving Portable Elevator Co., Jersey City, N. J., which is an elevating truck made of structural steel which has a platform that can be raised or lowered by means of a crank. By fastening a cradle to the platform, in which the lineshafting, countershafting, and motors were laid, one man was able to raise them to the proper position on the ceiling. Even in the case of a motor weighing about 1500 pounds, all that was necessary was to put the motor in the cradle and then hoist it to the ceiling, mark the holes on the ceiling, and lower the platform a few feet, or enough to allow the drill to be used for drilling the holes in the overhead construction, after which the motor was hoisted again and bolted to the overhead construction. This machine was also used in moving small lathes up to 2000 pounds. All that was necessary was to run it under the base of the lathe and then raise the platform enough to lift the machine from the floor. The overhead drilling was done by Van Dorn portable electric drills, as shown in Fig. 5. The heavy machinery was moved about the factory floor by means of small four-wheeled dolly trucks equipped with ball-bearing casters. All the light machines and boxes were handled on standard trucks having two large wheels and one swivel wheel on each end. The bulk of the stock, forgings, and castings was moved on one of the regular platform trucks.

* * *

STEEL FROM NICKEL-COPPER-IRON ORE

Large-scale experiments show that a metal giving test results equal to those of nickel steel such as is used for bridges and forgings can be produced at low cost from the Sudbury ores in which both copper and nickel are combined with the iron. According to a paper read by Lieutenant-Colonel R. W. Leonard before the Canadian Society of Civil Engineers, the new product has been named "Nicu" steel and is to be made by the Nicu Steel Corporation; this steel, however, has not yet been manufactured on a commercial scale. It has an ultimate strength of from 70,000 to over 100,000 pounds per square inch, a yield point of from 50,000 to 80,000 pounds per square inch, and satisfactory ductility for bridge or ordnance purposes. It may be produced for from $30 to $35 per ton. G. M. Colvocoresses made the original experiments and worked out processes for smelting the Sudbury ores or the slags now wasted in that district and took out patents on the processes. Subsequently, he and H. A. Morin smelted 200 tons of ore and 40 tons of slag in an improvised plant at East Montreal. After roasting, smelting with lime flux in an electric furnace performs the principal reduction. The pig iron thus obtained is of homogeneous composition and is refined to medium carbon steel partly in an electric furnace and partly in an open-hearth furnace using producer gas.

In ten of the heats, the steel contained from 0.17 to 0.73 per cent carbon and from 0.012 to 0.032 per cent silicon; the sulphur was always below 0.048 per cent and the phosphorus was generally below 0.01 per cent. The sum of nickel and copper ranged from 1.25 to 2.5 per cent, the copper usually being about one-fifth of the total. A test made by Dr. Alfred Stansfield, of McGill University, Montreal, showed that "Nicu" steel containing 2.26 per cent combined nickel and copper has a tensile strength of 96,500 pounds per square inch, a yield point of 52,800 pounds per square inch, an elongation in 2 inches of 24.2 per cent, a reduction of area of 50.8 per cent, and a 180-degree bend test without cracking. Three and one-fourth per cent nickel steel is commonly specified to have an elastic limit not below 50,000 pounds per square inch and an ultimate strength of 85,000 to 100,000 pounds per square inch with an elongation of 16 to 17 per cent in 8 inches and a reduction in area greater than 30 per cent.

* * *

According to an arrangement with the Fuel Administrator, the manufacturers of common window glass will make this year only one-half of their 1917 output. This reduction will mean a saving of 500,000 tons of coal and the removal of at least 18,000 carloads of freight from the railroads.

INSPECTION METHODS OF THE FUTURE

BY C. C. MARSH[1]

Successful manufacturing demands not only modern machine tools, a well-trained force of operators, and a sales organization that can put the article on the market and create a demand for it, but also an efficient inspection system. When a product that is to be absolutely interchangeable is to be manufactured, the measurements on all parts of one kind must be exactly alike as far as it is possible to make them.

Many manufacturers have failed to produce parts that are absolutely interchangeable because they have not entirely solved the inspection problem. Some of these manufacturers have been striving for years to solve this problem, but a number have failed to see the importance of automatic inspection. Accurate inspection is necessary to insure accurate machining, for the closer work is inspected, the more errors are found; and finding the latter, even in small numbers, gives the motive to correct, so that there is less chance for the error to be made again. It is also obvious that, though it is necessary to machine parts very close to the desired limits to guarantee interchangeability, unless the greatest skill is used in the inspection, variations are sure to pass and some parts will not fit. While it is possible to obtain machine tools that will turn out work with a great degree of accuracy and a small percentage of error, when errors do occur they are small and difficult to find, so a skillful inspector is needed, which increases the inspection costs.

The only remedy for these conditions seems to be to employ inspection methods that will not depend on the human senses; in other words, the inspection must be mechanical and automatic as far as possible. The ability of an inspector varies with his physical and mental condition, and an instrument, be it ever so accurately adjusted, that depends on his skill is not any more unfailing than he. There are also some conditions of the natural elements that are seldom taken into consideration by the average inspector, no matter how skillful. So if the rapid production of parts that are absolutely interchangeable is desired, the human element in inspection methods must be reduced to a minimum.

Competition is a great factor in the demand for more rapid and accurate inspection methods. The fact that many manufacturers are making the same article, and are striving to produce the greatest quantity for the least cost in order to undersell their competitors, must ultimately result in the least possible number of inaccurate parts appearing in their products and in every part of the same kind being alike; mechanical inspection is the only means by which this can be finally accomplished. Various concerns engaged in such work have employed women as inspectors, but it takes much time and money to train women to become proficient in this line; besides, the human element is present. Other concerns are trying to replace women with automatic and semi-automatic inspection machinery and equipment, and some have succeeded.

It must be remembered, however, that in general manufacturing, mechanical inspection is no small problem. While various devices have been designed to do all that the human eyes and hands can do, there always remain operations that must be done by hand. Some of the simplest devices have been the result of months and years of study of inspection needs and conditions; so the general development of mechanical inspection methods will be slow on account of the varying conditions thus encountered.

In the manufacture of automobiles, semi-automatic inspection devices have been tried with more or less success. The real advantage of these experiments has been shown in war manufacturing in such lines as airplane motors, gun parts, hand grenades, shells, fuses, and various other products where interchangeability and duplication are essential factors. The improved methods of machining parts in great quantities, which have caused radical departures in jig and fixture design, form another factor that is causing the demand for automatic inspection. Work turned out so rapidly that it must have an army of inspectors to handle it properly must be inspected more rapidly than is now generally done, and also with less human help and chances of error. The advantage of machine inspection lies in the fact that each part is inspected in the same manner and impartially.

Important Features in Design

One necessary and important detail must be remembered in designing an automatic inspection device. As even the hardest materials wear out in time, all contact surfaces must have some compensation for wear. Such surfaces may have springs and adjusting screws so arranged that the surface in question will have a constant pressure; in some cases it is possible to use weights, which are often better. There is practically no limit to the means by which an automatic device may separate the correct from the incorrect parts. The general idea so far is to have contact points that, on certain pressure or travel, will operate a mechanism that controls gates or openings in such a manner that various sizes are separated; in other cases, these contact points open or close electric circuits that are connected to incandescent lamps. Electricity, in fact, may be used in many ways, both to operate and to control these devices. Complication in design should be avoided; in fact, complicated design has been the main obstacle in the development of automatic inspection equipment.

Operation of Inspection Devices

The agents employed to operate automatic inspection devices are vacuum, electricity, compressed air, water, and steam. Water has been used for some time to test gasoline-engine cylinders for leakage. The cylinders are filled with water, which is then subjected to a much greater pressure than that which will be in the cylinders in actual use; in fact, the pressure is so great that, if the castings are porous, water will be forced through the cylinders. Water has also been used for some time on other products where an air-tight and waterproof material is desired.

Compressed air is used so often that it is practically unnecessary to mention the many purposes for which it is adapted; rubber products are only some of the many. Vacuum is not so often used, as it is not possible to obtain a pressure great enough to be applicable to general demands. It is, however, used successfully for inspecting solderless tin cans to insure that they are non-leakable. The machine works on a very simple principle and is operated on about one-half of the maximum vacuum that it is possible to obtain. It consists simply of a wheel, approximately sixty inches in diameter, on the periphery of which are placed soft rubber pads of a good quality that are a little larger in diameter than the can. Each pad has a hole in the center, from which rubber tubes lead to a rotating valve fitted to the hub of the wheel. The wheel is mounted on ball bearings, which are fastened in supports long enough to raise the wheel so that it will revolve. The wheel is driven by a 1/4-inch round belt from a countershaft at very slow speed. The vacuum is obtained by an electrically driven pump, the connections being fitted to the hollow hub of the wheel and thence to the rotating valve.

The cans are placed on the pads by girl operators as the wheel slowly revolves. If there is no leak in the can, the vacuum causes it to remain on the wheel until the latter has revolved far enough to come in contact with a trip, which closes the valve for that pad; then the can falls into a chute provided for that purpose. If a leak is present, a faulty seam being generally the cause, the can will either not stick at all or else it will not stay on the wheel until it has traveled far enough to enter this chute. In this case it is carried away by another chute, and later is tested by compressed air and the leak found and corrected. The concern using this device designed and built it in their own plant, and it is entirely independent of the human element. In this case the inspection requirements were studied and analyzed, and although the machine was perfected only after many trials and experiments, when the necessary result was obtained the design was simplified and the efficiency increased. It is needless to add that this machine has many times paid for itself in the cost of skilled inspectors, time, and wasted material that it has saved. Showing with unfailing accuracy the exact percentage of spoiled work, it created the motive to improve the product.

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Where mechanical devices are to be used to measure diameters and lengths accurately, care must be taken to eliminate chances of error caused by dirt, chips, or other foreign matter getting between the contact surfaces and the surface to be measured or gaged. This may be done in some cases by washing before inspecting. Another obstacle to mechanical measuring must also be taken into account. When steel or nickel stock is machined rapidly, it may become slightly magnetized, so that small particles of mineral dust and chips will adhere to it. This can only be overcome by eliminating, as much as possible, the friction of the cutting tools by using the proper lubricant when machining or by demagnetizing the part after machining. When this condition is overcome, there is less chance of error in mechanical measuring.

Electrical contact devices may be adapted to many uses and can be used in many assembling operations. One such device is often used to test the timing of gasoline motors, the contact points lighting lamps on the opening or closing of the valves. This device is contained in a small portable box, which contains a battery and a socket for a six-volt lamp. Wires about a foot long connect the battery with the motor, one wire being fastened to the valve stem and the other grounded to the motor. The mechanism is so arranged that the contact will be made only when the valve lifts from the seat, thus showing the exact timing. The complete outfit will not cost over twenty-five dollars. In place of the battery, ordinary electric current can be used and a lamp with a higher voltage can be employed.

There is no doubt that at some time in the future, on account of the constant demands now being made for rapid and accurate production, there will be evolved from the many ideas now being used a measuring device that will solve some of the inspection problems confronting American manufacturers. This instrument will probably be one that can be used in many ways; it will in no way depend on the skill of the operator and will leave no doubt as to its accuracy. It will have no master, that is, it will be its own standard, and will not have to be tested constantly in order that it will maintain its accuracy. Ten years ago, accuracy in ordinary manufacturing that is now quite common was considered impracticable. The real cause for the improvement is the demand for more accurate and a greater variety of measuring and inspection tools. The trade schools also are making a greater effort to familiarize themselves with modern inspection methods in order to be able to give the student a better education on this subject. With the proper talent bent in this direction, there is good reason to expect that the eventual result will be inspection on a scientific basis, mechanically, and without depending on the skill and senses of the trained operator.

* * *

Statements to the effect that the explosive force of dynamite acts downward are often seen. This statement, however, is entirely erroneous. Arthur LaMotte, manager of the technical division of the E. I. duPont de Nemours & Co., Wilmington, Del., explains the reason for this common fallacy as follows: When dynamite was first used, its action was so much quicker and more powerful than black powder that a sufficient fraction of its explosive force would fracture a rock when the dynamite was placed on top of it. Any explosive exerts its power equally in all directions, and the gases produced in consequence of the explosion seek to escape in the line of least resistance. While it is true that when a charge of dynamite is placed on top of a rock it will frequently break it, it would be found that it would break it just as easily if it were placed either on the side or on the bottom of the rock. Nitroglycerin, which is the active component of dynamite, changes almost instantly into gaseous form, and the gas is evolved at several thousand feet per second. In fact, the gas is evolved at such an extreme rapidity that the column of air above it is compressed to such a degree that it acts as a confining material, and hence much of the energy of the explosive is expended upon the support upon which it rests. A 60-per-cent nitroglycerin dynamite exploded in the open will develop nearly as great a velocity of detonation as when confined in a bore hole, and has a velocity of nearly 20,000 feet per second.

SAFETY AS AN INVESTMENT AND WAYS OF SECURING IT

BY H. P. HEYNE[1]

Safety first is a business proposition that may be considered from a financial as well as from a humanitarian standpoint. Every time an employe is injured and must be replaced by a less efficient worker, it entails an expense of from \$50 to \$100 to break in the new man. If a firm employing 5000 men has 100 time-lost accidents per month, or a total of 1200 cases per year, this will mean a total loss of \$60,000, based on \$50 per man.

By a systematic safety campaign, however, the number of accidents can be reduced. If a reduction of 25 per cent is effected during the first year of the safety campaign, there will be a saving of \$15,000, together with a higher percentage of efficiency for the plant. Even though \$10,000 may have been expended during the year in the installation of safety devices, etc., there still will remain a saving of \$5000, a body of more contented workers, due to the fact that they have been considered along welfare lines, and a less disorganized force through a reduction in labor turnover. The saving will increase annually by a still further reduction in accidents.

Maintaining a record of the causes of accidents, together with the percentages for all classes, gives a working basis for ascertaining what class of accidents is the most common. Then attention can be effectively directed toward these for corrective measures. It will often be found necessary to show the men just how to hold and work with tools, as the majority of injuries are due to the lack of ordinary care on the part of the injured or a fellow-employe in the discharge of his duties. The foremen have an important part in the safety movement and should teach the men safe practices, as they are held responsible for the injuries to the men under their supervision.

The introduction of safe methods and the installation of safeguards has a double purpose: First, it is necessary to effect a reduction in accidents; second, it shows the men that the firm has an interest in their welfare and is in earnest, and this knowledge is bound to make the men ambitious in accident prevention work. A man without ambition is not a desirable employe.

The men may be made enthusiastic over the safety measures by appointing them on plant safety committees and encouraging them to suggest safeguards and changes that will be beneficial to the company as well as to themselves. Many good ideas will be brought forth through this medium, and when the men observe that a certain guard has been installed or a recommendation accepted, they will have a feeling of satisfaction because they were consulted in the matter and will feel that they are a part of the organization, which will make them enthusiastic in the movement. Appreciation, cooperation, and enthusiasm are dominant factors in safety educational work.

Some of the little things that play a big part in the reduction of accidents are: Knuckle guards for wheelbarrows and trucks to prevent hand injuries when going around short corners; goggles properly fitted to conform with the men's faces; safety handles on crane hooks to prevent men's hands from being caught between the hook and the material; safety feet for portable ladders to avoid slipping and falling; red lights over danger signs so that employes working at night may be aware of the danger; safety shoes to protect men's toes from falling tools, etc.; soaking sledges in oil to prevent the handle in the eye of the sledge from drying out and becoming loose; proper goggles for various classes of work; checking drawings for safety; track clearances to avoid obstruction to trainmen, etc.; fire inspection to observe that hoses, fire plugs, and extinguishers are in good condition; danger tags to be attached to equipment temporarily out of order—such equipment should not be used until the tag is removed; proper piling of material to prevent falling on workmen; good order—a place for everything and everything in its place; proper care of pneumatic hammers to prevent injury; and proper installation and guarding of grinding wheels and other moving parts.

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[1] Safety Inspector, United Alloy Steel Corporation, Canton, Ohio.

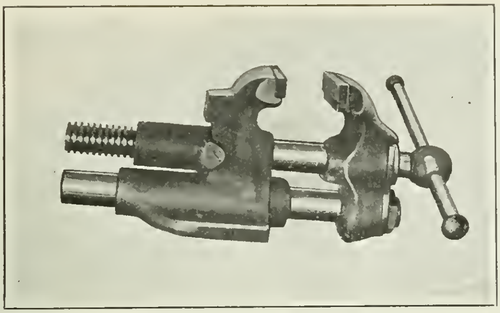

Fig. 1. Bench Vise made in a New Zealand Trade School

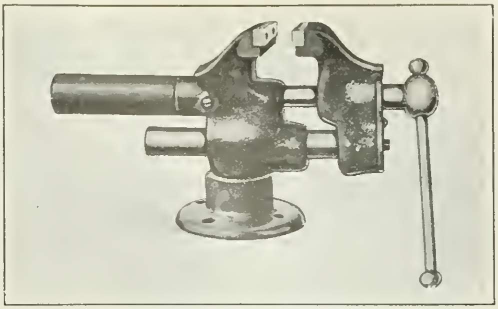

Fig. 2. Another Bench Vise made in the Trade School

A NEW ZEALAND SCHOOL WORK-SHOP

BY JOHN PEDDIE[1]

The accompanying illustrations show a few of the products of the evening school of the Technical College at Christchurch, New Zealand. Though the students are apprentices in various branches of the engineering trades, in many cases their evening school tasks are the only work these students do with machine tools. Some of them are in the electrical trades and do little work beyond wiring, some are engaged in the assembling of agricultural implements of the roughest kind, and some are restricted to one branch of machinist's work and will complete their apprenticeship with very little experience. To such young men, the evening school course is a valuable addition to their training, and they acquire familiarity with work-shop processes that would otherwise appear full of mysterious difficulties. They are shown how to use machines they are not allowed to touch in their employers' shop and how to do varieties of work that do not come within their employers' range of business.

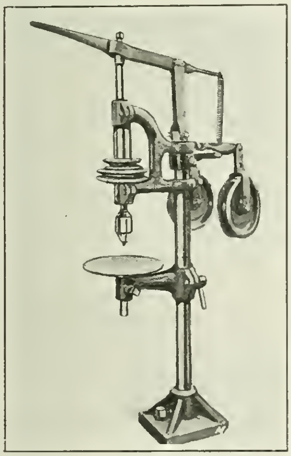

Fig. 3. Small Foot-power Drilling Machine—a Trade School Product

Some employers do not approve of this feature of the work. They say that the students should be taught to do their everyday work more rapidly, apparently being indifferent to the question as to whether at the end of five years they can claim to have taught their apprentices "the whole art and mystery" of the craft. In the past, this agreement was stated in the indenture; nowadays, while it may be implied, it is tacitly ignored. When a creditable piece of work, such as the surface gage shown in Fig. 4, is shown to critics of this type, they ask, "Ah, but how long did he take to make it?" Perhaps the lad who made it has done nothing in the shop in which he is employed except run a screw machine or drilling machine, or chip castings. The advice of Oscar Beale, in Brown & Sharpe's handbook, applies to this:

"During the first few weeks, it is well for a young apprentice to do his work of a quality about as high as he is capable of doing. After he is sure of the quality of his work, he can have a thought as to the quantity."

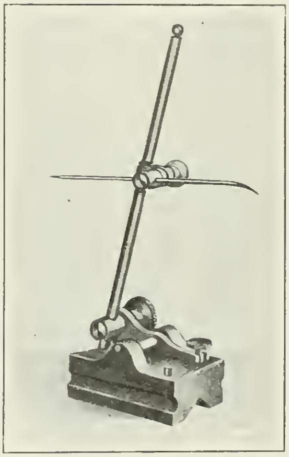

Fig. 4. Surface Gage made by Boys in New Zealand Trade School

As the time spent in the school shop does not amount to more than a few weeks' time in a commercial shop, it would appear that quality should be the chief aim. The students do not make more than one example of each class of exercise. They nearly all make a surface plate, 3 by 6 inches, or 6 by 6 inches, and in doing this get probably the only experience they will have for years of preparing a true plane surface by scraping. During this exercise, they learn

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[1] Address: Technical College, Christchurch, New Zealand.

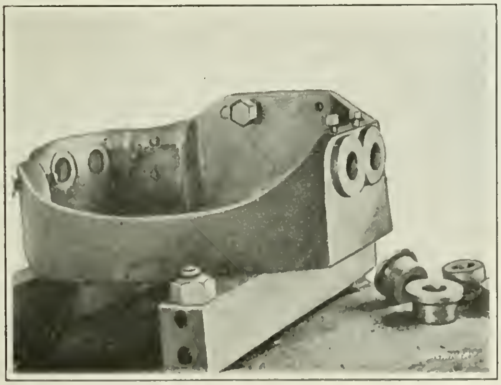

Fig. 5. Jig used when boring Vise shown in Fig. 1

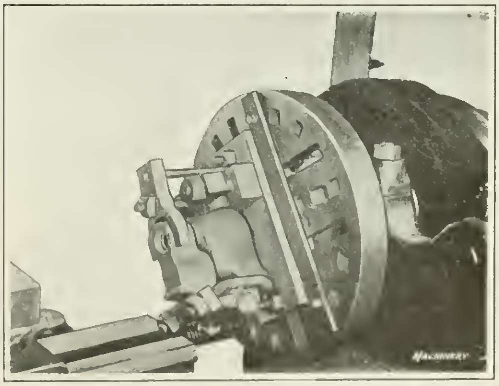

Fig. 6. Boring Vise on Lathe Faceplate

how to sharpen a scraper and how to dress and harden it when necessary. In other exercises, they learn to bore straight and taper holes, to turn and grind straight and taper spindles, and to cut screw threads. The ball on the end of the vise screw is finished with a hand graver; this is often the introduction of the student to such a tool, and frequently elicits a look of pleased surprise at the ease with which it can be used.

The vise shown in Fig. 1 has 4-inch jaws and the castings are bored while clamped in the jig shown in Fig. 5. The vise shown in Fig. 2 has 3-inch jaws, and is bored while held on a lathe faceplate, as shown in Fig. 6. The screws of both vises are protected with covers, that of the vise shown in Fig. 1 being removed. The small drilling machine, Fig. 3, was designed by the writer. The spindle bearings are babbitted, parallelism with the column being secured during this process by a very simple jig; the guide pulleys are free to adjust themselves without side pressure when the drill is being driven by foot power. The base and fine adjustments of the surface gage shown in Fig. 4 were also designed by the writer; quite a number of these gages have been made, and they afford a large variety of exercises.

Students attending the machine drawing class, as well as the work-shop, are required to make drawings of any piece of work they undertake in the shop. In some cases they also make tracings and blueprints for shop use. Before a student is allowed to attempt a project of his own design, he must produce a satisfactory drawing or sketch of it.

* * *

LEGAL DUTIES OF EMPLOYES

BY CHESLA C. SHERLOCK[1]

A great deal has been said and written concerning the duties which an employer owes to his employes, but very little is said concerning the legal duties of employes. Whether these duties are taken as a matter of course or whether they are implied in each case is not known. It is true, however, that very few employers know definitely just what duties their employes are bound by law to perform. In a general sense, the employe's services belong to the employer during the hours of the employe's employment, but whether a failure on the part of the employe to devote his entire time to the employer's service constitutes a breach of the contract of employment depends, as a rule, upon the circumstances of the particular case. If a man is employed at a given wage to make horseshoes, he has no right to take time off from his regular work to make wagon tires for another. This fact is too well known among employers to be further emphasized, but when we get into the more complex relations that arise in everyday work, it is not so easy to dispose of the cases.

Employes' Obligation to Obey Rules

It is implied, as a part of every contract of employment, that the employe shall obey the lawful rules, orders, and instructions of the employer, at least as far as they are reasonable and not merely arbitrary or capricious. This question of obedience to orders has called out legislation in some of the states. Where workmen's compensation acts are in force, a disobedience of an employer's order or rule will not be sufficient to deny the workman the right to recover compensation from his employer, unless such disobedience shall amount to "serious and willful misconduct" on the part of the employe. If an employe refuses to obey a reasonable rule or order of his employer, the contract of employment may be terminated then and there, even though nothing was said in the contract itself regarding such obedience. This statement of the rule must, of course, be subjected to some modifications.

The employe is not, however, bound to obey rules that he has not contracted to observe or that are not incident to or assumed by him in the general scope of his employment. Before he can be deemed to have been bound by a rule it must appear that he was cognizant of its terms. It is plainly the duty of employers, then, to publish their rules in such a way that they cannot fail to be brought to the employe's attention, if strict obedience of the latter is to be required. It is perfectly logical to say that no man can be required to do a thing of which he knows nothing or has no opportunity of knowing.

Employers' Right to Employes' Time

Where an employe sells his entire time to his employer, he has no moral or legal right to devote part of his time to an independent calling or business of his own, regardless of the fact that it may not interfere with his service to his employer. If he does so engage in outside work, his employer is entitled to his earnings therefrom. This rule is clearly illustrated in the case of a school teacher who made a practice of giving special tutoring to pupils after school hours. In the course of a year, he built up a very profitable business on the side and the school board employing him finally brought suit against him. He was forced to turn an amount equal to his earnings over to his employer—the complaining board. In another case, however, a college professor engaged in the coal business on the side, employing men to do the work and merely exercising supervision over their efforts. In this case, the court refused to disturb him, saying that his outside business did not interfere with the service he had contracted to render to his employer. It follows that if an employe engages in outside work to the injury of his service to his employer, that he may be held in damages for the injury done. If the profits earned in the outside business are not sufficient to compensate the employer, the latter may also recover damages sufficient to compensate him adequately for the injury done.

Right to Inventions

In the case of inventions, however, there is a different rule. The employer has no exclusive right to the inventions of his employe. Employes are not deprived of their right to inventions while in the service of others, unless they have been hired to exercise their inventive faculties for their employers. Some very bitter cases have arisen where an inventor has been hired at a stipulated salary to exercise his gifts in behalf of the employer. In nine cases out of ten, if the employe is successful in perfecting an invention, he will try to keep it for himself and keep his employer from reaping the profits. But the courts have adopted a very sane view of the matter and have held that it is the purpose, in such contracts of employment, to give the employer the fruits of the inventor's skill and that the employer has the right to such inventions as the inventor may perfect. It should be remembered, however, that where the invention of an employe arises casually out of his employment, that the employer has no right to it, unless a specific agreement had been reached prior to the invention or a valid assignment of the inventor's rights was made subsequent to it.

Where employes have permitted their employers to use their inventions, the law implies a license to the employer to continue to use the invention in his business even after the relations between the employer and the inventor have terminated, although the employe has taken out a patent therefor.

Where an employe produces a literary production, the courts are agreed that the employer has no right whatever to it unless the employe was employed for the specific purpose of making such a production.

Obligation to Preserve Trade Secrets

It is the duty of an employe to preserve all trade secrets of his employer. Courts of equity will restrain employes from making disclosures or use of trade secrets communicated to them in the course of confidential employment. The character of such secrets is immaterial. They may be secrets of trade, secrets of title, secrets of process of manufacture, or any other secrets important to the individual employer. This question of trade secrets, however, is limited to a certain degree. The secrets must not be general secrets of trade, but must be secrets of the complaining employer.

As a general proposition, then, the employe is directly liable to the employer for any damage occasioned by his negligence or misconduct, whether it be to the property of the employer or arise from compensation the employer has been obliged to pay third persons for injuries sustained by them, because of the employe's misconduct.

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The Wilt Process of Twist Drill Manufacture

By Franklin D. Jones[1]

Process in which All Machining Operations on Twist Drills, Except Grinding, are Done Automatically

An Automatic Machine is Used having Multiple Cutter-heads and a Single Stock-feeding Spindle

THE Wilt process for the manufacture of twist drills, developed during the last ten years, comprises a number of radical changes in former methods. Heretofore it has been necessary to put a drill through a number of machining operations in the course of its manufacture. The usual way, in the production of a 1/2-inch jobber's drill, for example, has been to shear off the blank to length from the long bar on a shearing machine, square the ends on a special lathe, point on a pointing machine, center, and square-center; then either finish-turn on a lathe or rough-turn on a lathe and soft-grind on a grinder; then mill the grooves on a groove-milling machine, and finally mill the clearance or relief on a clearing machine.

Many attempts have been made to shorten this process during the last ten or fifteen years, but most of them without success. One company has developed a magazine-feed machine, which combines the milling and clearing operations, but the blanks have to be prepared in advance. The Wilt machine, however, does all the machining operations enumerated above, except grinding, automatically. It applies the principle of an automatic screw machine, developed to a high degree, to the manufacture of twist drills. Briefly, the carbon or high-speed steel bars, either hot-rolled and in the condition in which they come from the steel mill, or drawn in the smaller drill rod sizes, are fed in long lengths into the automatic machine through a single stock-feeding spindle, and the blank is automatically cut off and pointed. As each successive blank is severed from the bar stock by a cutting-off and pointing tool, it is gripped by a collet in the blank carrier or work-holding turret, which has an intermittent or indexing movement in a plane perpendicular to the axis of the stock-feeding spindle, and presented, in turn, to a multiple cutter-head, which first rough-cuts the grooves, then finish-cuts them, and mills the clearance, so that all the machining operations are performed simultaneously, and a drill ready for soft-grinding is ejected from the machine at each indexing of the blank-carrier.

One of the important features of the machine, aside from the fact that it machines the drill automatically, is that it first roughs out the grooves in successive cuts, so that, when the blanks are presented to the finishing groove cutters, they take a cut of only about 0.015 inch on each side, thereby insuring a very good finish on a groove and effecting several great savings, not only in speed of production, but also in other expenses to which most drill companies are put, such as in polishing and grinding grooves. A relatively large number of teeth is used on the finishing cutters, and one or more sets of roughing cutters, to divide the amount of work of rough-grooving, so that the speed of the machine can be governed by the time required for the clearing cutters, which at the last position of the turret, mill the clearance of the drill. After this clearing cut has been taken, the drill drops from the machine. This is the only machine, so far as is known, that automatically takes successive cuts on the same groove.

Changes in Grinding

By the old process of making twist drills it is necessary that the drill blank be turned or ground to an almost exact size before the grooves are milled. This is necessary, as the blanks have to be held in close-fitting pilots or guides when milled in the single-cut groove milling machines. Drills that are milled at a very slow rate and fit very tight in the bushings are not so likely to require groove-grinding. Owing to the successive cuts on the Wilt machine, most of the stock from the grooves is removed before the blank is presented to the finishing-groove milling cutters, so that it is unnecessary to feed the blanks through close-fitting pilots or guides. Owing to this fact, blanks made from hot-rolled steel, as well as drawn stock, can be fed to the groove-milling cutters, and a smooth finish is produced in the grooves, in spite of the fact that the blank does not fit close in the pilots. In fact, the pilots on the machines are about 0.015 inch over size. It is possible to produce the larger sizes of drills without any pilots, although this is not done, as they are used chiefly for conducting oil to the cutters. The soft-grinding process is much simplified, because the clearing cutters, as well as the groove-milling cutters, have already removed most of the decarburized surface from the hot-rolled bar, and only the remaining decarburization on the narrow ridge along the groove edge is left to be removed. To do this a grinding machine has been developed, which does not require centering the blanks. This machine constitutes another interesting feature of the new process that has been evolved for making twist drills.

The point-grinding operation is necessary in the Wilt process as well as in all other processes. The novel feature of this operation by the Wilt method is that the point-grinding machine chucks the drill blank on the cleared part of the drill instead of on the outside diameter, thus assuring margins of a uniform height from the clearance. After the body of the drill has been soft-ground, the finishing processes are the same by the Wilt as by other methods. These finishing processes consist in hardening, tempering, straightening, sand-blasting, stamping, and finish-grinding to size, the point finally being sharpened or finish-point ground, ready for drilling holes.

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[1] Associate Editor of MACHINERY.

The operations as outlined constitute the general practice, which may be modified under special conditions, and is the practice followed in making ordinary jobbers' drills. In the taper-shank drills, the blank is made the same as in the case of jobbers' drills, from the cutting point to the neck, but is necked on the Wilt automatic at the same time that it is pointed and cut off. The cylindrical surface is then soft-ground and the drill pointed. It is then electrically welded to the shank, the taper shanks being made on automatic screw machines from low-carbon steel. It has been found possible to weld the shank to the drill with a welding alignment accurate to 0.002 inch. After welding, the drill is hardened, tempered, straightened, etc., just as in the case of the jobbers' drill. While the principal changes effected by this process have been referred to, the Wilt automatic machine results in other changes in handling and inspection, which will be considered later.

Brief History of Development of Process

The Wilt process has been developed by A. D. Wilt, Jr., during a period of about ten years, although he began to work upon the first idea of making twist-drills in some kind of automatic machine as early as 1905. In fact, the actual cause of the development goes back still further. After having graduated from the Harvard Engineering School in 1903, Mr. Wilt came to the National Cash Register Co., at Dayton, Ohio, and in the course of his work with this company found occasion to study the manufacture of twist drills, because of the great number of drills that were used by this company. From this time on he began maturing the idea, having gained experience and knowledge in automatic machinery during his employment as production engineer of the Burroughs Adding Machine Co., of Detroit, Mich., and later in the same capacity for the Standard Screw Co., which probably operates more automatic metal-cutting machinery than any other company in the United States in its five factories located in Detroit, Mich., Chicago, Ill., Hartford, Conn., Worcester, Mass., and Elyria, Ohio. In 1907, Mr. Wilt organized the Schweppe & Wilt Mfg. Co., Detroit, Mich., maker of automobile parts, of which company he has been president ever since and in the plant of which the new twist drill machines have been developed. In 1913, he organized a Canadian company for the manufacture of twist drills. Being engaged in twist drill manufacture, an opportunity presented itself for trying out in practice the efficiency of the machines designed.

In the development of the automatic twist drill machines to be described, E. J. Lees, of the Lees-Bradner Co., Cleveland, Ohio, gave valuable assistance by carrying out the design of the first machine, and later C. H. Whipple, of Detroit, Mich., designed and developed the two sizes of machines for the smaller sized drills. In fact, in the latest machine he has solved the problem of handling efficiently the hot rolled bars as they come from the mill.

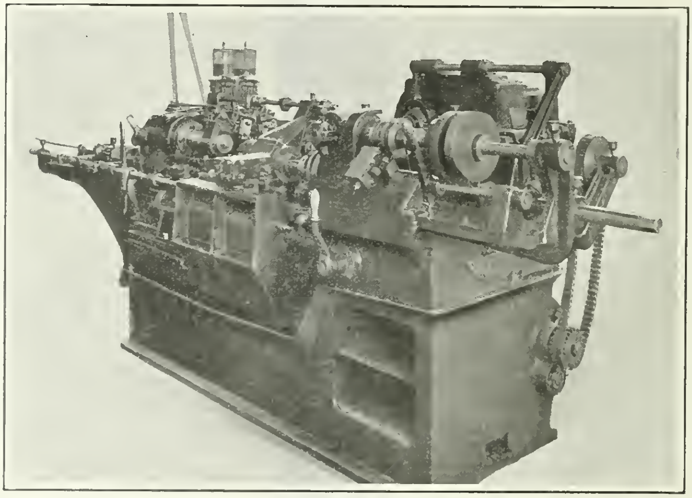


Fig. 1. Automatic Single-spindle Multiple Cutter-head Twist Drill Machine

Types and Sizes of Machines

For a complete line of automatic twist drill machines, except for the extremely large sizes of drills, three sizes are necessary, two of which have already been built. The largest machine, known as Type A, makes drills from ½ to 1¼ inch in diameter. This machine is provided with six collets or blank-carriers in the turret, one for cutting off and pointing, three for the successive rough-grooving cuts, one for finish-grooving, and one for milling the clearance. The next smaller machine makes drills from ⅛ to ½ inch in diameter. This machine is provided with four operating positions—one for cutting off and pointing, one for rough-grooving, one for finish-grooving, and one for milling the clearance. This machine is known as Type C. The smallest machine, known as Type D, makes drills ¼ inch in diameter and smaller and has four operating positions, the same as the Type C machine. Hot-rolled bars are customarily used for all sizes above 5/16 inch in diameter; for the smaller sizes, drill rod in long lengths is employed.

General Features of Machine and its Action

The mechanism of the automatic twist drill machine may be divided into two general groups: first, the means of severing the drill blanks from the bar of stock and of presenting them to the different cutting tools successively—which includes the means of advancing, withdrawing, and indexing the blank-carrier—and, second, mechanism for driving the different cutting tools and for controlling the action of these tools as required by the form of the product and the operation of the machine itself. While this machine is multiple in the sense that it has several cutter-heads which operate simultaneously on different blanks, all the blanks are cut from a bar of stock which is fed through a single spindle equipped with a suitable stock-feeding mechanism. In this respect the machine is radically different from a multiple-spindle automatic screw machine which operates on several bars of stock at the same time.

When the automatic twist drill machine is in operation, the bar of stock, after being fed out to the required length, is cut off by a V-shaped tool, which forms a conical-shaped end or male center on the inner end of the blank being severed and also on the outer end of the next successive blank. While the cutting-off and pointing tool is at work, the blank-carrier is advancing to receive the blank. The blank-carrier has several spindles equipped with collet chucks for holding the blanks. These spindles are equally spaced and are equidistant from the main shaft of the turret-carrier. The different cutting tools required are located opposite the blank-holding spindles. As soon as a blank is cut off, it is gripped by whichever spindle happens to be opposite the stock-feeding spindle. The blank-carrier then moves backward and indexes or rotates far enough to locate the blank that has just been cut off directly opposite the first tool-head, carrying two opposed roughing cutters, which take a roughing cut through the groove as the blank feeds forward. If the drill is larger than 1/2 inch and the work is being done on a Type A machine, the groove is first milled as indicated by the dotted line *a* of sketch *A*, Fig. 5. The next indexing movement locates the blank opposite

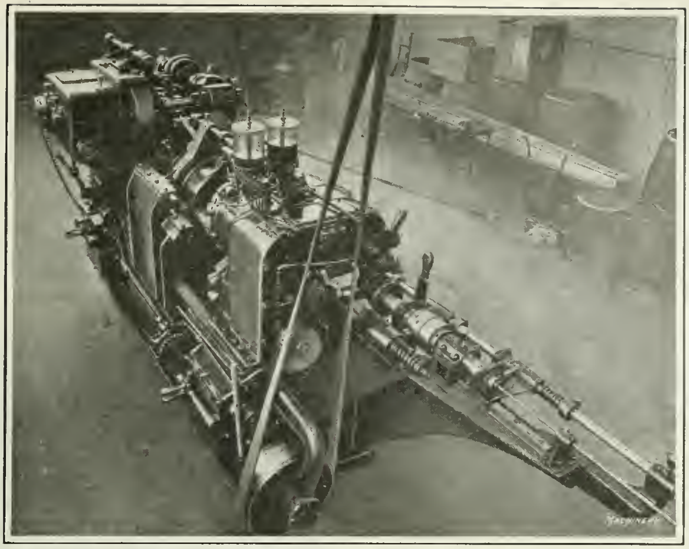


Fig. 2. View showing Rear Side and Stock-feeding End of Automatic Twist Drill Machine

the second set of rough-grooving cutters, which take cut *b*, and then it is indexed around to the third set of roughing cutters (cut c), and finally to the finishing cutters. The next and last operation on this machine is the milling of the clearance, which is done by means of end-mills, as indicated by sketch *B*, Fig. 5. The blank is now ejected from the chuck of the blank-carrier spindle, and another indexing movement locates this particular chuck opposite the stock-feeding spindle and in position for receiving another blank. It is evident, therefore, that as soon as the blank-carrier has made the first complete revolution after starting the machine, each spindle contains a blank, and all these blanks are operated upon whenever the blank-carrier advances; consequently, one blank is finished, so far as this machine is concerned, every time the blank-carrier indexes, the operation in this respect being similar to that of a multiple-spindle automatic screw machine.

The collet chuck of the stock-feeding spindle is opened and closed in the usual manner by the action of a sliding collar having a tapering section which operates bellcrank levers and a tube connecting with the chuck. The chucks of the carrier spindles are also of the collet type, and in the center of each of these spindles there is a rod which, at the proper time, moves forward relative to the spindle and ejects the drill after it has been grooved and the clearance milled. Before the blank is ejected, the sleeve of the chuck-closing mechanism is engaged by two spring-actuated arms which open the chuck and release the finished blank.

In making a twist drill, the milling of the grooves is the longest operation and the one requiring the removal of the most metal; consequently, the machine designed for medium- and large-sized drills has three sets of roughing cutters, as mentioned, so that the work of milling the groove to the full depth is distributed. The result is that the rate of production is not controlled and reduced by the groove-milling operation, and the output of the machine is much higher than it would be otherwise.

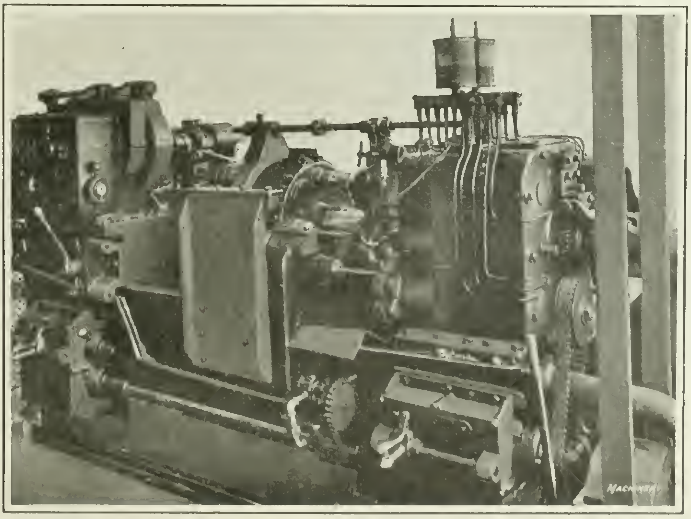


Fig. 3. Another Rear View of Automatic Twist Drill Machine

Variable Movements of Blank-carrier or Work-holding Turret

When the blank-carrier advances toward the stock-feeding spindle and the cutting tools, it moves quite rapidly up to the cutting position, and then at a reduced speed while the cutters are milling the grooves and the clearance. As the grooves are helical, it is necessary to rotate the blanks as they advance in order to generate a helix or twist of the required pitch. The mechanism for obtaining this rotary movement will be described later. After the tools are withdrawn to clear the drill blanks, the carrier returns rapidly to the starting point and the indexing movement occurs. The mechanism for transmitting and controlling these motions will now be described.

The forward and backward motions are derived from the mechanism shown partly in diagrammatical form in Fig. 8. The blank-carrier *A* is mounted upon shaft *B*, on which it is free to rotate. This shaft and the blank-carrier are given a lengthwise traversing movement when the machine is in operation. A sleeve *C* having a screw thread on it is attached to the carrier and engages a nut *D*, which is revolved by means of worm-gearing for traversing the carrier. All the motions of this machine are derived from the main shaft *E*, which transmits motion to the tool-heads of the machine, as well as to the blank-carrier. The transmission in each case is through a gear-box, there being one of these gear-boxes to provide speed changes for the cutters and another to vary the speed of the blank-carrier mechanism. (These gear-boxes and the levers for controlling the speed changes may be seen near the base of the machine, Fig. 2.) The silent chain drive, by means of which motion is transmitted from one gear-box to the mechanism for operating the blank-carrier, may be seen at the end of the machine in Fig. 1. The shaft which is driven by the silent chain drives worm-shaft *F* (Fig. 8) through different combinations of gearing, which are automatically engaged and disengaged in order to vary the forward and backward traversing movements. There are two driven shafts *G* and *H*. A pinion on shaft *G* meshes with a loose gear H_1, and another pinion on shaft *H* meshes with a loose gear G_1, the pinions in each case being attached to their respective shafts. Shaft *H* is also connected by gears at *I* with worm-shaft *F*. The automatic

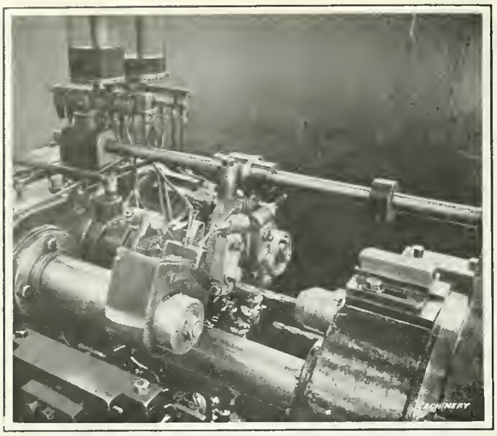


Fig. 4. Detailed View of Cutter-heads as seen from Front

control of the speed changes is effected by two clutches J and K, which, in turn, are operated by cams and other controlling mechanisms to be described. The cams located at L and M, and the levers and rods extending from the clutches to the cam, are clearly shown in the illustration.

After the indexing movement, cam L has turned to such a position that clutch J is shifted into engagement with gear G_1 for obtaining the fast forward movement of the blank-carrier, motion being transmitted from shaft G through gear G_1 to shaft H and then back through gears I to shaft F and the worm-gearing operating nut D. Just before the cutting tools begin to operate upon the blanks, the shaft carrying cams L and M again makes a partial turn (one-quarter revolution), and this causes clutch J to be disengaged from gear G_1, while at the same time clutch K, through the movement of cam M, is engaged with gear H_1. This imparts to the blank-carrier the slow forward movement which is required for milling the grooves and clearance. As soon as the blank-carrier has advanced far enough, another quarter revolution of cam M disengages clutch K from gear H_1 and throws it into engagement with gear O, which gives the blank-carrier a quick reversing or backward movement.

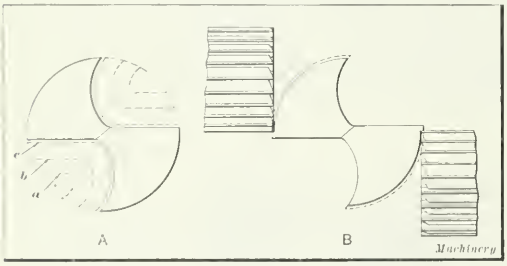


Fig. 5. Diagrams illustrating Methods of milling Grooves and Clearance or Relief

Controlling and Indexing Mechanism of Blank-carrier

The forward and backward motions of the blank-carrier, in conjunction with the indexing movement, are utilized to control the different traversing speeds previously referred to, by means of a mechanism that allows the shaft carrying cams L and M to revolve one-quarter revolution each time a speed change is required. This camshaft is connected by a slip clutch and gearing with one member of clutch P. This half of the clutch is in the form of a loose sleeve, and it is connected through spiral gears with shaft G. This loose sleeve revolves continuously, but shaft Q, which serves to index the blank-carrier, is rotated intermittently when, at the extreme backward movement of the blank-carrier, clutch P is engaged. Shaft Q carries a pinion which meshes with the large gear on the blank-carrier A, and in the case of the Type A machine, this carrier revolves one-sixth revolution for each complete turn of shaft Q. Incidentally, the pinion on shaft Q is shrouded or has flanges, and it is traversed with the blank-carrier.

The shaft Q is normally prevented from rotating by means of a stop R, Fig. 7, engaging a notch R_1 formed on a wheel carried by shaft Q. This shaft operates a slide S (see also Fig. 8) by means of a sleeve S_1. Slide S carries a rocking arm T, at one end of which there is a spring-actuated pivoted dog T_1, which may be engaged by the beveled side of a shoulder on plunger U. On the forward movement of a blank-carrier and shaft Q, a spring surrounding plunger U is compressed, and the plunger is cocked or retained by the pivoted spring pawl U_1. On the backward or return movement, this pawl, when near the limit of its travel, encounters a fixed stop, and is thereby released from the shoulder of plunger U, which, under the action of the spring, pushes back and rides over dog T_1. This rocks the pivoted arm T and releases the stop R from the notch R_1 in the disk on shaft Q; consequently, shaft Q is permitted to make a complete revolution, thus indexing the blank-carrier. Just how this indexing movement affects the mechanism for controlling the traversing speed of the blank-carrier will now be described.

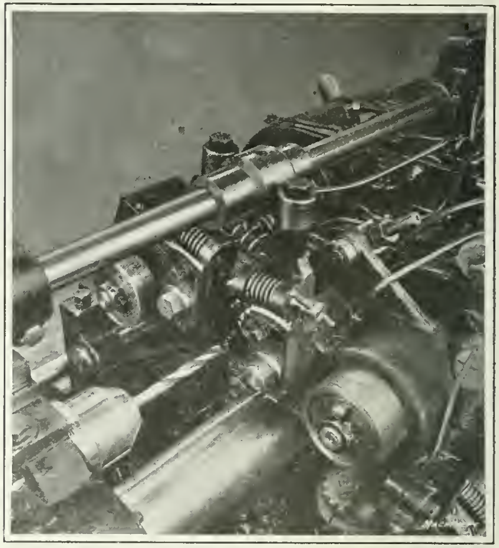


Fig. 6. Detailed View of Cutter-heads as seen from Rear

To begin with, there is an index wheel V, Fig. 8, on the shaft carrying the controlling cams L and M. This index wheel has four notches which may be engaged by a pawl mounted on shaft V_1, which is free to oscillate. This pawl is provided with an extension that engages successively with cam W and the beveled disks X and X_1. This cam and the

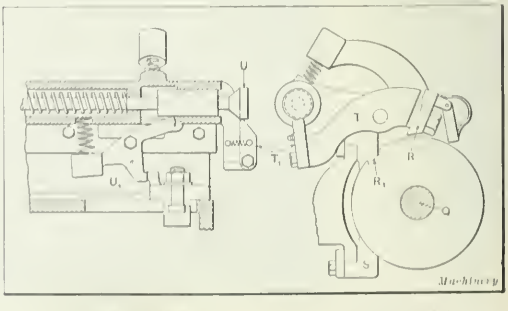


Fig. 7. Locking Device which forms Part of Indexing Mechanism

two disks are fixed to shaft Q. At the right-hand end of shaft V_1 there is a lever arm which, on the backward movement of shaft Q, engages beveled disk Y. When shaft Q turns through a complete revolution for indexing, the cam W releases the pawl from index wheel V, thus permitting the latter to make one-quarter turn, the movement being arrested by the engagement of the pawl with the next succeeding notch. The camshaft tends to rotate constantly, since it is connected by a slip clutch and gearing, as previously mentioned, with the sleeve of clutch P, which rotates constantly. This first movement of index wheel V is for the fast forward speed.

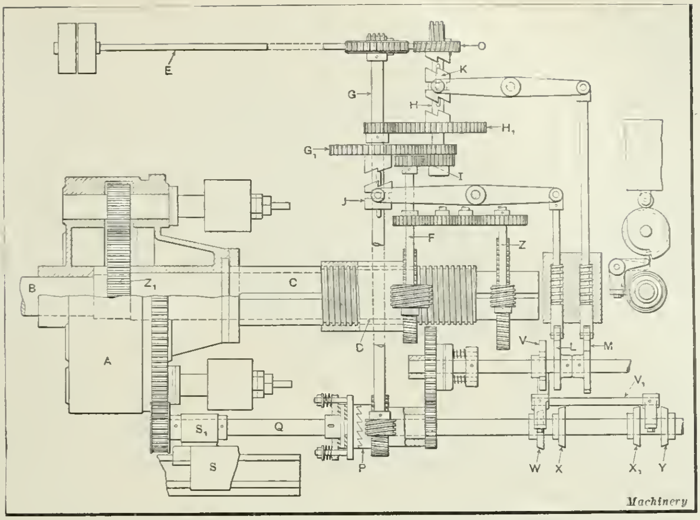


Fig. 8. General Arrangement of Mechanism for controlling Traversing and Indexing Movements of Blank-carrier or Work-holding Turret

As the blank-carrier and shaft Q continue to move forward, the beveled disk X again releases the pawl and the index wheel, which makes another quarter revolution, thus reducing the traversing movement for the cutting operation. The cutting tools are at work while the pawl is passing from disk X to X_1, and when the latter is encountered, index wheel V makes a third quarter turn, thus reversing the motion of the blank-carrier. On the return movement, the bevel disk Y again lifts the pawl and releases the index wheel, which makes a quarter turn and shifts clutch K to the intermediate or neutral position.

As it is essential to locate the blank-carrier accurately relative to the tools after each indexing movement, a positive method of holding and guiding it has been provided. Rectangular-shaped blocks are attached to the carrier, one of which engages a guide attached to the bed of the machine each time the blank-carrier advances. One of these blocks may be seen at the top of the blank-carrier in Fig. 4, and the guide at the front of the machine is clearly shown in Figs. 2 and 3.

Rotation of Blank-carrier Spindles for Generating Helical Grooves

The slow rotary speed of the blank-carrier spindles which is necessary for generating the helical grooves in the drills is derived from the mechanism illustrated in Fig. 8. The spindle F, which drives nut D through worm-gearing, also transmits motion to worm-shaft Z through change-gears selected according to the lead of helix required. The worm on shaft Z drives a worm-wheel on a sleeve keyed to the main shaft B (see also Fig. 9). In this way, a slow rotary motion is imparted to shaft B, and through it, by means of gear Z_1, to the blank-carrier spindles, which have pinions meshing with gear Z_1. This slow rotary movement, in conjunction with the advancing motion of the blanks, causes the tools to generate helical grooves. This machine mills a constant angle drill which the designers consider superior to an increased twist drill. While the machine is not arranged to produce drills having an increased twist, it may be adapted to such work by making a simple change. This change involves connecting a pin with a groove cut in shaft B, so that the forward traversing movement is varied independently of motion derived from the gearing referred to. For average purposes, a lead equal to one turn in a length equal to six diameters is considered the best for high-speed steel drills, and a lead of one turn in a length of seven and one-half diameters for carbon steel drills. The width of the groove may be slightly wider than the land or exactly equal to the land, which is also considered good practice.

Withdrawal of Grooving Cutters

The web of the drills made in this machine is of uniform thickness for about one-third of the length of the groove, and then the thickness is gradually increased for the remaining two-thirds of the length, so that at the upper end of the groove it is equal to about one and one-half times the thickness at the point. One of the most interesting features of this

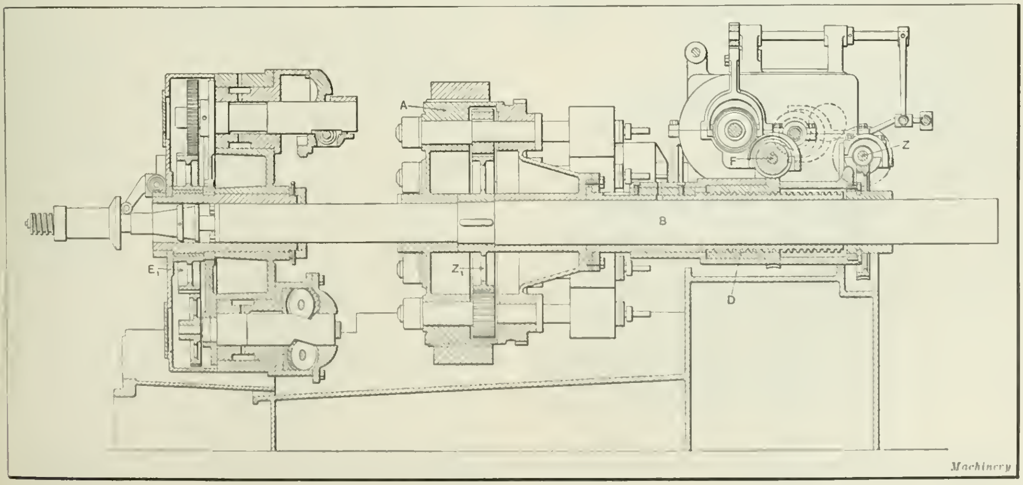


Fig. 9. Vertical Section showing Relative Positions of Blank-carrier and Cutter-heads

machine is the mechanism for controlling the action of the grooving cutters. The method of driving these cutters, as well as those for milling the clearance, is illustrated in Figs. 10 and 11. The main shaft *E* transmits motion to a central gear E_1, which, in turn, meshes with the pinions surrounding it, as the illustration shows. (This illustration does not represent the exact construction, as motion from main shaft *E* on the machine, as actually built, is transmitted through a gear-box and a silent chain drive.) The shafts carrying the pinions drive the cutters through spiral gearing, as shown in Fig. 11.

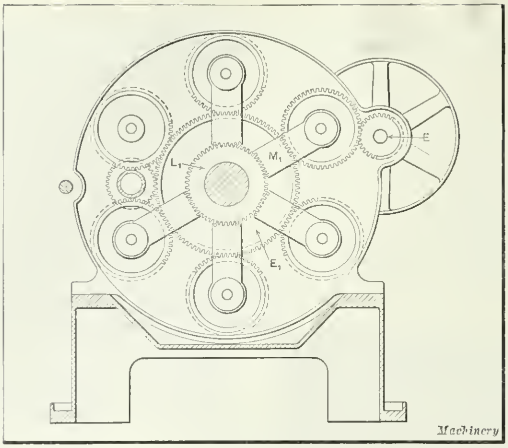


Fig. 10. Arrangement of Gearing for driving Cutter-heads and withdrawing Cutters

As the blank-carrier advances, it is necessary for the grooving cutters to move outward gradually, in order to increase the thickness of the web. Then, when the cuts are completed, both the grooving and clearance cutters must withdraw to clear the work and prevent marring it while the blank-carrier moves backward. The longitudinal movement of shaft *B* is utilized for shifting the position of the tool-holders. At the end of this shaft, there is an inclined member J_1; see Fig. 11, which illustrates the principle of operation, but not the exact construction. This inclined or tapering member engages with a roller at the end of lever K_1, which serves to operate a worm attached to a sleeve carrying gear L_1 (see also Fig. 10). This gear, in turn, meshes with the segmental gears M_1, which are fixed to the heads carrying the cutting tools. With this arrangement, the forward movement of the blank-carrier and shaft *B* causes lever K_1 to swing upward, thus turning slightly gear L_1, segmental gears M_1, and the pivoted members carrying the cutters. The result is that the cutters are swung outward from the center of the work. The amount of this outward movement depends upon the inclination of the part J_1.

When the end of the cut is reached, lever K_1 encounters a more abrupt projection and is moved outward quickly, thus separating the cutters far enough to clear the blanks when the blank-carrier returns to the starting position. This is an important detail in the design of the machine and it prevents the tools from marring the work as the latter is withdrawn. Just before shaft *B* reaches the end of its backward movement, the conical-shaped flange O_1 engages lever K_1 and forces it down, thus returning the cutters to the position required for the next milling operation. This flange is backed up by a stout spiral spring to take up the shock. The mechanism on the machine illustrated in Fig. 1, which controls the withdrawal of the cutters, is similar in principle to that just described, but instead of a conical sleeve J_1, Fig. 11, the action of the worm-lever is derived from an inclined guide which can be readily adjusted.

Arrangement of Tool-heads

The cutter-spindles are mounted in heads which have a swiveling movement either for withdrawing the cutters as just described, or for adjusting them relative to the work, in order to vary the depth of the cut. As Fig. 11 shows, each cutter of a pair is carried by a different head, and as these heads are adjustable relative to the sleeves upon which they are mounted, the position of the tools for varying the depth of the cut may easily be regulated. The fine adjustment of the grooving cutters is effected by the screws N_1 in this particular design. (The machine illustrated in Figs. 1 to 4, inclusive,

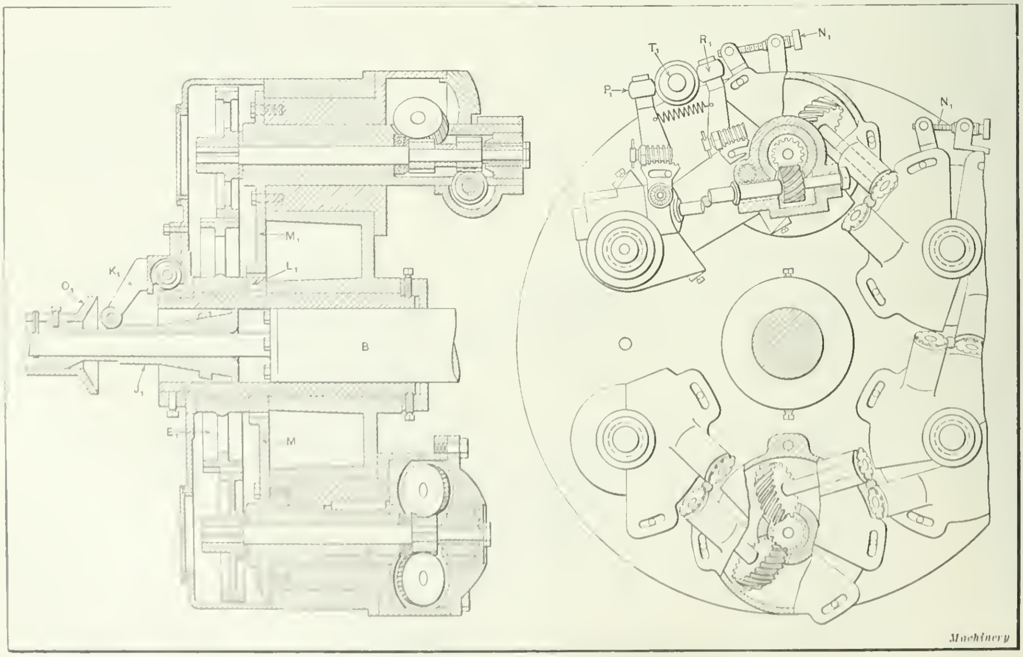


Fig. 11. Mechanism for driving Cutters and regulating their Position relative to Work

has the same general type of adjustment, but the arrangement is different. Instead of using a screw, the position of the cutter-head relative to the sleeve about which it swivels is varied by a worm engaging with teeth formed at the end of the cutter-head extension.)

A special feature of the machine is that the pilots for guiding the drills made from the hot-rolled bar are made 0.015 inch over size to allow for the variations in the diameter of the bar. This is permissible for two reasons: In the first place, oil is fed through the bushings from the inside on high pressure, which provides a film of oil under pressure all around the bar as it enters the bushing and steadies it; in the second place, the roughing cuts are divided on larger drills, where the cuts would be heavy, so that there is not the excessive vibration that there would be in an ordinary drill fluting machine. One cutter milling on each side also tends to steady the drill, making the support in the bushing of less importance. Of course, were the full depth of the groove on a large-sized drill milled at once, the vibration set up would make it impossible to support the rod in a bushing with so much clearance.

Withdrawal of Clearance Cutters

The end-mills which form the relief or clearance are the last to operate upon the blanks. These cutters, of course, remain the same distance apart while at work, but it is essential to separate them at the end of the cut in order to clear the blank, the same as with the grooving cutters. A special mechanism is provided for withdrawing the clearance cutters. This is illustrated clearly in Fig. 4. The same general type of mechanism is also shown in Fig. 11. As the latter illustration shows, the spindles may be moved axially by a rack and pinion when the levers P_1 and R_1 are separated by a cam sleeve T_1. These levers are held in contact with the sleeve by a spring as shown, and the cam sleeve has an enlarged portion (see also Fig. 4) with which the levers are engaged for withdrawing the cutters from the working position. This cam sleeve is mounted upon a shaft that is free to move lengthwise in its bearings. One bearing is on the cutter-head and the other on the blank-carrier. The shaft has attached to it two collars, there being one on each side of the blank-carrier bearing. These collars are alternately engaged by the blank-carrier, as it advances and returns, and the distance between them is such that the cam sleeve previously referred to is shifted at the right time. The cutters have an independent adjustment for regulating the depth of the cut which is practically the same as that described for the grooving cutters. The graduated screws or worms for making this adjustment are clearly shown in Fig. 4.

General Features of Design

The features which are most apparent upon an inspection of the automatic twist drill machine are its rigidity, adjustability, rapidity of action, and capacity for accurately duplicating work for which it is adapted. This machine is unusual in its general design on account of the absence of flat slides and the elimination of special cams for controlling the various movements. There is not a flat slide on the entire machine of the kind requiring gibs to compensate for wear, unless the guideway for holding the blank-carrier in alignment as it moves forward can be classified as a flat slide. All sliding surfaces are cylindrical, which the designers consider a commendable feature. If the action of the machine must be varied to adapt it for work of different diameters or length, this merely involves making certain adjustments, and it is not necessary to equip the machine with a different set of special cams. This is due to the fact that variations in the cycle of operations are obtained simply by adjusting certain parts of the controlling mechanism and possibly changing the gears which control the lead of the helical grooves. In brief, the design is self-contained or independent, which is regarded as a valuable principle in a machine of this type or in other classes of automatic machinery, the action of which must be modified to meet different operating requirements.

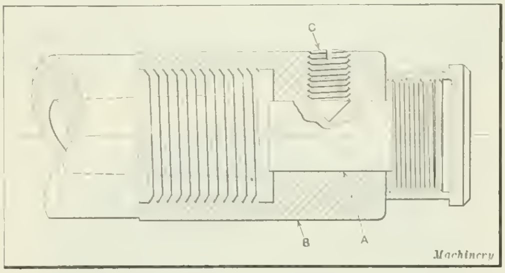
Under ordinary conditions, one operator and two helpers should be able to take care of a battery of ten machines. This not only greatly reduces the direct labor cost by performing automatically the various separate machining operations required by the other methods, but it also effects great savings in overhead. For example, fewer foremen are needed, because the machine combines a number of different operations usually done in a number of different departments by the old method. A number of handlings are eliminated. On making the 1/2-inch jobbers' drill, for example, the machine saves at least six truckings or handlings and two inspections, and the process saves overhead in other ways. It requires about one-fifth the space required by a similar number of machines to produce a given number of drills per hour by the old methods, with a consequent saving of heat and light, as well as interest on buildings, transmission equipment, etc.

The machinery cost by the Wilt method seems to be about the same as that by the old method, that is, the machinery investment necessary to produce a given size of drill at the rate of one per minute. While it has been impossible to get accurate figures on cutter savings, there is undoubtedly a saving in cutters by virtue of the method of taking roughing and finishing cuts on the same groove. The end-mill method of clearing used is found to be most economical. Also when one milling cutter removes all the material from a groove, it cannot be run as fast, because of the necessity of having the single milling cutter preserve the contour of the groove, as well as produce a smooth finish. As soon as the cutter becomes worn down the groove loses its contour. As the finishing cutters take such a light cut, there is no trouble from this source. In fact, by taking this light finishing cut, the operations of polishing and grinding grooves by the old method, which are direct labor costs in most factories, become overhead costs by the Wilt process. A very small percentage of drills made by the Wilt process have to have the grooves polished or ground, a good finish being secured by the sand-blasting operation only. It is estimated that on carbon steel drills there is a total saving in the manufacturing costs of at least 30 per cent over the cost of making drills by the methods generally employed.

* * *

STUD ARBOR

The purpose of this arbor is to hold an internally threaded piece of work for finish on the outside or on the end. In this class of work, the pressure of the tool would normally tighten the thread so that it would be impossible to remove the work without unduly marring the finish. This arbor overcomes this objection as follows: The member *A* has a threaded portion on the end, and it protrudes from body *B*, fitting it snugly. The body *B* is threaded on the rear end to fit the spindle of a regular turret lathe. Member *A* is held securely from longitudinal movement by screw *C* which has a conical point, fitting in a similar shape in the member *A*. When the work is placed on the end of the threaded arbor *A*, the screw *C* is seated fully in the countersunk portion of the arbor. At the end of the operation, the work has become tightened upon the arbor *A*, and by relieving the screw *C* the arbor moves forward a slight amount making it possible to remove the work with the fingers. V. B.



Arbor for holding Internally Threaded Work

* * *

A California court of appeals has decided that a foreman who was assaulted by a man he had dismissed was injured in the discharge of his duties and therefore entitled to compensation.

FUSION WELDING FALLACIES[1]—1

SOME COMMON BELIEFS AND WHY THEY ARE UNSOUND

BY S. W. MILLER[2]

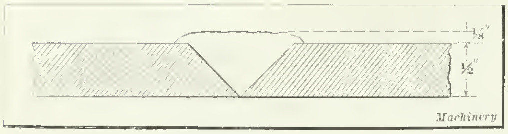


Fig. 1. Reinforced Weld

WITHIN the past two decades, fusion welding processes have been developed until they are now used both in the manufacture of articles, the parts of which would otherwise be riveted or joined by other means, and in repair work. In both fields, they have proved of exceptional value, and in many cases have revolutionized past manufacturing methods and made it possible to place on the market cheaper and better articles than was possible by the processes displaced; but fusion welding processes are not simple, and many fallacious ideas concerning them are prevalent. The more important of these will be treated in this series of articles; those that will be treated in the present installment are as follows: The belief that a reinforced weld is stronger than a weld of the same thickness as the sheet; that reinforcing a weld is as good as welding through a piece; that high tensile strength in a weld is of great importance; that wrought iron is the best welding material; that any wire is good enough for the added material; and that the addition of small quantities of metal at a time is good practice.

Reinforcing does not Necessarily Strengthen a Weld

Frequently a welder is advised to reinforce a weld; that is, to increase the thickness of the piece at and in the vicinity of the weld, as shown in Fig. 1, on the theory that the greater the amount of metal, the stronger is the piece; but this is not always true. Particularly is it not true when plates are welded from one side, as in the case of tanks, etc.; in fact, reinforcing then weakens the structure. This weakness is due to two conditions: First, the thickening of the weld concentrates the stresses at the junction of the thick and thin parts, which is likely to result in a detail fracture, even in uniform material; this is the same as having sharp corners in shafts, which frequently break from this cause. Second, the center lines of the reinforced weld and the sheet are not the same; therefore, a bending stress is introduced in addition to the tensile stress. This condition is called "eccentric loading," and the maximum fiber stress on the section may then be found by the formula:

$$S = p\left(1 + \frac{6E}{A}\right)$$

in which S = maximum fiber stress in section;

p = mean fiber stress in section, or $\frac{P}{A}$;

E = eccentricity or distance from center of section;

A = width of section;

P = total pressure on any section of a bearing of uniform thickness.

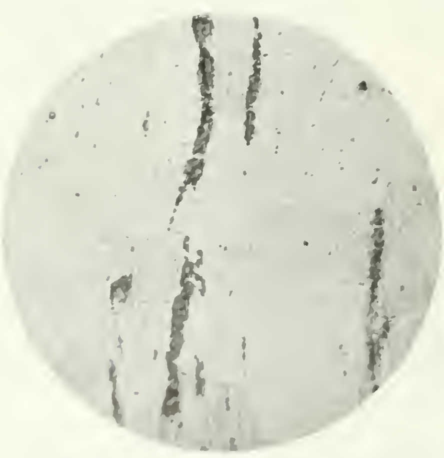


Fig. 2. Wrought-iron Wire showing Streaks of Slag, magnified 200 Times

Assuming that the sheets shown in Fig. 1 are straight and that the piece is subjected to an average stress p of 12,000 pounds per square inch, based on the thickness of the weld, P will be 6000 pounds; as shown, E is 1/16 inch, and A, 0.5 inch. Then, by the formula, the maximum fiber stress will be:

$$S = 12{,}000 \times \left(1 + \frac{6 \times 1/16}{0.5}\right) = 12{,}000 \times 1\tfrac{3}{4} = 21{,}000 \text{ pounds}$$

or 1¾ times the average stress over the section of the weld. But, based on the thickness of the sheet, the piece would be subjected to a stress p of 15,000 pounds per square inch. Then P will be 7500 pounds; E is 1/16 inch; and A, 0.5 inch. Then the maximum fiber stress will be:

$$S = 15{,}000 \times \left(1 + \frac{6 \times 1/16}{0.5}\right) = 15{,}000 \times 1\tfrac{3}{4} = 26{,}250 \text{ pounds}$$

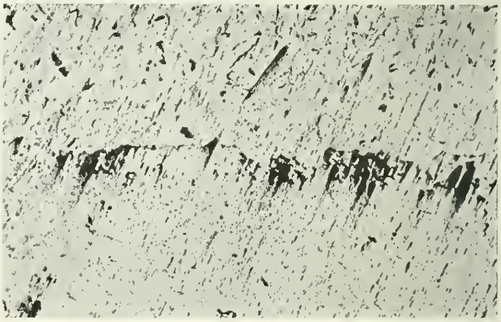


Fig. 3. Laps and Dirt along Edge of Vee; magnified 50 Times

In each case the maximum fiber stress will be too great for safety. This difference between the maximum and minimum stresses on opposite sides of the sheet causes the plate to bend toward the bottom of the vee, and, in the course of time, is very likely to result in fracture. The time necessary for this to occur may be short or long, depending on the eccentricity of the load and on the amount of the stress. Especial attention is called to the fact that a comparatively small eccentricity produces enormous fiber stresses, and it is possible for these stresses to be so great that the piece will break the first time the load is applied. Any results obtained from tensile test pieces made with reinforced welds are erroneous and misleading. All published tests the writer recalls were made on test pieces that were not machined, which doubtless contributed largely to the discordant results obtained. There are no published results of weld tests that are consistent, as far as the writer knows.

Somewhat along the same lines is the statement that reinforcing a weld is equivalent to welding through the piece, which was made to the writer some time ago by the foreman of welders in an important tank shop. It is evident that where the weld is not made entirely through the vee, the eccentricity and the fiber stress are greatly increased, thus weakening the structure.

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[1] For further information on fusion welding, see "Strength of Oxy-acetylene Welds," in the June, 1916, number of MACHINERY; "Metal Cutting with Oxy-acetylene Gas," April, 1916, and the articles there referred to; "Electric Seam Welding," January, 1917, and the articles there referred to.

[2] Address: Rochester Welding Works, Rochester, N. Y.

High Tensile Strength in a Weld is Seldom of Great Importance

Most welders, in speaking of the quality of their welds, lay great stress on the tensile strength. As a matter of fact, high tensile strength is of much less importance than other characteristics. No important engineering structure that the writer can think of at the present moment is subjected, in any of its parts, to an unvarying tensile stress. The stress always varies from zero, or some amount, to a maximum, or from a maximum in one direction to a maximum in the other; in addition, these changes are usually accompanied by shock. To provide for these variations from a steady stress, it is customary to lower the permissible fiber stress, especially in the last case. For instance, a boiler or pressure vessel is never free from changes in pressure, and so the proper reduction in stress must be made.

A weld is nothing more than a casting that has not been heat-treated; and while it has enough tensile strength, it is brittle and has low resistance to shock, vibration, and changes in stress. It is far more important to produce a weld without these bad qualities than to strive for high tensile strength, as the strength is always sufficient if the weld is no thicker than the sheet. In fact, an unannealed weld resembles, in ductility, a piece of cast iron. This is very noticeable in pulling test welds in a tensile testing machine, as, when not annealed, it is difficult to get their elastic limit, it being frequently so close to the ultimate strength that the piece breaks before it is really certain that the drop of the beam has occurred. It is, therefore, evident that physical properties heretofore generally neglected must be obtained in welds even at the sacrifice of some tensile strength.

Wrought Iron is not Necessarily the Best Welding Material

The statement is commonly made that wrought-iron wire is the best material for welding steel; in fact, in 1915, the writer made the following statement: "It is generally claimed that wrought-iron wire is the best for this purpose and that the imported wire is better than the domestic. . . . It is, however, somewhat of a question whether material with a small percentage of carbon, say, 0.1 per cent or, perhaps, as low as 0.05 per cent, would not give just as good results, provided the impurities, such as sulphur and phosphorus, were kept to as low a point as is the case in wrought iron. There are other matters in connection with this subject that have never been investigated, as far as the author knows, and inasmuch as their investigation requires great accuracy and considerable time and expense, the lack of information is not to be wondered at. It is a fact, however, that the use of any pure iron wire gives good results and, until the matter is more carefully investigated, one is safe in using that material." Wrought iron of the purest kinds was probably the best material available at one time, and it was much better several years ago than it is now. Also, as the demand for welding wire was small, it did not pay to make special materials for this purpose. However, wrought iron made by the puddling process contains slag which is likely to get mixed in the weld and weaken it. This may be seen in Fig. 2, where a piece of wire is shown magnified 200 times; also in Fig. 3, which shows the laps and dirt along the edges of a vee that has been magnified 50 times. There is no use in putting into a weld foreign matter that must at once be removed, but which can be done only with considerable trouble on the part of the welder. Low-carbon steel wire is free from slag, as shown in Fig. 4, and is, therefore, superior to a product that contains it. Still, care must be taken to get wire quite free from sulphur and phosphorus, either of which may cause trouble in the weld; and as ordinary wire is likely to contain these in quantity, it should be avoided.

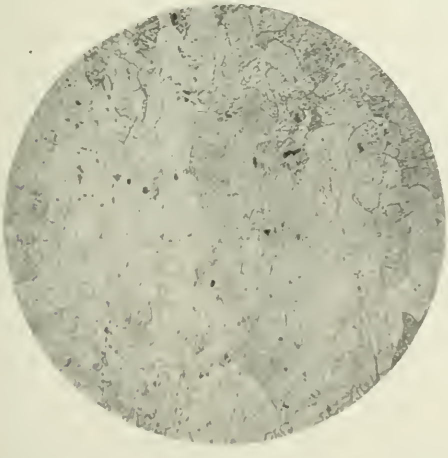

Fig. 4. Low-carbon Steel Wire, magnified 200 Times, showing Absence of Slag

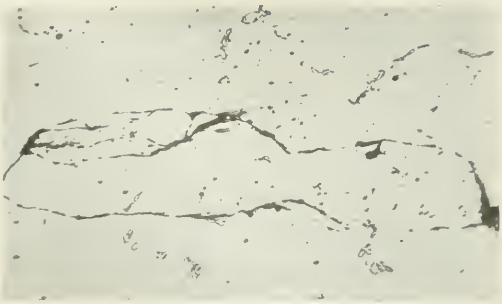

Fig. 5. Laps in Weld; magnified 430 Times

Adding Small Quantities of Metal at a Time is not Good Practice

A steel casting manufacturer does not pour his molds from a number of small ladles, but uses one large enough to pour the entire casting at one time. He also keeps the metal fluid, so that dirt and impurities can get to the risers, producing a clean casting. Making a weld in steel is the same as making a steel casting. Following the analogy, the more metal that can be kept in a molten condition at a time in a weld, the cleaner it will be. Adding small quantities tends to produce laps and cold-shuts and to include impurities in the weld; this is shown in Fig. 5, which illustrates a weld magnified 430 times. A clean weld is the foundation of successful welding; therefore, the addition of small quantities of wire at a time should be avoided.

* * *

NOVEL SCHEME FOR WRECKING OLD MASONRY

The expansive force of quicklime, according to the *Scientific American*, has been lately used effectively in breaking up brick masonry. It was necessary to remove three foundation piers, each 12 by 20 feet in area and 12 feet high, and similar piers supporting working engines on each side prevented blasting. As cutting and breaking up by hand was too slow and expensive, the new method was tried. Vertical holes three inches across and three feet deep were bored three feet apart in both directions and were filled to within six inches of the top with quicklime, fresh and well slaked. The holes over the wet lime being closed with well tamped brick-dust, cracks started in ten minutes, soon breaking the pier-tops into three-foot cubes, and making subsequent hand operations easy.

* * *

According to the Wisconsin Industrial Commission reports, during the last half of 1917, the industrial accidents in the state showed a reduction of 14 per cent as compared with the corresponding period in 1916. This decrease is attributed to the commission's safety and sanitation work.

OPERATING THE GRIDLEY AUTOMATIC TURRET LATHE—2

EXAMPLES OF CAMMING AND SETTING OF TOOLS

BY DOUGLAS T. HAMILTON[1]

In the first installment of this article, published in the June number of Machinery, the general directions for setting up and operating the Gridley automatic turret lathe were given. The present installment will take up some specific examples of work done on the machine and will show the camming required and the tool set-up necessary.

Tooling Lay-out for Making Counterbored Bushing

The counterbored bushing illustrated in Fig. 17 has been selected to show the working relations of the forming slide to the turret-slide, when working at the same time; and also of the cutting-off and counterboring tools when working at the same time. This part is to be made from 2½-inch cold-rolled steel, and hence will be handled on a 3¼-inch machine. The operations required to complete this part are:

Position	Operation
First	Form and drill large hole
Second	Drill small hole
Third	Skip
Fourth	Combination ream and counterbore, and cut off

The procedure to follow in setting the various cams, dogs, tools, etc., to complete this part is given in the following; the method of selecting the cams has been fully explained in the preceding article.

Assuming that the proper spring chuck and feed-chuck have been put into place and all the tools and cams used for a previous job have been removed, proceed in the following manner to set the cams, dogs, etc., for producing the part shown: First, crank the machine by hand, and when roll *B* is on the high point of cam *D*, roll *G* should be on the high point of cam 587-B. This cam should be relieved, depending on the amount that the collet feeds forward in closing on the work. To return the stop, return cam 66-B should be set to allow clearance for roll *G* to pass between it and cam 587-B. When roll *G* is flush with the high point of the return cam, the indexing dog should be set to index the turret. Indexing should only be done when the machine is operating on the fast feed. Now revolve the turret to bring the first slide into position, and set cam 64-B against roll *G*. The slow-feed dog should be set at this time for safety sake when setting up the machine. Crank the machine forward until roll *G* is on the high point of cam 64-B and set the forming cam to the high point of roll *H*, allowing clearance for the roll; also set the fast-feed dog on the cam-operating drum. Set the forming slide return cam 482-B and tool-slide return cam 63-B, allowing clearance for the rolls. Now crank the machine forward until roll *G* is flush with the high point of return cam 63-B and set the dog for indexing the turret; revolve the turret to the second slide, stopping the machine at this point.

Setting Drilling Cam

The next operation is drilling the small hole, which is to be performed from the second slide; cam 62-B is selected for this operation. Set this cam and the slow-feed dog and crank the machine forward until roll *G* is on the high point of the cam 62-B; then locate the fast-feed dog. Set return cam 63-B, allowing clearance for the roll to pass, and crank the machine forward until roll *G* is flush with the high point of the return cam; then set the indexing dog. Plug up the indexing slot in the third position and index to the fourth position.

Setting Cut-off and Counterboring Cams

We are now ready to set the cams for the cut-off tool and counterbore, which, as shown in Fig. 17, work at the same time. Crank the machine to the high point of the cut-off cam 499-B, which, with the return cam 483-B, should be set so as to return the cut-off tool clear of the spindle nose when roll *B* is on the high point of the chuck-opening cam *C*. Crank the machine backward to the high point of the cut-off cam and locate return cam 155-B, so as to return the tool-slide far enough to allow the piece to drop off the counterbore when it is cut off. Again crank the machine backward and set cam 62-B for the counterbore, allowing clearance for the roll; set the slow-feed dog at the low point of cam 62-B, where the counterbore starts to work. The fast-feed dog should be set at the high point of the cut-off cam 499-B, and the revolving dog should be set after the machine has been shifted to the fast feed. This completes the preliminary setting of the cams.

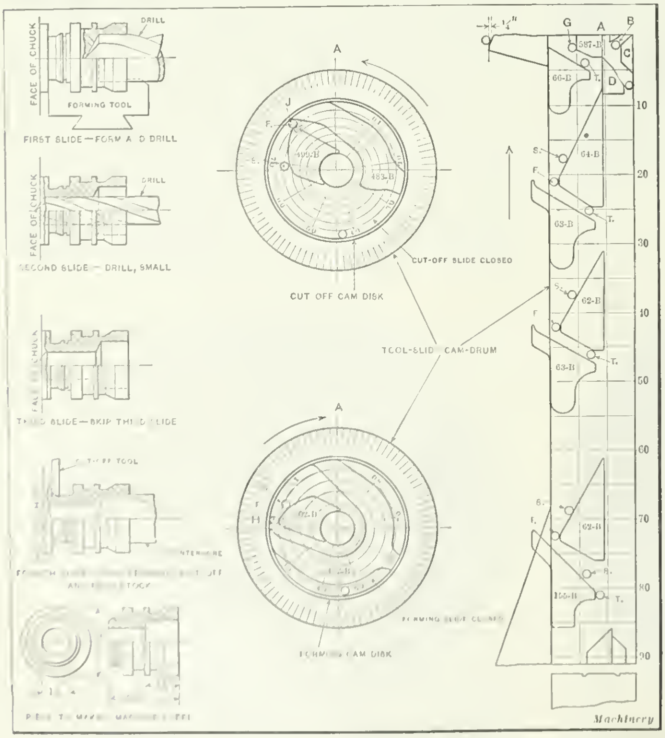

Fig. 17. Tooling Lay-out for Work in which Drilling and Forming Operations are performed at Same Time

Setting the Tools

The vertical forming tool and holder should be set to clear the spindle nose at the high point of the cam, and, at the same time, the large drill should be set at the required distance from the spindle nose. Set the stop for the stock at the required distance from the spindle nose; then place sufficient weights on the chain to feed the stock out to the stop and index from the corner stop position to the first slide. Crank the machine forward to the high point of the cam, watching the fast-feed dog, and adjust the forming tool for the height and diameter and set the stop for the slide. Index the turret to the second slide and drill the small hole. It is advisable in all cases to set the various tools with relation to the face of the chuck before placing the bar of stock in the chuck, as in this way the setting of the tools can be approximately located without wasting any stock. After setting the small drill, index to the fourth slide, skipping the third slide, and set the counterbore. Next set the cut-off tool to cut off the piece and travel only into the small drill hole, not to the center of the chuck. This completes the setting of the tools, but it is necessary to make a few pieces, adjusting the slow- and fast-feed dogs on the operating drum so as to reduce the non-cutting movements and thus produce the part in the shortest possible time. It is also necessary in some cases to make minor adjustments of the cutting tools.

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[1] Address: 45 Woolson Ave., Springfield, Vt.

Making a Thin Washer

The thin washer shown in Fig. 18 is to be made from 4⅝-inch stock, and hence will be handled on the 5-inch machine. It should be noted that the corner stop cannot be used because it will not clear. This example shows drilling, counterboring, and reaming operations with the cut-off tool working continuously. As shown, the operations are accomplished in the following order:

Position	Operation
First..........	Form, bore with set-over tool, and cut off 5/8 inch
Second........	Drill, turn, and cut off 3/8 inch
Third.........	Ream with strippers on reamer and finish cutting off 1/2 inch
Fourth........	Feed stock to stop

The procedure to follow in setting the various cams, dogs, tools, etc., does not differ materially from the preceding, and is, briefly, as follows: The cams are set in the following order: Set cam 65-B, for counterboring, against roll *G*, and set the slow-feed dog on the operating drum for safety. Crank forward to the high point of the cam and set the continuous cut-off cam 229-B, which is made special for this job, to the high point of roll *J* on the first rise; also set forming cam 502-B to the high point of forming-cam roll *H*. Set the return cam 482-B, allowing clearance for the roll to pass. Set the fast-feed dog on the cam operating the drum at this point.

Set the tool-slide return cam 155-B, allowing clearance for the roll *G*, and crank forward until the roll *G* is flush with the high point of the return cam, setting the revolving dog on the operating drum at this point. Index the turret to the second slide and stop the machine. Crank forward to the high point of the cut-off cam—the second rise—and then set the cam 64-B to the high point of the turret tool-slide roll *G*, and set the fast-feed dog on the drum. Crank backward to the low point of the cut-off cam 229-B—the second rise—and set the slow-feed dog for safety. Now locate the tool-slide return cam 155-B, allowing clearance for the roll *G*, and crank until the roll *G* is flush with the high point of the return cam 155-B and set the revolving dog. Index to the third slide and set the high point of the tool-slide cam 61-B to the high point of the third rise on the cut-off cam, and set the fast-feed dog at this point. Crank backward to set the slow-feed dog at the low point of cam 61-B and set the tool-slide return cam 155-B, allowing clearance for the roll; also set the special return cam for the cut-off arm, allowing for clearance. The next step is to crank backward until the roll *G* is flush with the high point of the return cam 155-B and set the revolving dog. When laying out the special continuous cut-off cam 229-B, the first rise on the cam is made to give 5/8 inch travel of the slide; the second rise gives 3/8 inch travel, and the third, 1/2 inch travel. These rises are laid out so that they occupy about the same time as the operations performed from the tool-slides. The concentric portions of the cam are laid out to stop the travel of the slide while the turret is indexing. On the third slide, the piece is cut off and the work is removed from the reamer by the strippers when the tool-slide returns; the stock is then fed out to the stop in the fourth position. The tools are set in the manner previously described, and the final setting of the indexing, fast-feed, and slow-feed dogs is made after the machine is operating under power.

Producing a Long Shaft

The third example is a long shaft, which illustrates a long forming operation, shown in Fig. 19. Owing to the length of this form, it is impossible to operate the forming tool at the same surface speed as the turning tool, so the order of the operations is as follows:

Position	Operation
First......................	Turn
Second....................	Form and support, using two rolls
Third......................	Skip
Fourth....................	Thread and cut off

This part is made from 1⅞-inch cold-rolled steel, and is handled on a 2¼-inch machine. As the corner stop is used, the fifth turret index-hole is not blocked. The first operation is to turn the bar for a distance of 4⅜ inches; then the turret is indexed to the second position, and the speed of the spindle changed to one-half the spindle speed used for turning. The bar is formed at the points indicated, and rolls held in special supports are brought in from the turret. In order that the rolls will remain stationary while the forming tools are at work, a special cam is used on the main drum; this cam is as long as the amount of circumference of the drum occupied by the forming operation. The third index-hole is plugged and the turret is indexed to the fourth position with the spindle still operating at the same speed as that used for forming.

The machine is run on the fast feed until the die has approached the work, when it is shifted to the slow feed, at which speed it is run until the die opens, when the spindle is

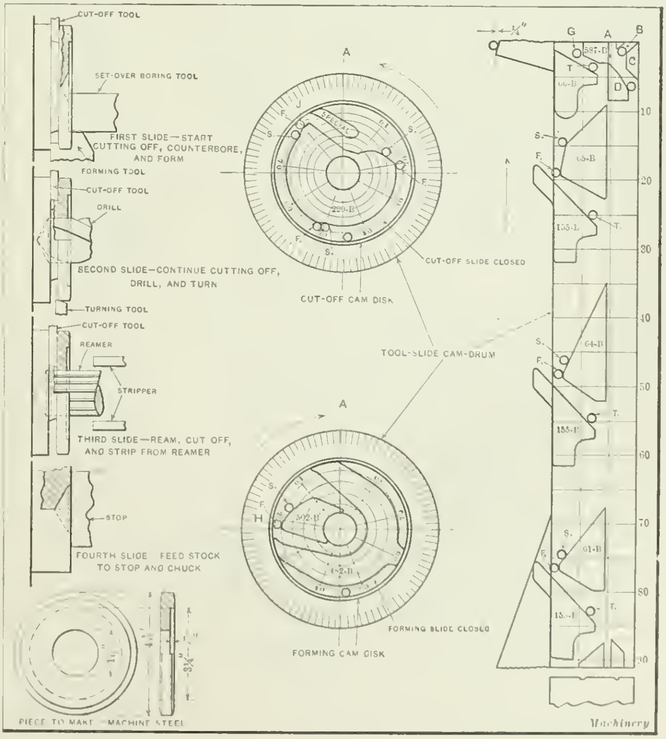

Fig. 18. Tooling Lay-out for a Thin Washer in which Cut-off Tool works continuously

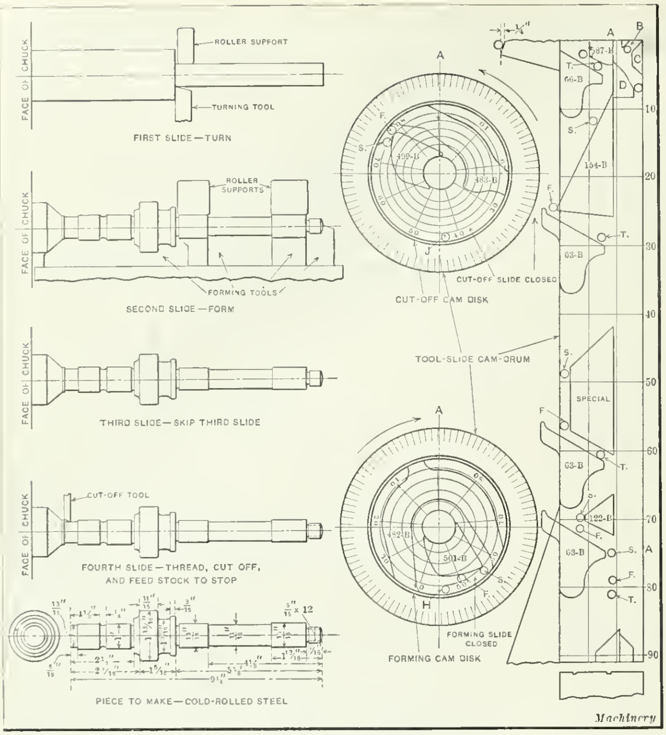

Fig. 19. Tooling Lay-out for a Long Shaft largely completed by Forming

changed to the fast speed again. The cut-off tool is now brought in on the slow feed and the piece cut off. As soon as the piece is cut off, the dogs are set to change to the fast feed and to index the turret. This series of operations is repeated on the next piece.

Producing a Long Sleeve with a Tapered Hole

The long sleeve with a tapered hole shown in Fig. 20 illustrates how drilling and turning operations can be accomplished at the same time, also reaming and cutting-off operations. The part is made from 4-inch cold-rolled steel, and hence will be handled on a 4¼-inch machine. The operations necessary to complete this piece are as follows:

Position	Operation
First	Drill and turn
Second	Rough-ream
Third	Form and support
Fourth	Finish-ream and cut off

The drill is the first tool brought into position, as it has to travel slightly farther than the turning tool, which is held on the same tool-slide. Cam 329-B is selected to give a feed that is suitable for both tools. The turret is now indexed to the second position and the work rough reamed. It is next indexed to the third slide, where the work is formed from the forming slide and is supported from the turret by a special internal support. In order that the support will remain in position while the forming tool is at work, a special cam 65-B is necessary on the main drum. The turret is now indexed to the fourth slide, where the hole is finish taper reamed, and cut off. It will be noticed that the reamer is required to take a long taper cut to finish, so that the feed of the tool will be reduced at the end of the cut. This is accomplished by a special cam 278-B, which is cut away to give a fast feed to start, and to reduce the feed when the taper part of the reamer comes into action. The cut-off tool comes into action after the reamer has been fully withdrawn from the work. A fast-feed dog is set when the piece has been cut off and the turret is indexed and the series of operations is completed on the next piece. The full procedure to follow in setting the various cams and tools has not been included in the last two examples for the reason that the setting of the tools and cams does not differ materially from that described.

* * *

TINNING CAST-IRON VESSELS

A method has been developed by the French, according to *La Chronique Industrielle*, for tinning cast-iron vessels. To secure adhesion of the tin to the cast iron, the carbon must be removed from the iron or the vessel must be polished by mechanical means. To remove the carbon, the iron vessel is coated with oxide of iron or manganese, or enclosed in a box filled with this oxide, and subjected to a high temperature for from four to six hours. After this length of time, the iron is sufficiently decarburized to permit the adhesion of the tin. The iron vessel is then cleaned with dilute sulphuric acid, to which a little blue vitriol has been added, after which it is immersed in molten tin. If the interior is to be coated, molten tin, to which a little sal-ammoniac has been added, is vigorously rubbed over the surface. The vessel should be heated before the tin is applied, and the heating must be carefully done to prevent the oxidation of the surface.

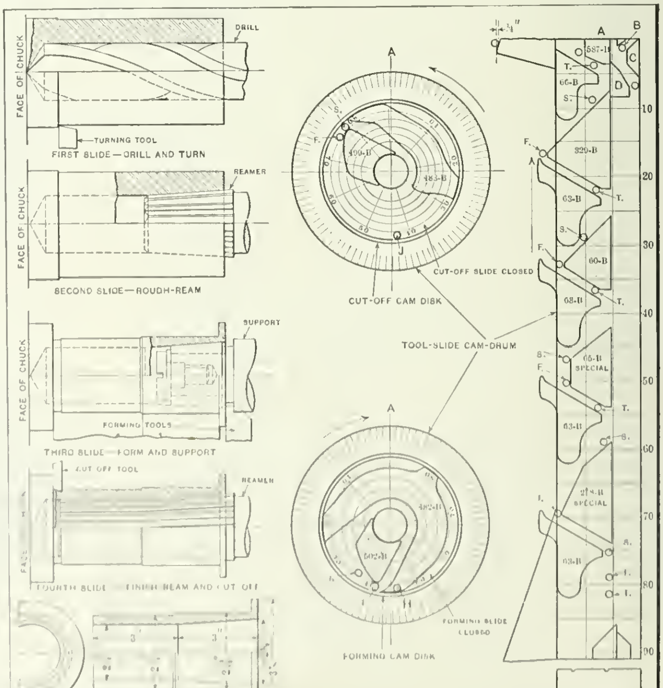

Fig. 20. Tooling Lay-out for a Bushing with Long Tapered Hole

MANUFACTURING WRIGHT ROLLER BEARINGS

MACHINING PARTS, HEAT-TREATING, ASSEMBLING, AND INSPECTING

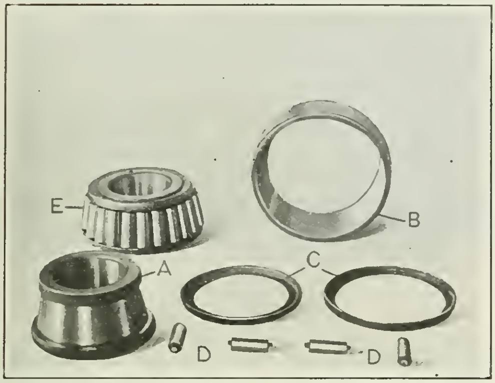

Fig. 1. Parts of Wright Roller Bearing before and after being assembled. A, Cone; B, Ring; C, Retaining Rings; D, Rollers; E, Assembled Cone and Rollers

THE Wright Roller Bearing Co. of Philadelphia, Pa., manufactures bearings for automobiles and commercial trucks. These bearings are made in a number of different sizes to cover a considerable range of load carrying capacities. All sizes are of the same design, and briefly stated, the component parts of a Wright roller bearing are the inner and outer raceways between which runs a series of tapered rollers; these rollers have a small pilot at each end so that they may be held in position on the inner raceway—at those times when the outer race is removed—by means of two sheet steel retaining rings. When the bearing is completely assembled, these retaining rings play no part in its operation, as the rollers are maintained in proper alignment by means of their taper, which causes each roller to automatically assume a position with its axis converging to a common point on the shaft axis, this point, of course, being located at some distance from the position at which the bearing is mounted. When the outer bearing raceway is removed, the retaining rings are depended upon to hold the rollers in position on the inner bearing raceway. From this description it will be seen that in the form in which it is shipped from the factory, a Wright roller bearing comprises two units, one of which is made up of the inner raceway, the rollers, and the retaining rings, while the other consists simply of the outer raceway.

It is the purpose of the present article to describe methods used in the Wright Roller Bearing Co.'s factory in manufacturing its product. Figs. 1 and 2 show parts of the Wright roller bearing. The inner raceways or cones are made from bar stock, which is machined on Gridley automatics. The inner cones are of the desired form when they leave these machines, with the exception that a "radius" has to be turned on the cut-off end, as shown at *A* in Fig. 2, and seats *B* and *C* have to be cut for the retaining rings. For performing the radial turning operation, the work is held in a Barker quick-acting chuck, which is made by the Thomas Elevator Co., 22 S. Hoyne Ave., Chicago, Ill., and the same type of chuck is employed for turning seats *B* and *C* for the retaining rings. In Fig. 3 is shown the operation of turning the radius at the small end of the cone.

Practice in Heat-treating Bearing Parts

The work is now ready to go to the heat-treating department, where the first step is to carburize the steel. This is done by the usual method of packing the bearing parts in boxes of carbonaceous material and subjecting it to a temperature of 1675 degrees F. for from eight to ten hours. The work is then removed from the carburizing boxes and placed in another furnace where its temperature is raised to 1550 degrees F., after which it is withdrawn and quenched in oil. A third heat-treatment is then given to the work by raising its temperature to from 1475 to 1500 degrees F. and quenching it in water. This procedure in heat-treatment is also followed in the case of the outer bearing races and the rollers, so that no further discussion will be necessary in connection with descriptions of the way in which these parts are made. This method of heat-treatment is the means of producing a very hard surface on the work. This department is furnished with Shore pyroscopes and Brown pyrometers.

Grinding Operations on Inner Cones

After being heat-treated, the work goes to the grinding department where the first step is to grind a flat surface *D*, Fig. 2, at one end of each cone. This is done by loading the work on a magnetic chuck mounted on a special surface grinder shown in Fig. 4. It will be apparent that this machine is a converted planer, and it is one of the oldest machines used by the company. Despite this fact, however, it is giving such satisfactory service that there seems to be no adequate reason for investing in a standard surface grinder to take the place of this special machine. It will be evident to the reader that this grinder has been made from a small sized planer. The magnetic chuck is placed on the planer table, while the special grinding wheel head is mounted on the regular ways on the cross-rail. The table reciprocates under the wheel and the regular power feed is used for feeding the wheel down until a stop is reached. The flat surface ground at one end of the inner cones by this machine, is used as a locating surface for the performance of subsequent grinding operations.

Next in order in performing the grinding operations on the cones comes the finishing of the inner hole *E*, Fig. 2, in the cone. For this purpose the work is held on a magnetic chuck mounted on either a Landis or a Bryant chucking grinder.

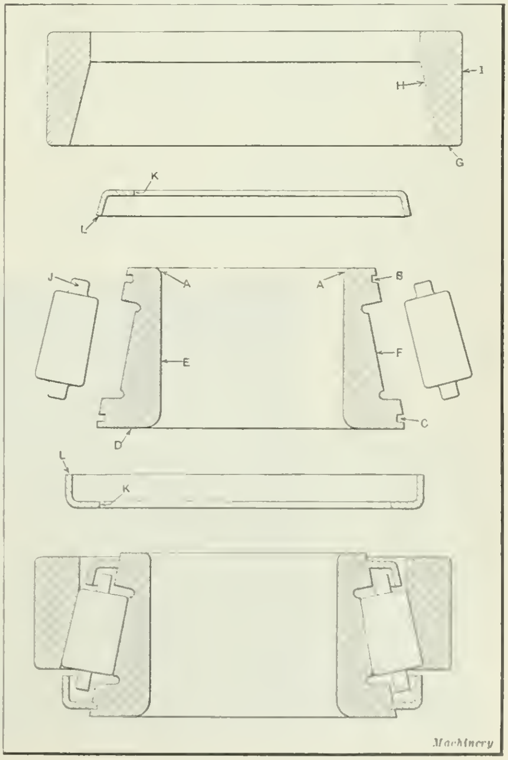

Fig. 2. Cross-sectional Views of Bearing Parts and Assembled Bearing

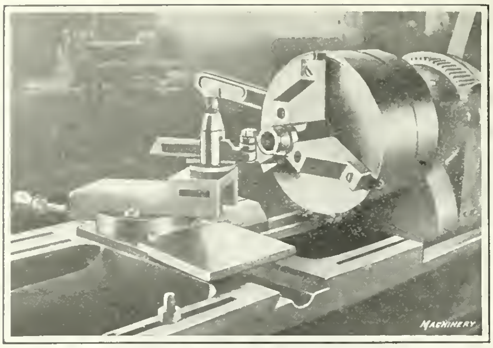

Fig. 3. Lathe equipped with "Barker" Quick-acting Chuck for holding Bearing Cones

It will, of course, be apparent that with the ground end surface held by the magnetic chuck, the hole will have to be ground at right angles to this surface. After this internal grinding operation has been completed, the cones are set up on a mandrel, which is located at the proper angle to the wheel-spindle of a Norton cylindrical grinder, so that a straight wheel can be used for grinding the roller track or raceway *F* on the cone. This is the final operation on these parts.

Machining Operations on Outer Bearing Rings

The rings in which the outer raceway for the rollers is ground, are made from bar stock which is machined on either 7½-inch Cleveland automatics, Fig. 7, or on Gridley automatics, according to the size of the work. After the rings have been turned on these machines, they are sent to the heat-treating department and subjected to the same treatment that is employed in the case of the inner cones. They are then brought back to the grinding room and ground on one end *G*, Fig. 2, on the machine shown in Fig. 4, which was described in connection with the grinding of the inner cones. The rings are next set up on either a Bryant chucking grinder, or on a Landis or Heald internal grinder, to provide for grinding the tapered hole *H*, Fig. 2, which forms the outer raceway for the rollers. As in grinding the inner cones, the Bryant and Landis grinders are equipped with magnetic chucks, while work ground on the Heald machines is held in collet chucks. In all cases the finished end surface of the ring is used as the locating point.

The final grinding operation on the rings consists of grinding the outer surface *I* on Norton cylindrical grinding machines, Fig. 8. For this purpose the work is held on mandrels, on which provision is made for holding from two to seven rings, according to their size. These mandrels are furnished with collars having a double taper corresponding to the ground inner surface in the work, so that two rings may be slipped onto each collar. The collars are then slipped onto the arbor, on which they are prevented from rotating by means of a key, and a C washer, used in connection with the clamping nut that holds the collars on the arbor, makes it necessary only to loosen the nut to remove the collars.

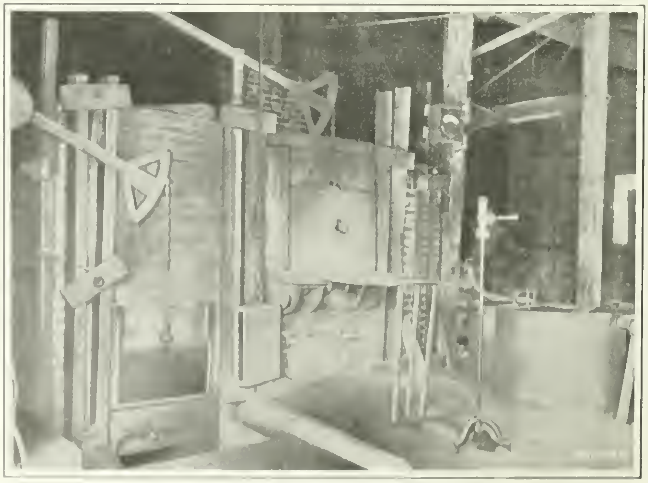

Fig. 5. Furnaces in which Cones, Rollers, and Rings are hardened

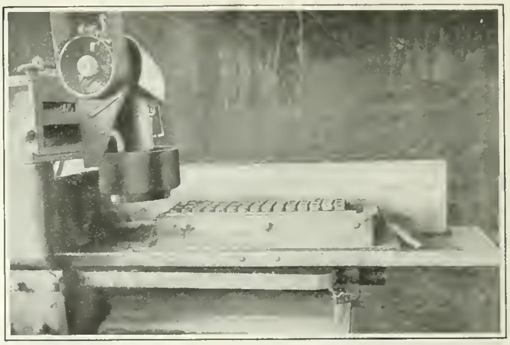

Fig. 4. Small Planer converted into Surface Grinder for grinding One End of Cones and Rings

Making Conical Rollers

The conical rollers used in Wright bearings are made on National-Acme automatic screw machines. In this connection attention is called to the fact that the rollers are centered at the end in order to provide means of holding for a subsequent grinding operation. The next step is to subject the work to the same process of heat-treatment which has been described for the cones and rings of the bearings. After heat-treatment the grinding is done on a Landis machine shown in Fig. 6, which is equipped with a collet chuck that grips the small pilot *J*, Fig. 2, at one end of the roller, while a quick-acting center, manipulated by lever *A*, Fig. 6, engages the opposite end of the roller so that it is firmly supported for grinding. In loading the machine, a roller is placed in clip *B*, which is manipulated by push-rod *C*. After a roller has been put in position in the clip, rod *C* is pushed forward so that the roller is brought into line with the collet chuck of the machine. Lever *A* is then operated to cause the center to engage the opposite end of the roller and push it over sufficiently so that the pilot on the roller enters the collet chuck.

Inspection of Rollers before Assembling

After being ground, the rollers must be very carefully inspected, both for finish, taper angle, and size. The inspection room is divided into several departments, and rollers arriving in the inspection room are first looked over by inspectors whose duty it is to determine the perfection of finish of each roller. All work which passes this inspection satisfactorily is sent to a second department where the inspectors use angle-gages of the form shown at *A* in Fig. 9. These gages have knife-edge blades, between which the rollers are placed, and if any light shows between the work and the knife-edges of the gage, it shows that the angle is incorrect, and such defective rollers are, of course, immediately rejected.

The actual size of rollers in a bearing is not of vital importance, but it is absolutely important for all the rollers in a bearing to be of exactly the same size. The reason for this is that, if there is any difference between the size of adjacent rollers, all of the load will be concentrated on the larger sized rollers, while those which are

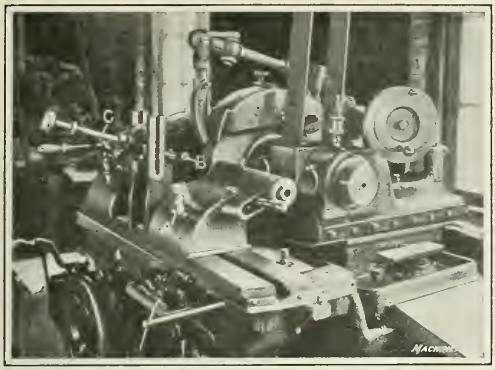

Fig. 6. Landis Grinding Machine with Special Means for loading and holding Rollers

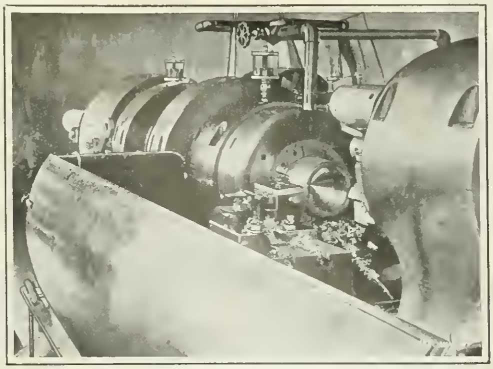

Fig. 7. Cleveland 7½-inch Automatic Screw Machines for turning Outer Rings

of smaller diameter will not be carrying their proportion of the load. On this account it is the practice to gage the rollers with a special dial indicator, shown at *B*, which has a V-block in which the roller is placed while being measured by a dial test indicator reading to 0.0001 inch. This indicator is set at such a distance from the V-block that when in contact with a roller of absolutely the required size, the needle will stand at zero on the dial of the instrument. By the help of instruments of this type, the rollers are sorted out into seven different grades, as follows: — 0.0015, — 0.0010, — 0.0005, O.K., + 0.0005, + 0.0010, + 0.0015 inch.

Placed on the inspection bench there are sheet-metal flaps shown at *C*. Each of these flaps has seven holes marked with the sizes of the seven classes of rollers, to which reference has just been made. As the inspectors measure each roller under the dial indicators, they drop it through the hole in the flap, which is marked with the size to which the roller has been found to belong. The roller drops through the hole in the flap into a chute leading to one of seven bins in which the different sizes of rollers are stored pending their delivery to the assembling department. Each of the sheet-metal flaps *C* is hinged, and when an inspector drops a roller through the flap he pushes it down. A Veeder automatic counter is geared to each flap so that in this way a record is kept of the number of rollers which are passed by the inspection department. In assembling bearings, rollers of the same size are put into a bearing so that the load to be carried when finally placed in service will be equally distributed over the rollers, in the way which has already been described.

Making Retaining Rings

Attention has already been called to the fact that the rollers used in Wright roller bearings have a small pilot at each end. The purpose of these pilots *J*, Fig. 2, is to fit under retaining rings so that the inner cone, the rollers, and the retaining rings may be held together in a single unit as shown at *E*, in Fig. 1. The retaining rings which are shown at *C* in Fig. 1 are blanked, drawn, and punched in a combination die and double-acting power press, which completes the press work on the rings at a single operation. From this machine they are taken to a speed lathe, on which the punched hole *K*, Fig. 2, in each ring is finished and the outer edge *L* turned down in order to obtain a good finish and to have the flange on the ring of exactly the desired length.

Assembling Bearings

In assembling, the first step is to press the retaining ring into its seat *C*, Fig. 2, at the large end of the inner cone, this operation being performed on an arbor press. The cone is then placed on a table with the large end down, and a complete set of rollers is dropped into place in the retaining ring. The outer bearing ring is then dropped into place over the rollers in order that the raceway in this ring may align the rollers properly. After this has been done, the retaining ring is dropped into place on the small end of the cone and pressed into its seat *B* with the arbor press. The flanges on the retaining rings now hold the rollers in place so that the outer ring may be removed, leaving the rest of the bearing as a self-contained unit, as shown at *E* in Fig. 1. The assembled bearings are next subjected to a general inspection, after which they are thoroughly cleaned, oiled, and wrapped in wax paper preparatory to being boxed for shipment. E. K. H.

* * *

An investigation of the heat-insulating efficiency of various materials, made by the United States Bureau of Standards, shows that gypsum is the most efficient fire-insulating material. The dense, high-plaster mixtures give much better results than the porous, low-plaster, high-water mixtures. Concrete and clay vary somewhat in their insulating efficiency, depending on their porosity. The denser clays conduct the heat a little more rapidly than the concrete, while the more porous clays conduct heat somewhat less rapidly. The effect of the aggregates on the conductivity of the concrete is not very marked; there is very little difference between gravel, trap rock, clay and soft-coal cinder aggregate. Limestone concretes, however, seem to give a much lower conductivity.

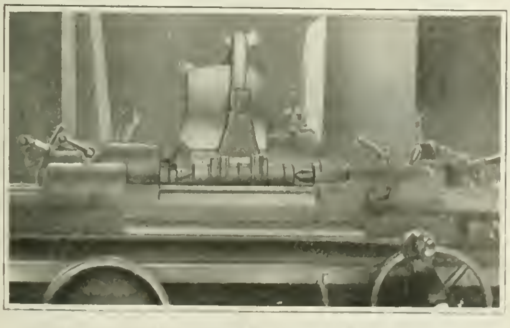

Fig. 8. Norton Plain Grinding Machine with Special Mandrel for holding Outer Rings

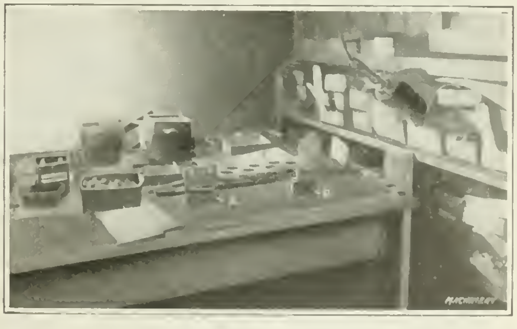

Fig. 9. Inspection Bench with Gages for testing Taper and Size of Rollers before they are assembled

NOTCHING AND ASSEMBLING PUNCH AND DIE FOR SHELL FUSE SOCKET

BY DONALD A. BAKER[1]

As shown in Fig. 1, the fuse socket of the U. S. three-inch shrapnel shell consists of a steel forging, machined as shown, which has inserted in it a thin sheet-metal disk *A*, swaged in place. The operations about to be described are the assembling of this disk and the cutting of the five notches *B*, which are performed simultaneously. It is not necessary to hold these notches closely to dimensions or any degree of smoothness, as their only use is to hold the fuse in place after it is assembled and screwed in. As first planned, the five notches were to be cut on hand milling machines fitted with suitable indexing fixtures. Based on a production of twenty thousand pieces per day, this would probably have meant the installation of about ten machines for this work alone; besides, a press operation would have been necessary later to assemble the disks. As three dies are enough to handle this production, it is hardly necessary to say that it pays to use considerable judgment and thought in the selection of methods on work of this kind. The unique idea involved in this die is the use of pivoted arms in place of the slides that are frequently found in shops handling sheet-metal products that require operations on several sides at the same time.

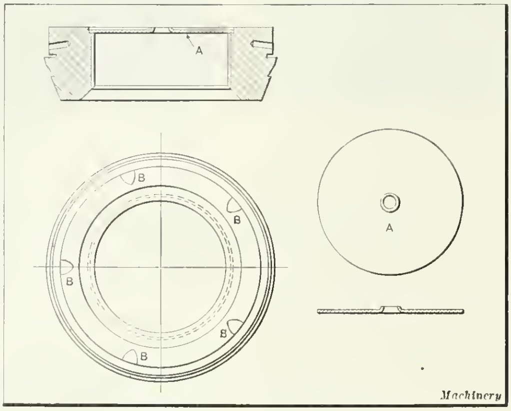

Fig. 1. Fuse Socket for Three-inch Shrapnel Shell

The die, shown in Fig. 2, consists of a cast-iron base or shoe *A*, into the center of which a hardened and ground steel post *B* is driven. Over this post is placed a soft steel spider *C*, into which is driven a hardened steel bushing *D*, which is a sliding fit on the post. This spider carries five punch-holders, or pivoted arms *E*, made of machinery steel, pack-hardened and ground. The punches *F* are shown with their backing-up and adjusting screws *G* and *H*, while at *I* is shown the locating plug over which the fuse socket is placed. The pins *J* and *K* take the thrust of the pins *L* and actuate the pivoted arms when the press is tripped; one of these pins *K* is slotted at the top, as shown, to prevent the spider from turning on the center post and throwing the arms out of alignment with the pins.

The body *M* of the assembling punch and punch retaining ring *N* are of soft machinery steel. The punch proper is shown at *O*, while *P* is a spring plunger, the purpose of which will be explained later. A spring attached to the press bolster plate or direct to the die-shoe, if more convenient, is used in connection with the push-rod *Q* to hold the spider at the top of its stroke ready to have the work placed in position over the locating plug *I*.

In operation, the punch and die works as follows: The fuse socket, top down, is placed over the locating plug *I*, the disk having been put in place in the bottom of the socket. Then, as the press is tripped, the punch descends, and the pilot on the end of the spring plunger *P* enters the hole in the disk to make sure that it is perfectly central. As the punch continues its downward movement, the outer edge of the spring plunger, backed up by the spring pressure, seats the disk firmly, and the punch *O*, coming into contact with the base of the fuse socket, forces the socket downward together with the spider *C*. As the spider moves downward, the pivoted arms *E* are forced inward by their contact with the pins *J* and *K* and cut out the five notches. The die is so planned that, as soon as the notches are cut, the spider bottoms on the end of the central post, and thus offers resistance enough for the punch *O* to swage the edge of the fuse socket base in and around the disk. To reduce the pressure required for this operation, the face of the swaging punch is corrugated or knurled deep enough so that only a part of it is used to accomplish the work.

On the up-stroke of the press, the spider is returned to position by means of a spring located under the die, which forces the push-rod *Q* upward, while the pivoted arms are returned to position by means of springs. The latter are not shown, as they were not thought necessary at the time the design was made. The speed of this particular die, of course, depends on the skill of the operator, but the average production is between 7000 and 8000 pieces per day.

* * *

The French Committee on Women's Work has raised the prohibited age for night work from sixteen to eighteen years. Night work for women must not exceed six hours actual work, must not be instituted if the output can be maintained by day work, and must be the first work to be cut off when reductions of output occur.

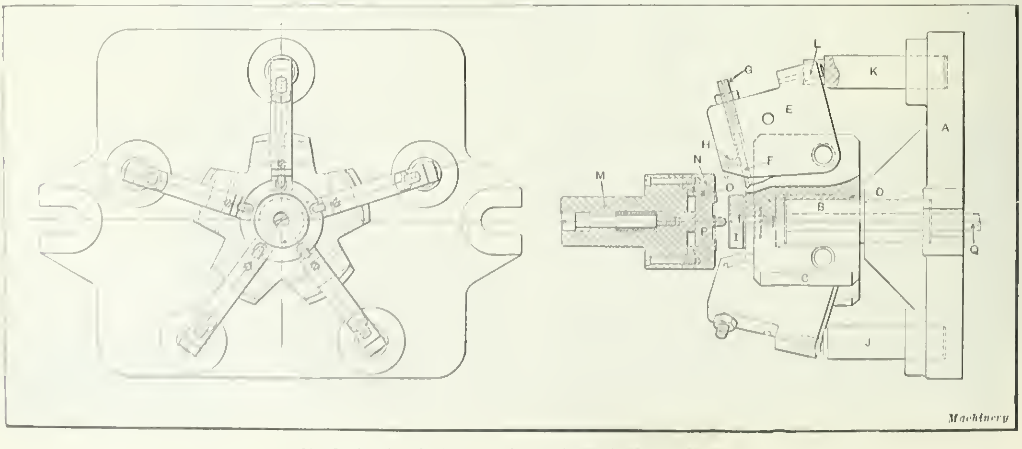

Fig. 2. Punch and Die for notching and assembling Fuse Socket

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[1] Address: Care of Service Engineering Co., 25 Church St., New York City.

GRINDING AND LAPPING THREADS

ATTACHMENTS, FIXTURES, AND LAPS USED FOR PRODUCING ACCURATE THREADS

BY J. E. LINDGREN[1]

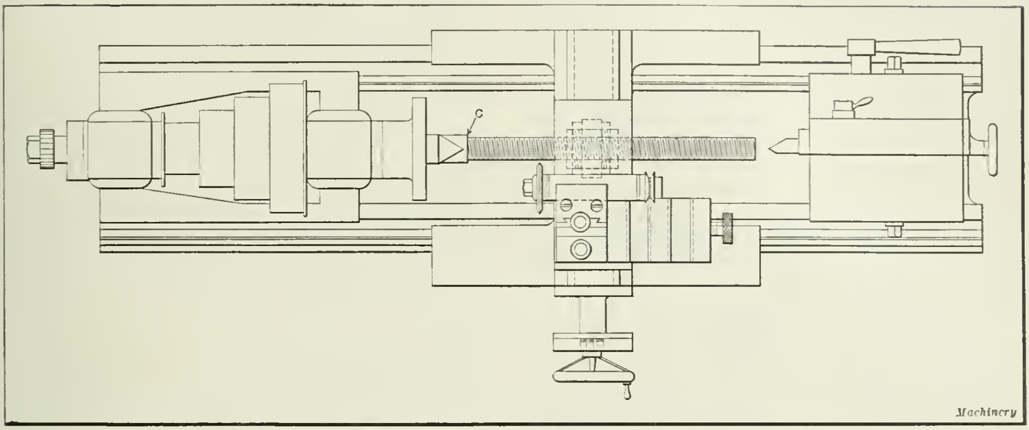

Fig. 1. Thread-grinding Lathe used in the Production of Accurate Threads

A SPECIAL thread-grinding lathe is shown in Fig. 1. Although this machine was designed for thread grinding only, it can be changed into a thread-miller by making a worm-wheel drive for the main spindle and also for the spindle on the grinding fixture. It will be noticed that this lathe is not provided with back-gears. This is because back-gears are objectionable on grinding lathes. The countershaft can be slowed down so that when the belt is placed on the largest step of the cone pulley the spindle will make 60 revolutions per minute, which would be the right speed for grinding a thread gage 3 to 4 inches in diameter. The lead-screw of this lathe is placed in the center of the lathe bed so that the pull on the carriage will be in the center. This obviates any possible twisting of the carriage and uneven feeding. Of course, the lead-screw has to be well covered, as it is necessary to use water in grinding a thread, and this would ruin the lead-screw if it were not protected.

The lead-screw is made on a master thread-cutting lathe and is made only long enough to provide feed for the work to be ground. It is not necessary to support one end of it, as it has three bearings, namely, the two brackets underneath the headstock and the nut under the carriage, which takes the place of one end bearing. It will be noticed that this nut is solid and not made in halves, as is the custom on other lathes, because it has been found that it is best to reverse the lathe when going back to take another cut. The solid nut also makes the carriage feed more rigid. The lead-screw can be disconnected from the drive shaft at *C*, so that when it becomes worn a little, it can easily be replaced. The tailstock and tailstock sleeve are cut away to let the grinding fixture pass when grinding very small plugs. The wheel that is used is only about 3 inches in diameter when new. The carriage is provided with a cross-slide and a compound slide, the cross-slide being adjusted with a fine-pitch screw of twenty threads per inch, so that the dial on the screw can be graduated to ten-thousandths; this is very necessary because in finish-grinding a thread it is necessary to move the wheel only 0.00005 inch to a cut, the dial being large enough to make the graduation lines about 1/32 inch apart. The compound slide has no graduated dial, as it is used only for adjusting the wheel to the thread groove.

The gearing for driving the lead-screw on this lathe should receive especial attention. Being a lathe of about 12 inches swing, it is advisable to make the gears of very fine pitch, say 20 diametral pitch, and as the gears will be small in diameter, they are made of steel. The gears must be turned and milled with the utmost care, because if they are not true, they will not drive the screw evenly, and drunken threads will be the result. As this lathe has no feed except the screw feed, it does not require an apron. The machine is simple and inexpensive to build and will be found very accurate and efficient. When grinding a thread, water must be used. It is therefore necessary to provide this lathe with a pan, tank, and a circulating pump; the top of the machine can be protected by covering it with heavy oilcloth. The kind of wheels to be used for grinding threads is a hard matter to decide upon, but by experience the writer has found that a 180-J carborundum wheel will give satisfactory results for grinding any thread having not over twenty-five threads per inch. If a finer thread is to be ground, an India oilstone wheel will be found satisfactory.

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[1] Address: 1242 Oak St., Beloit, Wis.

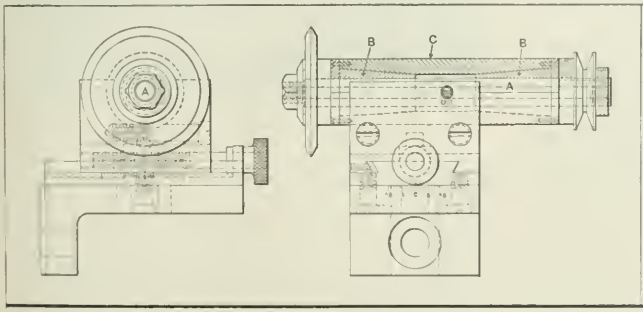


Fig. 2. Thread-grinding Fixture

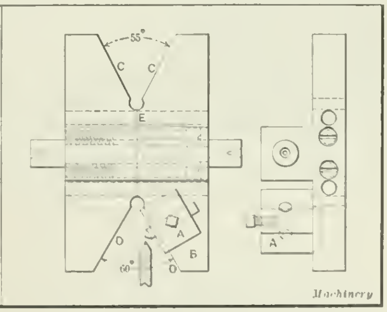


Fig. 3. Fixture for dressing Grinding Wheel

The thread-grinding fixture shown in the side elevation and plan view in Fig. 2 is designed to do accurate grinding at a high rate of speed. The wheel can be set at any angle to conform to the helix angle of the thread, and it can also be adjusted up or down to bring the center of the wheel in line with the center of the work being ground. In making a grinding fixture, one must bear in mind that it cannot be machined too accurately. The most important part of this fixture is the spindle *A* and its bearings *B*. The spindle, being made of tool steel, is hardened and ground. It is well to make it of some oil-hardening steel that will not change much, if any, when hardened. It will be noticed that the spindle is hollow, so that it will be cooled when running simply by the air passing through it. The bearings *B* are made of some good bearing bronze, and it is necessary that they be absolutely concentric. The casing *C* is a cast-iron sleeve with a taper hole in each end for receiving the bearings. These taper holes should be in line with each other. To obtain the accuracy desired, first grind one hole to fit the bearing; then put a plug in the chuck and grind this to fit the taper hole that is ground. Then place the casting on the plug and tap it lightly. If the other end is ground in this position, these two taper holes should be true with each other. It is also necessary to have the ends concentric with the holes, so they should be held on the plug while grinding.

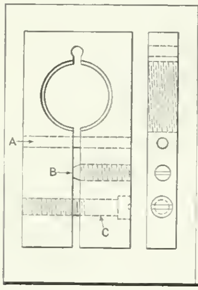


Fig. 4. Lap for Plug Gage

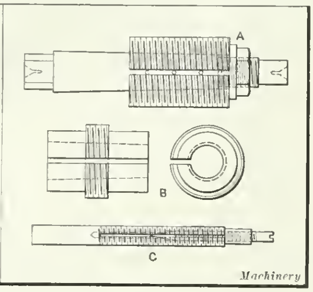


Fig. 5. Laps for Ring Gage

A block for dressing grinding wheels is shown in Fig. 3. This block should be hardened and ground all over, and it should be lapped at *C*, *D*, and *E* and tested with a sine bar. The hole through the block which is to receive the arbor must be true with *C*, *D*, and *E*. This fixture is simple in design, but can be made very accurately and will dress a wheel so that the only lapping necessary on the plug or ring gage is merely to remove the vibration marks. These vibration marks are so small that they will not be seen until a lap is applied. When using a block or fixture like this for truing the wheel, it is possible to grind a plug or ring gage almost to size. This will increase production, because it requires less time to grind than it does to lap. To use this block, simply put it between centers. A small jack should be put underneath it to keep it from turning. By sliding the small block *A* that carries the diamond against the angle of the large block *B*, taking care to press slightly against it, the wheel can be dressed. With a little practice, no difficulty will be experienced in handling it, and the writer ventures to say that a wheel can be accurately dressed in about two minutes.

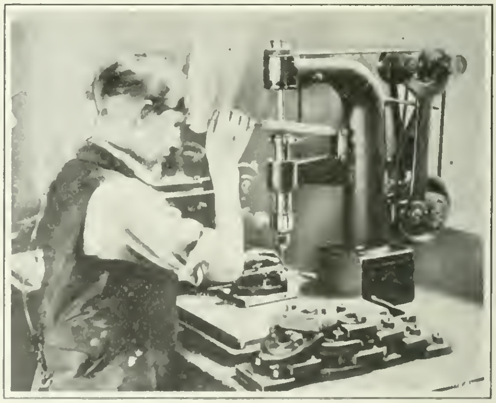
To lap a thread is a very easy matter if one has good laps. When a thread plug gage is to be lapped, the procedure is as follows: First make a tap and grind it on the master lathe to sizes corresponding to the plug before the plug is lapped. Good practice requires that there should be about 0.0005 inch to lap all over. After the tap has been made, inspected, and found to be all right, the lap can be made as shown in Fig. 4. This is made of very soft cast iron. It has a guide pin *A*, adjusting screw *B*, and a screw *C* for locking. To use the lap, simply adjust it to the plug thread, put on some lapping compound, and turn the plug back and forth a few times; then remove the plug and reverse the lap. Care must be taken not to run the lap over the plug loose, as this will ruin the shape of the thread, and if it is too tight, it will cause overheating. It will often be found that the plug has a tendency to become smaller at each end. To remedy this, a narrow lap must be used so that the high points can be lapped off. A good lapping compound is made by mixing flour carborundum with vaseline; the amount of each will vary according to the amount of stock on the plug. In this case, use a mixture of 8 parts of vaseline to 1 part of flour carborundum for rough-lapping. For finish-lapping, use 16 parts of vaseline to 1 part of flour carborundum. When lapping, wash the plug and lap often in gasoline to remove the fine steel chips that are produced.

Three laps are shown in Fig. 5 for lapping ring gages, *A* and *B* being made for large ring gages, and *C* for smaller sizes. They are made of cast iron and are ground to fit the ring gage to be lapped. Grinding the thread on a lap will insure accuracy. Lap *A* is designed for roughing, and has a tendency to make the ring bell-mouthed. Therefore, it is necessary to use a lap with only a few threads, as shown at *B*, for finish-lapping. With this lap, it is possible to obtain a ring which is straight from end to end. The lap shown at *C* is for small sizes, and as it will expand at one point only, one lap is sufficient.

* * *

DRILLING BAKELITE AT HIGH SPEED

At the plant of the Johns-Pratt Co. in Hartford, Conn., it is necessary to drill parts made of bakelite, three holes 1/8 inch in diameter being drilled through a thickness of approximately 1/16 inch. Trouble was experienced in handling this work through rapid destruction of the twist drills by chipping the cutting edges when the work was done on a drilling machine running at from 3000 to 3500 revolutions per minute. Recently, the Fenn Mfg. Co. of Hartford, Conn., developed a sensitive drilling machine adapted for operation at speeds ranging from 10,000 to 15,000 revolutions per minute, and after the trouble experienced in drilling bakelite had been called to the attention of this firm of machinery builders, one of the high-speed sensitive drilling machines was sent to the Johns-Pratt Co.'s factory for trial on this work. After preliminary experiments had been conducted, it was found that operating at a speed of 11,000 revolutions per minute, the machine gave extremely satisfactory results on this work, and it has now been in operation for several months, giving ample time to obtain results which are quite representative of average conditions. Running at this speed, the machine drills in excess of 6000 holes per day, i.e., the production is over 2000 pieces per day. The machines have been successfully used for drilling small holes in metal where the high speed enables the small letter sizes of drills to be run at efficient cutting speeds.



Drilling Bakelite on High-speed Sensitive Drilling Machine built by Fenn Mfg. Co.

A feature of this Fenn high-speed drilling machine is the arrangement of the feed lever which, it will be seen, is counterweighted with the spindle, so that all of the pressure applied by the operator to the lever goes direct to the drill point. This makes the machine very sensitive and greatly reduces the possibility of breaking drills. E. K. H.

RECENT PROGRESS OF PYROMETRY[1]

Considerable progress has been made in the manufacture of pyrometers during the past five years, several new instruments having been introduced for industrial and scientific purposes. Various investigations of fixed points have been made, and it has been found that, up to the highest reading obtainable on the gas scale—1550 degrees C.—the present-day standards are apparently fixed. The melting point of platinum is accepted as 1755 degrees C., which is a useful calibration point for high-reading pyrometers. The United States Bureau of Standards issues data on certified fixed points of materials for calibration, which, if accompanied by instructions, would eliminate the danger arising from the use of materials of unproved purity.

Thermo-electric Pyrometers

Base-metal couples, though their dependability has been questioned, are being extensively used in place of the more expensive platinum and platinum alloy junctions. Trials made on couples of the base-metal class, show changes in calibration, on heating for twenty-four hours, ranging from 20 to 130 degrees C. Errors of this nature are practically eliminated, however, if care is taken in selecting materials and in "ageing" the junctions by prolonged heating at the maximum temperature before calibrating. Base-metal couples develop a relatively high electromotive force and permit the use of strong, cheap indicators in place of the sensitive instrument required for platinum junctions. Among the base-metal couples the following are prominent; copper-constantan for temperatures below 700 degrees C., iron-constantan, which may be used to 900 degrees C., two iron-nickel alloys of different composition, which will register 1000 degrees C., and two nickel-chromium alloys capable of reading to 1200 degrees C. in continuous use, and to 1300 degrees C. for occasional observations. A thermocouple of carbon and graphite gives promise of a valuable extension in the range of thermo-electric pyrometers, readings as high as 2000 degrees C. being attainable. This junction should be heated to this temperature before calibrating, in order to expel volatile matter. Among the materials which have recently been introduced for protecting the unions from the corrosive action of furnace gases are: alundum (oxide of aluminum), which melts at 2050 degrees C.; and silit and silfrax, which are brittle substances resembling carborundum. Junctions used in reading temperatures of molten brass and bronze, are successfully protected by a tube of molybdenum.

A new departure in commercial indicators for thermo-electric pyrometers is the adoption of the potentiometer principle, the connections for which are shown in the accompanying illustration. *B* is a two-volt accumulator, R_1 an adjustable resistance, R_2 a fixed resistance, *DE* a uniform ohmmeter, *A* a switch, *S* a standard cell, and *G* a sensitive galvanometer of potential along *DE*. In order to maintain a steady stretched wire, R_1 is adjusted so that when *S* is switched into the circuit of *G* no deflection is observed. This adjustment must be made from time to time, as the voltage of *B* diminishes with use. The pyrometer is connected to one terminal of *G* and to a sliding contact which, when taking a reading, is moved along *DE* until no deflection is noticed on *G*. From the known constant for the junction used, *DE* may be graduated to read temperatures directly. Although the readings are not automatic, this method has the advantage of providing greater sensitiveness and independence of the resistance of the pyrometer and leads. An indicator has been substituted for the galvanometer for special-range readings. The slider is fixed at any given point above which higher readings may be taken, the fixed point being considered as zero. Suitable adjustments of the sliding contact along *DE* gives the range required. A suspended-coil indicator may also be used in this circuit. In the multi-range instrument made by R. W. Paul, the indicator replaces the galvanometer in a Wheatstone bridge circuit, the pyrometer being in series with the indicator. By throwing the bridge slightly out of balance, an opposing current to that produced by the thermo-couple is made, which, when overcome, will move the pointer. Resistances placed in the arm of the bridge, disturb the balance until the low reading of the selected range is reached. The variation in the temperature of the cold junction is recorded and automatically corrected, by the use of two copper and two manganin resistances in the arms of the bridge, since copper changes its resistance with the temperature, while manganin remains constant. An indicator unaffected by vibration and affording a high degree of accuracy, for use in regulating temperatures of superheated steam on locomotives, is now being produced.

Resistance Pyrometers

Platinum is distinctly volatile above 1000 degrees C., which explains the change that takes place in calibration when resistance pyrometers are employed for higher temperatures than this. For accurate results below this temperature, this type of pyrometer is much used, although the temperature to be measured must be subject to absolute control. A liquid element, such as melted copper, showing a uniform increase in resistance up to 1400 degrees C., might be utilized in extending the range of the resistance pyrometer.

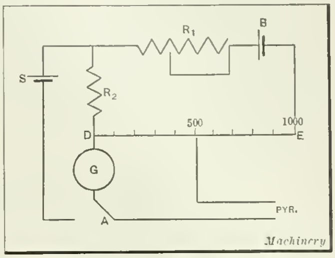


Diagram of Potentiometer Indicator

Radiation Pyrometers

A distinct improvement in these instruments has been the substitution of pivoted indicators for the suspended-coil type. More sensitive junctions, also, are being used. To determine the temperature of molten metals, the pyrometer may be mounted at the open end of a fireclay tube, and permanently focussed on the closed end, which is immersed in the metal. A salamander immersion tube is also used, the telescope being pierced by a tube, open at each end, through which air may be forced, preventing fumes from reaching and corroding the mirror. Another instrument of this type receives the rays in a tube containing a polished cone, a junction at the apex receiving the radiations. The same reading is obtained anywhere within a given limit, therefore requiring no focussing. A high degree of accuracy is now being attained with radiation pyrometers.

Optical Pyrometers

New types of optical pyrometers have recently been introduced, based on the principle of color extinction. In one form, cells containing a liquid of the correct color and density are used, the luminous rays from the heated object being extinguished at a given temperature. The instrument is an eye shade, in which four cells are mounted, two of which are capable of extinguishing the light at the working temperature, while the other two correspond to a slightly higher temperature. Either pair may be brought before the eyes by moving a slide, and when the heated object is barely visible in the lower pair, but invisible in the higher pair, the correct temperature has been attained. Another form has a single cell, in which the depth of liquid may be adjusted until the object is invisible, and the temperature readings taken on a scale, graduated according to the depth of the liquid. Still another form consists of a small telescope, through which the rays are intercepted by a dark-colored glass wedge, which is moved, together with a scale, until the sighted object just ceases to be visible. Temperatures are read from the scale, and the range may be increased by inserting tinted glass in the eye-piece, and reading from a second scale which has been prepared with the glass in position.

Recorders

Recorders for registering the readings of several pyrometers simultaneously are also receiving special attention. Of the more recent types, Foster's recorder possesses an indicator pivoted horizontally, the pointer being vertical and moving across a circular chart, which rotates about its center once a day. A black mark is made on the chart at regular intervals, by means of a presser bar, working against the pointer, at the end of which is a capillary tube containing an inked wick.

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[1] Abstract of a paper read before the Royal Society of Arts by Charles R. Darling.

In the latest thread recorder of the Cambridge Scientific Instrument Co., two threads are used, differently colored, and two indicators which record on a single chart. A mechanism which brings the threads alternately beneath the pointer produces four simultaneous records. The pyrometers are automatically switched onto the indicators in correct sequence.

Recorders with motor-driven mechanisms have been introduced by the Leeds & Northrup Co. and also by R. W. Paul. The latter also has other novel features. The chart is in the form of a continuous roll, of 1000 hours' duration, a large part of which is visible through a window extension. The mechanism which produces a dot periodically on the chart, may be varied in speed by inserting change-gears. The chart of the Siemens recorder is similar to the chart just described. It is furnished with a pivoted galvanometer. Clockwork is used to actuate this instrument.

* * *

SHIP TONNAGE

At the present time the term "ship tonnage" is frequently used in papers and periodicals. The general lack of knowledge in regard to the meaning of this term tends to confuse a great many people. This confusion may be attributed to the fact that the expression has five distinct meanings. Referring to merchant ships, the gross tonnage has nothing whatever to do with the weight of the ship nor the weight of the cargo, but pertains rather to the entire carrying capacity of the ship, expressed in tons of 100 cubic feet. The *Mauretania* is referred to as a ship of 32,500 tons, meaning gross tons.

Net tonnage, or registered tonnage, as it is often spoken of, is expressed by the same unit that is used in determining gross tonnage, that is, 100 cubic feet, but is figured exclusive of all space not adapted to the carrying of cargo, such as engines, boilers, bunkers, etc. The net tonnage of a merchant ship is registered on the records of the country whose flag it flies, and is what is generally implied when tonnage is spoken of.

Dead weight tonnage is the weight of the cargo in tons of 2240 pounds which the ship will carry. Dead weight tonnage is frequently referred to when speaking of ships which carry heavy cargoes, such as iron or coal, as tons, but in other cases the expression "dead weight tons" is used. A coal barge of 7500 tons would have a net tonnage of only approximately 3200 tons. When the ocean rate is quoted as so many dollars per ton, either measurement tonnage or dead weight tonnage is understood to be meant. Measurement tonnage is the amount of space occupied by the cargo, and the unit used is only 40 cubic feet. A ship can carry a cargo measuring 2½ times its net tonnage. On light, bulky cargoes, measurement tonnage is figured, while on heavy cargoes, the rate is figured on weight. The classification of the method of figuring the tonnage is optional with the owners of the vessel.

Displacement tonnage has to do with battleships exclusively, and is the actual weight of the water displaced by the ship, when fully equipped, or, in other words, the weight of the warship in tons of 2240 pounds. One very unfortunate outgrowth of the confusion arising from misunderstanding of the meaning of the word "ton" has been to deceive the layman as to the seriousness of the whole situation as regards ship production. During the year 1917, about 7,000,000 tons of shipping were sunk, yet this does not seem so alarming, for, according to reports, the United States alone is scheduled to build 6,000,000 tons during the present year, exclusive of that which is being produced by the other allied nations. Therefore, it would seem that the construction would overbalance the destruction. The fact is that the 7,000,000 tons sunk were net tons, while the 6,000,000 tonnage planned for 1918 does not represent net tons, but dead weight tons. The seriousness of the situation is apparent when it is understood that it requires fully two dead weight tons to equal the one net ton that is meant in the reports of the U-boat sinkings.

E. R. D.

GOVERNMENT SPECIFICATIONS

Manufacturers have had considerable trouble with the specifications furnished to them by some of the purchasing departments of the Government. There is a natural and commendable tendency on the part of the officers of the Ordnance Department to demand the best that can be produced. In their eagerness to obtain the best, however, specifications are often drawn that cannot be met commercially, and that unnecessarily increase the expense of the material. In some cases, however, the specifications are unreasonable, erroneous, and give evidence of carelessness or ignorance in their preparation. As an example may be cited the following specifications for a gun-metal. The government specifications read as follows: elastic limit, 54,800; tensile strength, 30,000; reduction of area, 30 per cent; elongation in two inches, 20 per cent.

The metal was to be composed of copper, from 87 to 89 per cent; tin, from 9 to 10.5 per cent; zinc, from 1.75 to 2.50 per cent; lead, 0.01 per cent.

To begin with, there is an obvious error in specifying a tensile strength below the elastic limit, and it is apparent that an error had been made in transposing these two items, it being evident that a tensile strength of 54,800 pounds per square inch and an elastic limit of 30,000 pounds per square inch were required. The company to whom the specifications had been submitted would not go ahead until the error had been corrected, and endeavored to submit them to the officer who had issued them. The sales manager of the company was sent to see him, but the officer refused to give him a hearing, stating that the specifications were not of his own making and that they would have to stand as issued.

Apart from the obvious error in giving the specifications, the values for the tensile strength and the elastic limit, even if transposed, were too high for the metal requested. The specifying of a percentage of 0.01 per cent of lead is also an evidence of poor judgment. After considerable delay, the Government finally accepted a gun-metal according to navy specifications, with a tensile strength of 30,000 pounds per square inch; an elastic limit of 15,000 pounds per square inch; and an elongation in two inches of 15 per cent.

In another case, the specifications called for a tensile strength of 65,000 pounds per square inch and an elastic limit of 50,000 pounds per square inch, and required the metal to be composed of from 56 to 57.5 per cent copper; 0.5 to 0.75 per cent tin; from 1.0 to 1.5 per cent iron; with a maximum of 0.5 per cent aluminum and 0.35 per cent manganese, the remainder being zinc.

After some delay, caused by the difficulty of proving to the government officials that these specifications could not be commercially met, the Government accepted a manganese bronze made to the standard navy specifications, with a tensile strength of 65,000 pounds per square inch and an elastic limit varying from 25,000 to 35,000 pounds per square inch.

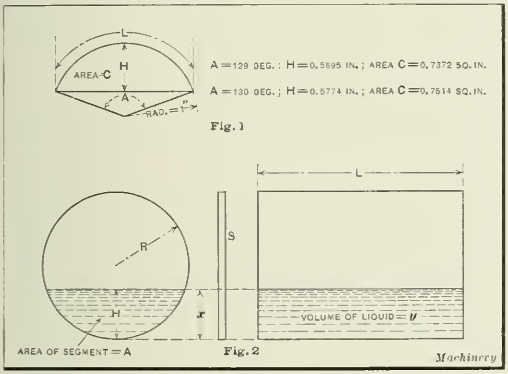
In a third instance, the specifications called for "Pc-2" navy phosphor-bronze, but specified a minimum tensile strength of 35,000 pounds per square inch with the following composition: copper, from 85.5 to 87.5 per cent; tin, from 10 to 11 per cent; zinc, from 2.0 to 2.5 per cent; lead, from 0.5 to 1.0 per cent; phosphorus, from 0.03 to 0.05 per cent; and with a maximum of 0.1 per cent of iron. These specifications for composition demand such close limits that it is not commercially practicable to produce a metal that will have these limits of analysis. The specifications accepted called for from 85 to 90 per cent copper; from 6 to 11 per cent tin; with a maximum of 1 per cent lead, 0.1 per cent iron, and 0.5 per cent phosphorus, the remainder being zinc.

Just why the Ordnance Department officer should try to improve upon the standard navy specifications cannot be explained, but much of the delay in the production of war materials is apparently due to the fact that people of limited experience, who have been taken into the Ordnance Department, are trying to make improvements upon the long-established specifications of the Navy Department which have proved satisfactory and which ought to be followed in order to prevent delay. We must all remember that we are at war; that we are in this war to *win, and to win quickly.*

FINDING CONTENTS OF CYLINDRICAL TANKS

BY LAY-OUT

On page 644 of the March number of MACHINERY, there is given a method of plotting a curve for finding the graduations of a scale used in measuring the number of gallons contained in cylindrical tanks, but the writer has found that, after he has computed the capacity and an easily found constant for any given tank, the distance of any graduation from the end of the scale for any given volume within the capacity of the tank can be quickly found by two settings of the slide-rule and reference to a table of the area of segments, like that found on pages 62 and 63 of MACHINERY'S HANDBOOK. One column H of this table gives the values for the height of the segment for different center angles and for unit radius; or, in other words, the ratio $\frac{\text{height of segment}}{\text{radius}}$. Another column gives the area of the segment in a circle of unit radius. The area of a similar segment of larger radius is this area multiplied by the given radius squared. The capacity of a tank of a given size is:


L
H
AREA C
A
RAD. = 1"
A = 129 DEG.; H = 0.5695 IN.; AREA C = 0.7372 SQ. IN.
A = 130 DEG.; H = 0.5774 IN.; AREA C = 0.7514 SQ. IN.
Fig. 1
L
R
S
H
x
VOLUME OF LIQUID = y
AREA OF SEGMENT = A
Fig. 2
Machinery

Figs. 1 and 2. Finding Contents of Cylindrical Tanks

$$\text{Area of segment} \times \frac{\text{length of tank, in inches}}{231}$$

which is the capacity of a section one inch square and as long as the tank times the number of such sections contained by the tank.

Let L = length of tank, as shown in Fig. 2, in inches;
R = radius in inches;
H = height of segment for unit radius = $\frac{\text{height}}{R}$;
y = capacity for which graduation is to be found, in gallons, on scale S;
x = distance from graduation mark to nearest end of scale;
$U = \frac{L}{231}$ gallons in one inch square section;
C = corresponding area in table of unit radius segment;
A = segment of given radius.

As $H = \frac{\text{height}}{R} = \frac{x}{R}$, $x = HR$; also by the rule at the head of the table, $A = CR^2$. (Some handbooks give this in terms of diameter in which case H is one-half and C is one-quarter of the value given in MACHINERY'S HANDBOOK.) As $H = \frac{x}{R}$, $A = CR^2$, and $y = AU = CR^2U$, $C = \frac{y}{R^2U}$. Therefore, R^2U is a constant for any given tank.

Example—If a tank is 20 feet long and 6 feet in diameter, its total capacity is:

$$\frac{\pi \times (\text{radius, in inches})^2 \times \text{length, in inches}}{231} = \frac{3.1416 \times 36^2 \times 240}{231} = 4230$$

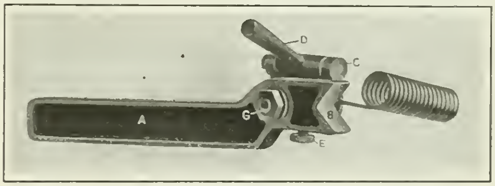
One-half of the capacity of this tank is, therefore, 2115 gallons. The constant R^2U for this tank is $36^2 \times \frac{240}{231} = 1346$. As $C = \frac{y}{R^2U}$, the corresponding area of unit radius and segment is $1000 \div 1346 = 0.743$. The table of corresponding areas given in MACHINERY'S HANDBOOK shows that this area is greater than the corresponding area of the segment of an angle of 129 degrees and less than that of the segment of an angle of 130 degrees. The illustration and values of A, H, and C shown in Fig. 1 are taken from the table in MACHINERY'S HANDBOOK. By interpolation in the table, the value of H is found to be 0.573. As $x = HR$, the graduation mark on the scale is $0.573 \times 36 = 20.628$ inches from the lower end.

In the case of 3000 gallons, the graduation will be marked from the top of the scale, because 3000 is more than one-half the capacity of the tank; therefore, y is $4230 - 3000 = 1230$, and $C = 1230 \div 1346 = 0.914$. By interpolation, the corresponding value of H is 0.665. Therefore, $x = 0.665 \times 36 = 23.94$ inches. The whole scale, of course, is equal in length to $2R$.

* * *

SPRING WINDER

In the accompanying illustration is shown a winding tool that is especially handy for winding heavy wire tension or compression springs. It may be used in the toolpost of any thread-cutting lathe that provides for the required pitch of the springs. The tool shank A is offset, so that it may come up close to the chuck, which holds the winding rod or mandrel. At one end B of the the tool shank is a V-jaw for any size of mandrel. The spring-wire tension box C contains two fiber blocks which may be adjusted by means of the screw E and may be quickly tightened or released by the lever D. The tension box swivels on a stud G and will adjust itself automatically to any size mandrel. J. V.



Spring Winding Tool

* * *

ILLNESS IN INDUSTRY

In a paper read before the American Institute of Mining Engineers, by Thomas Darlington, secretary of the Welfare Committee of the American Iron and Steel Institute, it was stated that records show that the time lost by employes, through illness, ranges from four to ten times that lost as the result of industrial accidents; in fact, illness affects operating costs much more than is generally realized. Proper care of the health of employes would prevent much of this illness; and the cost of health supervision is not great. A comparison of costs in ninety-nine industrial establishments employing 495,544 men showed that it was about three-fourths of a cent per man a day. In the case of an iron and coal mining company that employed 11,000 men and furnished all the medical attention required by the employes and their families, the cost was less than four cents per man per day.

* * *

It has been estimated that of about 13,000,000 men employed in manufacturing plants in the United States, 6,200,000 are working on war supplies and subsidiary industries.

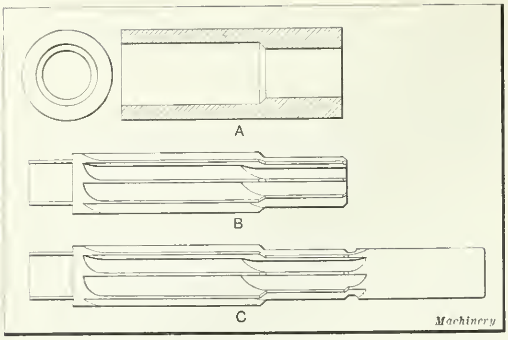


Fig. 1. Automobile Steering-knuckle Bushing and Reamers for machining Holes

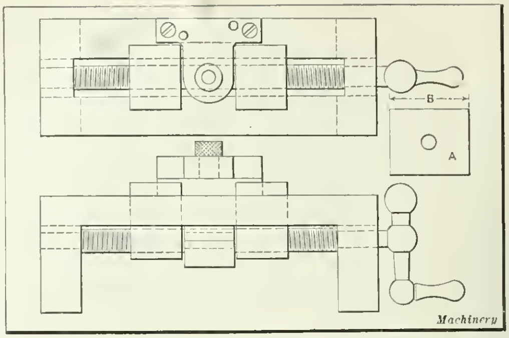


Fig. 2. Fixture for drilling and reaming Hole in Center of Work shown at A

RESULTS OF FAULTY TOOL DESIGNING

TOOLS AND FIXTURES THAT DID NOT WORK AND REASONS FOR FAILURE

BY F. B. JACOBS[1]

MODERN tool designing has been reduced to so exact a science that the drawings, or blueprints, that leave the drafting-room should impart full and explicit instructions to the toolmaking department. With expert tool designers, checkers, one or two assistant chiefs, and a chief draftsman, it would seem that none but perfect drawings should leave the tool designing department. This, however, is not always the case. In the vernacular of the shop man, "bulls" are often made with the result that tools made exactly according to the drawings furnished by the tool designing department are far from being efficient. The object of this article is to show a few simple mistakes in tool designing, the aggregate cost of which amounted to quite a sum. They were not all made in one shop nor in one locality, but have been found by the writer in various manufacturing centers.

At *A*, Fig. 1, is shown an automobile steering-knuckle bushing, in which both parts of the hole must be accurate as to size and at the same time concentric with each other. At *B* is shown the reamer that was made for this piece. As the large part of this reamer will begin to cut first, and as no means are provided to guide the smaller part of the reamer into the small part of the hole accurately, it is impossible for the tool to perform an accurate job. This reamer was expensive to construct, and it proved to be absolutely worthless.

The difficulty was overcome by providing the reamer with a pilot as shown at *C*. This makes the reamer more expensive, but its design is correct, and it is the style that should have been considered in the first place. In this case two reamers had to be designed and made to obtain one that proved satisfactory.

In Fig. 2 is shown a fixture for drilling and reaming a hole in the piece shown at *A*. Dimension *B* varies from 1 to 1½ inch, but it is necessary for the hole to be exactly in the center of the piece. The jig is equipped with a right- and left-hand screw, which actuates two jaws that grip the piece. If it were possible to produce a very accurate thread commercially, this principle might have worked all right, but it was soon found that the holes drilled were not central. To overcome this difficulty, the pieces are left a little large and finished by grinding on the fixture shown in Fig. 3. Two pieces *A* are held at one time and are forced upward against a stud *B* by wedges *C*. The wedge at the right bears at the center only, to insure the ground surface being parallel with the axis of the hole. The piece *A* is first ground on this side of the fixture and then transferred to the other side, where the other surface is ground. As the grinding of both sides of the piece is done at one setting of the grinding wheel, the hole must be in the center of the piece. The work is done on an ordinary surface grinder. This fixture gives excellent results.

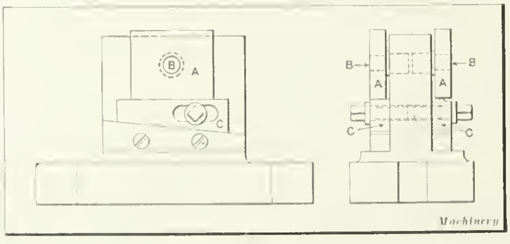


Fig. 3. Fixture for grinding Work shown in Fig. 2

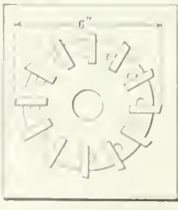


Fig. 4. Inserted-tooth Reamer

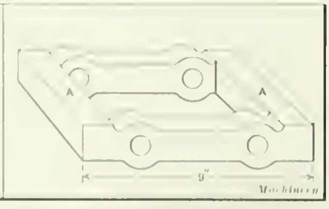


Fig. 5. Work in which Holes and Surfaces A must be Parallel

Fig. 4 illustrates a bad blunder. This is an inserted-tooth reamer with a cast-iron body six inches in diameter, in which the high-speed steel blades are held by taper pins. As the edge of the cutter blade does not come to the center of the taper-pin hole, all the driving possible will not make the pins hold the blades, inasmuch as the action of setting up the pins only causes them to fit a little tighter in their taper holes without exerting any influence on the blades. The tool designer, in this case, excused himself by saying that he "didn't think."

The piece shown in Fig. 5 presents an interesting problem, as the surfaces *A* must be parallel with the holes. The original practice was to machine these surfaces and then drill and ream the piece in the jig shown in Fig. 6, in which the surfaces *A*, Fig. 5, are forced against the locating pads of the jig by means of two clamps. In theory, the jig is all right, but from a practical point of view it is all wrong. In the first place, it is almost impossible to machine the surfaces *A* so they will be absolutely accurate, and a slight error in parallelism, say 0.0015 inch, will have a tendency to cause the work to spring when clamped in the jig. As the holes are machined in this position, they will be out of line as soon as the jig clamps are released. Again, a slight amount of dirt on one of the locating pads will accomplish the same result, even though the piece is machined absolutely accurately.

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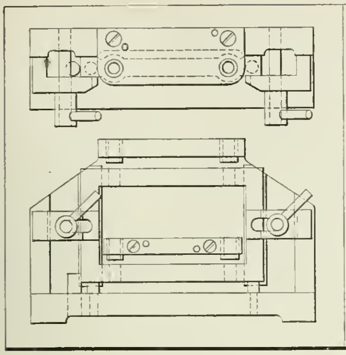


Fig. 6. Jig for drilling Work shown in Fig. 5

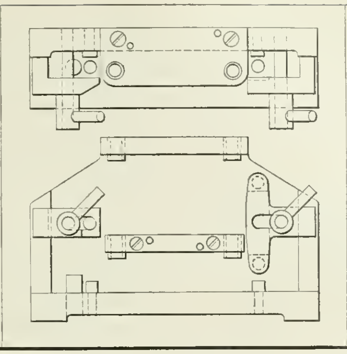


Fig. 7. Jig shown in Fig. 6 Redesigned

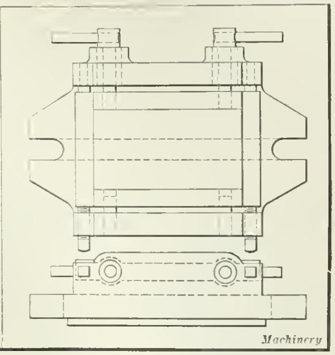


Fig. 8. Grinding Fixture for Work shown in Fig. 5

When the fault was shown to the chief draftsman, he thought it would be a simple matter to remedy the difficulty by redesigning the jig as shown in Fig. 7. In this jig the three-point suspension principle is utilized, two clamps holding the work against three stops, and this produced holes that were in line, as far as that went; but still the problem of inaccurate machining of the surfaces *A*, Fig. 5, was not solved. Then the chief draftsman designed the grinding fixture shown in Fig. 8. After the holes were drilled and reamed in the jig shown in Fig. 7, the surfaces *A* were finish-ground in this fixture. It will be seen that the work is held in place by two aligning rods and two square-head set-screws, which force it against two stops. This fixture worked like a charm and accurately machined pieces were produced. Of course, it was necessary to remove a small amount from the location stops on the jig shown in Fig. 7 to compensate for the amount left for finishing by grinding.

At *A*, Fig. 9, is shown an automobile torque tube, on one end of which it is necessary to do some machine work after the flange *B* has been placed on the other end. This work is done on an engine lathe, and the piece is held in a fixture that is clamped on the faceplate while the tube revolves in the back-rest. In the particular case in question, the man that did this machining operation worked on a premium system, and he wanted a faceplate fixture that would save all the chucking time possible. So the fixture *C* was furnished, which, without a doubt, is very novel in design. Two straps *D* are held against the flange of the torque tube by heavy springs. The straps revolve on their studs over annular cam-shaped pieces *E*, the idea being that as the straps were struck with a lead hammer they would rotate around the stud and be raised out of contact with the work.

The operator placed his fixture in position on the faceplate of his lathe, set his back-rest, put a torque tube in place, and started to take a cut. As soon as the tool began to cut, its pressure forced the other end of the torque tube off the center, breaking the back-rest. The springs *F* were then removed and washers substituted.

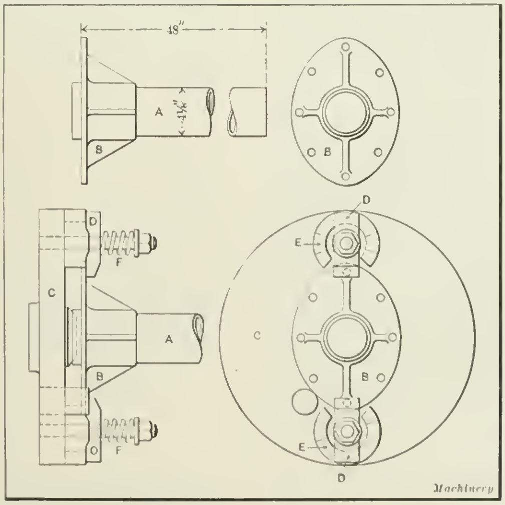


Fig. 9. Automobile Torque Tube and Fixture for machining One End

The tools and fixtures described illustrate graphically the results of not thinking beforehand, and the only remedy the writer can offer for conditions producing such results is for the tool designing department to pay a little more attention to practical details. The tool-room foreman is a good man to consult occasionally. If he is a man of wide experience, he can, no doubt, point out many errors in design that the tool designing department frequently overlooks. Harmony between the tool designing department and the tool-room should prevail, because this "get together" spirit has proved to be productive of excellent results.

* * *

BRITISH PARLIAMENTARY COMMISSION REPORTS AGAINST METRIC SYSTEM

A final report has been presented to the British Parliament by the Committee on Commercial and Industrial Policy after the War, which has been at work for the past two years. The section of the report relating to weights and measures says: "We are unable to recommend the compulsory adoption of the metric system in this country. In our opinion, it is absolutely certain that the anticipated uniformity could not be obtained for a very long period, if ever. There is no unanimity even as to the theoretical merits of the metric system as compared with our own. The practical argument that its adoption is desirable in order to secure uniformity in the markets of the world has been shown to be unfounded. We are not satisfied by any evidence which has been brought before us that trade has actually been lost to this country owing to the fact that the use of the metric system is not compulsory. To attempt to make the use of the system universal and obligatory in this country would cause loss and confusion at a particularly inopportune moment, for the sake of distant and doubtful advantages. We are convinced that, instead of assisting in the reestablishment of British trade after the war, such a measure would seriously hamper it. The popular belief that the introduction of the metric system would render possible the immediate sweeping away of many complicated weights and measures is, in our opinion, wholly fallacious."

* * *

When work being ground is of such a nature as to cause the wheel to run out of true, frequent dressing will save the wheel rather than waste it. For example, a wheel that runs out 1/32 inch after one hour's grinding will run out 1/8 inch after two hours' grinding. If it is dressed after the first hour and again after the second hour, the amount wasted by dressing will be 1/16 inch, whereas after running two hours it is necessary to dress off 1/8 inch, or twice as much.

INTENSIVE PRODUCTION ON DRILLING MACHINES—2

DESIGN OF CUTTING TOOLS AND WORK-HOLDING FIXTURES FOR HANDLING TURRET LATHE WORK ON DRILLING MACHINES

BY EDWARD K. HAMMOND[1]

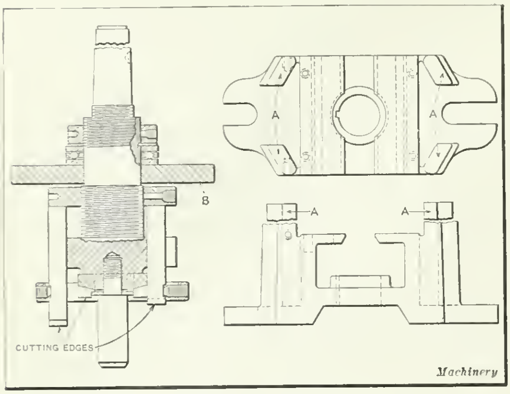


Fig. 6. Type of Tool and Work-holding Fixture used on Parts where Accuracy in tripping Feed is of Great Importance

IN the first installment of this article, information was given in regard to the organization of the drilling machine department and a description was presented of special equipments which were provided on the Baker Bros. high-duty drilling machines in order to adapt them for handling a wide range of work for the machining of which turret lathes would usually be considered necessary. In the present article, it is intended to describe the various special forms of cutting tools, jigs, and work-holding fixtures which are used on the machines, and to explain principles of tool design which have been responsible for making substantial increases in rates of production.

Design of Tools and Fixtures

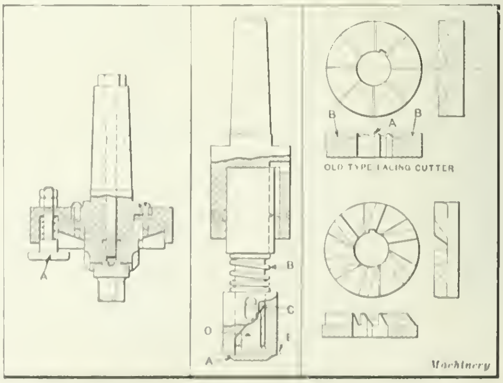
It will be apparent when looking over the schedule of operations presented in the first installment that advantage is frequently taken of the possibility of machining two or more surfaces on the work at a single operation. The form of each piece of work to be machined has been carefully studied, and after deciding the maximum number of surfaces that could be machined simultaneously the tool designers have taken up the problem of working out the form of tool best adapted to meet the requirements of this particular operation. Another point which will attract the attention of experienced machine shop men while looking over the illustrations of typical parts machined in the Bowser factory, will be the large number of parts which have several holes or holes and surfaces concentric with each other. In all cases it is desirable to maintain this concentricity within a reasonable degree of accuracy, and there are many cases where a very high degree of precision is important to obtain the desired alignment when these parts are assembled together. Here advantage is taken of the concentric holes or holes and surfaces on the work to provide for the use of piloted tools which may be depended upon to maintain the concentricity of different surfaces on the work from some hole which has already been machined.

In many cases it is also necessary to hold vertical dimensions on the work within close limits. Various means are provided on the tools for obtaining this result. In piece No. 2 in the table of operations (June installment) it is required to maintain the height *E* from finished face *B* to the upper side of the flange on the rough casting within 1/64 inch. The automatic tripping point for the feed of the drilling machine spindle is set as closely as possible, but to guard against lack of uniformity in the castings a button *A* is provided on the facing tool which comes down into contact with the casting that is being machined. This tool is shown in Fig. 7. Normally the power feed is tripped at the same time that this button engages the work. The drilling machine on which this operation is performed is set up without having the automatic return for the drill spindle in operation; and after the power feed has been tripped the operator looks at the button on the tool to see that it is down in contact with the work. Should it happen that this engagement has not been obtained, he feeds the spindle by hand before returning it and setting up a fresh piece of work on the machine.

How Accuracy in Tripping of Feed is Assured

In starting to describe special means provided in the design of tools to assure accuracy in tripping the feed mechanism, attention is called to the fact that Baker high-duty drilling machines are especially adapted for heavy work, and although the automatic trip for the feed mechanism may be safely relied upon to disengage the feed within 1/64 inch of the desired point, it is not safe to rely upon a much closer limit. As a matter of fact, this is quite close enough for many classes of work handled on the battery of Baker drilling machines used in the factory of S. F. Bowser & Co. At the same time, there are many classes of work where the maximum error must not exceed 0.005 inch, and in such cases the tools are designed to make sure that the work is held to at least this degree of accuracy. As shown in Fig. 6, it will be seen that the arrangement employed calls for a combination of work-holding fixture and cutting tool which work in conjunction with each other. On the fixture there are placed four posts *A* that are engaged by a flange *B* on the cutting tool. This fixture and tool are used for machining the gear shown in the fifth position in the table of operations. It is necessary to have the thickness of this gear 1.750 ± 0.005 inch, and to provide for obtaining this result the tools are so designed that collar *B* comes into engagement with the top of posts *A* when the cutters in the tool have reached the desired depth in the work.

To prevent binding, it will be seen that a ball thrust bearing is provided on the tool above the collar. The regular trip mechanism on the machine is depended upon to disengage the feed worm clutch at the desired point, but the arrangement of the tool and work-holding fixture makes it impossible for a slight lack of sensitiveness in the machine to prevent tripping to take place until the work has been machined beyond the minimum dimension which is called for. Those who have not experimented with the amount of spring which is possible to obtain in machine tools, naturally assume that the use of an arrangement of this kind would result in damage to the machine if the trip for the feed mechanism



Figs. 7, 8, and 9. Tool which assures Accuracy in tripping Feed, Design of Under-cutting Tool, and Old and Improved Types of Facing Cutters failed to operate at the same time that collar *B* came into engagement with posts *A*. As a matter of fact, experiments have shown that it is quite practicable to obtain a spring of from 0.005 to 0.010 inch before any damage is done, and as a result, the provision made in designing the tools makes it impossible for the bits to cut into the work beyond the desired point. If the trip for the feed mechanism fails to function when this point has been reached, the bits are prevented from cutting further, and springing of the machine members takes place until the feed is disengaged.

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[1] Associate Editor of MACHINERY.

Design for Under-cutting Tool

Where it is necessary to make an under-cut on the work, use may be profitably made of the type of tool shown in Fig. 8. This tool is used in making the under-cut in the "fill pipe cap" shown in the next to last position in the table of operations. The following is a brief explanation of the way in which this tool operates. Button *A* comes down into engagement with the side of the casting in which the under-cut is required. Further travel of the feed mechanism results in compressing spring *B* which, in turn, forces a cam *C* down into contact with the angular top of cutter *D*. When cam *C* engages cutter *D* further movement of the feed mechanism of the drill press results in forcing out the cutting edge *E* which is thus fed into the work. This is a simple and convenient arrangement for machining under-cuts on the drill press. Of course, it is understood that at the same time that cutting edge *E* is being fed into the work, the edge is rotating to machine the under-cut all the way around the piece.

Special Form of Facing Cutters

To provide for utilization of tool steel as far as possible, the tool designers have worked out a special form for facing cutters used on this battery of drilling machines. For the purpose of comparison, Fig. 9 shows the old type of facing cutter and the improved type of cutter which is now in use. Referring to this illustration, it will be seen that teeth of the old type of cutter have all of the lines diverging from a common point *A* at the center of the top surface of the cutter. In sharpening a cutter of this type, grinding may proceed until the teeth of the cutter are worn down to a point indicated by dotted lines *B*. When this point has been reached the cutter is considered worn out.

It will be apparent to anyone who gives this matter consideration that not over approximately 12½ per cent of the steel in the cutter has been used up when the teeth are ground down to line *B*. To overcome this obvious waste, an improved type of facing cutter was developed, in which it will be seen that the flutes are milled to a constant depth. This result was easily accomplished when the tool designer once decided to break away from established practice in grinding the teeth and flutes with all lines converging from a common point *A* to which reference has already been made. In sharpening one of these improved cutters, it will be evident that the teeth can be ground right down to the bottom so that 50 per cent of the steel in the cutter is used up, i.e., four times as much service is obtained as from the old type of cutter. A further advantage of this improved facing cutter is that the cutting edges of the teeth are arranged tangent to a small circle surrounding the center of the cutter instead of having them converge to this center. As a result, a shearing action is obtained which enables the tool to cut more freely than is the case where the cutting edges of the teeth are radial. Also, additional clearance for the chips is provided by having the flutes milled to a constant depth.

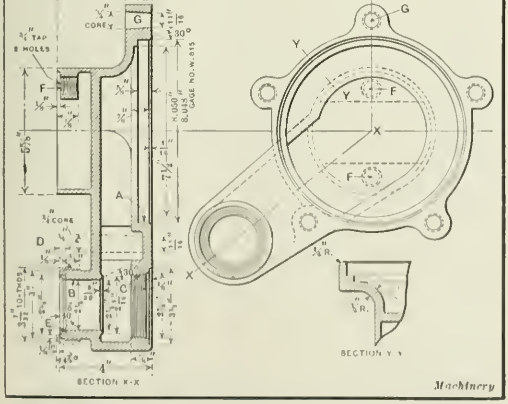


Fig. 10. Larger View of Cylinder Bottom shown in First Position in Tabulated Data on Machining Operations in the June Installment

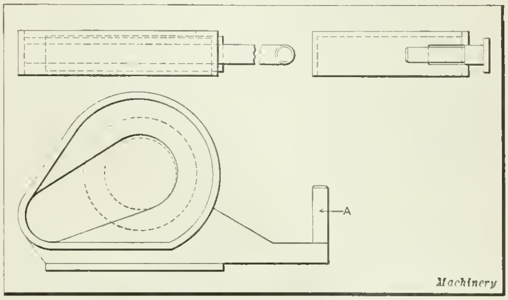


Fig. 11. Fixture used to hold Work while performing Disk-grinding Operation on Besly Double-spindle Machine

Special Features of Jigs and Fixtures

It is not within the scope of this article to enter into an exhaustive discussion of the jigs, fixtures and similar equipment provided for use in machining the great variety of parts that are handled on Baker drilling machines used by S. F. Bowser & Co. There are one or two points, however, which are of more or less general application, and these will be mentioned very briefly. For instance, there are many parts where simple drilling, boring, facing, and similar operations have to be performed. Here it is unnecessary to provide a jig or fixture for locating the work, but means must be provided for preventing the work from turning while the machining operation is in progress. For this purpose considerable use is made of what are known as slotted fixtures, one of which is shown on the first machine illustrated in Fig. 2 in the first installment of this article in the June number. Suppose a square or hex-shaped piece has to be machined; one of these slotted fixtures will be set up on the drill press table and then two rails will be slipped into slots in the fixture at such a distance apart that the work can just be dropped between them. This is only one of the many uses which is made of these slotted fixtures. In the illustration the fixture is shown set up with a work-holding device made out of boiler plate, that affords clearance for the tool after it has passed through the work.

In most cases the outstanding feature of the jig and fixture equipment is the extreme simplicity of its design. This is, of course, a point of cardinal importance where high production is aimed at, because the least unnecessary complication of equipment would result in a corresponding reduction in the speed of operation and rate at which parts could be set up and removed after machining. In many cases it has been found feasible to use standard three-jaw chucks where circular parts have no projections to prevent them from turning around under the spindle. Another feature, which is a result of the war-time cost of copper and zinc, is the provision of special trays around the fixture holding brass and bronze parts that are being machined. These trays catch all of the chips as fast as they are produced and enable them to be collected without loss—an important saving at the present time.

Tools and Fixtures for Machining Cylinder Bottoms

Lack of space obviously makes it impossible to enter into a complete discussion of all the cutting tools, jigs and fixtures used for machining the parts for which the operations and

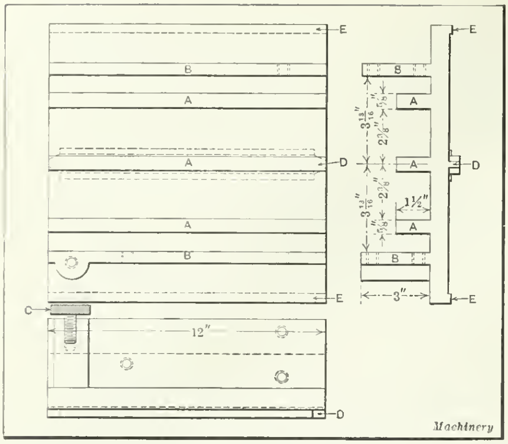


Fig. 12. Fixture in which Work is held while boring and reaming Hole A

rates of production have been tabulated. At the same time, the practice of S. F. Bowser & Co.'s factory engineer in designing tools and work-holding fixtures is unusually interesting, and with the view of giving a general idea of this practice, a complete description is given of all cutting tools, jigs and fixtures used for machining the cylinder bottom which is shown first in the tabulated information on machining operations, and also in Fig. 10.

The first operation consists of disk-grinding the top and bottom of this piece of work, and a Besly double-spindle machine is used for the purpose. The work-holding fixture employed is shown in Fig. 11, and will be seen to consist of a socket in which the work is held in an edgewise position with the top and bottom extending out from the fixture so that they may be engaged by the two disk wheels. This fixture has a handle *A* by which it is pushed back and forth between the disk wheels on the machine, and these wheels are relied upon to hold the work in the fixture.

The second and third operations consist of rough-boring and reaming hole *A*. In both cases the work is held in the fixture shown in Fig. 12, and the cutting tools are shown in Figs. 13 and 14. For both boring and reaming, the speed is 25 R.P.M., and the feed is 0.018 inch per revolution. Referring to the tool shown in Fig. 13, it will be seen that the boring is done by bits *A*, while the function of bits *B* is merely to cut a 30-degree chamfer at the top of the hole. Fine-pitch screws *C* furnish means for making accurate adjustment of the position of the chamfering cutters. The tool for reaming this hole requires no special description.

The work-holding fixture, Figs. 12 and 12A, used for these two operations is of simple design, three rails *A* supporting the work while a rail *B* at each side of the fixture prevents the work from rotating. Very little time is required to slide work into such a fixture. It will be apparent from the dimensions that the flange on the work has considerable overhang at one end, and as this flange is at a higher level than the top of the side rails *B*, it would be unsupported. To overcome this difficulty, and at the same time to allow for slight variations in the castings, a knurled-headed screw *C* is provided on the fixture. When the operator sets a casting in place he adjusts the position of this screw so that it comes up against the under side of the flange, thus supporting the work ready for the machining operation. Particular attention is called to the tongue *D* and strips *E* on the under side of the fixture. This is a standard construction on practically all work-holding fixtures, the purpose being to provide a "floating" fixture which is enabled to align itself properly with the drill spindle. All fixtures of this type rest on a standard base-plate (not shown in the illustration) which is not bolted down to the table of the machine. The upper side of this plate has a groove to receive tongue *D* and is machined to form bearings for strips *E*. On its under side this plate has a tongue running at right angles to the groove in its upper surface, and this tongue fits into the T-slot on the drilling machine table. As a result, the fixture floats in so far as the spindle of the drilling machine is concerned, although it is held in such a way that rotation of the fixture is impossible.

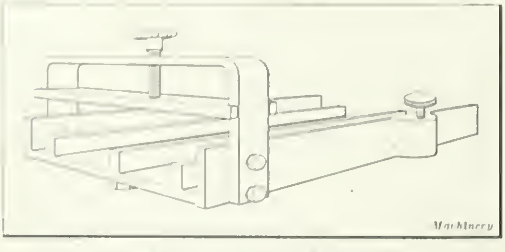
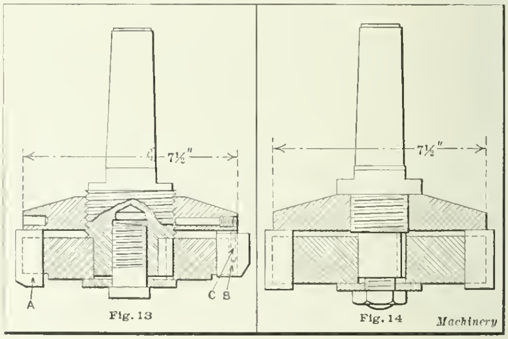


Fig. 12A. Perspective View of Boring and Reaming Fixture, showing Arrangement of Clamping Mechanism

The fourth operation consists of boring holes *B* and *C* and cutting a 30-degree chamfer at the top of hole *B*. For this purpose the same work-holding fixture is employed that was used on the two preceding operations. The cutting tool is shown in Fig. 16, and will be seen to consist of cutters *A* and *B* for boring holes *B* and *C*, respectively. The operation is performed at a speed of 100 revolutions per minute, and a feed of 0.010 inch per revolution.

The fifth operation consists of finish-boring hole *B*, facing the surface at the top of the valve seat in this hole, and chamfering and facing top of hole *C*, for which the fixture used is shown in Fig. 15. It will be seen that to all intents and purposes the fixture is the same as that used for performing the preceding operations, except that the portion of the fixture under the part of the work that is being machined is furnished with solid metal surfaces shown at *A*, instead of simply having the work supported by a narrow rail. The reason for this construction is that, while the previous type of fixture is plenty good enough for the performance of roughing operations, for taking the finishing cut it is possible for the work to be cocked sufficiently out of alignment to produce an appreciable error. It is to guard against the possibility of such a contingency that the present type of fixture is employed. Attention is called to the fact that this fixture is used for the performance of several other operations, and the openings at *B* and *C* with solid metal surfaces surrounding them have no special significance in connection with the present operation. The cutter used for taking this finishing cut is shown in Fig. 17. It will be seen that cutter *A* reams hole *B*, while cutter *B* faces the top of this hole. Chamfering and counterboring the top of hole *C* is done by cutter *C*, while facing the top of this hole is done by cutter *D*. Attention is called to the fact that cutters *C* and *D* are piloted in hole *C* to assure accurate alignment. This operation is performed at a speed of 100 revolutions per minute, and a feed of 0.014 inch per revolution.



Figs. 13 and 14. Tools used for boring and reaming Hole A in Work shown in Fig. 10

The sixth operation consists of tapping hole *C*, for which purpose a No. 9 tap, made by the Manufacturers' Equipment

Co., of Chicago, is employed, this tap being furnished with a special pilot shown in Fig. 18, which runs in hole *B*. This pilot is shown at *A* in Fig. 18, and is held in place in the tap by a draw-bolt *B*. Above the collar on this draw-bolt the design is similar to the regular bolt used on the standard tap, but the thin extension *B* below the collar is provided to reach down and hold pilot *A* in place. The fixture used for performing this operation is the same as that used on the second, third and fourth operations. The work is done at a speed of 25 revolutions per minute.

The seventh operation consists of finishing the valve seat. The work is set on the bed of the machine without using a fixture, and the tool used is shown in Fig. 19. The valve seat cutter is shown at *A*, and attention is called to the fact that a collar *B* is provided on the tool which enables the seating tool to cut in to exactly the proper depth. This operation is performed at a speed of 100 revolutions per minute with hand feed.

After the valve has been seated, the eighth operation is to turn the outside of union *D*, face the top of this union, and counterbore for the brass insert *E*. The work-holding fixture used for this purpose is shown in Fig. 20; and it will be seen to be practically identical with the fixture used for performing the second, third and fourth operations. It consists of three rails *A* to support the work and two side rails *B* to prevent the work from rotating. The cutting tool used for this purpose is shown in Fig. 21, from which it will be seen that three bits *A* provide for turning the outside of the union, three cutters *B* for counterboring for the brass insert *E*, and tool *C* for facing the top of the union. It will be seen that the design of this tool is worked out in such a way that two lock-nuts *D* support the bits *A* and *B* from the top and provide accurate means of adjusting them in the desired vertical position.

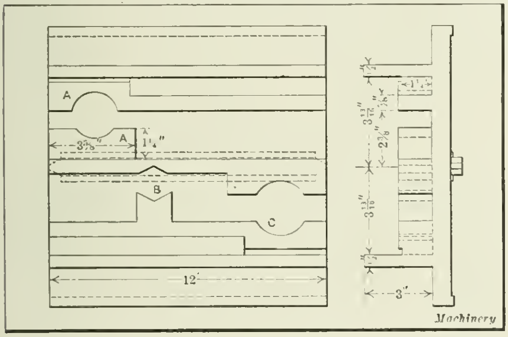
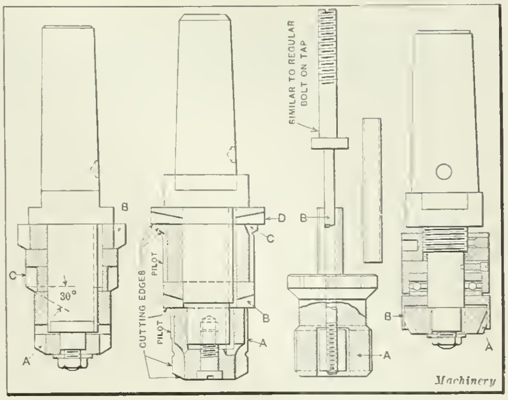


Fig. 15. Work-holding Fixture in which Casting is held for finish-boring Holes B and C

At the same time, the bits are furnished radial support by means of set-screws *E* carried in a collar surrounding the lower part of the tool. This is a somewhat old tool, and recently the design of this type of tool has been considerably modified to provide better radial support for the cutters. In designing tools of this type it is now the practice to bring the collar down within about ¼ inch of the cutting edge of the bits, instead of having the bits overhang approximately 1¼ inch. In this way there is far better support and the possibility of their springing away from the work is very materially reduced. Some tool designers will be inclined to say that the amount of spring which could possibly occur in a tool of the type shown in Fig. 21, is so small that the change in design is scarcely worth while. Granting that this is the case, the Bowser tool designers did not feel satisfied with any form of construction which left the possibility for an error which there was any way to overcome. The speed at which this operation is conducted is 72 revolutions per minute, with a feed of 0.012 inch per revolution.

The ninth operation consists of reaming the bore for the brass insert *E*. The same fixture is used as for the preceding operation, and the tool employed is shown in Fig. 22. This will be seen to consist of a simple reaming cutter *A* mounted on a suitable shank. The operation is performed at a speed of 100 revolutions per minute, with hand feed.



Figs. 16 to 19. Tools for rough-boring Holes B and C, finish-boring Holes B and C, Special Pilot for Tap for Hole C, and Valve-seating Tool for Top of Hole B

After reaming the hole for the brass insert, the tenth operation is to thread the outside of union *D*, which is done with a threading die. The same fixture is used as for the two preceding operations, and the work is done at a speed of 25 revolutions per minute. After threading, the work is ready for the eleventh operation, which consists of pressing the brass insert into place. This is done with a portable arbor press, which is brought up to the gang drills at such times as it is required for service. The arbor press is mounted on a skid, so that it can be carried on an elevating truck; it is motor-driven and connected to the power circuit arranged on this battery of drilling machines.

The twelfth operation consists of cutting the valve seat in brass insert *E* in the union. The work is held in the same fixture as for the preceding operation, and the tool used is shown in Fig. 23. It will be seen that this is a simple angular mill *A* mounted on a suitable shank. A guard *B* is placed around the cutter to provide for the operator's safety. The operation is performed at a speed of 180 revolutions per minute, and a feed of 0.010 inch per revolution.

The thirteenth operation consists of drilling two holes *F*. The same work-holding fixture is used as in the preceding operation, and the holes are located by means of a jig shown in Fig. 24. Pin *A* is dropped into the cored hole *G* on the work and locating pins *B* enter the rectangular shaped hole in the work, shown by dotted lines between the holes *F* which are to be drilled. When handwheel *C* is turned so that tapered block *D* is drawn up between the heads of pins *B*, these pins are forced outward, which results in clamping the jig firmly in place over the work. Hardened steel bushings, through which the holes are drilled, are located in holes *E* in the jig. The drilling operation is performed at a speed of 280 R.P.M., with a feed of 0.010 inch per revolution. After these holes have been drilled, the jig is removed from the work, which is left in position in the fixture ready for the performance of the fourteenth operation. This consists of tapping the holes *F*. This tapping operation is performed at a speed of 72 R.P.M.

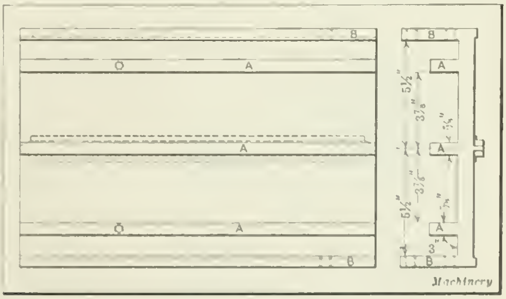


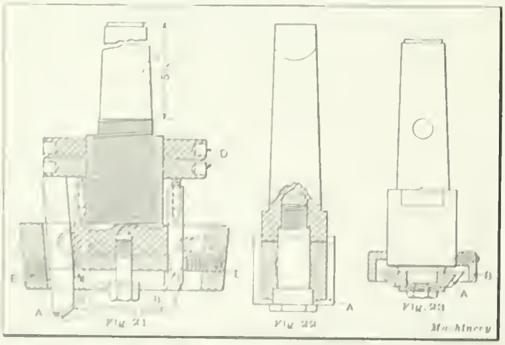
Fig. 20. Fixture used for holding Work while turning and facing Union D

Of these fourteen operations, it will be recalled that Operation 1 is done on a disk grinder, while Operation 11 consists of pressing a brass bushing into place in the work, a portable arbor press being used for this purpose. As a result, there are twelve operations that are performed on the Baker drilling machines, and these are divided up into three groups of four operations each. In order to have the relative amount of time taken by different operations work out to the best possible advantage, the following grouping was decided upon: Operations 2, 3, 13, and 14 are performed on a group of four machines; Operations 4, 5, 6, and 7 are next performed on this group of four machines at the second setting; and Operations 8, 9, 10, and 12 are performed at the third setting of these four machines.

It will be recalled that in the first installment attention was directed to the fact that an endeavor is always made to select groups of four operations in such a way that all four machines of the group may be kept as constantly employed as possible. The grouping together of Operations 2, 3, 13 and 14 is a good example of this kind. Operation 13 calls for drilling two holes *F*, one at a time, and Operation 14 consists of tapping these holes one at a time. To provide for performing these two double operations without keeping other machines idle, they are grouped with Operations 2 and 3, which consist of boring and reaming the large hole *A*, and take as much time as the double operations of drilling and tapping two holes *F*, one at a time. In handling his battery of four machines, the operator goes from Operation 2 to Operation 3, then to Operation 13, where he starts drilling one hole, then to Operation 14, where he starts tapping one hole and waits until this operation is completed, the time being only a few seconds. He then starts the tap in the second hole for Operation 14, after which he starts the drill for the second hole in Operation 13. After this, he goes back to Operation 2 to start work on a fresh piece, and this order of procedure is followed continuously, with the result that all machines are kept constantly employed. In conclusion, it may be mentioned that only one group of four machines is working on the same piece at a time. After the first four operations have been performed on all pieces, this same group of four machines starts on the next four operations; and when these have been completed, the final group of four operations is performed on this set of machines. It would not do to have twelve machines out of a battery of twenty-eight working on one part.

Concerning Rates of Production

As most of the work handled on this battery of high-duty drilling machines is of a character where an extremely high degree of accuracy is not required, the rates of production obtained in performing machining operations become a matter of unusual importance. A good idea of the actual output in machining various parts which could be handled with a shop equipment of this character will be gathered from a study of the machining operations and rates of production which are tabulated in connection with this article. It will at once be apparent to the experienced production engineer that these rates of output are very satisfactory. But a man who is considering the problem of selecting equipment for machining a given line of work which might be handled on drilling machines will naturally ask himself the question, "Is there no better way in which I could machine these parts?" An answer to this question is found in the experience of S. F. Bowser & Co. during the past two years. This firm's shops have been so rushed with work that a practice has been made of arranging with outside concerns to machine work on a contract basis. In many cases the figures submitted for machining parts which are ordinarily handled in the drilling machine department have been so far above the company's own production costs that a good deal of hesitation was felt about letting contracts to these bidders. Investigations which were conducted, however, went to show that the margin of profit made on the work by these outside concerns was not at all excessive, and as most of the bids obtained from outside machine shops were considerably above the cost of producing work on drilling machines—after deducting a reasonable margin of profit—it is fair to conclude that these shops based their bids upon the use of equipment which was unable to compete with the highly specialized tools and methods which have been described in this article.



Figs. 21, 22, and 23. Tool for turning, facing, and boring Union D, Tool for reaming Seat for Bushing E, and Tool for chamfering Bushing E

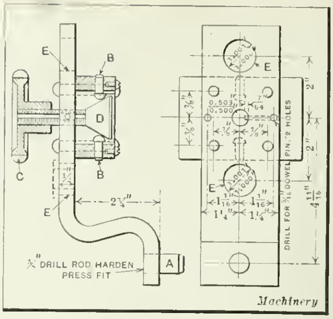


Fig. 24. Jig used for drilling Holes F

* * *

DRAFTING-ROOM SPECIFICATIONS FOR COMPRESSION SPRINGS

BY C. C. SPREEN[1]

Many mistakes in drawing and figuring springs may be avoided if the following rules are observed in the drafting-room. The standard sizes of wire and wire gages that are standards for the different metals used in the making of springs should be specified on drawings as follows:

Washburn & Moen gage, now known as American Steel & Wire Co. gage, for steel and iron wire and for tempered steel wire springs.

American Steel & Wire Co. music wire gage for music wire springs.

Brown & Sharpe gage for brass, phosphor-bronze, and German silver wire springs.

Name inside diameter of springs if used over a rod, and state size of rod.

Name outside diameter of springs if used in a hole, and state size of hole.

If used over a rod and in a hole, give dimensions of both rod and hole.

State free lengths of springs, pitch of coils, or number of coils per inch.

The style of ends should be specified as open ends, not ground; open ends, ground; closed ends, not ground; and closed ends, ground. If the ends should be closed and ground perfectly square with the axis, the specifications should read accordingly.

If the springs should be scale tested, state length to which they should be compressed, under a specified number of pounds pressure.

State variation allowable over and under the number of pounds pressure specified.

Note if plain or japanned, etc., finish is desired.

* * *

To close large cracks and small holes in brickwork, fill the opening with asbestos, and cover this with a cement made in the proportion of 10 pounds of asphalt, 10 pounds of magnesia-asbestos, 10 pounds portland cement, and 1/2 gallon benzine. Heat the asphalt until it is fluid, remove from the fire, and mix in the benzine; then add, while stirring, the cement and magnesia-asbestos, which have been previously mixed and heated to 300 degrees F. If the surface to be sealed is subject to high temperature, increase the proportion of cement and magnesia.

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LETTERS ON PRACTICAL SUBJECTS

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REAR SIGHT OF AIR RIFLE

The accompanying illustrations show the rear sight of an air gun and the three-stage follow-die for making it in one operation. In Fig. 1, *A* is the finished sight and *B* is the end of a strip which shows the first two stages. The strip of metal from which these sights are made is 0.59 inch wide. Fig. 2 is a cross-section on the line *XY*, Fig. 6, through the notching punches and dies and shows the stripper and guide, as well as outlines of parts of the shoe and the punch-holder. Fig. 3 is a cross-section, on the line *UV*, through the parting die and shows the parting punch *I*, the pilot *H*, and the forming die *E* and punch *J*. Fig. 4 is a plan of the top of the punch-holder. Fig. 5 is a projection through the die and the punch, and Fig. 6 shows the plan of the die; the notching dies are shown at *A;* the piercing punch at *B;* the parting die at *C;* the tongue-bending punch at *D;* the forming die at *E;* the notching punches at *F;* the piercing die at *G;* the pilot at *H;* the parting and bending punch at *I;* the forming punch at *J;* the stripping pins at *K;* the holding pad at *L;* the main die-plate at *M;* the supplemental die-plate at *N;* the first stop at *O;* and the second stop at *P*.

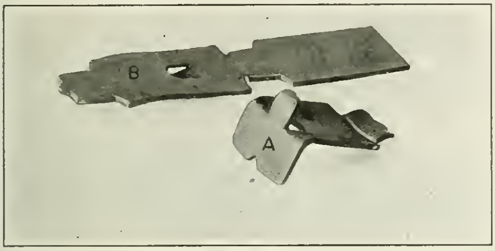


Fig. 1. Rear Sight of Air Rifle

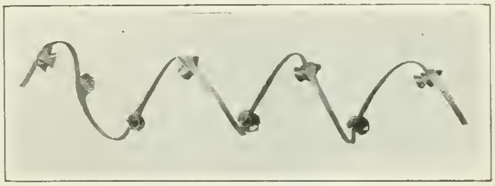
The die for cutting the tongue is in the punch-holder at *G*, and the punch *B* is below. The tongue is forced out of the die by a pad actuated by a spring in the punch-holder, and is stripped from the punch by the pins *K*. The notching punches *F* are much wider than the notches cut out and have heels, which center the strip and back against the dies to resist side thrust. The pilot *H* keeps the strip lined up.

The main forming die *E* slides in the plate *M* and rests on a spring pad that is actuated by a heavy square-section spring *R;* above, the pad *L* is backed by a lighter spring. The pad *L* holds the piece to the die *E* while it is being cut off by the punch *I;* the spring *R* is then compressed, allowing *E* to descend. As the punch *D* is stationary in the plate *N*, it forces up the tongue into the recess in the punch *J*. At the end of the stroke the die *E* bottoms on the plate *N*, giving the piece its final form.

De Kalb, Ill. W. B. Greenleaf

PECULIAR DRILL CHIP FORMATION

The accompanying illustration shows a curious chip formation obtained when drilling tool steel with a 3/4-inch drill in a turret lathe. The drill was ground as accurately as possible, and the steel, as far as could be judged, was not piped or seamed. Nevertheless, one-half of the chip rolled up into small curls at regular intervals, while the other half presents an unbroken helix. The cause for this peculiar chip formation is somewhat of a puzzle. L.

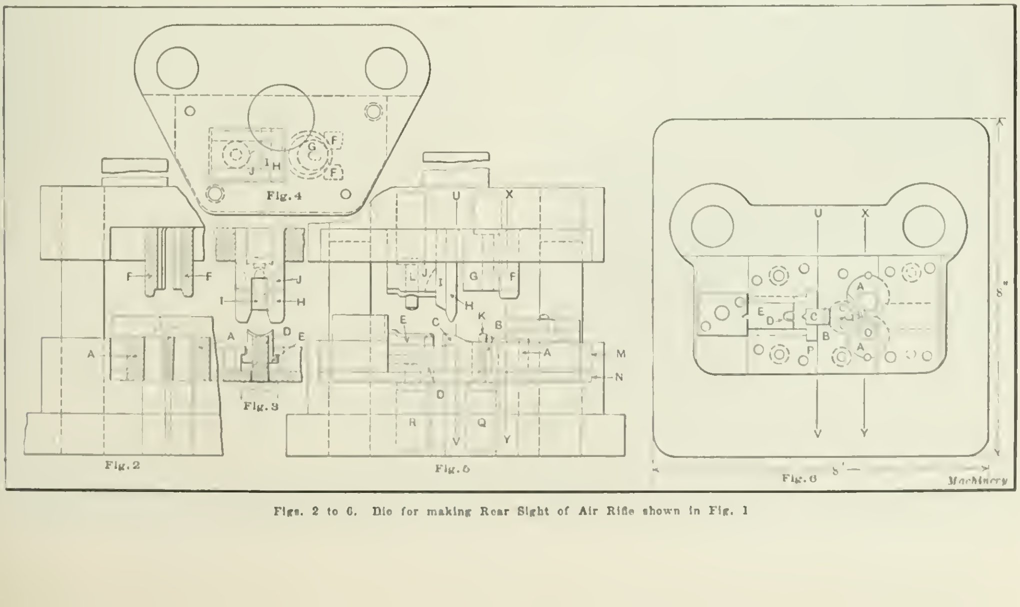


Peculiar Drill Chip Formation

ACCIDENTS ON MONDAY

In reply to a query as to the proportion of accidents on Monday as compared with those on other days of the week, owing to Saturday and Sunday drinking, the Brown & Sharpe Mfg. Co., which has paid especial attention to the gathering of accident statistics, writes:

> We are interested in the point raised, regarding the drink question and its relation to accidents. Our accidents last year were equal on Monday and Tuesday, with a larger



Figs. 2 to 6. Die for making Rear Sight of Air Rifle shown in Fig. 1

percentage of the more serious ones coming on Tuesday. This, however, would not indicate that your general principle as laid down was wrong, because Monday night is pay-night with us, and this might encourage such habits in the case of certain employes as would lead to a greater number of accidents on Tuesday. The accidents for these two days are somewhat above the average for the week; but on the whole our employes are of a temperate class, and we do not think this trouble is exaggerated, as in many shops.

New York City ROBERT GRIMSHAW

SIMPLE TOOLS FOR MAKING COIL SPRINGS

A great many manufacturers using coil springs are not in a position to make them as cheaply as firms making a specialty of this business, but it often becomes necessary, due to delayed delivery, etc., for them to make these springs in their own plant. The tools here illustrated and described are simple, low in cost, and produce springs suitable for practically any class of service.

The winding mandrel shown at *A*, Fig. 1, has a clamp for the end of the wire that is simple but positive and from which it is possible to remove the spring quickly. The diameter of the mandrel is determined by trial before making the clamp attachment, starting with a size that is amply large and turning it down until the spring winds to the correct size, using a temporary clamp to hold the end of the wire. A mandrel 20 inches long over-all is satisfactory for springs of ordinary size. The combination steadyrest and wire guide *B* has interchangeable bushings for the mandrel and the wire.

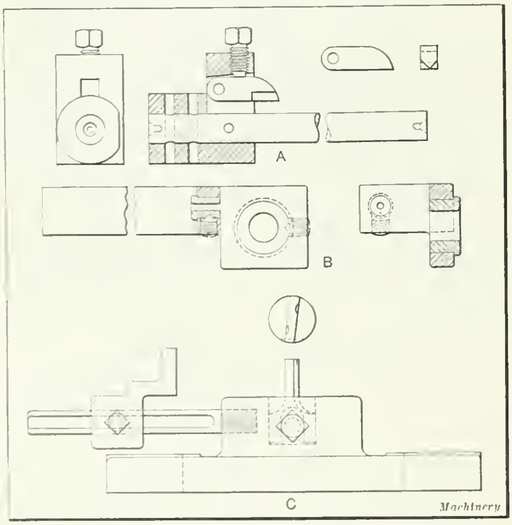


Fig. 1. Mandrel and Guide for winding Spring, and Cutting-off Jig

The cutting-off jig *C* is used in a power press and has a chisel-pointed tool in the ram. An adjustable stop is provided to gage the length, which is determined by trial; a record of this length is kept The shape of the anvil is important, and an anvil will probably be required for every different spring, due to variations in diameter, space between coils, etc. Notches in the flat part of the anvil provide clearance for the coils.

The grinding mandrel shown at *A*, Fig. 2, clamps the spring on its end by a collet, which is expanded as the taper end of the internal rod is drawn back by the wing-nut. This collet has four longitudinal slots, as shown, and is of a length which will clear the grinding wheel about 1/16 inch when the wire is of the ordinary size. The thickness of the steel washer shown is one-half the difference between the cut-off length and the finished length of the spring. It is placed on the mandrel back of the spring when grinding the second end so as to insure the same amount being ground off each end The heat generated in grinding tends to close the end coil somewhat, making a more continuous flat bearing on the end. The rest shown at *B* serves as a holder for the pilot part of the mandrel and also as a stop. By making the pilot diameter of sufficient size, one rest can be used for springs of various sizes. The grinding is done on the side of the wheel.

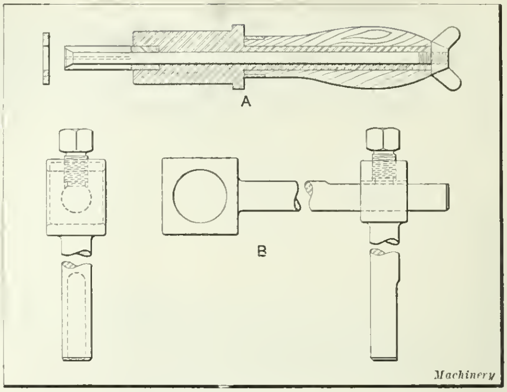


Fig. 2. Mandrel and Rest for grinding Ends of Springs

Dubuque, Iowa CHESTER W. HATHAWAY

MEASURING TAPERS AND RING GAGES

A great many uses have been found for the common roller of a roller bearing in the tool-room. Because of the high grade of steel used and the accuracy with which the roller is manufactured, it is valuable in measuring tapers, gages, and in many other difficult measuring propositions. Fig. 1 shows an example of the use of the rollers in measuring a taper. The work *M* has been turned to a given taper per inch and is to be tested for accuracy; *A*, *B* and *C* are Johansson test pieces of 1, 2 and 3 inches height, respectively, while *D* and *E* are rollers of equal, known dimensions. Gage *M* is placed on a surface plate as shown, and the blocks *A* set up to the taper; the rollers *D* and *E* are then placed on the blocks in contact with the taper, and the measurement *F* is taken. The blocks *B* are then substituted for *A* and another measurement *G* is taken, which should equal the measurement of *F* plus the given taper per inch. For further accuracy the blocks *C* may be substituted and the same procedure followed by taking measurement *H*.

Fig. 2 shows an example of the use of the rollers for measuring a ring gage. The gage is placed, flat side down, on a surface plate, and two rollers *A* and *B*, of known dimensions, are placed as shown. The distance between the rollers is built up by means of the Johansson test pieces *C*, *D* and *E*, leaving *E* for the final piece so that a measurement to four decimal places can be obtained. The total dimension of *A*, *B*, *C*, *D* and *E* will equal *X*. This operation should be tried in several places to locate high or low spots and insure accuracy. The rollers may also be used by the toolmaker for accurately locating work in jigs and fixtures, for setting a piece of work, on which a surface is to be planed or milled at an exact angle, for testing a square, measuring dovetails, and numerous other cases that are continually met with by a toolmaker.

Westboro, Ottawa, Canada FRED V. BALL

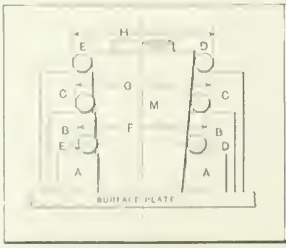


Fig. 1. Measuring Taper with Blocks and Rollers

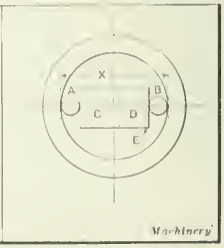
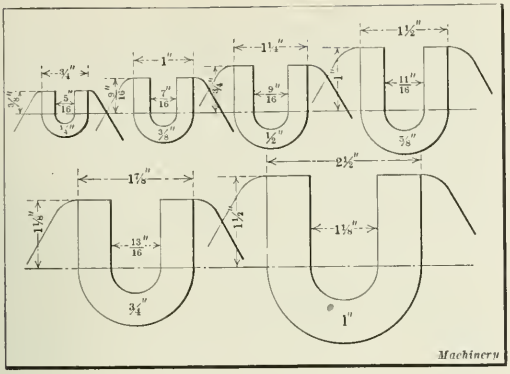


Fig. 2. Measuring Ring Gage with Blocks and Rollers



Standard Proportions of U-lugs

STANDARD SIZES OF U-LUGS

In the accompanying illustration are shown the standard sizes of U-lugs for jigs and fixtures. These lugs are for bolt sizes from one-fourth to one inch and are used for fastening the jigs or fixtures to machinery beds, tables, etc.

Flint, Mich. C. C. Spreen

ALUMINUM IN BRASS CASTINGS

The use of aluminum in brass castings becomes quite an obsession with some foundry foremen, and they entirely ignore the purpose of the aluminum, adding to every pot of molten brass from two to eight ounces. Apart from any deoxidation which is effected, the usual result is to give a bright color to the castings; assuming that they are to be used as they leave the molds, their appearance is very desirable. If, however, the articles are to be dipped and lacquered, or if they are to be either silver- or nickel-plated, the aluminum is fatal to good work, as its rapid oxidation prevents the regular action of the acid or plating baths. Therefore, dry polishing is the only available method of finishing brass castings containing aluminum.

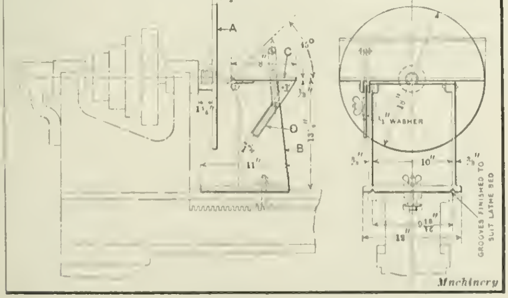
Liverpool, England Mark Meredith

LATHE DISK SANDER

The economic value of sandpaper is becoming more apparent every day, and one of its most useful applications is in the patternmakers' art. Five minutes of sanding on a disk will frequently accomplish more than an hour would in any other way. It smooths up end grain and sands out saw marks. A large disk is more desirable than a small one, because the sandpaper farthest from the center does most of the work.

The illustration shows a side and end elevation of a disk sander attachment for use on a wood-working lathe, which can be quickly removed from the lathe and stored away when not in use. The sander consists of a disk *A*, stand *B*, plate *C*, arm *D*, pins and bolts. The disk *A* is screwed on the lathe spindle and is machined to receive the sandpaper, which is cemented to the face of the disk. The stand *B* is machined to fit the lathe bed, and is held in place by a bolt and wing-nut. The plate *C* is pivoted to the stand *B* at the front, and has a lug at the rear in which an arm *D* is secured by a pin. The plate *C* can be raised from a horizontal position to an inclination of 45 degrees by means of the arm *D*. The arm is held in different positions by a bolt and wing-nut.

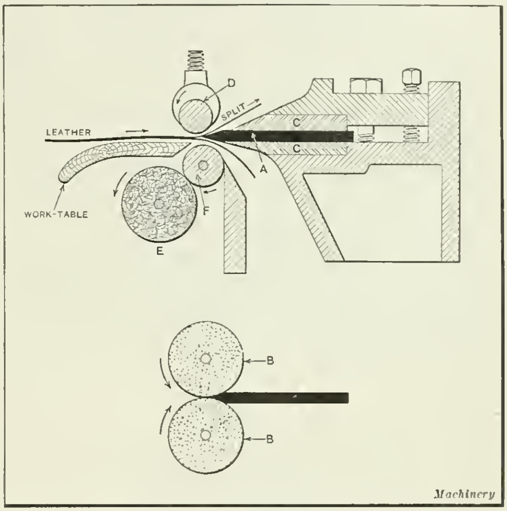
Chester, Pa. George W. Childs



Lathe Disk Sander

MACHINE FOR SPLITTING HIDE

On account of the extensive use of leather in automobiles there has been so great an increase in the demand for leather that it is necessary to split the hides to a greater extent than formerly. For most commercial purposes a hide is cut up into several thin sheets called "splits," and it is only for such uses as belting and sole leather that the natural thickness of the hide is retained. The outside or hair side of a hide is the best and most expensive of all the sheets into which it may be separated. The other sheets are known as "doped" splits; in the manufacturing process these are treated to give them the properties of the outside piece as near as possible and an artificial grain that makes them all look alike.



Section of Hide-splitting Machine

There are features of interest about every special machine, but the one to be described is especially noteworthy when one considers that a hide ready for splitting is as soft as paper, that it is not symmetrical, has projecting ends, and measures eight to nine feet one way, and that it is required to cut these splits so that they are gaged within the 0.002 inch limit. The machine used for quantity work is of the continuous knife or belt knife type, and might be likened to a band saw with a long dimension horizontal instead of vertical, and a wide blade without teeth.

The accompanying illustration represents a section through the machine, showing the blade or knife with its guiding jaws and the rollers for feeding and sizing the leather. The knife is 1/16 inch thick, and when new, 3 inches wide. It is kept in a state of almost razor-like sharpness by a pair of emery wheels *B* which are continuously running and act on the knife on its lower or return travel. The jaws *C* which guide the knife weigh altogether nearly a ton; they are faced with hardened steel wearing surfaces, which are ground straight after fastening on the jaw castings. This makes a rigid assembly, which holds the knife under perfect control and forms a working basis of known accuracy. Above the knife is the gage roll *D*. The split passes out between it and the knife, the required thickness being obtained by adjusting the bearings of the roll up or down. This roll is set by using tissue-paper feelers between it and the knife; then when parallel, a standard feeler is used to set the roller to the correct height for a certain thickness of leather. Because of its length the roll would sag in the middle, thus causing a split to be thin at this point, so two three-quarter bearings are placed so as to support it, this being done by screw adjustment when setting the roller parallel.

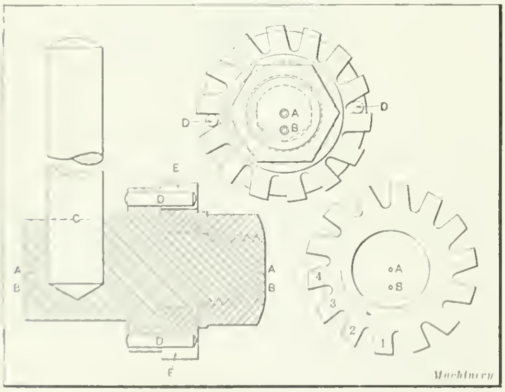
Below the knife are two other rollers forming the drive, provided with a self-adjusting feature which takes care of any inequalities in the hide. These rollers need only occasional resetting. The large roller *E* is made from a gum composition of such resiliency that the rollers *F* above embed themselves in it when a heavy section is passing through the machine. The rollers *F* are not continuous, but consist of a series of short brass rollers mounted on a rod, forming a flexible driving roller for the under side of the hide no matter how uneven it may be. The gum roller is power-driven, transmitting power to the brass roller, which is maintained in position by a back-plate. This machine splits one hundred hides a day into four hundred parts, and to do that it requires four men to feed and handle the hides.

Middletown, N. Y. DONALD A. HAMPSON

FIXTURE FOR BACKING OFF MILLING CUTTERS IN THE LATHE

An efficient and cheap device for backing off small milling cutters is shown in the accompanying illustration. It consists principally of a steel arbor that has two sets of centers. One set *A* is used when the arbor is turned to the required shape; the other set *B* is placed 1/4 inch to one side and is used for backing off the cutter. When backing off, the arbor is turned by the handle *C* that is fitted into it as shown; this handle should be placed at a convenient angle for the operator. Two driving pins *D* fit between the teeth of the cutter *E*, which is held in place by a nut and washer; one pin, however, will be found strong enough for this purpose.

In the end view of the cutter, the dotted arc recedes toward the center as it passes from tooth 1 to tooth 4, indicating the degrees of clearance produced on these teeth. If more or less clearance is required, the cutter is moved around on the arbor to the required position. It is better to mount the cutter on the arbor so that it may be moved in the direction indicated by the arrow. The lathe tool is fed in after each cut in the backing-off process, and as each tooth is finished the cutter is moved around and the driving pin placed in the next slot.



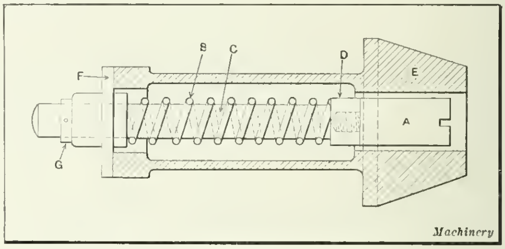
Fixture for backing off Milling Cutters

New York City E. J. HIGGINS

INTERCHANGEABLE EJECTOR FOR HAND SCREW MACHINES

In the accompanying illustration is shown an ejector for hand screw machines that can be used in any size collet by simply changing the knock-out pin *A*. With this ejector, the operator does not have to stop to remove the completed work; when he releases the collet, the reaction of spring *B* causes the knock-out pin *A* to throw the work into a box or pan placed beneath the machine. This ejector will be found especially useful on work that must be set a given distance in the collet. When setting such work without an attachment that will keep the work in contact with the stop in the turret, the work sometimes slips away from the stop and must be removed and reset.

The knock-out pin *A* is made of tool steel and should be 1/16 inch smaller than the diameter of the collet. It is hardened and drawn to a straw color. A slot is cut in the front end for a screwdriver; the other end is turned down to about 1/4 inch diameter and threaded. This end screws into a hole in the plunger *C*, which is made by turning down a piece of 9/16-inch, round, cold-drawn steel to 3/8 inch, leaving a 1/4-inch shoulder *D*. The length of this plunger depends on the style of collet *E* with which it will be used. The plunger *C* is actuated by a helical spring *B*, which is made of 1/16-inch spring steel, is 9/16 inch in diameter, and has four or five turns to the inch. One end of this spring bears against the shoulder *D*, and the other end bears against a bossed flange or center plate *F*, through which the plunger *C* passes. This plate is made from a piece of steel 1/16 inch larger than the inside diameter of the spindle in the machine and is about 1 inch long. After a 3/8-inch hole is reamed through it, the piece is placed on an arbor and the bosses turned to 3/4 inch in diameter. The flange is turned 0.003 inch smaller than the inside diameter of the spindle and is 1/8 inch wide; care must be taken to make its sides parallel with the 3/8-inch reamed hole. Plate *F* is held in place on plunger *C* by a collar *G*, which is fastened to the plunger by a cotter-pin. When milling the hole for the cotter-pin the spring *B* must not be compressed, but should fit between the shoulder *D* of the plunger and the center plate *F* without any play.



Interchangeable Ejector for Hand Screw Machine

Aurora, Ill. JOHN J. BORKENHAGEN

INVENTIONS AND INVENTORS

The article "Inventions and Inventors" in the April number of MACHINERY was not, in the writer's opinion, in the least overdrawn with reference to the lack of consideration and fair play that is generally extended to inventors. The writer knows of at least one concern that makes a rule of hiring its designers and inventors only upon condition that they agree in writing to assign any patents or inventions that they may perfect while on the payroll in consideration of the payment of the sum of $1. Such a policy cannot possibly create an incentive to apply inventive ability to the best advantage, and the effect of this practice is to discourage the naturally creative mind, causing a lack of interest in the work. The writer knows of a case where even the sum of $1 was not forthcoming as provided for in the contract.

Hopedale, Mass. F. R. DANIELS

FUEL VALUE OF POWDERED COAL

In the article entitled "Solution of the Fuel Problem," on page 680 of the April number of MACHINERY, there are given the costs and methods of pulverizing the coal, but nothing is said of the comparative values of different fuels. Based on a plant using 54,000 cubic feet of natural gas an hour, the fuel costs per hour are: 54,000 cubic feet of natural gas at 35 cents per 1000 cubic feet, $18.90; 4000 pounds of coal at $3 a ton, $6;

400 gallons of fuel oil at 8 cents a gallon, $32; producer gas, $10.

As the operating costs, including the cost of fuel, are: Oil fuel, $34.59; producer gas, $14.73; and powdered coal, $8.41, the saving per hour of operation effected by the use of powdered coal as a fuel instead of natural gas is $10.49; instead of fuel oil, $26.18; and instead of producer gas, $6.32. At these prices there is obtained, for one cent, 64,210 British thermal units from powdered coal; 36,660 British thermal units from producer gas; 15,614 from fuel oil; and 28,571 from natural gas. This shows clearly that powdered coal is easily the cheapest fuel.

New York City W. O. Renkin,
Manager, Engineering Dept.,
Quigley Furnace Specialties Co., Inc.

RECORD OF HEAT-TREATMENT OF TOOLS

In the daily routine of toolmaking and diemaking, it is frequently necessary to repair work that was made, perhaps, the previous year. If the foreman and the man who made the work have left, no one knows the steel used nor the treatment given. As a result, though the repairs may be made in an excellent manner, the inspection, after hardening, may show that the work is warped, twisted, or perhaps cracked in various places and so is worthless. Nowadays, when there are various kinds of steel on the market, the tool department must be systematized the same as other departments. In many plants there is a tool-room in the different departments, each under the supervision of the foreman of the department, who designs the tools, giving verbal instructions to the men, or, if one is at hand, using a similar tool in place of a blueprint, but who makes no record for future reference. Such a record, however, can be easily and quickly made by using a chart like that here shown. On this chart is given all the kinds of steel used in the tool-room, and beneath each is placed a designating letter and the proper heat-treatment for that steel. Then, after a tool is made, the letter is stamped upon it before it is hardened and tempered.

CHART FOR RECORDING HEAT-TREATMENT OF STEEL

	Name of Steel	Name of Steel	Name of Steel
Identification letter	A	B	C
Heat, degrees F.	1360	2200	1400
Quench	In oil	Oil or air blast	Water

Machinery

East Rutherford, N. J. George F. Kuhne

SAVING TIME IN THE DRAWING-ROOM

In many drafting-rooms it is not uncommon to see draftsmen making sketches on the back of discarded blueprints, letters, calendars, and other papers that happen to have one blank side. This practice may seem economical in view of the present high cost of paper, but undoubtedly there is often a great deal of time lost by the careless manner in which these papers are handled; this lost time would more than pay for better paper. The paper need not be of a very good quality, but the one thing that should be borne in mind is, that these sketches are valuable data and should be kept the same as a letter, drawing or other record. The writer recalls a number of instances when rough and greasy sketches, which were made in the shop and carefully filed away, were the deciding factors in questions brought up at a later date.

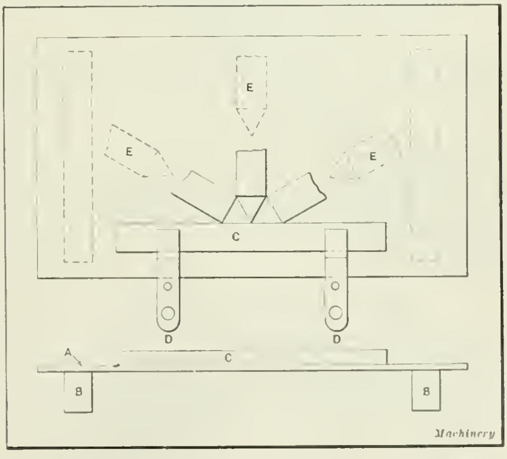
The writer uses a loose-leaf binder, taking sheets 7 by 9 inches in size. The binder is filled with blank sheets already punched, and whenever it is necessary to go into the shop to make sketches, a few sheets are taken from the binder and then filed in their proper place in the binder after the sketches are made. The binder is not only used for sketches, but may be subdivided with index tabs for filing other records, such as calculations, etc. The matter of making calculations is another source of much lost time in the drawing-room. When calculations are required, a great many draftsmen use the same system as in making sketches, namely, to use the first piece of paper that happens to be at hand, and after the problem has been solved the only record of it that remains is in the draftsman's mind. As a result, when the drawing is checked and the checker's calculations do not tally with the draftsman's, the latter has to do the work all over again. Had the calculations been filed, they could have been given to the checker to compare with his calculations, thus saving much of the draftsman's time.

Making pencil erasings on vellum paper is not an easy matter, as the lightest line seems to penetrate, and even with the greatest care in erasing, a smeared appearance results, but if before the drawing is started, magnesium carbonate is rubbed on the paper with a piece of cloth or felt, erasing becomes comparatively easy. Small blocks of magnesium carbonate can be purchased at any drug store.

Indianapolis, Ind. Harry W. Davis

CHECKING 60-DEGREE POINTS FOR GAGING THREAD ANGLES

While employed as an inspector, the writer was asked to check some 60-degree points that had to be made absolutely correct. As he did not think the sine bar would give accurate enough results, for it is difficult to slide the indicator across the work with any degree of accuracy, he used the device shown in the accompanying illustration, which worked very satisfactorily. It consists of a sheet of glass *A* mounted upon two parallels *B* and supporting a third parallel *C*, which is held firmly in position by two clamps *D*. By placing a sheet of white paper under the glass *A* and then sliding the 60-degree points *E* into the position shown by the full lines, any rays of light that may pass between the points because of their inaccuracy is easily seen, it being assumed that the two points on the sides are known to be accurate. If none of the points are known to be accurate, the accuracy can be determined by interchanging points until three are found that are correct.



Method of checking 60-degree Points for gaging Thread Angles

Two of the points that have been found to be accurate can be used as masters for checking all others, which may be placed in the center.

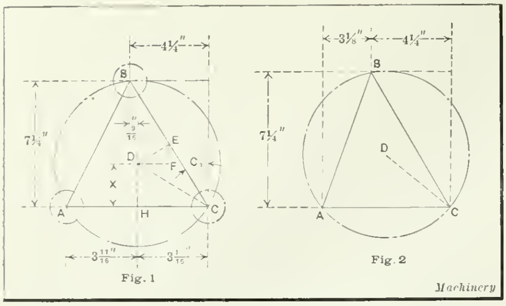
Cos Cob, Conn. Charles W. Caavette

PROBLEM IN TRIGONOMETRY

Two additional solutions of the problem in trigonometry, which appeared in the November number of Machinery, may be of interest. It is desired to calculate the center distance of a gear and three pinions, arranged as shown in the illustrations. In Fig. 1:

$$BC = \sqrt{4.25^2 + 7.25^2} = 8.4038 \text{ inches}$$

$$\text{Tan } C, = \frac{4.25}{7.25} = 0.58621 = 30 \text{ deg. } 22 \text{ min. } 46 \text{ sec.}$$



Figs. 1 and 2. Problem in Trigonometry

$$ACB = 90 \text{ deg.} - 30 \text{ deg. } 22 \text{ min. } 46 \text{ sec.}$$

$$ACB = 59 \text{ deg. } 37 \text{ min. } 14 \text{ sec.} = DEF$$

$$EC = \frac{BC}{2} = 4.202 \text{ inches}$$

$$DF = \frac{4.25}{2} - 9/16 = 1\ 9/16 \text{ inch}$$

$$DE = \frac{DF}{\sin DEF} = 1.8112 \text{ inch}$$

$$DC = \sqrt{DE + EC} = 4.576 \text{ inches}$$

$$X = DH$$

$$DH = \sqrt{DC^2 - CH^2}$$

$$DH = \sqrt{4.576^2 - 3.6875^2}$$

$$DH = 2.710 \text{ inches}$$

In Fig. 2:

$$BC = \sqrt{4.25^2 + 7.25^2} = 8.4038 \text{ inches}$$

$$AB = \sqrt{3.125^2 + 7.25^2} = 7.894 \text{ inches}$$

By geometry, in any inscribed triangle, the product of any two sides is equal to the product of the altitude upon the third side by the diameter of the circumscribing circle; therefore,

$$7.25 \times \text{diameter} = 8.4038 \times 7.894 = 66.3396 \text{ inches}$$

$$\text{Diameter} = 2DC = \frac{66.3396}{7.25} = 9.1503 \text{ inches}$$

$$DC = 4.5756 \text{ inches}$$

F. R. Daniels

USE FOR OLD FILES

The old-fashioned way of blowing chips and dust out of bottomed holes in castings or forgings with the blowpipe might well be discarded. By means of a magnetized old rat-tail file one can clean out the hole without filling the eyes or the atmosphere with dust.

New Haven, Conn. Eric Lee

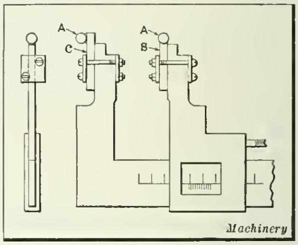
SPECIAL TAPER BORING TOOL

The special taper boring tool shown in the accompanying illustration is designed for use on milling or drilling machines. The piece *A* is made from machine steel and is pack-hardened. The tapered portion at *B* fits the taper in the machine spindle in which it is to be used, while the tapered portion *C* is made to fit the taper in the work to be finish-bored. The feed-screw *D* which feeds the tool *E* is squared at the end so that an offset socket wrench may be used to make a quick return of tool *E*. Feed-screw *D* is driven by star-wheel *F* through the spur gears *G* and *H*. The cap-plate *I* holds the feed-screw in place. The writer has used this tool on boring dividing heads, and found it exact where the limits of accuracy required were ± 0.001 inch. This tool can be made by any shop at a low cost.

Worcester, Mass. H. F. Clifford

ATTACHING BALL CONTACT POINTS TO A BEAM CALIPER

A method of attaching ball contact points to a beam caliper that is a little different from that shown on page 836 of the May number of Machinery is shown in the accompanying illustration. In this case, a 24-inch vernier caliper was used to measure from groove to groove and from grooves to a concave surface, and the attachment proved very satisfactory. The balls *A*, the size of which vary with the work, are soldered to the pieces *B* and *C*, which are held in place by clamps and bolts. When the piece *C* is used as shown, the caliper will measure from a concave surface to a groove; to measure from groove to groove, two pieces like that illustrated at *B* are employed.



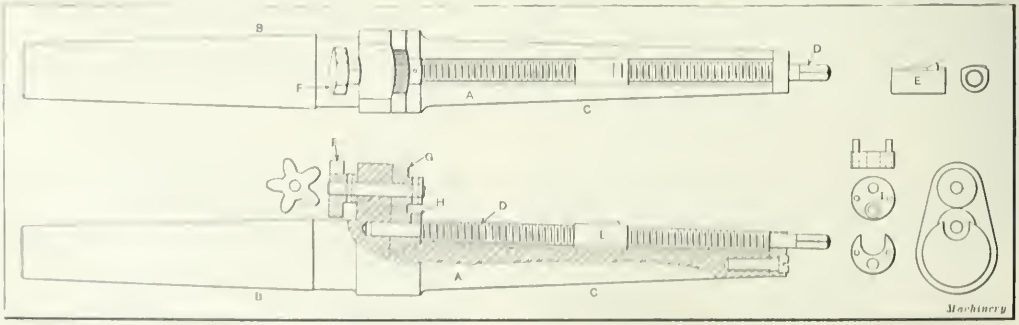
Method of attaching Ball Contact Points to a Beam Caliper

Wilkinsburg, Pa. William S. Rowell

WOMEN IN THE DRAFTING-ROOM

One of the remarkable developments of the war is the showing made by women in mechanical work. The May number of Machinery, page 799, tells of the women tracers at the Reed-Prentice plant, and, among other things, speaks of their speed and accuracy; women, however, made good in somewhat similar work twenty-five years ago when the International Correspondence Schools began to train them to correct and make drawings for the students, and found that they were remarkably suited to the work. Starting on the simpler geometric drawings and working to the more complicated ones, in a few months the women become so proficient that they can draw and letter extremely well. While the writer was a fair draftsman when he started a course with these schools eighteen years ago, he was forced to admit that their corrections were very fair and to the point. When a drawing came back corrected by L. McAndrews, he did not know it was Laura McAndrews until he was at the schools at a time that a rival institution was trying to discredit them in the courts by alleging misrepresentation in using women teachers for mechanical subjects.

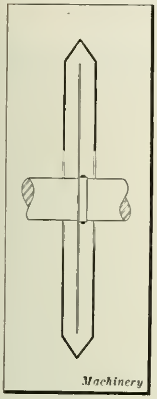
Middletown, N. Y. Donald A. Hampson



Special Taper Boring Tool

SHOP AND DRAFTING-ROOM KINKS

REMEDY FOR OIL-THROWING SHAFT



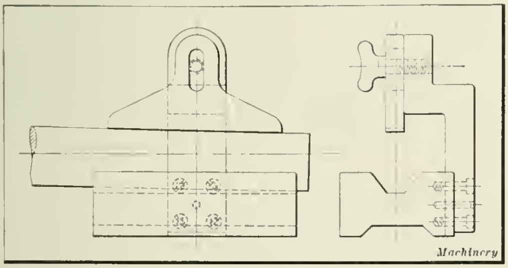
Device for returning Leaking Oil to Reservoir

A short line of shafting and pulleys caused considerable inconvenience and loss of oil, because the lubricant would leak out of the bearing boxes and travel along the shaft until it encountered one of the pulleys, where it would come in contact with the belt or be thrown down into the room. The device illustrated was designed to remedy this. Since the oil was being thrown off by centrifugal force, a disk of galvanized tin, eighteen inches in diameter, was mounted on the shaft close to the bearings, and the oil traveled along the shaft until it reached the disk, when it was carried toward the edge of the disk and was thrown into a trough by centrifugal force, from which it was drained into an oil-can and was again ready for use.

Philadelphia, Pa. W. A. Lailea

DEVICE FOR FITTING TAPERS

The accompanying illustration shows a simple device for fitting tapers that the writer has found useful when making taper arbors or spindles to fit different makes of machines. In most cases it is impossible to bring the machine into the tool-room to have a new arbor or spindle fitted in, but by setting this device to the taper of the old arbor or spindle, it is easy to fit the new taper without wasting time running back and forth to the machine to try the new piece.



Simple Device for fitting Tapers

South Manchester, Conn. Alfred Pillino

A GOOD CONCRETE FLOOR

A good concrete floor may be made by mixing thoroughly one part of good hydraulic cement, two of sand and three of gravel, and spreading the mixture evenly over the floor, with a gentle slope in two directions toward one corner, where there is a drain. All around the wall, while the cement is still soft, a gutter of semicircular cross-section should be made by pressing a smooth round log into the mass; this makes a desirable curved imprint. Of course, the gutter must have the same slope toward the outlet as the cellar floor.

New York City Robert Grimshaw

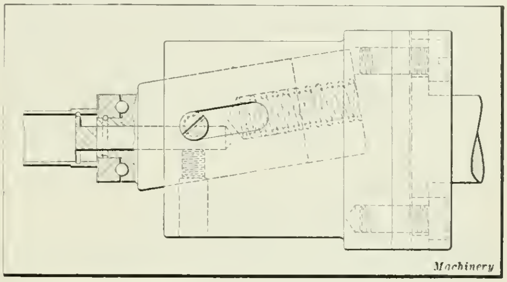
EMERY CLOTH HOLDER

In a tool-crib known to the writer emery cloth is bought in rolls ten inches in diameter and one and one-half inch wide. The roll is mounted on a revolving holder that is similar to those used for strips of theater tickets. In most cases it is a small piece of emery cloth that is required; but the old custom was to ask for a whole sheet, tear off a strip, and leave the rest on the bench, eventually to find its way, unused, into the dirt can. With the new method of having various grades on roll-holders near the tool-crib window, time and emery cloth are saved, as a mechanic can see and get what he needs.

New York City E. J. Higgins

RECESSING TOOL

The accompanying illustration shows a universal recessing tool. This tool was designed for automatic screw machine work, but it can be used on hand screw machines, lathes, and in drill presses when the work is made fast to the table of the machine, as either the work or the tool can be revolved. When the tool is brought up to the work, the work presses against a ball bearing; then, as the holder is pressed against the work, the tool is forced up an inclined plane and is caused to cut.

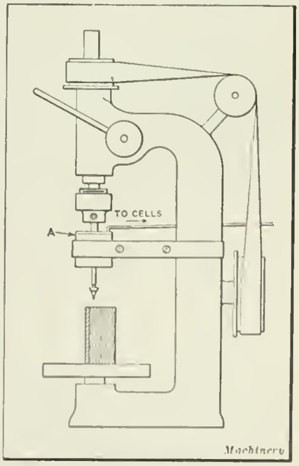


A Universal Recessing Tool

Providence, R. I. John W. Hird

MAGNETIC SCREWDRIVER

The accompanying illustration shows a device that was used on a war order for small packing boxes with hooks and hinges screwed on. Although women did the work, the ⅛- by ¼-inch screws were too small to handle conveniently, and an electrician suggested using a magnetic screwdriver having an electromagnet energized by dry cells. The idea was applied to a small bench drilling machine. The magnet *A* was held stationary, and the screwdriver was secured to the drill spindle. A friction device was set to give the desired tightness to the screws. The work was facilitated by first piercing the wood for the screws.



Bench Drilling Machine converted into a Magnetic Screwdriver

Donald A. Hampson
Middletown, N. Y.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

USE OF MERCURY COLUMN FOR TESTING VACUUM PUMPS

G. M. S.—When using a mercury column for testing a vacuum pump, what effect do the climatic or atmospheric conditions have upon the results and how should the test be made?

A.—When using a vacuum gage of the mercury type for testing a vacuum pump, the atmospheric pressure at the particular time must be taken into consideration. We shall assume that the upper end of the mercury column is connected to the vacuum cylinder and that the air is exhausted by the pump sufficiently to raise the mercury 29.5 inches. Now, in order to know just how nearly perfect this vacuum is, it is necessary to compare it with the barometer at the particular time the test is made. For instance, if the barometer stands at 30 inches at the time the pump is being tested, and the reading of the gage attached to the pump is 29.5, this indicates that the vacuum is within 1/2 inch of the barometer. Now, if this same pump were tested the next day, the reading might be 29.3 inches, but the pump would be just as good as it was the day before. The lower reading simply means that the barometer has fallen 0.2 inch, or to 29.8 inches. It is evident, therefore, that the mercury column attached to the pump cannot be used alone, but must be compared with the barometer.

TO FIND RADIUS OF CIRCLE INSCRIBED IN TRIANGLE

A. S.—In a right triangle having the dimensions shown in the accompanying illustration, a circle is inscribed; please show how to find the radius of the circle.

Answered by J. J. Clark, Scranton, Pa.

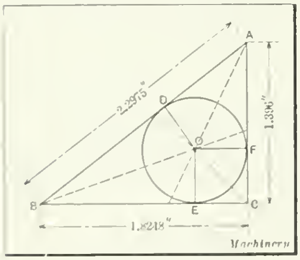


Diagram for finding Radius of Circle inscribed in a Triangle

A.—The square of the hypotenuse is not quite equal to the sum of the squares of the other two sides; but, by making AC 1.3959, all three sides will be correct to four decimal places. Hence, this value will be used instead of the value indicated, 1.396. According to geometry, the bisectors of the three angles meet in a point O, which is the center of the inscribed circle. From this point O, draw the perpendiculars OD, OE, and OF; then D, E, and F are the points of tangency of the circles with the sides, and $OD = OE = OF = r$, the radius of the circle. Let S = area of triangle ABC = sum of areas of triangles AOB, BOC, and COA. Hence, $S = \frac{1}{2} \times AB \times OD + \frac{1}{2} \times BC \times OE + \frac{1}{2} \times CA \times OF = \frac{1}{2} \times AB \times r + \frac{1}{2} \times BC \times r + \frac{1}{2} \times CA \times r = r \times \frac{1}{2}(AB + BC + CA) = rs$, when $s = \frac{1}{2}(AB + BC + CA)$ = one-half the perimeter of the triangle. Since $S = rs$, $r = \dfrac{S}{s}$. In the present case, $S = \frac{1}{2} \times BC \times CA$; therefore, $r = \dfrac{\frac{1}{2} \times BC \times CA}{\frac{1}{2}(AB + BC + CA)} =$

$$\frac{BC \times CA}{AB + BC + CA} = \frac{1.8248 \times 1.3959}{2.2975 + 1.8248 + 1.3959} = 0.46161.$$

Evidently, the formula $S = rs$ applies to any plane triangle. Letting a, b, and c denote the sides opposite the angles A, B, and C, respectively, the area of a triangle is $S = \sqrt{s(s-a)(s-b)(s-c)}$; whence, $r = \dfrac{\sqrt{s(s-a)(s-b)(s-c)}}{s} = \sqrt{\dfrac{(s-a)(s-b)(s-c)}{s}}$.

PROBLEM IN TRIGONOMETRY

C. E. M.—Referring to the accompanying illustration, please show how to find the angle ϕ. I should like to have the method explained in detail.

Answered by J. J. Clark, Scranton, Pa.

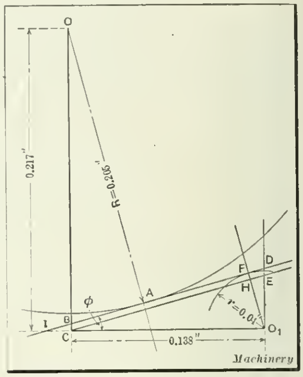


Diagram illustrating Problem in Trigonometry

A.—O_1C is perpendicular to OC. Draw O_1D perpendicular to O_1C; it will be parallel to OC. Through C, draw CE parallel to the tangent BD. Draw OA and O_1F perpendicular to BD; then A and F are the points of tangency of BD with the two circles. The angle $AOB = O_1D = FO_1D = \phi$. Let $x = AB$, R = radius OA, r = radius O_1F. $a = OC$, and $b = O_1C$. $OB = \sqrt{R^2 + x^2}$; whence, $BC = DE = a - \sqrt{R^2 + x^2}$, and $FH = (a - \sqrt{R^2 + x^2}) \cos \phi$. $O_1H = r - FH$. $\sin O_1CH = \dfrac{O_1H}{O_1C} = \dfrac{r - (a - \sqrt{R^2 + x^2}) \cos \phi}{b} = \sin \phi$. Clearing of fractions and transposing terms, $r - b \sin \phi = (a - \sqrt{R^2 + x^2}) \cos \phi$. But $\sin \phi = \dfrac{\tan \phi}{\sqrt{1 + \tan^2 \phi}}$, and $\cos \phi = \dfrac{1}{\sqrt{1 + \tan^2 \phi}}$. Substituting these values of $\sin \phi$ and $\cos \phi$ in the last equation, there is obtained, after reduction, $r\sqrt{1 + \tan^2 \phi} - b \tan \phi = a - \sqrt{R^2 + x^2}$. Now, $\tan \phi = \dfrac{AB}{OA} = \dfrac{x}{R}$; hence, substituting this value for $\tan \phi$ in the last equation. $r\sqrt{1 + \dfrac{x^2}{R^2}} - b\dfrac{x}{R} = \dfrac{r}{R}\sqrt{R^2 + x^2} - \dfrac{bx}{R} = a - \sqrt{R^2 + x^2}$, or $\left(1 + \dfrac{r}{R}\right)\sqrt{R^2 + x^2} = a + \dfrac{bx}{R}$, and $\dfrac{R + r}{R}\sqrt{R^2 + x^2} = \dfrac{Ra + bx}{R}$. From this last equation,

$$\sqrt{R^2 + x^2} = \frac{Ra + bx}{R + r}.$$

It will be seen that the last expression contains all the given values and the unknown quantity x; by squaring and reducing, x may be obtained as the root of an affected quadratic equation, but it will entail less work to substitute the given values in the equation as it stands. Doing so, $\sqrt{205^2 + x^2} = \dfrac{205 \times 217 + 138x}{205 + 40}$, or $\sqrt{42025 + x^2} = 181.5714 + 0.5632653x$. Squaring, transposing, and combining terms, $0.682732x^2 - 204.546x + 9056.84 = 0$. Solving this equation by the regular rule for affected quadratics, $x = 54.0168$. Therefore, $\tan \phi = \dfrac{54.0168}{205} = 0.263497$, and ϕ = 14 degrees 45 minutes 42 seconds. Note that before substituting the given values, they were all multiplied by 1000, to avoid decimals; this, of course, was not necessary, but it tends to reduce the chances of making errors.

FINDING ANGLE OF SPECIAL SCREW THREAD

A. B.—The illustration shows a section of a screw thread; please show me how to find the angles x and y.

Answered by J. J. Clark, Scranton, Pa.

A.—The dimensions when expressed as common fractions are 3/16 inch, 5/16 inch, and 1/4 inch, and the radius is 1/20 inch. As these are rather awkward numbers to handle, it will be more convenient to multiply them by 160, thus obtaining 30, 50, 40, and 8, respectively. Angle $BOE = GO'H = GBF = \alpha = 90$ degrees $- x$; $GF = 40 - 2 \times FJ = 40 - 2 \times 8\,(1 - \cos\alpha)$; $BF = 30 - 2 \times FL = 30 - 2 \times 8 \sin\alpha$; therefore, $\dfrac{40 - 16(1 - \cos\alpha)}{30 - 16\sin\alpha} = \tan\alpha$. Clearing of fractions, $24 + 16\cos\alpha = 30\tan\alpha - 16\sin\alpha\tan\alpha = 30\dfrac{\sin\alpha}{\cos\alpha} - 16\dfrac{\sin^2\alpha}{\cos\alpha}$. Again clearing of fractions and substituting $\sqrt{1 - \sin^2\alpha}$ for $\cos\alpha$, $24\sqrt{1 - \sin^2\alpha} = 30\sin\alpha - 16(\sin^2\alpha + \cos^2\alpha) = 30\sin\alpha - 16$, since $\sin^2\alpha + \cos^2\alpha = 1$. Squaring both sides of this equation, transposing, and combining terms, $1476\sin^2\alpha - 960\sin\alpha - 320 = 0$. Solving this last equation by the ordinary rule for quadratics, $\sin\alpha = 0.89315$; whence, $\alpha = 63$ degrees 16 minutes 18 seconds, and $x = 90$ degrees $-$ 63 degrees 16 minutes 18 seconds $=$ 26 degrees 43 minutes 42 seconds. Letting $\beta =$ angle CAD, find in exactly the same manner $3076\sin^2\beta - 1600\sin\beta - 320 = 0$; whence, $\sin\beta = 0.67441$; $\beta = 42$ degrees 24 minutes 30 seconds; and $y = 90$ degrees $-$ 42 degrees 24 minutes 30 seconds $=$ 47 degrees 35 minutes 30 seconds.

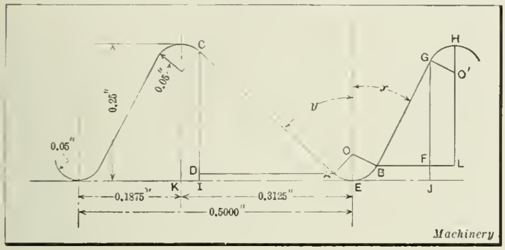


Diagram for finding Angle of Special Screw Thread

FINDING RADIUS OF CIRCLE

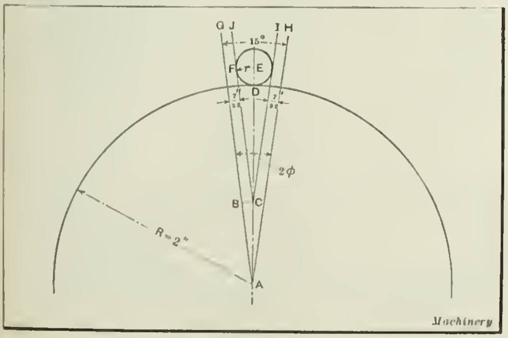
L. A. Z.—Will you please show me how to find the radius r from the dimensions given in the accompanying illustration? I should like a formula for all such cases.

Answered by J. J. Clark, Scranton, Pa.

A.—Draw CB, in the accompanying illustration, perpendicular to AB and EF perpendicular to CF. Let $R =$ radius AD, $r =$ radius EF, $a = BC = 0.21875$ inch, and $2\phi =$ angle $GAH = JCI$; then, $\phi = BAC = FCE = \dfrac{15 \text{ deg.}}{2} = 7$ degrees 30 minutes. $CA = \dfrac{a}{\sin\phi}$; $CD = R - \dfrac{a}{\sin\phi} = \dfrac{R\sin\phi - a}{\sin\phi}$. In the right triangle EFC, $\dfrac{r}{EC} = \dfrac{r}{r + \dfrac{R\sin\phi - a}{\sin\phi}} = \sin\phi = \dfrac{r\sin\phi}{r\sin\phi + R\sin\phi - a}$. Dividing by $\sin\phi$ and clearing of fractions, $r = r\sin\phi + R\sin\phi - a$; transposing, $r(1 - \sin\phi) = R\sin\phi - a$; whence $r = \dfrac{R\sin\phi - a}{1 - \sin\phi}$, which is the formula sought. Substituting in this formula, the values given,

$$r = \frac{2 \sin 7 \text{ deg. } 30 \text{ min.} - 0.21875}{1 - \sin 7 \text{ deg. } 30 \text{ min.}}$$

$$= \frac{2 \times 0.130526 - 0.21875}{1 - 0.130526} = 0.04865 \text{ inch}$$



Finding Radius of Circle

KYANIZING

B. H. M.—The writer has noted that in lists of building material the term "kyanized" is used in reference to wood plank. What is the principal use of kyanized plank, and how is the kyanizing process accomplished?

A.—Kyanizing, named after the inventor of the process, J. H. Kyan, is a treatment applied to wood to render it proof against decay by saturating it with a solution of corrosive sublimate (mecuric chloride, $HgCl_2$). The saturating is done either in open tanks or under pressure in closed tanks. Wood which has been kyanized is used to a great extent by textile plants in structures that are subjected to acid fumes and conditions that produce rapid decay. In cases where the commercially treated wood cannot be obtained, the kyanizing has been satisfactorily accomplished in open wood tanks by using a solution composed of twelve gallons of wood or denatured alcohol and one gallon of corrosive sublimate (50 per cent solution). It will then be necessary for the wood to soak only about two minutes; but if it can be allowed to soak for half a day, the amount of alcohol used may be reduced to three gallons, and if the wood is allowed to soak one week, no alcohol will be required.

* * *

A NATIONAL TRADEMARK

Opposition is expressed by American trade representatives in London to the movement for a distinctive national trademark to be affixed to goods of American origin. They fear that legislation along these lines necessarily carries dangerous possibilities and demands great caution and elaborate safeguards to protect American export trade interests in European markets. Their opinion is that any common national mark is dangerous to export trade unless it is absolutely restricted to a standardized quality of goods only. Such restriction is believed to be impossible of efficient application. Further, goods selling to the general public in the British and other commercially developed European markets will in no way be benefited by a displayed mark of foreign origin. On the other hand, the National Association of Manufacturers, at its recent convention in New York, endorsed the idea, especially as the national association of French manufacturers has already adopted a French national trademark, which is now being used by eighty different associations, and the manufacturers in Great Britain are supporting a movement for the establishment of an empire mark of origin, such as "British Made." The Department of Commerce also is urging the adoption of a national trademark, because of the wholesale pirating of American trademarks in Latin-American countries. Recently, one firm applied for the registration of the trademark of six of the best-known American automobiles, while another has tried to register "Ford American Products," which would give him absolute control of the use of the word "Ford" on all goods that are sold in the country where this trade name is registered.

THE SAFETY ENGINEER[1]

BY L. A. DE BLOIS[2]

Analysis of industrial accidents shows that from 15 to 25 per cent are unavoidable, and they may be passed by with the brief statement that even this number is gradually decreasing as the general knowledge of accident prevention broadens. Of the remainder, or avoidable accidents, between 10 and 20 per cent are caused by unsafe mechanical or structural conditions and are therefore possible of correction. This leaves from 80 to 90 per cent attributable to human defects, that is, to the shortcomings of the individual—ignorance, carelessness, irresponsibility, indifference, disobedience, recklessness, and inexperience of the injured or his fellow-employe—and to defects of the system, such as lack of proper supervision, discipline, etc., in the organization.

Obviously, the safety engineer may not confine his attentions solely to the elimination of those accidents for which his employer or company could be judged responsible under the common law of master and servant; he seeks to eliminate all accidents regardless of responsibility. Each accident is an interruption to output, a needless expense, a cause of suffering, and a drain on the resources of the community and of the country at large. In 1916, there were approximately 22,000 persons killed in industrial accidents in this country alone and 500,000 injured to the extent of losing over four weeks from work. Such wastage of man-power and production is enormous and constitutes a great economic loss.

A remarkable thing about the preceding analysis of industrial accidents is that it seems to apply equally well to any industry. The Dupont Co., for instance, which is engaged in the manufacture of the most dangerous materials used in both industry and war—explosives, ammunition, and strong acids—discovers about the same assignment of responsibility for accidents as does the cement industry. Mining, railroads, and other industries have the same experience. Moreover, the non-fatal and fatal accident rates on the Dupont Co.'s plants do not themselves differ greatly from the rates of other and so-called "non-hazardous" industries. Both premises lead us directly to the logical, though somewhat surprising, conclusion that neither the nature of the industry nor the character of the materials produced or handled has as much effect on the cause, frequency, and severity of accidents as the safe design and equipment of plants, the provision of a proper organization and constant supervision, and the education of the working force into habits of caution and careful practices.

Safety in Equipment

We are all acquainted with new plants where aisles are dangerously narrow, where there is insufficient headroom, where machinery is inaccessible for repairs and valves are difficult to reach for manipulation or repacking. The safety engineer who sees these conditions and recognizes that accidents will inevitably occur may be met with the objection that they have not yet caused accidents and that expensive alterations are not justified and would hold up operations. These matters could have been corrected at less expense in the original design, and probably would have been if any one with experience had considered them from this angle.

In the field of general mechanical safeguarding there has been marked progress in recent years and some excellent standards have been formulated, among them those of the American Society of Mechanical Engineers; but the more difficult problems encountered are those arising from local application and arrangement of machinery, often peculiar to the industry in question, and others due to conditions abnormal to regular operation. As a fundamental we may as well admit that no machinery can be made fool-proof in its regular operation, and we must furthermore admit that conditions occur during adjustment, oiling, cleaning, repairs, replacement, etc., under which standard safeguards may be useless or may even introduce hazard. Evidently the solution of the problem of how to make the equipment as safe as possible under all conditions cannot be reached through mere general acquaintance with machinery of the class in question, nor by a casual inspection of the plant in normal operation. The problem will yield only to analysis after a painstaking study of all phases of operation and of conditions such as poor lighting, inaccessibility, and congestion which are contributory to accident.

Safety through Supervising and Educating Workers

The majority of accidents are due to the shortcomings of human nature, to personal tendencies and traits in the individuals liable to injury, and to deficiencies in the organization that employs, instructs, holds in restraint and disciplines them. Here the safety engineer must employ his knowledge of psychology and the principles of industrial organization. His greatest aids will be diplomacy, perseverance, tact, and patience with the slow response to his insistent efforts to change the mental viewpoint; but there is in this branch of the work a principle so important that its neglect will bring failure in place of success; it is a clear recognition of the fact that the safety engineer can no more effect general accident reduction by his direct efforts alone than the doctor can make a healthy community by curing the sick.

The safety inspector or safety engineer should be able to tell whether a certain practice is dangerous when he sees it, but he cannot watch all the practices of a thousand working men, or even a hundred. The one class of men who can perform this function most efficiently are the foremen, but some one must instruct the foremen as to what is dangerous. This is the function of the safety engineer or inspector. However, an executive authority immediately above the foreman must first convince him, and continue to convince him, that he is required to supervise properly for safety. The plant manager must place himself clearly on record to the effect that safety is as important in the day's work as production or quality, for it is from him that the organization takes its tone. From the directing officials of the company must come moral and financial support. Thus the whole organization is involved. All must work for safety, with the safety engineer in the position of technical adviser.

Relation of Safety Engineering to Other Branches of Engineering

Some instruction in the fundamentals of safety engineering should be given a place in the training of every young engineer. He should be taught to think in terms of safety as he now thinks in terms of efficiency. Conservation of life should surely not be rated below the conservation of energy. Yet few of our technical schools and universities offer instruction in this subject and the graduates go out to their profession with only vague surmises on "what all this talk on safety is about." We have safety inspectors by the hundred, but scarce, indeed, are safety engineers—technically trained and experienced men who are capable of studying an industry or process from all its angles and of making constructive recommendations for changes in design and operation which strike to the root of the unnecessary accident evil.

The National Safety Council is the representative organization of the country dealing with safety. Since its foundation in 1912, its activities have extended until its membership now represents the employers of over 6,000,000 men. The safety of this vast army of workers should be in the hands of trained men, but there are few to fill the vacancies that exist today and the new positions that will be created tomorrow. If there was ever need for a national campaign to reduce death and disablement from industrial accidents, that need is today. They tell us that at least three workers are necessary at home to supply one man at the front. By workers is meant producers—not hospital patients—and the war will bring us enough reconstruction problems in the employment of war cripples and returned soldiers without the problem of employing the many men crippled in our industries. Let us realize, then, that "safety" is not a passing fad, but real work for real engineers, and that the sooner we accept this viewpoint the less cause shall we have later to regret the days of complacent inaction.

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[1] Abstract of a paper presented at the spring meeting of the American Society of Mechanical Engineers at Worcester, Mass., June 5.

[2] Safety Engineer, E. I. du Pont de Nemours & Co., Wilmington, Del.

THE DUTY OF EMPLOYERS WITH RELATION TO CRIPPLED SOLDIERS

In a paper prepared by Douglas C. McMurtrie, director of the Red Cross Institute for Crippled and Disabled Men, 311 Fourth Ave., New York City, attention is called to the fact that the only sound method of dealing with the crippled soldier is to train him for a trade in which his physical disability does not incapacitate him. The American Red Cross is inaugurating a campaign to promote general intelligence regarding the true needs of men incapacitated while fighting for their country. The disability of some crippled soldiers is no bar to their returning to their former trade, but the injuries of many disqualify them from pursuing again their past occupation. The schools of training prepare these men for some work in which their physical handicap will not materially interfere with their production.

In the readjustment of the crippled soldier to civilian life, his proper employment is a matter of the greatest moment, and in this connection the employer has a very definite responsibility; but the employer's duty is not entirely obvious. It is, on the contrary, almost diametrically opposite to what one might superficially expect it to be. The duty is not to "take care of," from patriotic motives, a given number of disabled men, finding for them any odd jobs which are available, and putting the ex-soldiers to work without much regard to whether they can earn the wages paid or not. This method is absolutely erroneous. The positive aspect of the employer's duty is to find for the disabled man a constructive job that he can hold on the basis of competency alone. In such a job he can be self-respecting and happy, and look forward to a future. This is the definite patriotic duty. It is not so easy of execution as telling a superintendent to take care of four men, but there is infinitely more satisfaction to the employer in the results, and infinitely greater advange to the employe; and it is entirely practical, even in dealing with seriously disabled men.

With thoughtful effort, many men can be employed directly on the basis of their past experience. With the disabled soldiers who profit by the training facilities the Government will provide, the task should be even easier. This, then, constitutes the charge of patriotic duty upon the employer: To study the jobs under his jurisdiction to determine which ones might be satisfactorily held by cripples; to give the cripples preference for these jobs; to consider thoughtfully the applications of disabled men for employment, bearing in mind the importance of utilizing to as great an extent as possible labor that would otherwise be unproductive; to do the returned soldier the honor of offering him real employment, rather than proffering him the ignominy of a charity job.

* * *

REPAIRING A LARGE BORING MILL TABLE

The cutting of cast iron with an oxy-acetylene or other high-temperature cutting torch is generally considered impossible because the melting temperature of the oxide which forms on the cast iron is higher than that of the metal itself. Wrought iron or steel has a higher melting temperature than the oxide of iron which forms when the oxygen jet of the cutting torch is applied; consequently the oxide melts and either flows or is blown away from the surface against which the flame is directed. As the result of this constant removal of the oxide in the case of wrought iron and steel, new surfaces are continually exposed to the action of the oxygen jet, so that the metal is literally burned as the cutting proceeds. The difficulty in cutting cast iron is due to the fact that the metal melts sooner than the oxide and the latter interferes with a burning or oxidizing action.

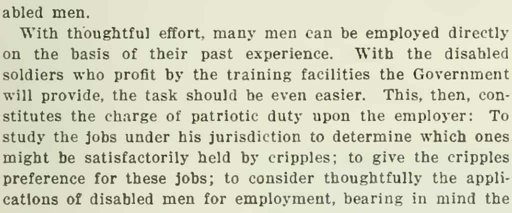

Fig. 1. Cast-iron Table of Large Vertical Boring Mill

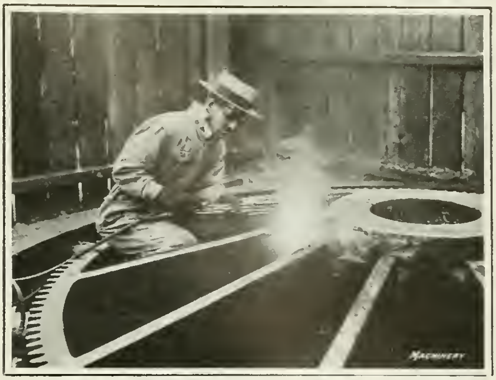

Fig. 2. Cutting out Sections of Ribs with Oxy-acetylene Torch, to repair Cracked Hub

Notwithstanding this theory, an oxy-acetylene torch was used very effectively at the Graves Machinery Exchange, 305 Johnson Ave., Jersey City, N. J., for cutting away sections of the ribs of a large cast-iron boring mill table in connection with its repair. This table, which is shown in the accompanying illustrations, Figs. 1 and 2, was badly cracked through the hub, and as it is part of a fourteen-foot boring mill and weighs about twelve tons, it would have been very expensive to replace. In order to strengthen the hub, it was decided to shrink around one end a 4- by 4-inch steel ring, which involved cutting away sections of the 2¼-inch ribs in order to form a place for the steel ring.

Fig. 1 shows a view of the boring mill table, and this illustrates how the ribs have been cut away next to the hub. Fig. 2 shows how an oxy-acetylene torch was used for this purpose. This torch has six small holes in the tip for the preheating jets which surround a larger central hole for the oxygen. Attempts were made to cut the casting with a tip having only four outer holes, but this form of tip could not be used. The torch is adjusted to give a rather long preheating flame. The pressure of the acetylene is about 30 pounds per square inch, and of the oxygen, 90 pounds per square inch. This method of removing the rib sections saved considerable time, as a 4- by 4-inch piece was cut out of each rib in ten or twelve minutes by means of the torch. The edges of the cut-out sections were left soft and could easily be trimmed by chipping. While the composition of this casting is not known, it probably contains considerable scrap. It is claimed, however, that other cast iron of the gray iron variety has been cut successfully. F. D. J.

* * *

WAR COMMITTEE, TECHNICAL SOCIETIES OF CHICAGO

The technical societies centered in Chicago have formed a joint war committee, the object of which is to cooperate effectively and vigorously in all war activities. The committee is known as the War Committee, Technical Societies of Chicago. The purpose of this organization is to enable the technical societies to call into play the efforts of their members as occasion may arise, and to coordinate their various activities in the most effective manner to help win the war. The secretary is Edgar S. Nethercut, whose offices are at 1735 Monadnock Block, Chicago, Ill.

THE LABOR PROBLEM OF THE SMALL MANUFACTURING PLANT

BY A MANUFACTURER

The small and medium-sized manufacturing plant is facing a serious difficulty on account of the present labor conditions, especially in localities where there is a great deal of manufacture of munitions and other war materials. The latter industries are able, on account of the prices that they receive from the Government and the methods under which the contracts have been let, to pay much higher wages than a manufacturer engaged in a regular line of machinery. Many of the early war contracts were let on a cost-plus-percentage basis which enabled the contracting manufacturers to pay any price for labor and made it possible for them to draw their labor supply from the plants of manufacturers engaged in regular commercial lines. In the face of these conditions, many manufacturers have been forced to curtail their production, not because their industry is non-essential, but because their product is of such a nature that they are not in a position to increase prices appreciably. There are many small and medium-sized plants in and adjacent to cities where large munition factories are located that work now at only about 50 per cent of their capacity; and if there is not soon an improvement in the conditions, some of these manufacturers will be forced to close their plants entirely.

The Small Manufacturing Industry is Vital to the Country

Many of these smaller manufacturing industries make tools and supplies that are just as essential to the effective prosecution of the war as are the actual war materials. Hence, the shutting down of these plants would seriously hamper the nation in its present undertaking. Furthermore, it is the small and medium-sized plants of today that will be the large manufacturing plants of tomorrow. It is often the manufacturer of limited resources who is most active in development work along mechanical lines, and to hamper him is to hamper the progress and growth of the whole industry.

What we need in order to keep the nation fit for an effective prosecution of the war is a policy that keeps all useful industries at their maximum vitality and vigor. At the present time, the thing most important in order to accomplish this is for the Government to inaugurate some policy whereby the small manufacturer may be assured of a reasonable labor supply. This might be done by increasing the authority of the labor bureaus already established in our larger industrial centers by the Department of Labor, so that these bureaus would have the power to pass upon the justification of any man changing from employment in one plant to another. No men should be hired unless they pass through this labor bureau. Their reasons for changing should be investigated, and in case the change was shown to be detrimental to the best interests of the nation at large, in that it made it impossible for the smaller industries to conduct their business properly, it should not be authorized. A system similar to this is in force in England and appears to work very satisfactorily. In England, wages also are regulated by the Government, the manufacturers, and the labor organizations in cooperation with each other, but this would probably not be necessary here if only the Government would aid the industries by regulating the all too frequent changes of employment that take place.

Present Labor Bureaus are Useless as Regulators of Labor Supply

The employment bureaus so far established by the Government do not sufficiently protect the manufacturers who operate small and medium-sized plants. As an example of how ineffective the present arrangement is, it may be mentioned that when a manufacturer in a city with large war industries recently laid his troubles before the officials of the bureau, he was asked what rates of wages he would pay mechanics such as he required. He supplied these figures to the Labor Bureau. Upon comparison with the rates of pay in the large munition factories, his rates were low, and all the comfort he received from the Labor Bureau was to be told that of course he could not get any labor as long as he paid so much less than the prevailing rates at the other large plants.

Now, the manufacturer did not need to go to a labor bureau to become aware of this. He knew well enough that the source of his troubles was that the munition plants outbid him. He also knew that he could not possibly pay the rate of wages that the manufacturers of war materials could afford, because his product had to be sold largely in an open market that would not allow of raising prices to such an extent. Furthermore, he knew that if he could bid as high as the munition manufacturers he could get all the labor he wanted. What he expected from the Labor Bureau and what manufacturers in general should have a right to expect from the Department of Labor is the establishment of an authority that could prevent unfair labor market competition. A manufacturer who at this time tries to obtain skilled labor from another manufacturer by offering exorbitant wages, rather than train men himself, should not be permitted to do so, and the Labor Bureau should be the regulating influence.

Small Factories Train Men for the Larger Plants

The small factory has been made a training school for the large munition plants. In many instances, the smaller plant takes in green men constantly, trains them for a few months, and when they are capable of producing they are absorbed by the larger plants, which can afford to pay them higher wages and which thereby also benefit by the training for which the smaller plant has paid. A labor bureau having sufficient authority could overcome this difficulty of the small manufacturer and could make the larger plants train their own labor to meet their own requirements.

For the national welfare, it is certainly necessary that something be done to regulate the labor supply, so that the manufacturer who is not in a position to realize more than a normal return on his investment and who cannot reimburse himself for the payment of exorbitant wages by charging proportionately high prices for his product may receive some protection. In order that we may be able to continue the war without unnecessarily sacrificing or retarding industrial development for years to come, all industries that perform a useful service, and particularly those directly or indirectly aiding in the prosecution of the war, should be given all the assistance possible, or at least they should not be discriminated against. If this is done, healthy activities on the part of small and medium-sized manufacturers may be encouraged, industrial development will be insured, and labor will gain by the stability of employment.

* * *

WAGES FIXED FOR MACHINISTS AND TOOLMAKERS

The Labor Adjustment Board of the Army Ordnance fixed the wage rates of machinists in the Bridgeport, Conn., district, June 7. The board decided upon the following rates of pay per hour: Toolmakers, 78 cents; special tool-room helpers, 64 cents; all-around machinists, 68 cents; medium and rough-work machinists, 64 cents; lathe hands, 59 cents; planer hands, 64 cents. These rates per hour are on a basis of an eight-hour day, with pay for all over-time at the rate of time-and-one-half. Work on Sundays and holidays shall be considered as overtime. Those who receive rates of pay in excess of the rates mentioned shall not be reduced in their present employment because of the decision rendered by the board, and all employers who have been paying more than time-and-one-half on Sundays and holidays are to continue to pay the higher rate. Any disputes in regard to classification of men in accordance with the wage scale are to be referred to a representative designated by the War Department, and his decision in each case shall be final and binding.

* * *

Although Japan began the manufacture of machine tools ten or fifteen years ago, the most progress has been made in the past four years. Jigs and fixtures and powerful plain milling machines, however, are used comparatively little; probably because there is little specialization. Turret lathes are much appreciated, but the cheapness of labor has prevented the rapid introduction of automatic machines.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

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COMMUNITY THREAD-GAGE GRINDING MACHINE

On this gage-grinding machine, a wheel-truing device is provided with which to dress wheels for grinding U. S. standard, Whitworth, or Löwenherz threads. Interchangeable spindles are furnished, carrying grinding wheels trued to these three forms, and changes of spindle may be rapidly made. A set of master screws is furnished with the machine, which correspond in lead to the different thread gages that have to be ground. A graduated swivel provides for adjusting the grinding wheel for the helix angle of the thread.

FOR use in grinding thread gages, the Community Machine & Tool Works, Inc., 154-156 Grand St., New York City, is now building a machine which forms the subject of the following description. This thread-gage grinding machine was originally designed and built for use in grinding thread gages made by this company, but the results obtained have been so successful that subsequently a decision was reached to build the machine for the general market. Before starting upon a detailed description of features of the design, it will be of interest to state briefly the way in which the machine operates for the benefit of those who have not had experience in thread-gage grinding.

The work is mounted between centers, and grinding is done by a wheel which is accurately trued up to exactly the required form for the thread that is being ground. While the grinding operation is being performed, it is necessary to provide for both rotating the work and traversing it past the grinding wheel. This result is accomplished by means of the crank handle which will be seen at the extreme right-hand end of the machine. This crank is attached to the spindle, which carries an interchangeable master screw of the same lead as the thread gage that is being ground; this screw runs in a nut, so that as the spindle is rotated the work receives a corresponding rotary motion through connection made between the work and spindle by a driving dog, and the work is traversed past the grinding wheel at the proper rate, owing to the screw on the spindle to which attention has just been called. In order to provide for this traverse movement, the dead center at the left-hand end of the work is held in contact with the work by means of a compression spring. Consequently, traverse motion of the work is accomplished by pushing the center back against this spring tension. Attention is called to the fact that as soon as the traverse movement has been completed in one direction, the machine operator simply reverses the direction in which he has been rotating the crank, thus feeding the work back past the wheel with the work rotating in the opposite direction. In this way, no time is lost in the performance of the grinding operation.

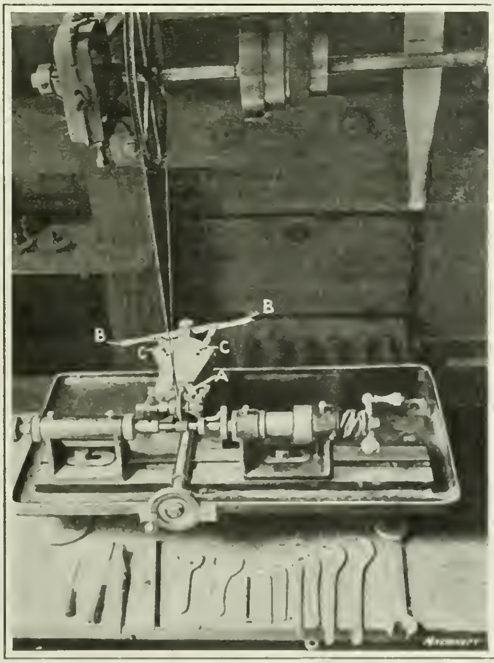


Fig. 1. Thread-gage Grinding Machine built by the Community Machine & Tool Works

It is important for the nut in which the master screw runs to be a close fit, and before starting to describe the provision made for assuring a tight fit of the nut on the Community gage-grinding machine, attention is called to Fig. 2, in which there is shown a close view of one of the interchangeable master screws and nuts. The screw thread is cut on a steel sleeve that is held in place on the spindle by lock-collars; and the nut, which is made of bronze, is tapered on the outside with a straight threaded section below the taper. An adjusting collar goes on the outside thread, and by tightening this collar, the nut is pulled into its seat in the machine frame, thus assuring a close-working fit between the screw and nut. As shown in the illustration, the machine is said to have given perfectly satisfactory results, but a point was raised concerning

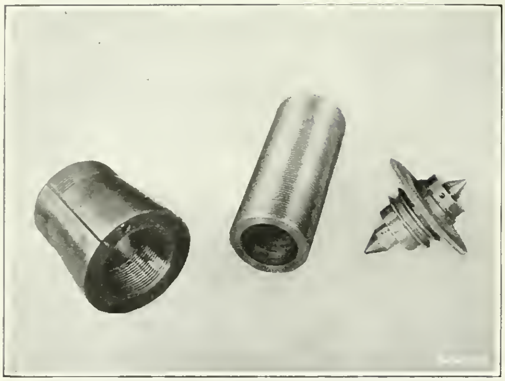


Fig. 2. Close View of Nut, Master Screw, and Grinding Spindle for Community Thread-gage Grinding Machine

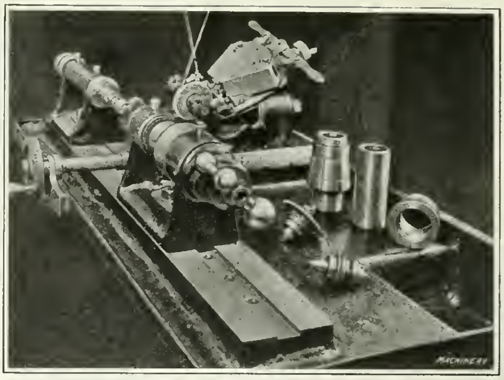


Fig. 3. End View of Community Thread-gage Grinding Machine, showing Graduated Swivel to adjust for Helix Angle

whether the spindle is subjected to unnecessary strain by having the crank handle mounted directly on it. On this account, an improved design is now being developed, where the end of the spindle is square to slide in a corresponding opening at the end of a sleeve on the opposite end of which the operating crank will be carried. In this way, the spindle will be relieved of all unnecessary strain.

This machine is used for grinding U. S. standard, Whitworth, and Löwenherz threads, and, of course, different shaped wheels must be provided for grinding each form of thread. To obviate the necessity of redressing the wheel to different shapes each time a change is made on the class of work that is being ground, interchangeable spindles are provided for use on the machine, on which the different forms of wheels are permanently mounted. One of these spindles with its grinding wheel is shown in Fig. 2, where it will be seen that at each end the spindle is provided with a 60-degree tapered center. These centers fit into corresponding sockets carried in the wheel-head, and when it is desired to change wheels, it is merely necessary to loosen a binding screw and move one of the sockets back sufficiently so that the spindle can be removed and another one substituted in its place. This change of spindles can be made with very little loss of time.

For truing the grinding wheel there is an attachment permanently secured to the machine that is furnished with means of adjustment to provide for truing wheels for grinding any of the three forms of thread to which reference has been made. Extending out of the attachment at each side of the grinding wheel, there is a bar which carries a diamond point (one of these bars is clearly shown at *A*, in Fig. 1). Truing of the grinding wheel is accomplished by imparting an oscillating movement to the diamond holders by rocking lever *B* about its central pivot. Connection is made from this lever to the diamond holders by means of pivoted links clearly shown in the illustration. When lever *B* is rocked, an oscillating movement is imparted to the diamond holders, which results in carrying first one diamond and then the other over the face of the grinding wheel, causing the wheel to be accurately trued to exactly the desired form. For truing wheels for grinding U. S. standard, Whitworth, or Löwenherz threads, adjustment is provided on the wheel-truing attachment to make the two bars *A* which carry the diamonds travel past the grinding wheel at exactly the proper angle for each form of thread, namely, 60 degrees for the U. S. standard thread, 55 degrees for the Whitworth thread, and 53 degrees 8 minutes for the Löwenherz thread. This adjustment is accomplished by pulling out pins *C*, which control the position of the diamond-bars in the attachment and entering these pins into the proper holes for the particular type of thread for which the wheel-truing attachment must be set. Patents have been applied for on certain features of the design of this machine.

DUFF HEAVY-DUTY TURRET LATHE

In the accompanying illustrations there are shown three views of a new heavy-duty 26-inch turret lathe, built by the Duff Mfg. Co., of Pittsburg, Pa. This machine was designed for the heavy work encountered in machining ammunition and for other similar service. The operative control is so designed as to be easily accessible at all times to the operator, thus reducing to a minimum the amount of actual labor required in operation. This turret lathe has a length over all of 13 feet 7 inches and a swing over the ways of 27 inches. Mounted on the top of the headstock there is a 20-horsepower motor, from which power is transmitted to a driving pulley 10½ inches in diameter (constant speed, 1000 revolutions per minute) at the rear of the headstock by means of a silent chain drive, and thence through a train of gears to the spindle. Twelve mechanical changes of speed are provided—open and reverse—giving a range of from six to one on low gear to one hundred seventy-four to one on high gear. These speed changes are controlled by levers within easy reach of the operator. Conveniently located, behind the chuck at the top of the headstock, is the starting, stopping, and reversing lever.

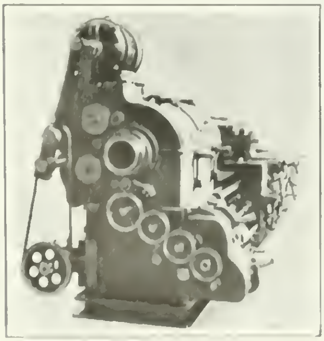


Fig. 1. Duff Heavy-duty Turret Lathe

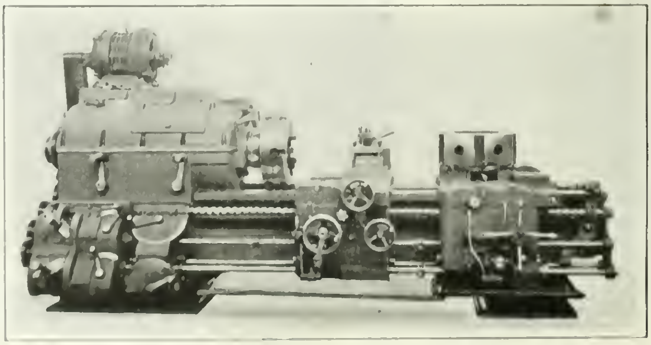


Fig. 2. Front View of Heavy-duty 26-inch Turret Lathe built by the Duff Mfg. Co.

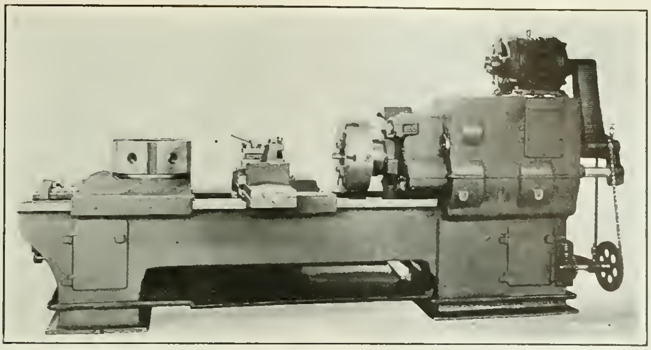


Fig. 3. Opposite Side of Duff Heavy-duty Turret Lathe shown in Fig. 1

The spindle is a hammered steel forging, heat-treated and ground. At the rear of the spindle is placed a ball thrust bearing. To insure proper lubrication along the entire length of the spindle, a well is provided in the cap, from which wicks carry the oil, covering the full length of the bearing. The hole through the spindle is 7⅛ inches in diameter, and the chuck, which is 20 inches in diameter, is of the compound, three-jaw, universal type. The turret is of the broad-faced, hollow, hexagon type, containing tool holes 3½ inches in diameter and measuring 21 inches across the flats. It rests on a base 30 inches in length, and is clamped by means of the handle shown at the base. This clamp-handle permits a powerful clamp over the entire surface of the turret base, which is sufficient to hold the turret firmly against play under the heaviest work. The turret carriage has a travel of 45 inches, and the turret is of the automatic indexing type. The geared feed changes of the turret are absolutely independent of the toolpost feeds, resulting in the advantage that a very fine feed can be used for boring or facing, and at the same time a very coarse feed can be used for the toolpost. The long lever at the left of the turret apron is the quick-return lever, which provides for moving the turret forward with the same speed that is obtained in reversing. The feed-lever is located at the right of the quick-return lever. A large pilot wheel is used on the turret apron for operating the turret backward and forward by hand, and adjustable automatic knock-out stops are provided, which operate instantly and accurately—an essential feature when handling duplicate work. Feeds can also be engaged or tripped as desired by hand operation through use of the feed-lever shown on the turret apron.

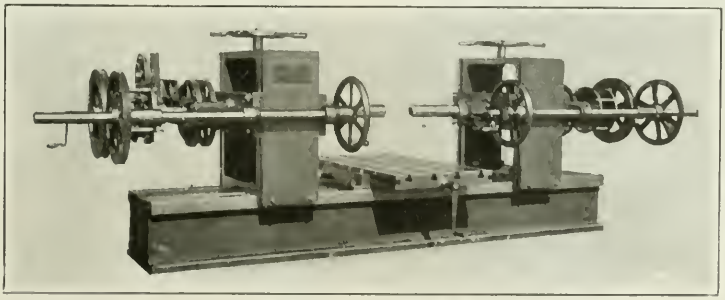
The toolpost carriage is heavily built and of special design, having front and rear tool-slides with power and hand feed in both directions. Either toolpost can be clamped and locked rigidly in any one of a number of positions, as they operate entirely independently of each other. The toolposts are of the side carriage type, and can pass completely by the chuck, permitting greatly increased capacity in relative swing over the carriage and increasing the range of chucking work that the lathe can accommodate; also, it permits the toolpost to be moved completely out of the way when using the tools in the turret, it being possible to bring the turret-head up close to the chuck. The carriage can be firmly clamped to the bed to hold it in a fixed position. The toolpost feeds are absolutely independent of the turret feeds, providing advantages already outlined. The feed changes for the toolpost carriage are so arranged that it is possible to shift instantly from any heavy roughing feed to a proper finishing feed. All feeds are reversible. Adjustable automatic trip-off stops are provided, which operate instantly and accurately. The feeds can be engaged or tripped at will by hand, through the use of a lever handle shown in the illustration at the right of the quick-return lever. Three handwheels are provided on the apron, one for adjusting each of the two toolposts, and one for feeding the carriage forward or backward.

One of the most notable features of the Duff heavy-duty 26-inch lathe is its efficient system of lubrication. This is taken care of by a single pump located at the rear of the headstock and driven by the lathe motor. By means of this pump, every single point in the machine demanding lubrication is automatically supplied with oil. Care has been taken to make this machine as fool-proof as possible. The danger of stripping gears, through changing spindle speeds while the lathe is in operation, has been eliminated by the use of a safety governor, which works automatically, unlocking and allowing the changing of spindle speeds only when the machine has been thrown out of motion. Another desirable feature of the Duff lathe is the use of a knock-out box containing a train of gears, acting on the feed-shafts, and controlled by two handles, which are used for reversing the feed-shafts. In building this machine, great care was exercised to design it so that it could be readily adapted for a single-purpose machine for ammunition work. All non-essentials for the work required can be omitted. This machine can be built as an engine lathe, and as such it is amply strong to handle shells up to and including 15 inches in size. It can be furnished with any number of speeds up to twelve, with any number of feeds up to ten, with any size of spindle hole up to 10 inches, and with any length of bed.

PEDRICK DUPLEX BORING MACHINE

Among the machines which have fulfilled special war requirements is the one illustrated herewith. It was originally designed with only one boring-bar, but was easily arranged for using two bars, one in each housing, and in this form is serving a useful purpose in ordnance shops. Several plants using this machine have adapted jigs of proper construction to suit their individual requirements, and in connection therewith are using the duplex horizontal boring machine for turning trunnions and boring the bearings in gun carriages. A bed, planed and scraped on its bearing surfaces, forms a base for two box-like housings. These are movable along the bed to suit conditions and are securely locked in position by four bolts. In each housing is a complete boring-bar or spindle having its own driving gearing, feed mechanism, and motor. Handwheels above the housings are for vertical adjustment of the bars.

The bars are held in a long bearing in the form of a quill, so machined that accurate alignment of the bar is assured. A feed-case on the end of the bar regulates the feed of the bar, there being three changes controlled by a slip pin. The feeds are reversible. In order to bring the feed control nearer the work, a shaft is run to a gear engaging another gear on the feed-case and a handwheel located at the side of each housing. One of the features of



Horizontal Duplex Boring Machine built by the Pedrick Tool & Machine Co.

this new feed is the rapid return of the bar. A crank handle shown at one end of the feed-case operates this movement. The driving gearing on the bar is compounded in such ratio that motors of small horsepower are ample. The gear guard cover is designed to form a base for the motor, and a swing-arm, on which various sizes of gears may be applied, transmits the power from the motor to the driving power pinion. In the end of the bars is a Morse taper hole for holding drills, auxiliary bars, facing heads, etc. Two sizes of the machine are made for carrying 3- or 6-inch bars. This machine is a recent product of the Pedrick Tool & Machine Co., 3639 N. Lawrence St., Philadelphia, Pa.

GRAND RAPIDS DRILL GRINDING MACHINES

The Grand Rapids Grinding Machine Co., Grand Rapids, Mich., is now building a line of drill grinding machines which comprises four different styles, two of which are shown in the accompanying illustrations. The Style C3T machine, shown in Fig. 1, has a capacity for grinding drills from ¼ inch to 2½ inches in diameter, and it will be seen that this machine is furnished with a water attachment for wet grinding. In Fig. 2 is shown a Style B2T drill grinding machine, which has a capacity for sharpening drills from ⅛ to 1½ inch in diameter; and it will be seen that on this machine no water attachment is provided. In addition to the two styles of machines illustrated, there is a Style B3T machine, equipped with a water attachment and having a capacity for sharpening drills from ⅛ to 1½ inch in diameter; and a Style C2T machine, without a water attachment, which has a capacity for grinding drills from ¼ inch to 2½ inches in diameter. Aside from differences in capacity and the provision of a water attachment, the design of all of these machines is quite similar.

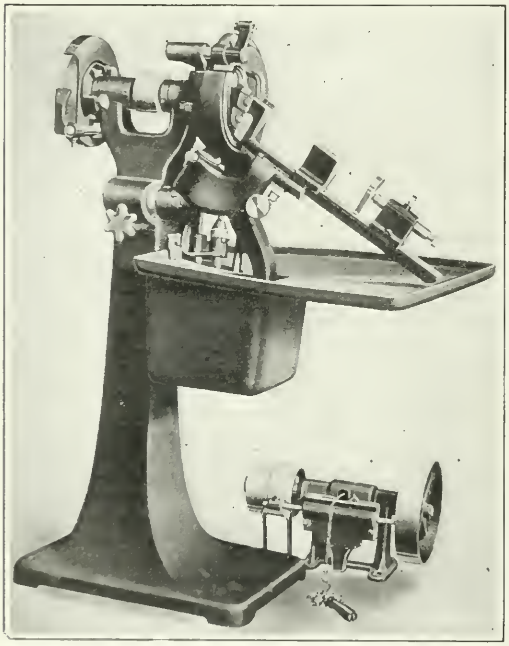


Fig. 1. Grand Rapids Style C3T Drill Grinding Machine

Attention is called to the fact that the machines work on the non-callipering principle; that is to say, it is unnecessary to make an adjustment before starting to grind different sizes of drills, other than to set the tailstock for the particular length of drill which is to be sharpened. The swivel bearings are made of ample size to provide the necessary stiffness. Provision is made on the standard holder for taking care of drills with enlarged shanks, as well as those with the standard straight or tapered shanks. The spindle is made of from 60- to 80-point carbon crucible steel, and is carried in ring-oiled bronze bearings. On these machines, a diamond truing device with a safety stop is one of the important features. It insures getting the drill-holder into close proximity with the grinding wheel and at the same time eliminates danger of bringing the lip rest against the wheel and causing it to be ground off.

The diamond truing device consists of a swinging arm in which the diamond is mounted. Adjustment may be conveniently made. In the case of double-holder machines, a truing device is furnished for both wheels, and a diamond is part of the standard equipment furnished with each device. In connection with the truing device, a stop is provided which is in the form of a track on a movable section of the wheel hood. As the diamond is advanced into the grinding wheel during the process of truing, this movable section of the wheel hood with its track is advanced an equal amount, so that it always remains at a fixed distance from the face of the grinding wheel. A circular stop on the front of the drill-holder abuts against the track and rocks on it during the process of swiveling the holder. It is so adjusted that it brings the lip rest into close proximity to the wheel, which is desirable in drill grinding. At the same time, it is impossible to get the front of the holder or the lip rest against the grinding wheel, where it would be ground off.

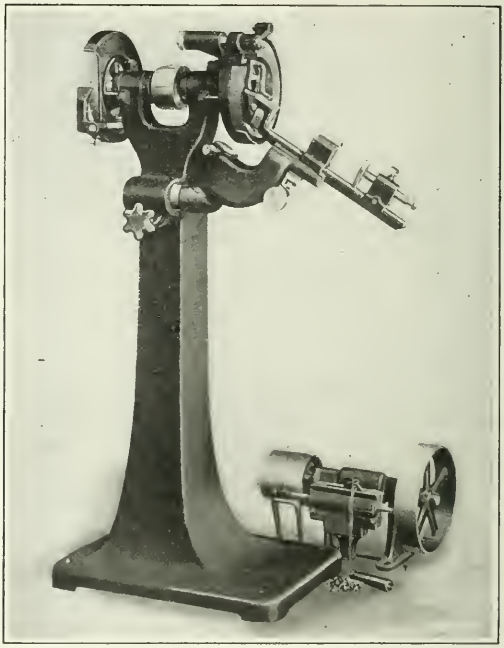


Fig. 2. Grand Rapids Style B2T Drill Grinding Machine

Drills working on tool steel require less clearance than those engaged in drilling soft gray iron, while the drills working in steel require a stronger cutting edge than those which are drilling iron. Provision is made for rapidly making an adjustment of the amount of clearance provided in grinding a drill. In making this adjustment on the Grand Rapids machines, there is no danger of getting other adjustments on the machine out of order. It is merely necessary to turn a small handwheel which rocks the drill-holder the proper amount.

HALLDEN TUBE AND ROD CUTTER

This machine has been designed to cut tubes and rods into short accurate lengths rapidly. The tube or rod is fed to the saw by a pair of feed-rolls revolving intermittently, and at each pause of the feed-rolls the saw table is raised and a piece of metal is cut off. On the smaller sizes of work, two

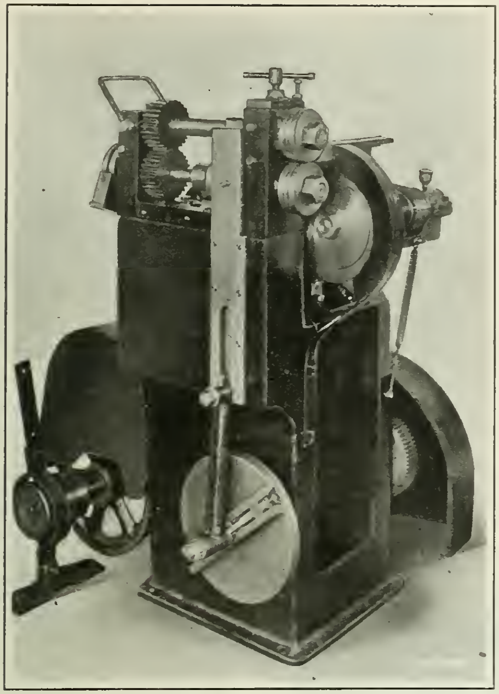


Fig. 1. Tube and Rod Cutting Machine built by the Hallden Machine Co.

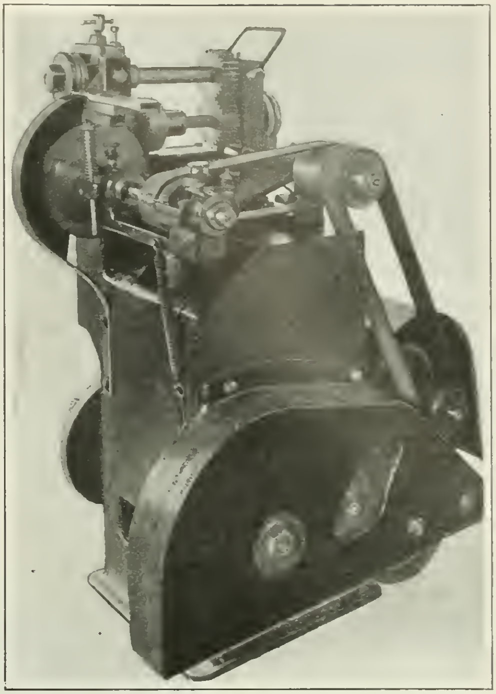


Fig. 2. Opposite Side of Hallden Tube and Rod Cutting Machine

tubes can be cut at the same time. The feeding mechanism consists of a reciprocating rack with one end connected by a lever to an eccentric and the other end meshing with a gear connected to a one-way clutch. Thus on the upward stroke of the rack the feed-rolls are revolved forward, but on the downward stroke the feed-rolls stand still, and the saw table is raised upward by a cam connected directly to the shaft driving the feeding mechanism.

During the time the saw passes through the metal the tube or rod is held firmly by the feed-rolls and stock casing, and the piece being cut off is held by a clamping device, which releases as soon as the saw has passed through the metal. The eccentric can be adjusted quickly to give any length of stroke to the rack, thus enabling the machine to cut any desired length. When cutting brass or copper, a regular metal saw is used, but on steel a metal disk rotating at high velocity gives the best results. The machine is a recent product of the Hallden Machine Co., 27 Benedict St., Waterbury, Conn.

SHEPARD LATHES

The line of screw-cutting engine lathes manufactured by the Shepard Lathe Co., Canal and Jackson Sts., Cincinnati, Ohio, has been increased by the addition of several new types of machines. Among these are the 12-inch, all-geared head, semi-quick-change screw-cutting engine lathe, equipped for various styles of drives, such as individual motor drive mounted on either the headstock or on the lathe leg, and countershaft and single-pulley drive. These lathes include the well-known Shepard features, such as the semi-quick-change attachment

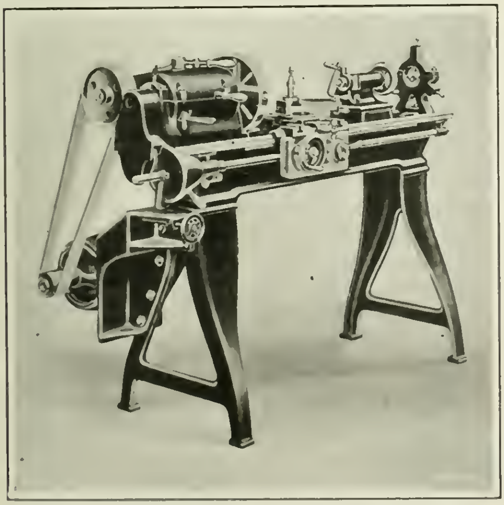


Fig. 1. Shepard 12-inch Engine Lathe with All-geared Head and Motor mounted on Leg

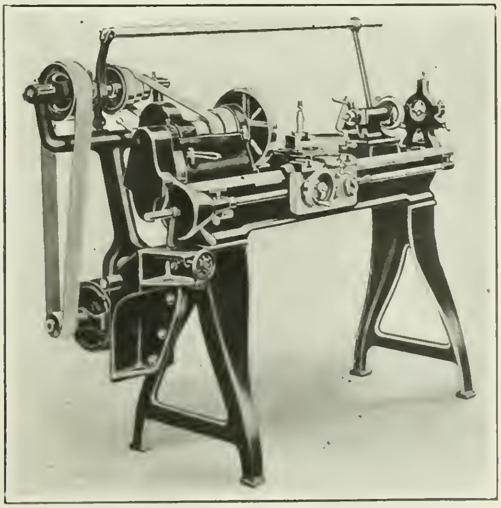
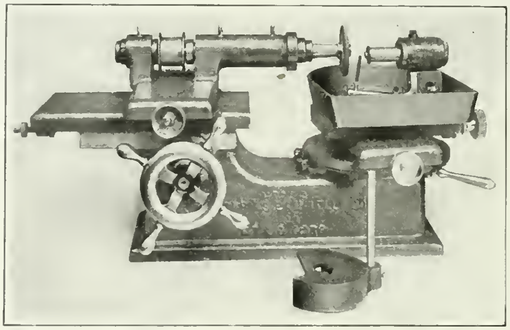


Fig 2. Shepard 12-inch Engine Lathe with Cone Head and Individual Motor Drive

which does away with separate change-gears and possesses many of the advantages of the complete quick-change lathe; also the reversing lever in the headstock, whereby the different feeds of the lathe may be instantly reversed without stopping the machine, shifting belts, or changing the direction of rotation. This mechanism is operated by a positive clutch and permits the lead-screw nut to remain in constant engagement when changing threads, making it unnecessary to reverse belts or watch a dial, thus greatly increasing the speed and decreasing the complexity of the operation.

This lathe is provided with six changes of spindle speed, ranging from 32 to 502 revolutions per minute, driven by a positive seven-jaw steel clutch. The changes in speed and shifting of the clutch are easily and readily accomplished by means of two levers conveniently situated. All clutches, clutch gears, and smaller gears are made of steel. The face of the headstock gears is 13/16 inch in width. The hollow spindle is made from 0.50 carbon steel and ground with a 1-inch hole, permitting the use of a draw-in attachment and collets. The spindle runs in phosphor-bronze bearings. The carriage has exceptionally large bearings on the bed; and the compound rest has an unusually large bearing surface to insure rigidity of the cutting tool. The compound rest is also gibbed and graduated. The tailstock is of the offset type, with an extra long bearing on the bed, and with provision for setting it over to allow for turning tapers. The bed is of deep section, designed for rigid construction under heavy cuts. The weight of the lathe is from 800 to 900 pounds net, according to the length of bed desired. This lathe is furnished with either bench or standard length legs.

Another type of Shepard lathe is the 12-inch, cone-head, semi-quick-change screw-cutting engine lathe shown in Fig. 2, which is being made with either a regular double-friction countershaft drive or with an individual motor drive attachment, giving practically all the advantages of a geared-head lathe. This type of lathe also includes the special features of semi-quick-change attachment and the reversing mechanism operated by the reverse lever in the headstock. It also has an enclosed headstock, 0.50-carbon-steel spindle running in phosphor-bronze bearings, and a three-step cone pulley for two-inch belt. All other features of the design and attachments are the same as for the geared-head lathe. The cone-head lathe equipped for individual motor drive has a swinging arm supporting the countershaft, which, with the electric motor, is fastened to a bracket bolted to the lathe leg. This device puts the entire lathe and drive in one unit and supports the additional weight near the floor. •



Circular Cutter Grinding Machine built by Robbins, Gamwell & Co.

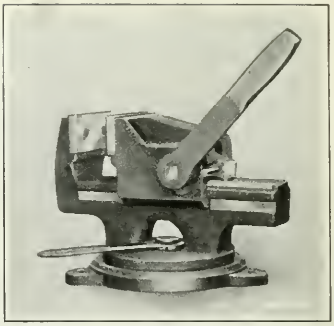
SMITH & HEMENWAY LOCK-WASHER

There are six points of contact—three engaging the nut and three engaging the under surface—on the "Red Devil" corrugated lock-washer which is the latest product of the Smith & Hemenway Co., Inc., 130 Colt St., Irvington, N. J. The washer is made of a special manganese steel, oil-tempered and given a gun metal finish. It is claimed that this lock-washer is made to hold under the most extreme conditions of vibration.

Red Devil" Corrugated Lock-washer made by the Smith & Hemenway Co. In

The washers are packed for sale in boxes of 100, 250, 500, and 1000. In addition, smaller boxes of assorted sizes are put up for the convenience of automobile owners. It is stated that one and one-fourth turn of the nut is required to loosen it from this lock-washer, so that it possesses exceptional holding power.

WINANS' VISE



Winans' Vise made by the Barnett Foundry & Machine Co.

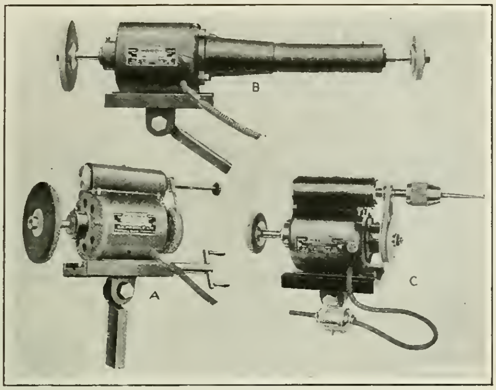
The Barnett Foundry & Machine Co., Lyons Ave. and Coit St., Irvington, N. J., has just brought out a machinist's bench vise under the name of "Winans' New Idea" vise that embodies several interesting features. Reference to the illustration herewith presented will show its general characteristics. It will be seen that the screw and lever arrangement has been replaced by a pawl and rack. This is actuated by a handle on an eccentric shaft, which will exert ample pressure for holding the work. The adjustments from zero to maximum are made instantly with one sliding movement. The pawl eccentric and sliding jaw form a toggle joint, bringing the greatest pressure to bear on the top part of the jaws and causing the work to be clamped tightest at the working part. The moving member of the vise slides away from the operator and there is no handle between the operator and the vise. The gripping plates are hardened and ground, and the rack and pawl are also made of hardened steel. A feature of especial importance is that the whole vise may be removed from its swivel base and taken to a surface plate, or to a drilling or milling machine for continuous operations, since the base of the vise is accurately machined at right angles to the jaws. These vises are made with standard sizes of jaws from 3 to 8½ inches, and openings of 3½ to 12 inches. The whole design is such that it will stand up under the most trying conditions of service.

ROBBINS-GAMWELL CUTTER GRINDER

For use in grinding circular cutters, Robbins, Gamwell & Co., Pittsfield, Mass., have recently placed upon the market the machine which is illustrated and described herewith. It is especially suited for grinding convex and concave profile cutters and has a capacity for work up to 7 inches in diameter. In grinding convex cutters, true half circles can be ground on the periphery of cutters not less than 3 inches in diameter, and arcs of circles less than 180 degrees can be ground with a radius depending upon the diameter of the cutter, ranging from 1⅝ inch on a cutter 7 inches in diameter to ¼ inch on a cutter 2 inches in diameter. In grinding concave cutters, part of a circle slightly less than 180 degrees can be ground on a cutter not less than 3 inches in diameter. Attachments for grinding certain types of cutters that do not come within the capacity of the machine as regularly furnished, such as small cutters with large radii, can be supplied as extra equipment of the machine.

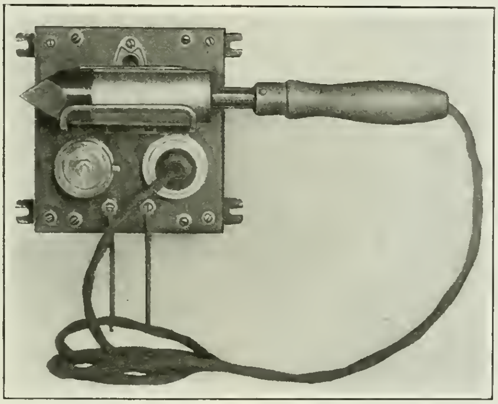
PRINGLE PORTABLE GRINDING MACHINES

R. E. T. Pringle, Ltd., 308-309 Tyrrell Bldg., Toronto, Canada, is now manufacturing what is known as the "Aro" portable electric grinding machine, which is made in a number of different types. One of these is a Type A universal machine, in which the motor runs at the correct speed on either alter-



Types A, B, and C Portable Electric Grinding Machines made by R. E. T. Pringle, Ltd.

nating or direct current, giving a speed of 10,000 revolutions per minute on the main drive, and 30,000 revolutions per minute on the internal attachment. The motor and internal spindle are equipped with "Norma" adjustable ball bearings in order to reduce friction and wear to a minimum. The equipment furnished with this machine includes a set of grinding wheels and a cutter-grinder rest. The Type B machine is furnished with an extension arm 10 inches in length to adapt it for use in grinding deep holes where a light cut is to be taken at high speed. This is said to be an excellent machine for use in the tool-room for lapping dies, gages, etc. In addition to the internal spindle, this grinding machine is furnished with a larger grinding wheel for the performance of external operations. This wheel is 4½ inches in diameter by ⅜ inch face width, and the internal wheel is 2½ inches in diameter by ⅜ inch face width. A wheel of each of these sizes is furnished with the machine. The spindle of the Type C machine is driven at 40,000 revolutions per minute, which has been found to be the correct speed for grinding button dies and for chuck and small die work. This machine is furnished with a high-speed spindle provided with a chuck for carrying round carborundum sticks, and a second spindle for driving rubber grinding wheels. The equipment furnished with the machine includes two "Aro" rubber grinding wheels and two carbo sticks, ⅜ by 4 inches and ⅜ by 3 inches.



Cutler-Hammer Electric Soldering Iron Rack and Control Panel

CUTLER-HAMMER RACK FOR ELECTRIC SOLDERING IRONS

Electric soldering irons which are left lying on a bench or other convenient place when not in use gather dirt and become a hazard. Often the tip will be overheated, necessitating refiling; the heating unit may also burn out, or the hot iron may set fire to the bench or other material. If the current is turned off, the iron cools down to such a degree that considerable delay is caused when the iron is again to be used. To overcome these objectionable features, the Cutler-Hammer Mfg. Co., Milwaukee, Wis., has recently developed an automatic soldering iron rack and control panel which decreases the amount of current taken by the iron when it is placed on the rack. This keeps the iron from overheating, prevents burn-outs, saves current, and encourages orderliness by providing a convenient connection point and support for the iron. The rack consists of a small slate panel, arranged for wall mounting, and carries a support for the iron which acts on the principle of the telephone receiver hook.

When the iron rests on the support or hook it bears the support down, and the resistance which is mounted on the back of the panel is inserted in the circuit with the iron. The current is reduced and the temperature held at a safe value, but ready for service and full current just as soon as the iron is lifted from the hook. Taking the weight from the hook disconnects the resistance for the soldering iron circuit and allows full current to flow. Below the hook, on the same panel, there is a push-button snap switch and a standard receptacle to which the plug of the soldering iron cord is connected. This little panel, therefore, is a complete switchboard, which may be mounted on the wall or machine within reach of the workman. When not in use and at night, the switch is snapped off, which completely opens the circuit to the iron. These automatic racks are designed for use with Cutler-Hammer soldering irons, but may be used with other similar types as well.

NEW BRITAIN STEEL BENCH DRAWER

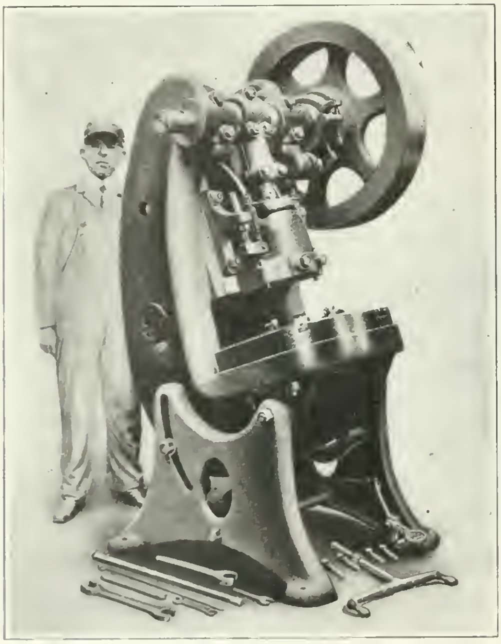
An all-steel bench drawer, which has recently been added to the line of shop furniture built by the New Britain Machine Co., New Britain, Conn., is designed to meet the requirements of shops that want a practically indestructible drawer. A seam of triple thickness runs around the upper edge, and all joints in the steel are welded to provide ample strength and durability. In a commonly used type of bench, a thinner back plank is used than the one at the front, leaving an open space between the back plank and the ordinary type of drawer, which affords a possibility of reaching into the drawer from the back by those who are not provided with a key. In the New Britain steel bench drawer, a solid sheet-metal top makes it impossible to take things out at the rear, and also prevents blocking the drawer through wedging its contents against the under side of the bench. This sheet-metal top also excludes any oil or water which may soak through the top of the bench. The slideways are always integral with the top of the drawer, giving a smooth, free movement without tendency to bind or cramp. The handle is of generous size, and so shaped that it is comfortable to hold. The drawer is provided with a cylinder lock and two individual keys. If desired, a master key may be provided at extra cost, and attention is called to the fact that possession of a master key by the foreman will prevent men from stowing contraband materials in bench drawers. Drawers of this type may be easily and quickly installed without requiring the bench to be cut. It is simply necessary to remove the two stops and pull the drawer completely out from the slideways. After fasten-

Steel Bench Drawer made by the New Britain Machine Co.

ing the top to the under side of the bench with wood screws, the draw is inserted and the stops are replaced. The principal inside dimensions of these drawers are: 18 inches long by 16 inches front to back, by 5 inches deep; over-all dimensions are 19 inches long by 16½ inches front to back, by 5¾ inches deep; and the weight, packed for shipment, is 40 pounds.

FERRACUTE SINGLE-ACTION PRESS

The Ferracute Machine Co., Bridgeton, N. J., is placing a new series of single-action presses on the market, the accompanying illustration representing the fourth size in this series. These presses have the general characteristics of similar machines previously built by this company, but are heavier and contain longer ram bearings. The shaft may more easily and quickly be removed than in other types of such presses. Each shaft-cap is clamped to the frame by two bolts which are of unusually large size and equal in strength to the four bolts often used. The pitman-strap is removable in separate halves, and a new form of ram knock-out is also used, but this is omitted unless specially ordered.

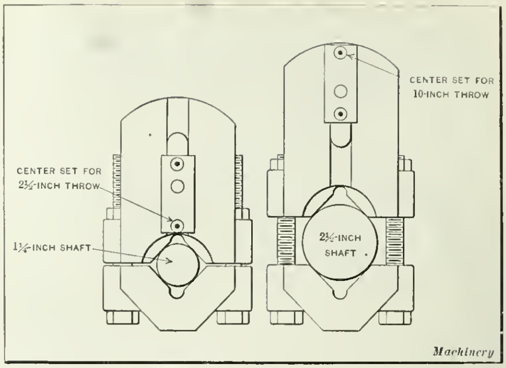


Single-action Press built in Six Sizes by the Ferracute Machine Co.

The press is shown partially inclined. It may be completely inclined or raised to an upright position by an elevating attachment, operated at the back of the press by the two-handled wrench shown on the floor. Presses of the same size and construction are also built with gearing instead of a flywheel. This machine exerts a pressure of 35 tons and weighs 4700 pounds. Some of the dimensions are as follows: Stroke of ram, 2 inches; adjustment of ram, 3 inches; opening through back, 17 inches wide by 11 inches high; depth of throat from center of ram back to frame, 9 inches; height from bed to ram at top of stroke and adjustment, 10½ inches. The flywheel has a diameter of 35 inches, width of 6 inches, and weight of 750 pounds. The diameter of the steel shaft at the journals is 3½ inches and at the crank, 4¼ inches.

SALTER CRANKSHAFT CENTERS

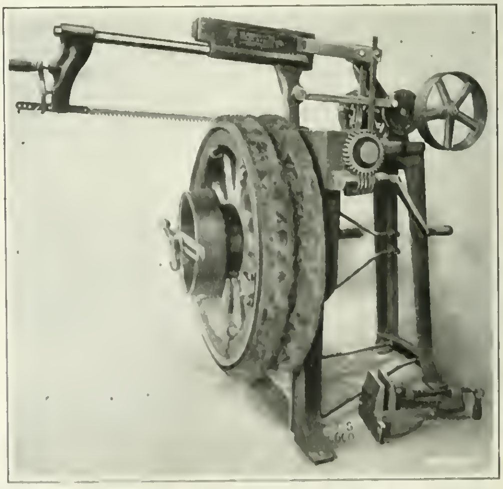
For use in turning the bearings on crankshafts, the Salter Motor Mfg. Co., 1516-1518 Oakland Ave., Kansas City, Mo., developed a set of universal centers for its own use. The centers are adapted for turning one-cylinder, two-cylinder, four-cylinder, or six-cylinder crankshafts, and they will fit any shaft from 1⅛ inch to 2½ inches in diameter, and turn any throw from a 2½-inch crank to a 10-inch crank. These centers proved so successful in operation that recently a decision was reached to make them for the market. They are especially adapted for use in garages where machines are sent in that require the crankshaft bearings to be trued up in order to enable the engine to run quietly and efficiently.



Centers made by Salter Motor Mfg. Co. for Use in refinishing Crankshaft Bearings

ROBERTSON HACKSAW FOR TIRE RIMS

For use in cutting old tire rims of any size from 30 to 40 inches in diameter, the W. Robertson Machine & Foundry Co., 56-58 Rano St., Buffalo, N. Y., has placed on the market the No. 600 hacksaw machine which is here illustrated. This machine is adapted for cutting the steel rims supporting the rubber on truck tires. When new, these tires are placed onto the wheel rim with a hydraulic pressure of from 30 to 50 tons, and after the wheel has been used, rust and corrosion occur between the wheel rim and the tire rim, thereby uniting the metals to such an extent that it is often impossible to remove the tire rim from the wheel. To facilitate cutting the rims of these truck tires, a special frame was designed with worm-gearing employed to raise the wheel to the proper height. Very little effort is required to raise a thousand pounds, and one man can take care of the work of cutting a rim of the maximum size. The machine cuts on the draw stroke and lifts the frame on the return stroke, this being accomplished by an oil compression lift pump. The saw frame has a capacity for blades from 12 to 24 inches in length and will cut

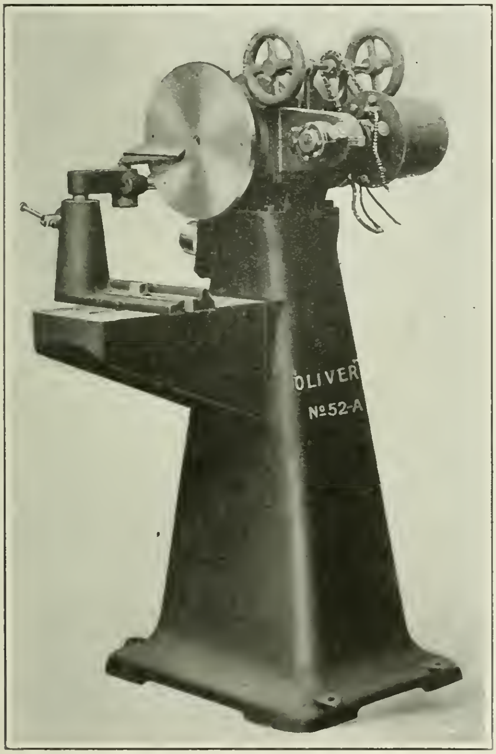


No. 600 Power Hacksaw Machine built by the W. Robertson Machine & Foundry Co.

rims on dual tires up to 16 inches in width. Either belt or motor drive may be provided. The machine occupies a floor space 36 by 66 inches in size; the height of the blade when the cut is completed is 40⅛ inches; the over-all height of the machine is 55 inches; and its net weight is 590 pounds.

OLIVER FACE LATHE

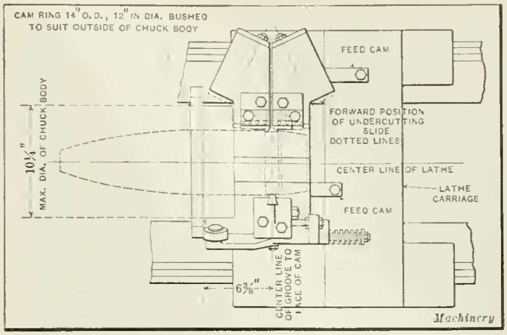
In the accompanying illustration there is shown a motor-driven face lathe which is one of the recent products of the Oliver Machinery Co., Grand Rapids, Mich. This machine is self-contained, the motor-driven head, controller or switch, and rests being mounted on a floor column, making the machine especially desirable for use as a portable face lathe. All electrical parts are totally enclosed to exclude dust and provide for the safety of the operator. This lathe swings 24 inches over the bracket, 20 inches over the rest socket, and will turn work up to 12 inches wide by 20 inches in diameter, or up to 6 inches wide by 24 inches in diameter. The equipment furnished with the machine includes a 16-inch tool-rest with an offset rest-holder, a right-angle rest, a 6-inch faceplate, a 12-inch faceplate, and a 2¼-inch screw chuck. A motor head may be provided for use on this machine equipped with an alternating-current motor to run from 800 to 3500 revolutions per minute, the speed being controlled by handwheels which govern a self-contained controller. A direct-current motor for the head may also be provided to run at from 600 to 3000 revolutions per minute, with the speed controlled by a controller mounted on the floor column.



Face Lathe built by the Oliver Machinery Co.

GRAY WAVING AND UNDER-CUTTING ATTACHMENT

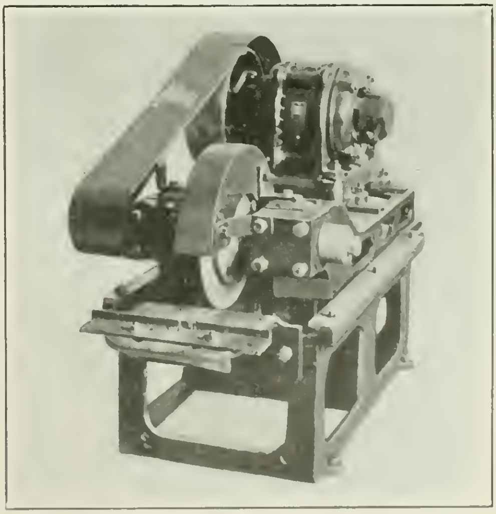
An attachment is now built by the Gray Machine Tool Co., Inc., 2661 Main St., Buffalo, N. Y., for use in waving and undercutting the copper band groove on all sizes of shells. This attachment is built in different sizes for handling various shells, although it is usually employed on shells from 4½ to 6 inches in diameter; on larger shells complete machines are usually employed. Where the attachment is used, it is made to fit any standard lathe of dimensions suitable for the operation. The shell should be held in an air-operated collet chuck, although it may be satisfactorily supported in other ways, as by a threaded nut in the fuse hole in the nose and the tailstock center, and driving with a clamp or dog. Such a method of holding is slower than where an air-operated collet is employed. The main body of the attachment is clamped to the lathe bed and on this casting are placed the waving slide and two under-cutting slides through which run hardened steel cam-bars that are bolted to the carriage at one end. On the slides are bolted the waving and under-cutting tool-blocks made of machinery steel, that hold the high-speed steel tools. As the carriage feeds along, the cam-bars force the slides and tools in to the depth set for the cut, and when the high spot is reached the slides recede. The waving and under-cutting tools are automatically brought into the work at the same time, the under-cutting tools being a few thousandths ahead of the waving tool. The wave is produced by a roller, held on a bracket from the waving slide and against a hardened steel cam-ring which is bolted to the face of the chuck. This waving cam ring is machine-cut from a master cam.


CAM RING 14" O.D., 12" IN DIA. BUSHED TO SUIT OUTSIDE OF CHUCK BODY
FEED CAM
MAX. DIA. OF CHUCK BODY
10¼"
FORWARD POSITION OF UNDERCUTTING SLIDE DOTTED LINES
CENTER LINE OF LATHE
LATHE CARRIAGE
FEED CAM
CENTER LINE OF GROOVE TO FACE OF CAM
6⅜"
Machinery

Under-cutting and Waving Attachment for 6-inch and 155-millimeter High-explosive Shells made by the Gray Machine Tool Co., Inc.

POND-ROBINSON METAL-CUTTING SAW

The Pond-Robinson Metal Saw Co., Ltd., 1204 Howard St., San Francisco, Cal., is now building a metal-cutting saw for which the following advantages are claimed: The blades have a long operating life and are capable of cutting hard metals without requiring the use of a cutting fluid or coolant. The

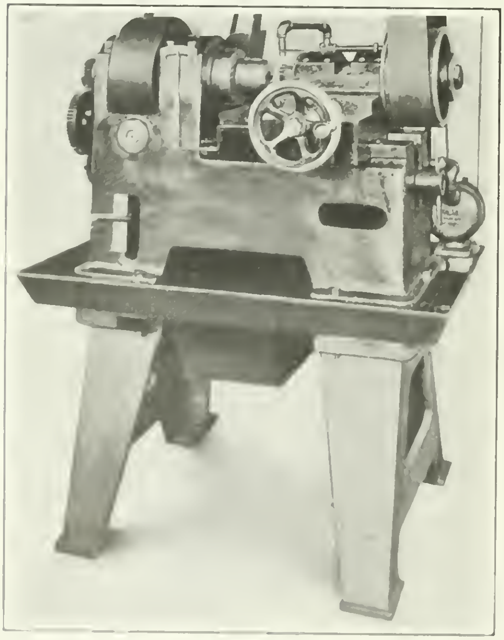


Pond-Robinson Metal-cutting Saw equipped with Improved Type of Circular Saw Blade

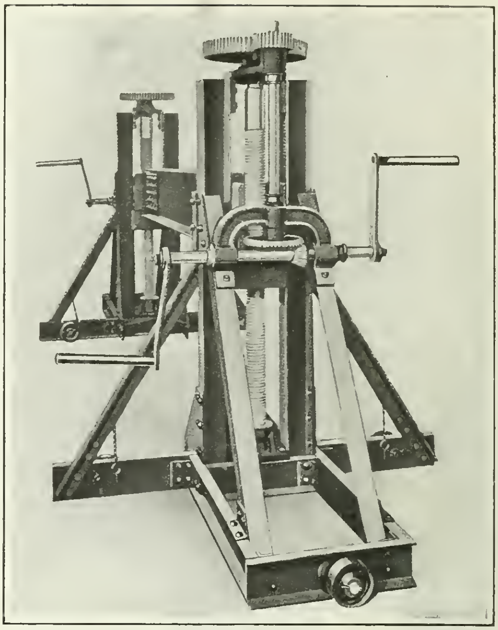
blade is mounted between bearings and ample cutting power is provided. The saw cuts rapidly and is particularly well suited for use in cutting tubes, pipe, and similar material. Saw blades are made with the cutting edge somewhat wider than the remainder of the blade, thus affording clearance, and the teeth are so formed that in cutting tubing, pipe, etc., there is no danger of their being broken off. The blade is made of steel and heat-treated by a process which makes the rim and teeth very hard. It is claimed that the saw will cut all kinds of hard steel, stellite, etc., without the necessity of annealing. Machines equipped with saws 36 inches in diameter and over are provided with air-feed cylinders. An idea of the rate at which cutting can be done will be gathered from the fact that channels ranging in size from 0 to 10 inches and tubes 6 inches in diameter can be cut in from three to ten seconds. The machines are built in four different sizes, known as Nos. 1 to 4, inclusive, and they are equipped with saws 18, 24, 36, and 48 inches in diameter, respectively. The No. 1 machine occupies a floor space 2 by 4 feet in size and weighs 600 pounds; it has a capacity for cutting steel shapes or tubes up to 2 inches and solid bars up to ¾ inch. The No. 2 machine occupies a floor space 3 by 4 feet in size and weighs 1000 pounds; it has a capacity for cutting tubes and shapes up to 3 inches, and solid bars up to 1¼ inch. The No. 3 machine occupies a floor space 3½ by 7½ feet in size and weighs 3500 pounds; it has a capacity for cutting tubes and shapes up to 6 inches, channels up to 10 inches, and solid bars up to 1½ inch. The No. 4 machine occupies a floor space 4 by 8 feet in size and weighs 5000 pounds; it has a capacity for cutting 90-pound steel rails, 18-inch channels, and 15-inch I-beams.

WOODS THREAD MILLING MACHINE

The Woods Engineering Co., Alliance, Ohio, is now building a small thread milling machine for threading shell plugs. This type of machine was developed to meet the requirements of a contractor engaged in the production of plugs for the United States Government, who was unable to procure equipment for threading the plugs. In addition to this special work, the machine is adapted for many other thread milling operations. It is interesting to note that this machine was designed and built within three weeks of the date on which the order was received.



Thread Milling Machine built by Woods Engineering Co. for threading Shell Plugs



Portable Crane built by Fox Bros. & Co. for Use in Shops where a Traveling Crane is not Available

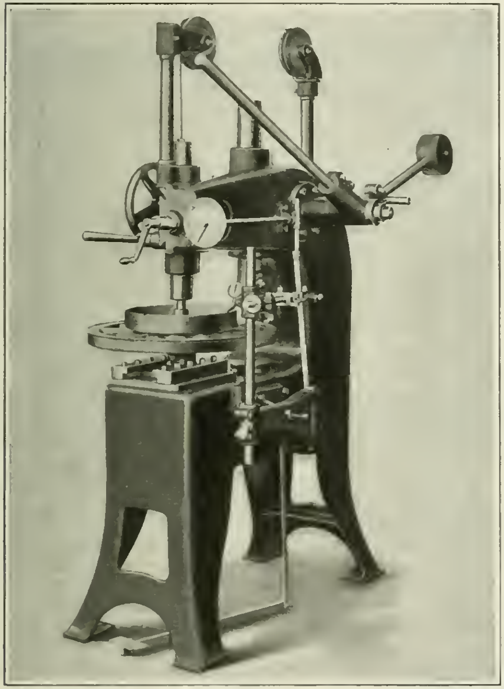
FOX PORTABLE SHOP CRANE

To meet the requirements of railroad shops and other plants where an overhead traveling crane is not provided, Fox Bros. & Co., 126-130 Lafayette St., New York City, have placed on the market the portable shop crane here illustrated and described. The complete outfit consists of four separate jacks and two cross-girders. Each jack is operated by a pair of handles so arranged that either two or four men can operate two jacks at the same time. In the case of light loads the handles are so balanced that one man can operate a jack. Each jack is mounted on cast-iron wheels with flat treads, so that they can be moved from place to place with little effort. These wheels revolve on shafts attached to eccentric bearings, so that when the jacks are in position pins are removed from the bearings, allowing the wheels to rise and the entire base of the jack to rest on the shop floor. The framework is built of structural steel shapes with the members strongly riveted together with gusset plates. Particular attention has been paid to the design of this equipment with reference to rough usage, all members having been made of ample strength so that they are capable of standing up under severe conditions of service. The crane has a working capacity of 60 tons, although each crane is actually tested under a load of 75 tons.

BLOMQUIST-ECK WHEEL INSPECTION AND TRUING MACHINE

A machine especially intended for inspecting and truing automobile wheels has been brought out by the Blomquist-Eck Machine Co., 1146 E. 152nd St., Cleveland, Ohio. This machine is provided with an indicator that shows whether the wooden automobile wheel is out of true sidewise, and whether the pressed steel brake-drum attached to the wheel is true on the inside and outside diameters, and on the rim or edge. The machine also has provision for correcting the errors of the wooden wheel that may be shown by the indicator. An arbor is held in the spindle at the top and is guided in a bushing at the bottom. On this arbor, and also on the guiding bushing, there are mounted rings, which, in turn, fit the bore of the wheel. These rings are free to revolve, so that the automobile wheel, when mounted upon them, can be turned by hand. When mounting the wheel in the machine, the operator puts his foot on the treadle shown, which withdraws the small plug bearing against the under side of the wheel rim. After mounting, he locks the spindle in position by the straight lever at the left.

When the wheel is locked in place, as far as vertical motion is concerned, the small plug bearing against the lower side of the wheel rim is permitted to come into contact with the rim by the pressure on the foot-treadle being released. A counterweight then presses the plug up against the rim, and keeps it in contact throughout the test. The plug is connected by levers with the large indicator dial shown, so that, as the operator revolves the wheel by hand, any sidewise irregularities of the rim will be indicated on the dial. While rotating the wheel, the operator keeps his eyes on the dial, and then operates the long lever that is connected by a gear and rack to the ram, which, when brought down upon the side of the wheel that is high, corrects the error by bending the wheel rim straight. In case the wheel rim needs to be pushed up instead of being bent down, the lift attachment, provided with a hook and mounted on the end of the ram, is brought into use. The spindle is mounted on an arm, and made adjustable along this arm in order to provide for different diameters of wheels. The slide on the table is provided for the same purpose, as the ram is always in the same position and must come over the wheel rim. The brake-drum is inspected in the same machine by bringing up against it a swinging arm on which is mounted an Ames indicator. In this way the truth of the inside cylindrical surface, the outside surface, and the edge of the brake-drum are tested. If they are found to be out of true more than is permissible, the drum is removed and trued up by suitable means in another machine.



Wheel Inspection and Truing Machine built by the Blomquist-Eck Machine Co.

LAFAYETTE THREAD-TOOL GRINDING FIXTURE

The thread-tool grinding fixture here illustrated was recently developed by the Lafayette Tool Works, 176 Worth St., New York City, for use in grinding thread-cutting tools of any angle from the 29-degree Acme thread to the 60-degree U. S standard. The fixture consists of a cast-iron body in which there is a 5/16-inch square hole, provided for holding the tool to be ground. A set-screw is provided for tightening down onto the tool, which may be of either square or round stock. There are two hinged bases held inward against an adjustable wedge by a single coiled spring. These bases are hinged on two taper pins which provide for slight wear. The wedge is adjustable in and out along a line parallel with the center line of the tool to be ground. By turning the double slotted screw, the adjusting wedge is operated in and out, thereby throwing the hinged bases inward and outward on their pivots, causing them to form various angles with the center line of the fixture. This wedge is graduated with a neutral mark and the base is graduated by degrees from 29 to 60.

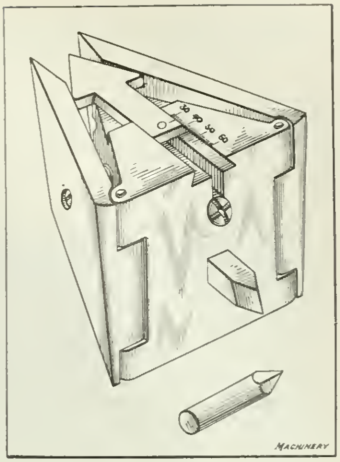


Fig. 1. Close View of Thread-tool Grinding Fixture, showing Arrangement of Mechanism

The clearance angle on the tool is automatically provided for by the hinged bases being set off at 15 degrees in the correct direction for producing clearance on the tool. This tool not only takes the place of the three solid blocks that would be required for the Acme 29-degree, Whitworth 55-degree, and U. S. standard 60-degree thread, but may be quickly adjusted to any of the angles in between, such as 46 and 47, which are often used in gage-making for grinding a tool that is to cut a thread that is afterward to be ground to 60 degrees. While the fixture is graduated only in degrees, minutes and seconds may be set upon it by a toolmaker's protractor. The device is cast iron, except the wedge, which is cold-rolled steel, hardened,

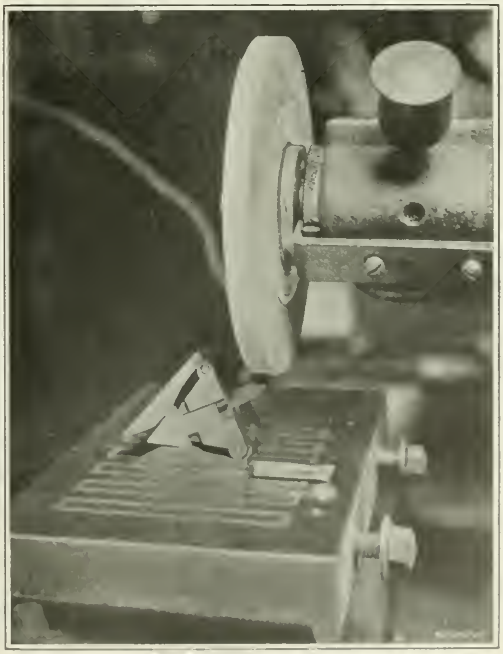
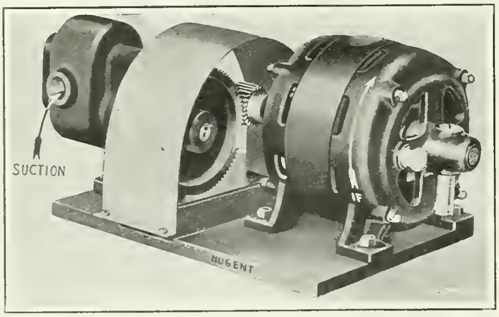


Fig. 2. Universal Thread-tool Grinding Fixture made by the Lafayette Tool Works

NUGENT MOTOR-DRIVEN OIL PUMP

William W. Nugent & Co., Chicago, Ill., have developed a geared, motor-driven rotary oil pump for oiling systems and for pumping oil from a barrel to an overhead reservoir. Two sizes are obtainable, having a delivery of eight quarts per minute and forty quarts per minute at 500 revolutions per minute. Power is furnished through a noiseless rawhide pinion from a fractional horsepower motor made by the General Electric Co., Schenectady, N. Y., for the prevailing current. The motor is controlled through a rheostat and switch box mounted in a convenient location.



Motor-driven Oil Pump built by William W. Nugent & Co.

ALTERNATING-CURRENT ARC-WELDING MACHINE

It is rather a general impression among users of arc-welding machines that satisfactory results can only be obtained where direct current is used for operating the equipment. Despite this fact, the Arcwell Corporation, 42 Broadway, New York City, has placed on the market an apparatus in which alternating current is successfully used for arc-welding. Under ideal conditions of operation, the length of arc used for welding should be approximately 1/16 inch, but it is impossible for even the most experienced welders to continue to hold their hands steady enough to maintain the desired uniformity in the length of the arc. Ordinarily, where alternating current is used, the arc will be broken whenever the welder's hand moves sufficiently so that its length is considerably in excess of 1/16 inch. If the arc is broken, it is necessary to bring the welding electrode into contact with the work to be welded and then to draw it away in order to re-establish a fresh arc, after which welding can be continued until the arc is once more broken. In standard forms of equipment using direct current, slight variations in the length of arc do not result in trouble of this kind.

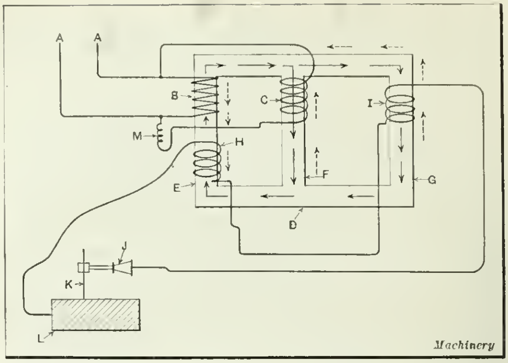


Fig. 2. Diagram showing Arrangement of Transformer Windings

In the apparatus built by the Arcwell Corporation, where alternating current is used for arc-welding, a special form of transformer is contained in the case illustrated in Fig. 1. This cuts down the voltage from 220 to approximately 80 volts on open circuit; while welding, the potential across the arc is less than 25 volts. So far as the method of procedure is concerned, there is nothing unusual about the machine. The apparatus is connected to an ordinary power switchboard or service and Swedish iron wire is used for the welding electrode. In Fig. 1, the operator is shown at work repairing a cracked hub of a pulley.

An arrangement of transformer windings has been developed, which keeps the temperature of the arc constant, even though the operator's hand wavers. As a result, the weld produced by the machine is soft, strong, and ductile. The theory of operation of the transformer will be readily understood by referring to Fig. 2 while reading the following description. At *A* there are shown the terminals where connection is made with a source of alternating-current power, and the main primary winding of the transformer is shown at *B*, while the auxiliary primary winding is shown at *C*. There is an iron core *D* consisting of three legs *E*, *F*, and *G*, and the main secondary winding is shown at *H*, while the auxiliary secondary winding is indicated at *I*. The electrode holder in which a piece of Swedish iron wire is carried will be seen at *K*, and the work to be welded is indicated at *L*. Coil *M* is simply a retarding inductance. Primary coil *B* sends magnetic flux through the cores in main primary winding *B* and auxiliary primary winding *C*, and core *G* in the direction indicated by heavy arrows. As a result, when electrode wire *K* touches the work *L* current flows through the secondary windings *H* and *I*. Flux produced by these two windings is sent in the direction indicated by dotted arrows. Under a light load, the auxiliary primary winding *C* prevents the primary flux from entering core *F*, but under a heavy load the secondary flux becomes strong enough to overcome the effect of primary winding *C*; in other words, the transformer can be short-circuited without damage. Arcwell electric arc-welding machines are built in 75-, 150-, 300-, 400-, and 600-ampere sizes. The 150-ampere size, which is best suited for average classes of service, has leads brought out for welding at 75, 100, 125, and 150 amperes. A cutting lead is also brought out to provide for the rapid performance of cutting operations at 200 amperes.

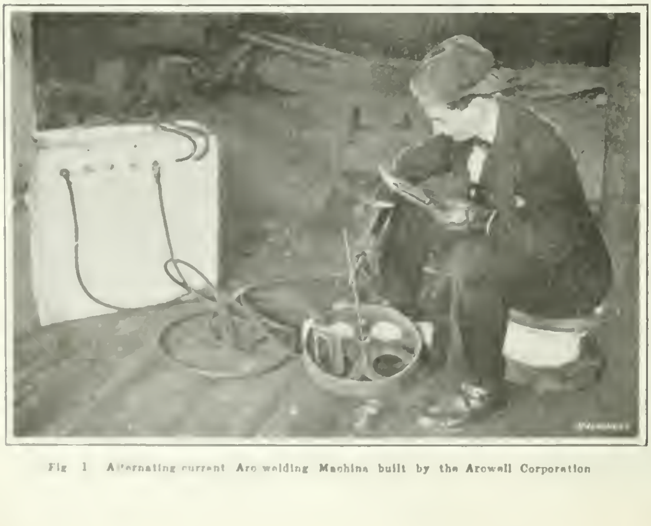
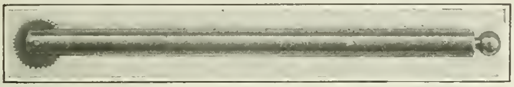


Fig. 1. Alternating-current Arc-welding Machine built by the Arcwell Corporation

"SECTOSTYLE" FOR CROSS-SECTIONING

To facilitate the work of drawing evenly spaced cross-section lines on drawings, the American Sales Co., 311 W. 59th St., New

York City, has recently placed on the market an instrument known as the "Sectostyle." It consists of a handle carrying a pivoted toothed wheel which the draftsman impresses into the paper where cross-section lines have to be drawn. As this wheel is rolled over the paper it marks spaces which indicate the points at which section lines should be drawn, thus improving the appearance of the drawing by making the lines regularly spaced. The instrument is held in the same way as a pencil and the wheel is moved along the edge of the T-square or triangle. Various effects in the spacing of section lines may be obtained by skipping alternate marks laid out by the "Sectostyle," etc. This instrument is very simple to use and enables inexperienced draftsmen to produce cross-sectioning of good appearance rapidly.



"Sectostyle" made by the American Sales Co. for cross-sectioning Drawings

NEW MACHINERY AND TOOLS NOTES

Belt Dressing Distributor: Improved Surface Mfg. Co., North Tonawanda, N. Y. A cylindrical tin with rubber cushion contact for a speeding belt and lineal regulator to keep the material in condition.

Countersink: Standard Tool Co., Cleveland, Ohio. A countersink especially designed for countersinking holes in ship plates. This tool is made in two styles with spiral or straight flutes and has three cutting lips. It is made of high-speed steel.

Forming Hammer: C. M. Yoder Co., Engineer's Bldg., Cleveland, Ohio. A power hammer designed for use in forming and planishing various shapes of sheet metal, such as automobile bodies, hoods, cowls, and other curved sheet-metal products. This hammer is built in several sizes to meet the requirements of diversified classes of work.

Bevel Knife Grinding Machine: Machinery Co. of America, Grand Rapids, Mich. A bevel grinding machine for use on circular knives, cutters, and similar shaped work, ranging from 3 to 20 inches in diameter. This machine is suitable for grinding or sharpening the circular cutters or knives commonly used for cutting paper, cork, cloth, and similar substances.

Planing Machine: Bickett Machine & Mfg. Co., Cincinnati, Ohio. This company is now building an improved line of planers of extremely rigid construction which are made in the following sizes: 36 by 36 heavy, 42 by 36 heavy widened, 44 by 36 heavy widened, 42 by 42 both standard and heavy, 48 by 42 heavy widened, 52 by 42 heavy widened, and 44 by 44 standard.

Shell-nosing Attachment: R. J. Whelan, 328 Fourth St., Elyria, Ohio. An attachment designed for use on any standard steam or air hammer or any mechanical forging press in which the lower is the fixed die and the upper the movable one. This device is built for handling forgings for the following sizes of shells: 4.7-inch, 155-millimeter, 8-inch, and 240-millimeter.

Industrial Truck: Cowan Truck Co., 88 Water St., Holyoke, Mass. An elevating truck provided with an improved locking device which consists of a mechanism designed principally to prevent the load from becoming unseated when the truck is being drawn over uneven floors. Trucks of this type are built in various sizes, with load-carrying capacities ranging from 1000 to 3000 pounds.

Grinding and Boring Attachment: Nelson Tool Co., 1605 W. Lake St., Chicago, Ill. A combination boring-bar and grinding wheel attachment for use on lathes and shapers. This device is placed over the toolpost and is held by means of the regular toolpost screw which is tightened down upon a bar slipped through the hole. An adjustment provides for raising or lowering the bar or wheel to any required position.

Journal and Axle Lathe: Niles-Bement-Pond Co., 111 Broadway, New York City. This machine provides for turning car wheel journals without removing the wheels from the axle. It is a combination journal turning and axle lathe for machining the inside and outside journals on axles of the center-drive type. The upper portions of the bed are capable of contraction to form gaps which will clear wheels mounted on the axle.

Bench Furnace: Johnson Gas Appliance Co., Cedar Rapids, Iowa. A bench furnace adapted for heating small parts. This is known as a No. 108 furnace and gas is used for fuel. A work-rest block is furnished and a baffle plate partially closes the mouth of the furnace. These features, together with the angle of the burners and curved shape of the hood are said to enable the furnace to give very uniform results in heating the work.

Shell Lathe: Buffalo-Pitts Co., 4th and Carolina Sts., Buffalo, N. Y. A machine which provides for the performance of three operations at a single setting of the work. The functions of the machine are to cut off the open end of the shell forgings to a predetermined length from the inside of the base, to drill a centering socket in the outer surface of the base, and to face off the outer surface, giving a predetermined thickness of the base.

Rifling Machine: J. N. Lapointe Co., New London, Conn. A machine developed for use in broaching the rifling in one-pounder gun barrels. Two operations are required to complete the rifling operation, roughing and finishing broaches being employed for the respective operations. The length of the rifled section in these gun barrels is 44 inches and there are twelve helical grooves approximately 0.015 inch deep which make one complete turn in 40 inches.

Power Presses: Moore & Co., Grand Ave. and Franklin St., Chicago, Ill. These machines are designed with an exceptionally large die-bed and ample lift of the ram. These features allow the use of large dies for comparatively light work that would otherwise have to be done on punch presses of considerably greater capacity. These new additions to the line of presses built by Moore & Co. include a No. 4 punch press, a No. 2 screw press, and a No. 3 inclinable punch press.

Belt Fastener: W. O. & M. W. Talcott, 91 Savin St., Providence, R. I. Two types of belt fasteners, one of which is known as the "Ideal" and is used on rubber, canvas, balata, and textile belts. This fastener is used between the layers of the belt or on the side away from the pulley. The fastener is secured to the belt by means of rivets. The other type of fastener is known as "Acme" steel belt hook and is adapted for use in fastening leather, rubber, or canvas belts.

Filing Machine: Barry Mfg. Co., 5-11 E. Kinzie St., Chicago, Ill. This machine is made in two sizes which are designated as Nos. 2 and 3. They are provided with a file holder that permits the use of any regular or special file with either a straight or tapered shank. Jig-saw or hacksaw blades can also be accommodated. The table is adjustable in four ways to give any angle or clearance required on the work, and indicator scales and needles facilitate accurate adjustment.

Drilling, Boring, and Tapping Machine: Rockford Drilling Machine Co., Rockford, Ill. A combination horizontal drilling, boring, and tapping machine which is especially designed for use on large parts where the regular table cannot be used to advantage. This machine has vertical and horizontal movements of the head and column, which permit the spindle to work over an area 18 inches high by 36 inches long. Floor plates and work-tables can be furnished with the machine to meet the customer's specifications.

Stud Driver: Giern & Anholtt, 33-43 St. Aubin Ave., Detroit, Mich. With this tool the stud is screwed into a tubular portion held by means of an inclined slot in the tube working on a pin in the handle. Due to the action of screwing the stud into place, the handle is advanced by means of this slot and pin, and firmly holds the stud. When the motion is reversed, the pin moves in the slot and releases the pressure on the stud, thus allowing the driver to be easily unscrewed without disturbing the position of the stud.

Grease Cup: Dawson Mfg. Co., 4928 Broadway, Chicago, Ill. A line of grease cups which comprises a number of different styles. A feature of the design is that it has been worked out in such a way that a device is provided which prevents the cap of the cup from unscrewing due to vibration. Another feature is that assurance is provided that the cap will be lined up properly when it is screwed into place without danger of damaging the threads. These cups are made in six styles with inside diameters ranging from 13/16 to 1¼ inch.

Fluid Pressure Governor: General Electric Co., Schenectady, N. Y. A pressure governor adapted for use on gas and liquid systems where it is important to maintain the pressure fairly constant. This governor is so designed that it provides for maintaining pressure between certain predetermined limits, starting or stopping the motor-operated pumps or compressors as may be required. Governors of this type are made with rated capacities for pressures of 80, 100, 160, 300, or 500 pounds and operate within settings of from 3 to 12 pounds between the high and low pressures.

Electrical Switch: Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. A switch designed with no exposed live parts, which is used as a substitute for the ordinary knife switch. The current carrying parts and fuses of this safety switch are enclosed in a steel box, and the circuit is opened and closed by a toggle type of operating mechanism. The cover of the box that contains the switch is divided into two parts, one of which forms a permanent covering for the switch while the other part is hinged to swing back, thus permitting renewal of the fuses.

SPRING MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

At the spring meeting of the American Society of Mechanical Engineers, held in Worcester, Mass., June 4 to 7, a number of valuable papers and reports were presented. Among the latter, the most important was the report of the Committee on Screw Thread Tolerances, part of which is abstracted elsewhere in this number of MACHINERY. A report of the Committee on Weights and Measures was also presented, consisting almost entirely of a reprint of the report entitled "The Metric System in Export Trade," made by F. A. Halsey to the American Institute of Weights and Measures, an organization that has for its main object the maintenance of the English system of weights and measures in the United States.

This report is based upon more than a thousand answers to a questionnaire which was sent to several thousand manufacturing concerns in the United States, some or all of whose products are shipped to countries where the metric system is in use. The conclusion of this report is that the export trade in the United States is mainly conducted in the English system of measurements. Eighty-two per cent of the exporters to countries using the metric system do not use this system in their production, while 14 per cent use it partially, and 0.4 per cent exclusively. Between 3 and 4 per cent of the manufacturers did not reply to this question. Only 1.6 per cent of American exporters that replied to the questions put to them by the American Institute of Weights and Measures use the metric system in response to a commercial need, and 38 per cent make some use of it in shipments, because compelled to do so by the laws of foreign countries.

A report was also presented by the Committee on Steel Roller Chains, this committee having cooperated with a committee of the Society of Automotive Engineers. This report recommends mainly retaining the standards already in use by various manufacturers.

Standards of Graphic Presentation

A report was presented by the Committee on Standards of Graphic Presentation, to which a number of associations of national scope have appointed representatives. This committee has been making a study of the methods used in different fields of endeavor for presenting statistical and quantitative data in graphic form. It is evident that the graphic method permits the presentation of such figures and data with a great saving of time, and with more clearness than would otherwise be obtained. If simple and convenient standards can be found and made generally known, there will be possible a more universal use of graphic methods, with a consequent greater speed and accuracy with which complex information may be imparted and interpreted. The report lays down a number of fundamental principles that ought to be observed in elementary graphic presentation. Copies of the report may be had from the American Society of Mechanical Engineers, 29 W. 39th St., New York City, at a price of 10 cents.

Papers Read at Convention

A great number of papers were read at the various sessions, many of which dealt directly or indirectly with war conditions. Among those that had more direct bearing upon the war were "The Textile Industry in Relation to the War," by J. E. Rousmaniere; "The Small Industry in a Democracy," by George H. Haynes; "Converting a Factory for Munitions Manufacture," by John S. Holbrook; "Some Economic Aspects of Fire-protection Problems and Hazards in War Times," by J. Donald Pryor and Frank V. Sackett; and addresses on emergency technical war training, which were given in connection with the vocational training session.

The fuel problem is particularly pressing at this time, and there were two papers relating to this question: "Oil Fuel in New England Power Plants," by Henry W. Ballou, and "An Investigation of the Fuel Problem in the Middle West," by A. A. Potter. Two papers were contributed relating to safety education, one by L. A. De Blois, "The Safety Engineer," and one by George N. Fellows, on "New Course of Instruction in Safety Work."

Efficiency of Gear Drives

A paper was read by C. M. Allen and F. W. Roys on "Efficiency of Gear Drives." The usual method employed in determining the efficiency of a gear drive is one in which the power loss is obtained by measuring the input and output and subtracting the latter from the former. In good drives, however, the efficiency is high and the input and output are very nearly equal, and any error in their measurement will result in a large percentage of error in their difference, or the power loss. It is, therefore, evident that a method by which the power loss may be directly measured will be much more accurate. The paper described such a method, developed recently in the Mechanical Engineering Laboratories of the Worcester Polytechnic Institute. In the apparatus used, an electric motor was so suspended in a cradle that both its armature and field were free to turn. The armature shaft was connected directly to the pinion gear shaft and the driven shaft directly to an Alden absorption dynamometer. The reaction of the motor field was balanced by the action of the dynamometer through a simple lever, the arms of which were accurately proportioned to the ratio of the gears. Results of tests on bevel-gear and worm-gear drives were given in tables and charts, and from the form of the curves presented and the consistency of the data, the conclusion was made that the method described is apparently the best yet devised for testing gear drives of all types.

Stresses in Machines when Starting and Stopping

A paper on the subject "Stresses in Machines when Starting or Stopping" was read by F. Hymans. For the intelligent determination of the dimensions of machine parts, it is necessary that the forces acting on them be known. The calculation of these forces follows at present one of two methods. The first assumes a state of equilibrium for the machine, which, however, exists only when the machine runs at constant speed or is at rest. In the second, the machine is considered to consist of rigid parts, but their acceleration at start or stop is considered. Neither of these methods leads to even approximately correct results. A new method for the correct evaluation of the forces acting on machine parts during start or stop is developed in this paper, and illustrated by application to a vertical geared hydraulic hoisting machine. It is shown that the stresses during start or stop depend on the inertia and elasticity of the parts, their distribution throughout the system, and on the magnitude and nature of the accelerating force. Vibrations at start or stop always occur, but whether they are pronounced and give rise to dangerous stresses depends to a very great extent on the character of the accelerating force.

Self-adjusting Spring Thrust Bearing

A paper on "A Self-adjusting Spring Thrust Bearing," by H. G. Reist, mentions how a careful study of the difficulties experienced with various types of thrust bearings used in supporting the heavy loads of water wheels and the electric generators driven by them, led the author to design the flexible bearing described in the paper. This bearing consists of a runner of a special grade of cast iron resting on a thin steel ring with a babbitted surface. The babbitted stationary ring, in turn, rests on a large number of short helical springs (ordinarily wound of ½-inch wire, 2 inches in diameter and 1½ inch long) and is held against rotation by dowel pins. A saw cut through one side does away with any tendency to dish with a change in temperature. This construction prevents the possibility of undue pressure at any point and compels each element of the surface to carry its share of the load.

Advantages to be derived from the use of such bearings are set forth, and figures are given showing a reduction in friction accompanying an increased unit pressure. Two designs are described and illustrated.

Elastic Indentation of Steel Balls under Pressure

A Paper on "The Elastic Indentation of Steel Balls under Pressure," by C. A. Briggs, W. C. Chapin, and H. G. Heil, reports the results of experiments recently carried out at the Bureau of Standards, Washington, D. C., in connection with the adjustment and standardization of precision apparatus incident to the testing of munition gages. For the case of balls pressing against flat surfaces, which was the one considered in the experiments, the results obtained show that the indentation is not directly proportional to the pressure, but to the two-thirds power of the pressure. This is of importance in the design of ball bearings, as it indicates what effects are produced on the distribution of the load by slight variations in the size of the balls in a bearing. The results are given in the form of alignment charts and in metric and English units.

Fire-protection Problems in Factories

A paper was presented on "Some Economic Aspects of Fire-protection Problems and Hazards in War Times," by J. Donald Pryor and Frank V. Sackett, which pointed out the hazards involved at the present time in the war work of five great essential classes of industry, namely: metal-working; textile mills; shipyards; flour mills and grain elevators; and piers, wharfs, and docks. The engineering problems in connection with the adequate protection of such properties have to a large extent been solved, but the necessary safeguards are lacking, due either to a failure to grasp the necessity for such safeguards or else to economic conditions. Standard automatic-sprinkler protection is the most dependable means of safeguarding these various classes of risks, but in shipyards and piers that protection alone is not enough, but must be reinforced by hydrant systems, certain structural changes, and the organization and careful training of private fire brigades.

Other papers of interest presented were "A Foundry Cost and Accounting System," by William W. Bird; "The Public Interest as the Bed Rock of Professional Practice," by Morris L. Cooke; "Moisture Reabsorption of Air-dried Douglas Fir and Hard Pine, and the Effect on the Compressive Strengths," by Irving H. Cowdrey; "A High-speed Air and Gas Washer," by Lieutenant John L. Alden; "Investigation of the Uses of Steam in the Canning Factory," by Julian C. Smallwood; "Air Propulsion," by Morgan Brooks; and "Electric Heating of Molds," by Harold E. White. Copies of these papers may be obtained upon application to the American Society of Mechanical Engineers.

Workmen's Homes and Their Influence upon Production in the Factory and upon the Labor Turnover

Leslie H. Allen, of the Aberthaw Construction Co., Boston, Mass., read a paper on the influence of the workman's home upon production in the factory and upon the labor turnover, in which he stated that recent investigations have shown that one of the most important causes of the present abnormal labor turnover is the lack of sufficient homes for the population around industrial plants. A questionnaire, prepared and circulated by the company with which the author is connected, elicited 840 replies, from which many interesting and valuable extracts are given. From a study of these replies, the general impression is gained that the causes of the labor turnover today are improper or insufficient housing, inadequate transportation, the general restlessness usual in war times, and a lack of care in placing men in positions for which they are best fitted. One point that an investigation of housing conditions has brought out is that the type of house in which the workingman is generally lodged is not suited to his needs and is often beyond his earning power to support. Three- and four-room apartments and four- and five-room houses are an experimental type meeting with considerable success.

This paper was presented at the session held at the Norton Co.'s plant in Worcester. At this session addresses on the Norton Co.'s work relating to home developments for employes, their employment methods, training schools, and hospital service, were also read. The first of these subjects was dealt with by Clifford S. Anderson in a paper on "Indian Hill Development of the Norton Companies." The employment methods as followed by the Norton companies were explained by E. H. Fish, and J. C. Spence referred to the methods followed by the companies in the training of new employes in a paper entitled "Vestibule Schools," while Dr. W. Irving Clark gave a talk on the Norton hospital service. A lunch was served to members and guests of the American Society of Mechanical Engineers at the Norton Co.'s plant.

REPORT OF THE A. S. M. E. SCREW THREAD COMMITTEE

A report was presented at the spring meeting of the American Society of Mechanical Engineers held at Worcester, Mass., June 4 to 7, by the Committee on Limits and Tolerances in Screw Thread Fits, of which Luther D. Burlingame of the Brown & Sharpe Mfg. Co., Providence, R. I., is chairman. The following paragraphs contain a brief abstract of the general scope and methods followed by the committee in its work. The complete report, containing charts and tables of limits and tolerances, as well as illustrations of gages and measuring devices recommended by the committee, may be obtained from the American Society of Mechanical Engineers, 29 W. 39th St., New York City.

The Committee on Limits and Tolerances in Screw Thread Fits was assigned by the council of the American Society of Mechanical Engineers the task "to prescribe the permissible tolerances in the commercial manufacture of taps, dies, bolts, nuts, and screws, including the method of measuring." During the years following the appointment of this committee, many meetings have been held, and work has been done through subcommittees, involving a great amount of investigation and study. Careful study has been given to data already published, and assistance has been secured from the U. S. Bureau of Standards, the Franklin Institute, the Navy Department, and from other sources. A request sent to many tap-makers for confidential information showing the limits allowed for their commercial work, led to a response by a number of leading manufacturers giving such information. This was tabulated and compared. Later, some of the tap-makers assisted by having over four thousand taps of commercial sizes from one-fourth inch to two inches, secured from a number of different makers, measured for errors in lead, in order to obtain the average variation of commercial taps which are in use today.

Early in the investigation, a meeting of screw manufacturers and users was called at the headquarters of the American Society of Mechanical Engineers in New York, at which about forty representatives were present, and the matter of tolerances and limits in screws was thoroughly discussed in the light of a tentative report which this committee had prepared. This meeting resulted in the appointment of a subcommittee to cooperate with the general committee by obtaining data from the screw manufacturers. Through this committee, and the officers of the American Society of Mechanical Engineers, over five thousand screws were obtained from the regular commercial stock of many different manufacturers, these representing work of various grades and sizes, and with cut and rolled threads. These screws were measured and the results tabulated. Sample screws and nuts were prepared having varying degrees of error in diameter and lead, and from these was determined the maximum allowable error, and charts were made to show the relation of taps and screws measured to these allowable limits.

Sample gages were also made to a closer limit than those now proposed by the committee, in order to learn how close it was practicable to make commercial work. These gages were distributed without stating what the allowance was in order that the users might not be prejudiced by thinking the limits were closer than they could work to. Comparisons have also been made with the allowances and tolerances recommended by the British Engineering Standards Committee, and the recommendations of the report are the outcome of all this study and investigation.

The study given to gaging systems led to the conclusion that no one system is best adapted to all needs; and that for a variety of work made in moderate quantities a gage for measuring errors of diameter and lead combined in the same instrument may give the best results, while for manufacturing in large quantities a fixed gage for one size only and having separate means for measuring errors in diameter and lead may be best. There is also the need in many cases of master gages, inspection gages, and workman's gages, each so made as to suit the particular needs. A number of designs of gages for these various purposes have been submitted to forty prominent manufacturers and users, and following their recommendations selections have been made which are illustrated and described in the report.

Limits and Tolerances

It is believed that eventually three grades should be established to cover not only general work, such as is here provided, but also that of more restricted and more liberal tolerances. This report deals with limits and tolerances for general work only. Tables covering medium-grade work for general use have been prepared for diameters from one-fourth inch to two inches, but the formulas can be used for sizes beyond this range. They can also be used for different numbers of threads for a given diameter within ordinary range, provided the thread is of the U. S. standard form.

Generally stated, all tapped holes should be above basic standard and all screws, below; the more above or below in pitch diameter the greater the allowance possible in error ot lead, while still maintaining a satisfactory fit.

* * *

WAR EMERGENCY COURSE ON EMPLOYMENT MANAGEMENT

Upon the outbreak of the war it became evident that the outcome of the conflict would depend upon a wise and efficient handling of labor in plants doing war work. The heads of the Industrial Service Sections of the Federal Departments, entrusted with the responsibility of formulating and administering correct labor policies, realized that there was a great lack of men trained in the art of labor management. It was decided, therefore, by these Industrial Service Departments, representing the Emergency Fleet Corporation, the Ordnance Department, the Quartermaster's Department, the Department of Labor, and the Navy, that short intensive courses should be established for the training of employment managers. The organization of such courses was undertaken by the Storage Committee of the War Industries Board. Captain Boyd Fisher of the Ordnance Department was put in charge of all these war emergency courses on employment management.

The first intensive course, from which twenty-four students were graduated, was started at the University of Rochester on March 26, 1918, under the direction of Professor Meyer Jacobstein. Another course was started at Boston on April 22, with Harvard University, Boston University, and Massachusetts Institute of Technology cooperating with the Boston Association of Employment Managers, under the direction of Professor Roy Kelly. The second course at Rochester was opened on June 3, with forty-three students.

The course consists of lectures, assigned readings, and visits to the large, well-organized plants of the city for observation and laboratory study. It requires the full time of the students for six consecutive weeks. Seven hours each day are scheduled for lectures and study, and, in addition, time will be required for notebook work and reading on assigned subjects. The topics covered in the first course are the treatment of absenteeism, tardiness, accidents, complaints, and grievances of employes; the direction of athletics and social activities, and the cooperative activities of employes; and the maintenance of discipline. Then are studied methods of hiring, including introduction of employes into business; the labor supply and insurance; relation of employment manager to management; lay-out of employment office; labor economics; medical examination; relation of employment department to outside agencies; personal service work; relation of employment manager to production; promotion of employes; records and statistics of employment office, safety work and safety organization; health of employes; specifications for jobs; suggestion system in plant; training and educating workers; transfer of employes; turnover of labor; union activities; wage systems; women in industry; workmen's compensation; industrial organization, and nature and use of statistics.

Qualifications for Admission

The authorities at Washington have stipulated that the applicant shall have had at least three to five years of good business experience and the equivalent of a high school education; he must also be a person with a strong personality, good initiative, resourcefulness, and a sympathetic understanding of the problems affecting the worker. It is moreover preferable that a person even with these qualifications be designated as a prospective employment manager by a firm engaged in war work, or designated by such a firm or a government department as its representative. The manufacturer or the government department so designating the student must agree to use him as an employment man upon completion of the course or some other satisfactory outcome of the work must be prearranged.

The course is open to women who have the prescribed qualifications. Participating in this course will not exempt a man of draft age from military duty, nor will a commission be given to graduates. Because of the intensive nature of the work, there are no evening courses, nor are there special summer or correspondence courses; persons enrolling must be present throughout the entire period of six weeks. There is every indication that there will be a large demand for competent employment managers and the Government will attempt to place people satisfactorily completing the course. It is, however, impossible to make definite promises to this effect.

It is becoming increasingly evident that a number of women and some men who wish to enter the field of employment management are fully qualified in all respects except industrial experience. It is the consensus of opinion that people who have had valuable experience in other fields, and even men and women who have had close contacts with industry from various angles but have never worked in a factory, need some experience in actual factory processes before they are adequately prepared for the six weeks' course in employment management. Women employment managers especially need this mechanical training because more and more women workers are going into the machine trades, and the proper selection and placement of workers depend largely on the employment manager's knowledge of mechanical processes. For this reason a two months' course in factory work under supervision will be offered in Pittsburg, Cleveland, or Detroit because of the large number of war contracts which the manufacturers of those cities have.

Official information and application blank for the course may be secured by addressing Captain Boyd Fisher, 717 Thirteenth St., Washington, D. C. The authority to enroll students in all War Emergency Courses on Employment Management and the passing upon the applicant's qualifications rest entirely with the government agencies at Washington.

* * *

WOMEN WORKERS IN FRENCH FACTORIES

As the employment of women in the various industries increases, much is being written of the results of the employment of women in England and France. Many of the writers, however, give widely different views; therefore an effort has been made by MACHINERY to learn the true conditions in France. Emile Chouanard[1] and George H. Brigham,[2] of Paris, in answer to inquiries sent them, state that one-third of the employes in French munition shops are women, while in shops engaged on light work they form about two-thirds of the force. In the Citroen and Delage plants they form 60 per cent of the force and in the Renault works, 30 per cent. In the Citroen factory, they are employed only in the manufacture of 75-millimeter shells; at the Renault factory the work is more general, comprising airplane engines, motor trucks, armored cars for machine guns, etc. In fact, they are employed in the various factories in inverse proportion to the heavy work done; that is, if the work is practically all hard and heavy, less women are employed. As a rule, women are not employed in shops handling heavy work, such as locomotives, for the pieces are too heavy for them to handle and the work requires well trained mechanics.

Owing to the impossibility, during war time, of creating schools for their training, women workers in French factories had to receive their training in the shops. In the Citroen works, after an apprenticeship under the men, they are put directly on the machines; several women have gone into the tool-room and have become all-around machinists. In the Renault works, women are put directly on the machines with someone working with them until they become accustomed to the work; then they are left to themselves. Their wages are arranged during a period of fifteen days in such a way that if they do not become experienced enough to make a good day's wage on piece-work, they will still have enough to live on; if, at the end of that time it is seen that they will not make good on that particular work, they are changed to other work. In most factories women begin with the simplest work and run ordinary lathes without any training. Some of the more skillful are soon able to run other machines.

---

[1] Care of Aux Forges de Vulcan, 3 Rue St. Denis, Paris, France.

[2] Address: 91 Rue de Maubeuge, Paris, France.

In the Citroen works, women are employed on inspection, and also work on automatic or semi-automatic machines tooled by experienced men. In the Renault works, women are employed on all kinds of work-adjusting, setting up, inspection, work on automatics, semi-automatics, etc. Some are grinding cylinders, work that requires much skill, while others are grinding valves. In the tool-room, some women are making taps and dies, while others are employed simply as operators, running machines that have been tooled by men.

While the number of accidents has been reduced with the employment of women, this is due considerably to the larger use of safeguards by the manufacturers. In the Citroen works, however, the proportion of accidents has remained practically the same. In the Renault works, as about 30 per cent of the employes are women and about 30 per cent of the cases given first-aid are women, apparently the proportion of accidents has not increased.

Wages and Output

The women come from all sorts of occupations and many have never worked in factories before. Some were maids, others were cooks and shop attendants of all kinds, and a large number were the wives or daughters of mechanics. As a rule, the women improve rapidly in their work, and when on piece-work make considerable progress and good wages. They prove most useful in work requiring dexterity and skill. In the Citroen works, they are given the same pay as the men for the same work. In the Renault works, even in the tool-room, they are not paid quite the same wages as the men; care is taken to keep women on light work, and all the heavier work is done by unskilled male labor. As a rule, in the munition factories, the average woman's earnings are three-fourths of a man's. In some cases, particularly at the beginning, some women produced more than the men, perhaps on account of a spirit of rivalry, but it was found that they could not maintain this speed. Many became ill from fatigue and were forced to take a rest; when they resumed their work, the production was lower. In general, the women belong to the same union as the men.

Opinion of Employers as to Efficiency of Women

Manufacturers differ greatly in their opinions of the efficiency of women employes, and the opinions seem to vary according to districts. Some manufacturers, like André Citroen, say that they are well pleased with the results produced by the women, while others are eagerly awaiting the end of the war when they will have their male mechanics back again. They seem to be more satisfied with repetition work than the men, but, on the other hand, are less stable. If they do not feel quite well they do not come to work when a man would. During a certain period when observations were taken, there was an efficiency among the men of 90 per cent of the total number of machine hours, while the women showed only 75 per cent.

In many cases, the hours of work have had to be altered; at first they were about the same as for the men, but later they had to be reduced. Many lifting devices also had to be designed to make the work less laborious, especially in the case of handling shells on a lathe. In the Citroen works slight modifications have been made on the machines to help in tightening up chucks, but as the work is entirely on the 75-millimeter shells, no further modifications were necessary.

PRIORITY ORDERS FOR STEEL

In order to preserve the nation's steel supply, and to prevent the use of steel in industries that are non-essential to the winning of the war, the Government has made a ruling that no steel is to be furnished by the steel mills to manufacturers or dealers except upon presentation of a priority order. If this ruling is to be literally interpreted, it will cause a great deal of difficulty in many industries that produce materials directly or indirectly necessary in the conduct of the war; and the machine tool industry would especially be hampered in its production, delays in filling orders would be inevitable, the clerical work of keeping track of hundreds, and perhaps thousands, of priority orders, as in the small tool industry, would be greatly increased, and instead of aiding in winning the war by conservation, the new ruling would hamper its prosecution by slowing up production.

It is therefore to be expected that modifications in the ruling will be made to suit certain absolutely essential industries, like the machine tool industry. In this industry, practically all work now done is for war materials—directly or indirectly. One manufacturer reports over 90 per cent of all his work to be war work directly, and of the remainder, it is likely that a large percentage is indirectly used in the production of war materials. Another manufacturer reports 95 per cent, and still another 98 per cent of his work to be war work.

In view of these facts, it has been suggested that machine tool builders and makers of tools who can show so large a percentage of war work be exempted from the literal interpretation of the steel priorities order, and that some blanket priority order be issued to the machine tool and small tool manufacturers that would cover all their requirements. The steel jobbers and dealers who supply manufacturers of this kind should also be assured that when they fill orders on these blanket priority orders, they may replenish their stock from the mills without other formality than a statement of the order number for which the steel was supplied.

The Cleveland Twist Drill Co., Cleveland, Ohio, makes the following specific suggestions with regard to this subject, and if, upon the publication of this article, the Government has not yet modified the details of the ruling to meet the necessary demands of the machine and tool industries, manufacturers generally ought to forward to the Priorities Board at Washington similar suggestions. The suggestions of the Cleveland Twist Drill Co. are, in substance, as follows:

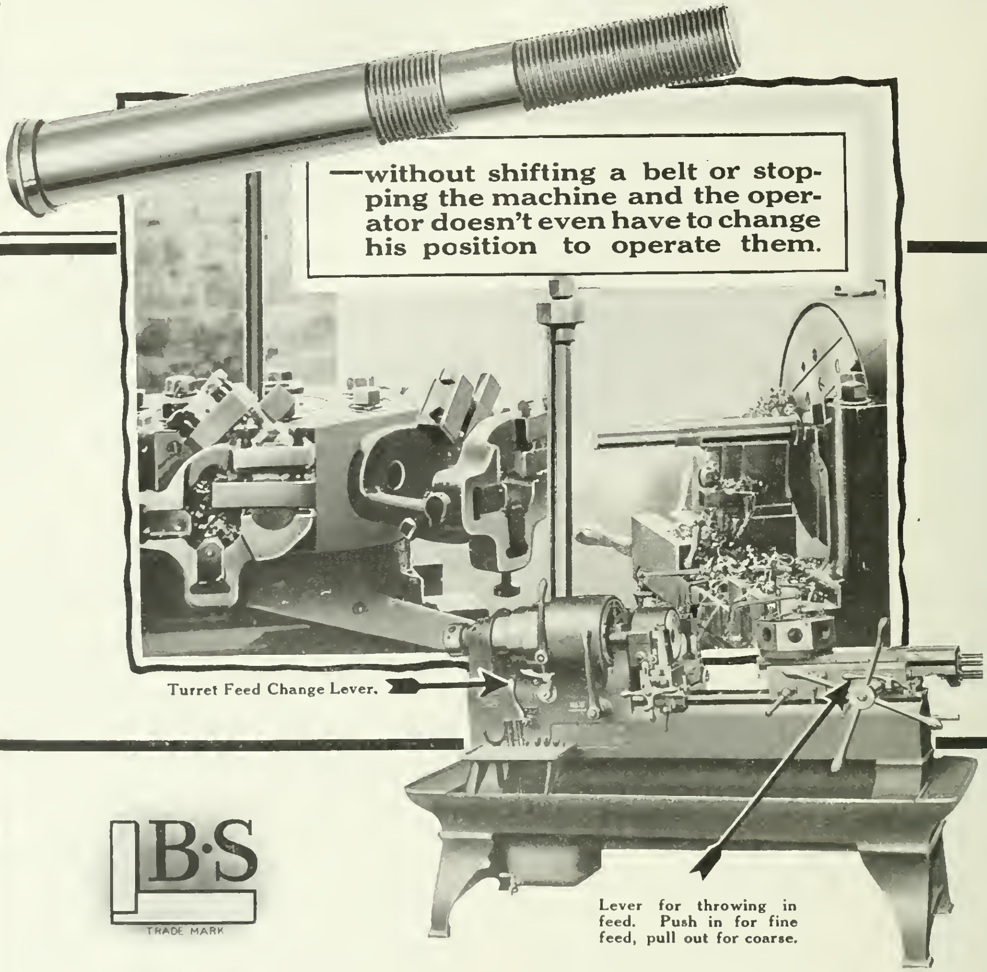
> The description of essential and non-essential industries is not fully or well defined at this time. Until they are generally understood, it would be of material assistance, and would reduce clerical work to a minimum, if the Government would issue a Manufacturer's Priority License, or, in other words, a license issued to manufacturers of essential war material, machinery, and tools, for securing factory supplies. The number and symbol of such license or certificate should be used on order blanks to assure the recipient, without further investigation, that the Government recognizes the firm ordering the supplies as a bona fide war material manufacturer, and that, therefore, this order is entitled to all possible consideration. Such a stamp of approval could be made to carry with it a penalty for offense if used for any other than a legitimate purpose.
>
> For operating a plant and manufacturing machine and tool products, thousands of different items are essential, and it would be a criminal negligence on the part of the machine industry if the industry would not endeavor to secure recognition of the Government, enabling manufacturers to receive without unnecessary delay such articles as are necessary to carry on their business.

It certainly would greatly facilitate the speeding up of the production of war materials if, in this way, a whole manufacturing plant, engaged principally on war work, could be given a single blanket priority order; the delay incident to securing and handling hundreds of separate priority orders is unwarranted. What we want is simply an assurance that whatever steel a manufacturer receives is used for a purpose essential to the prosecution of the war; after that, cut the red tape to a minimum and let us speed up for victory.

* * *

According to the *Iron and Coal Trades Review*, of London, Great Britain has increased its output of steel from 7,800,000 tons in 1914 to about 11,000,000 tons in 1917; on the present basis, the output will reach 12,000,000 tons this year.

Two Handy Levers Provide



—without shifting a belt or stopping the machine and the operator doesn't even have to change his position to operate them.

Turret Feed Change Lever.

Lever for throwing in feed. Push in for fine feed, pull out for coarse.

B·S
TRADE MARK

The simple movement of one or both of these levers is all that is required to get the most productive feed for each turret operation, eight feeds in geometrical progression being instantly available for each spindle speed.

Practically no more effort is required to use the correct feed for each operation than to use the same feed for the entire seven tools.

This "self-contained-turret-slide-feed" feature of Nos. 4 and 6 B & S Wire Feed Screw Machines is but one of their many points that make for handiness and consequently FAST PRODUCTION. It will pay you to investigate these efficient machines in detail.

Send for Catalog 21-G

Brown & Sharpe Mfg. Co.,

OFFICES: NEW YORK, N. Y., 20 Vesey St. PHILADELPHIA, PA., 1103-1105 Liberty Bldg. CHICAGO, ILL., 626-630 Washington Blvd. ROCHESTER, N. Y., 415 Chamber of Commerce Bldg. SYRACUSE, N. Y., Room 419 University Block. PITTSBURGH, PA., 2538 Henry W. Oliver Bldg. CANADIAN REPRESENTATIVE: MONTREAL, TORONTO, WINNIPEG, CALGARY, VANCOUVER, ST. JOHN, SASKATOON, The Canadian Fairbanks-Morse Co., Ltd.

the Correct Speed and Feed For Every Operation on This Piece

Brown & Sharpe

Nos. 4 and 6

Wire Feed Screw Machines

Screw Machine Operators

the same as all mechanical workers, demand an accurate, handy, adaptable way of keeping their work to predetermined limits. Accuracy must not be sacrificed for fast production. Both can be maintained by the use of "Brown & Sharpe Equipment." A small but important part of this equipment is the precision tools employed. Brown & Sharpe Tools have supplied, for three generations, the handy, adaptable, sure method of keeping the work of the machine tool operator, the machinist and the toolmaker up to the highest standards of accuracy.

Brown & Sharpe Machinists' Tools

Not only should shop superintendents and foremen specify B & S Tools for their tool cribs, but they should encourage their men to buy them for their kits. Better work and faster production naturally follow such a course.

Send for Catalog 27
listing the thousand varieties of these world-known and world-endorsed tools

Providence, Rhode Island, U.S.A.

REPRESENTATIVES: BALTIMORE, MD., Carey Machinery & Supply Co. CINCINNATI, O., INDIANAPOLIS, IND., The E. A. Kinsey Co. SAN FRANCISCO, CAL., Pacific Tool & Supply Co. CLEVELAND, O., DETROIT, MICH., Strong, Carlisle & Hammond Co. ST. LOUIS, MO., Colcord-Wright Machinery & Supply Co. SEATTLE, WASH., Perine Machinery Co. PORTLAND, ORE., Portland Machinery Co.

HELPING UNCLE SAM

An organization has been formed by the workers in one of the departments of the Scovill Mfg. Co., Waterbury, Conn., known as the "Building No. 99 Club," the requirements for members of which are as follows: Fear God, hate Prussianism, and work or fight to beat the German Empire. Buy at least one War Stamp a week, a bond at each issue, and stand ready to serve in any capacity demanded by the Government.

The Naval Reserve Force desires to enroll at once one thousand men experienced in the operation and maintenance of gas and gasoline engines. These men are required for immediate duty and will be rated as machinist's mates. The age limits are from eighteen to thirty-five years. The applicants must be American citizens. Draft registrants with letters from their local boards will be accepted. Applicants should apply at the Naval Reserve enrolling office, 51 Chambers St., New York City, or at any Navy recruiting station.

The Government is in need of a number of mechanical laboratory assistants and draftsmen for important war work in the development of parts from sheet metal, fabric, and rubber. Graduates from manual training schools with one or two years' shop experience, or men with one or two years in an engineering school are desirable, and the pay is dependent upon ability and experience. Applicants should communicate with B. B. Fogler, mechanical engineer in charge of the Mechanical Research and Development Division, Army Defense Problems, American University, Washington, D. C. It is requested that applicants send a photograph and state their age, reference, positions in the draft, and willingness to enlist or be inducted in the army for work of this nature if necessary.

According to a statement made by Major Mark L. Ireland, Quartermaster Corps, U. S. A., who is in command of the extensive automobile repair shops at Fort Sam Houston, Texas, the great need in the present war is motor transportation, and the greatest problem arising in connection with motor transportation is to keep it available at all times for service. In order to accomplish this the Government is in actual need of hundreds of automobile mechanics and men possessing qualifications for automobile repair work. The most urgent need at the present time is for men having experience in the following trades: General automobile repair, battery repair, blacksmithing, and sheet metal work. In addition, machinists and machinists' helpers, motor vehicle inspectors, magneto repair men, and oxy-acetylene and electric welders are required. Any man, whether in the draft age or otherwise, who has had experience along the lines above indicated, is requested to write without delay to the Commanding Officer of Quartermaster Mechanical Repair Shop, No. 304, Fort Sam Houston, Texas, who will furnish full particulars concerning pay, and other subject matter indicating opportunities that are open to men possessing qualifications making them desirable for duty with this organization.

The United States Army requires 2000 additional engineering officers. The age limits for the first grade of lieutenant are from thirty two to thirty-six years of age, and for captain, thirty-six to forty two years. These limits may be slightly increased or decreased in special cases, but no one within the draft age will be considered. The applicants must be engaged in the active practice of the engineering profession and be in good physical health. The fitness for commission of all applicants will be passed upon by an examining board. Applicants must be citizens of the United States, but no application will be considered from anyone now in the government service, nor will applications be considered from anyone born in a country with which the United States is at war, or born in a country allied with a country with which the United States is at war, even though he may be a naturalized citizen of this country. Requests for application blanks should be made in writing to the Chief of Engineers, United States Army, Washington, D. C. All applicants accepted by the examining board will be commissioned within ten days or two weeks and will receive orders to report at an engineer officers' training camp, where he will be given a course in military training previous to being assigned to duty with the engineer troops.

The Secretary of the Treasury says, "The releasing of labor and materials from the pursuits of peace to the business of war is one of the necessities of our war program if we are to put our whole strength behind our men in France." This is a call to the machinists and mechanics of America engaged in the manufacture of non-essentials, to perform the highest form of service possible back of the firing lines. The government arsenals must have skilled workmen to man the ever-growing equipment called for by the needs of the ever-growing army.

This service is not in the nature of sacrifice, for the Government pays good wages for work performed under the best conditions. At the Watervliet Arsenal, Watervliet, N. Y., the housing problem is solved by a special department which devotes its entire time to securing suitable homes for its new workmen. Situated on the Hudson River, opposite Troy, and only a few miles from Albany, this arsenal offers unusual advantages to the man with a family, as it is in close proximity to good schools, libraries, churches, places of amusement, and has a moderate cost of living.

Get behind the men behind the guns! If you are running a machine anywhere that does not produce some tool, device, or material necessary to the conduct of the war, offer your skill to your country. Applications should be directed, in writing, to the Commanding Officer, Watervliet Arsenal, Watervliet, N. Y.

* * *

STANDARD SIZES OF CATALOGUES FOR PURCHASING AGENTS

The National Catalogue Conference, held at Chicago in May, recommended that catalogues be standardized to 6 by 9, 7½ by 10⅝, or 8 by 11 inches. The standardization committee of the National Association of Purchasing Agents asks that all catalogues intended for purchasing agents be made 7½ by 10⅝ inches, or one-half this size, provided they are saddle stitched, so that when opened, in filing, they will measure 7½ by 10⅝ inches. Single sheets, such as blueprints, will be filed in the purchasing agent's standard file provided they may readily be folded to the standard size. Pamphlets of the standard size may be folded for convenience in mailing, but should be so made as to permit easy unfolding and filing by the purchasing agent. The committee also recommends that paper for catalogues be confined to weights, based on the 25- by 38-inch size, of 40, 45, 50, 60, 70, and 80 pounds, and that colors be restricted to white and natural.

* * *

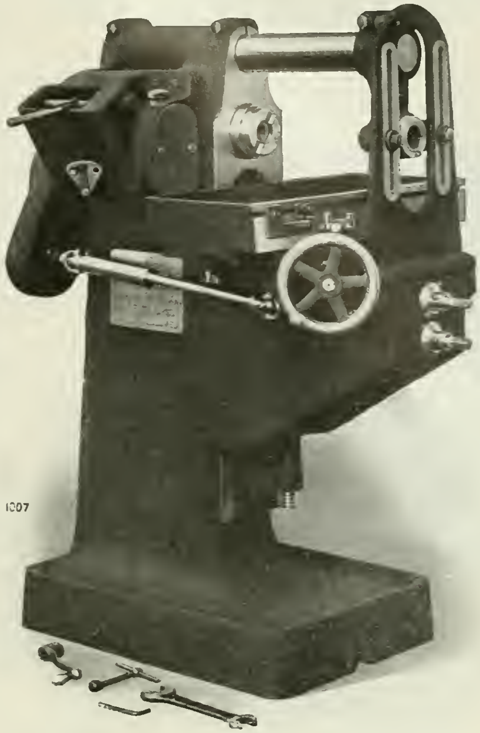
According to the reports of the deans and presidents of 150 colleges and universities with women students, girls' colleges are now reorganizing to meet the war emergency. Usually the war courses are given in the time formerly devoted to recreation; no student is allowed to elect more than one, and no student can be enrolled unless her work is up to the regular standard. The special courses are: telegraphy, wireless telegraphy, automobile mechanics, nautical astronomy, navigation, elementary nursing, first-aid, principles of war relief, drafting, medical laboratory methods, map drawing, home economics (dietetics, conservation of food, training for work in cafeterias, and soup kitchens), industrial chemistry, farm management, surgical dressings, office routine (all business training for office work), and a course for teachers in occupational therapy.

* * *

The Manufacturers' Association of Connecticut has issued a thirty page pamphlet called "Our Job," which contains portions of President Wilson's address in Buffalo, 1917, on the test of a true American, with a statement of why America is at war and an appeal for loyalty. The pamphlet is printed in English, Lithuanian, Polish, Russian, German, and Italian.

The New Cincinnati 12" Knee Type Manufacturing Miller for Repetition Work

Arms manufacturing plants and any other shops turning out great quantities of small parts will find this machine intensely profitable. Capable of standing up to the drive of twenty-four hours a day service, and giving maximum production at all times. It is compact, having only 12″ table travel. It is powerful—4 h.p. at the spindle. The drive is by constant speed belt, with a commercial range of feeds and speeds, and for the sake of simplicity, quick change mechanisms have been avoided, the change in feed or speed being made by interposing change gears.



The Cincinnati 12-inch Knee Type Manufacturing Miller.
(Patent Rights Fully Reserved)
Single Pulley Drive—4 H.P.—Twelve speeds—Four feeds.

It Is Handy

The operator stands at the end of the table. Assume that a new piece has been chucked: He runs the table forward with his right hand at 2¾″ per turn of the hand wheel. A dog hits the trip, which automatically disengages the hand movement, and at the same time throws in the power feed. When the piece has been milled, another dog disengages the power feed, and the operator brings the table back by hand, ready to chuck a new piece. *This is quick action. The operator can slam the table forward as fast as he pleases without danger of jamming the work into the cutter.* The trip dog takes care of that, and it can be set so that the work will be close up to the cutter before the power feed engages, thus reducing the power travel of the work to a minimum.

Ask for Complete Specifications

THE CINCINNATI MILLING MACHINE CO.
CINCINNATI, OHIO, U. S. A.

OBITUARIES

HENRY WARE CLARKE

Lieutenant Henry Ware Clarke, son of Charles A. Clarke of Hill, Clarke & Co. and Georgiania W. Clarke, was killed in action in France on May 29. Lieutenant Clarke was born in Chicago, where his parents then resided, on November 19, 1893, and returned with them to Newton, Mass., when he was two years old. He was educated in the public schools of that town and entered Harvard College, graduating in the class of 1916.

Lieutenant Clarke went to Plattsburg in 1916-1917, and was commissioned from there as Second Lieutenant, volunteering at once for active service in France, where he arrived in September, 1917, and began training with different units, being finally assigned to the 16th Regiment, Regular Army, Machine Gun Company. In April of this year he received an honor chevron for six months' service in the front zone. As his record shows, Lieutenant Clarke was one of the first to respond to the call of duty, inspired with that devotion to high and noble ideals which has characterized the youth of our country in her hour of need.

Lieutenant Clarke was a member of the Doric Masonic Lodge of Hudson, Mass. After leaving Harvard he became associated with his father in the manufacturing business of the Universal Boring Machine Co. of Hudson.

LESLIE H. COLBURN

Leslie H. Colburn, general manager of the Colburn Machine Tool Co., Franklin, Pa., died at his home in that city May 26. He was born in Fitchburg, Mass., in 1867, and was the second son of Henry J. and Eliza A. Colburn. When fifteen years of age, he went with his father to Toledo and after two years in the Toledo High School started to work in the shops of Baker Bros., and there learned the machinists' trade. While working at his trade, he designed and built two marine engines, one of which was in use for several years on his steam yacht *Rambler*. Mr. Colburn assisted his father in developing many of the latter's inventions, and when his father resigned as superintendent of the plant of Baker Bros., he was selected to fill this position. Leslie H. Colburn served Baker Bros. at various times in the capacity of designer and production and sales manager, and has to his credit a number of valuable patents on machine tools which he took out while with this firm. He invented the Colburn keyway cutter, which was built by the Baker Bros., and which had a large sale in this and foreign countries. He next developed a high-speed heavy-duty drilling machine for use in drilling bicycle, automobile, and harvesting machinery parts. While superintendent of Baker Bros. the business grew so rapidly that it became necessary to build a large modern foundry and machine shop which was located in an undeveloped section of Toledo, now in the center of the manufacturing district. In 1901, he left this position and went to Franklin, Pa., where he founded the Colburn Machine Tool Co. As general manager of the Colburn Machine Tool Co., Mr. Colburn supervised the bringing out of a number of new machines, including a universal saw table designed and patented by his father, Henry J. Colburn, a draw-stroke vertical shaper, a vertical boring mill, and a high-speed heavy-duty drilling machine. The boring mill and the drilling machine met with such success that the universal saw table and the draw-stroke shaper were discontinued. Mr. Colburn gave close attention to details, and always considered that the successful solution of any problem required the utmost care in the development of smaller as well as larger factors.

In 1892, Mr. Colburn married Leora I. Westbrook, of Detroit, Mich., who survives him. He is also survived by three brothers, Charles B. Colburn of Franklin, Pa., George L. Colburn, general manager of the Colburn Gear & Mfg. Co., Boston, Mass., and Harrison S. Colburn, president of the Harrison S. Colburn Real Estate Co., New York City.

Although in poor health for several years, Mr. Colburn took great interest in the various activities of Franklin, in which his business was located, and was one of the first men to urge better housing facilities for the working men of the community. He was a man of strong personality, and his passing away is deeply regretted by those who knew him.

PERSONALS

J. B. Fitzgibbon, treasurer of the Anderson Die Machine Co., Bridgeport, Conn., has resigned his position with that company.

E. P. Essley was made secretary of the E. L. Essley Machinery Co., Chicago, Ill., machine tool dealer, at a recent meeting of the company.

Walter E. Bush, 109 Highland Ave., Jersey City, N. J., has recently been appointed United States buyer for one of the largest importing corporations in Australia.

W. A. Viall, secretary of the Brown & Sharpe Mfg. Co., Providence, R. I., has had the honorary degree of Master of Arts conferred upon him by Brown University.

R. W. Ellingham, formerly factory manager of the Bilton Machine Tool Co., Bridgeport, Conn., is now connected with the Heald Machine Co., of Worcester, Mass., in a similar capacity.

E. J. Edwards, formerly assistant chemist and engineer of tests with the American Locomotive Co., has been appointed engineer of tests with that company, with headquarters in Schenectady.

Herman Weyrauch, formerly superintendent of the American Spray Co.'s Works at Elizabeth, N. J., is now employed in the Ordnance Department, U. S. Army, Gage Section, New York District Office.

L. F. Mulholland, local chemist and engineer of tests of the Richmond Works, has recently been appointed assistant engineer of tests of the American Locomotive Co., with headquarters in Schenectady.

E. F. Lake has been made superintendent of the Rich Tool Department of the American Car & Foundry Co., Chicago, Ill. William R. Man, who formerly held this position, has started a manufacturing plant of his own.

D. P. Brown, formerly of the Bryant Chucking Grinder Co., Detroit, Mich., has now become associated with the Hendey Machine Co., and is in charge of this company's office in Rochester, N. Y., Chamber of Commerce Bldg.

S. R. Hunter has recently become associated with the American Rolling Co. of Middletown, Ohio, as production superintendent. He was formerly superintendent of the Gas Engine Department of the Fairbanks, Morse Co., Beloit, Wis.

Charles A. McCune, formerly chief engineer of the Commercial Acetylene Co., has become associated with the Page Steel & Wire Co., 30 Church St., New York City, as sales engineer, and will devote his time to the sales of "Armco" welding rods.

F. J. Kidd, for six years with the Racine Mfg. Co., and former treasurer of the Corliss Mfg. Co., has been made manager and assistant treasurer of the Racine Tool & Machine Co., of Racine, Wis., manufacturer of high-speed cutting-off saws.

Arthur B. Babbitt, for the past six years head of the Department of Drawing and Design, at Wentworth Institute, Boston, Mass., has resigned that position and has given up his private engineering practice to become general manager of the Kent Machine Co., Kent, Ohio.

Frank Wollaeger, Jr., secretary of the Kempsmith Mfg. Co., Milwaukee, Wis., who enlisted in the Milwaukee Base Hospital Unit, has been transferred to the Ordnance Department and has been sent to Camp Hancock, Augusta, Ga., to take special training for his work in this department.

V. P. Signorelli, formerly secretary and assistant treasurer of the Southwark Foundry & Machine Co., Philadelphia, Pa., is now office manager and auditor of the Foundation Company-Carpenter-Watkins, Inc., Brunswick, Ga. The previous announcement concerning the change of Mr. Signorelli's position, published in the June number of Machinery, was in error.

The LUCAS

(OF CLEVELAND)

"PRECISION"

BORING, DRILLING AND

MILLING MACHINE

ALWAYS GOOD

and as time goes on

ALWAYS BETTER

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF CLEVELAND, O., U.S.A.

R. McA. Keown, associate professor of machine design in the University of Wisconsin, has been appointed engineer of the Industrial Commission of Wisconsin, Madison, Wis., in charge of the Department of Safety and Sanitation, succeeding Sidney J. Williams, who resigned to become manager of the Accident Prevention Department of the National Safety Council.

J. E. Parker, formerly efficiency engineer with the Cincinnati-Bickford Tool Co., Cincinnati, Ohio, has become factory manager of the Spencer-Smith Machine Co., Howell, Mich., which manufactures automotive pistons exclusively. The Spencer-Smith Machine Co. is installing new equipment in order to facilitate a greater production of pistons for government aircraft.

Julius Alsberg has opened a consulting engineering office in Room 1526, Tribune Bldg., 7 S. Dearborn St., Chicago, Ill., and will specialize in power plant work and efficiency work in connection with power plants, lay-outs of industrial and chemical plants, the study of industrial and chemical problems in connection with industries, and efficiency work generally in connection with these lines.

William R. Tomlinson, who was for many years superintendent and for the past year vice-president and works manager of the Billings & Spencer Co., Hartford, Conn., is now works manager of the Pratt & Whitney Co., of the same city. Mr. Tomlinson served his apprenticeship with the Pratt & Whitney Co. some twenty years ago, and after an extensive experience elsewhere, now returns to the company as head of the mechanical departments.

F. O. Hoagland has left his position as works manager of the Pratt & Whitney Co., Hartford, Conn., and is now vice-president and works manager of the Bilton Machine Tool Co., Bridgeport, Conn. He will remain on the staff of the Pratt & Whitney Co., however, in a consulting capacity. Previous to coming to the Pratt & Whitney Co., Mr. Hoagland was for several years works manager of the Union Metallic Cartridge Co., Bridgeport, Conn., and at an earlier time chief engineer of the Remington Arms Co., Ilion, N. Y.

C. E. Carpenter, of the Paris office of the Allied Machinery Co. of America, 120 Broadway, New York City, has been requested by officers of the American Expeditionary Forces in France to accept a commission as captain in the United States Army, Quartermasters Department, and has complied with the request, since the Allied Machinery Co., for patriotic reasons, had declared itself willing to release him. Mr. Hartridge, manager of the New York office, and Mr. McKay, also of the Allied Machinery Co., have sailed for France to obtain first-hand information relating to the machinery situation there, and to confer with Mr. Carpenter in regard to the procedure to follow during the duration of the war. Mr. Hartridge and Mr. McKay will return within three or four months.

COMING EVENTS

July 25—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

September 10—Twenty-sixth annual convention of the Traveling Engineers' Association, in Chicago, Ill. Secretary, W. O. Thompson, General Offices, New York Central Railroad, Cleveland, Ohio.

October 7-12—Joint convention of the American Foundrymen's Association and the American Institute of Metals in Milwaukee, Wis. Concurrent with these meetings there will be an exhibition of foundry equipment, machine tools, and accessories.

SOCIETIES, SCHOOLS AND COLLEGES

Detroit Technical Institute has changed its name to Detroit Institute of Technology and has appointed Benjamin D. Edwards chancellor.

Lowell Textile School, Lowell, Mass. Catalogue for 1918-1919, containing calendar, synopsis of courses, and other information relating to the work of the school.

University of Arizona, College of Mines and Engineering, Tucson, Ariz. Pamphlets entitled "Mining Engineering as a Profession," "Electrical Engineering as a Profession," "Civil Engineering as a Profession," and "Mechanical Engineering as a Profession," containing an outline of the advantages offered to students of the university in these courses, necessary qualifications, opportunities, and pay.

University of Illinois, College of Engineering and Engineering Experiment Station, Urbana, Ill., announces special advanced courses in the mechanics and properties of materials of construction, and in materials testing, to be given at the university in the summer session beginning June 17 and ending August 9. These courses constitute an intensive training for men who desire to qualify as testing engineers in the government service or in the service of manufacturing companies. The courses offer an excellent opportunity for advanced work in mechanics and in materials testing to instructors who wish to familiarize themselves with the latest methods of instruction in such work. Further information concerning the courses may be obtained from the Director of the Summer Session, University of Illinois, Urbana, Ill.

NEW BOOKS AND PAMPHLETS

Mineral Waters in 1916. By Arthur J. Ellis. 47 pages, 6 by 9 inches. Published by the Department of the Interior, Washington, D. C.

Gold, Silver, Copper, Lead, and Zinc in Idaho and Washington in 1916. By C. N. Gerry. 51 pages, 6 by 9 inches. Published by the Department of the Interior, Washington, D. C.

The Storage of Bituminous Coal. By H. H. Stoek. 172 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the University of Illinois, Urbana, Ill., as Circular No. 6.

Fuel Economy in the Operation of Hand-fired Power Plants. 89 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the University of Illinois, Urbana, Ill., as Circular No. 7.

Legal Weights (in Pounds) per Bushel of Various Commodities. 29 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular No. 10 of the Bureau of Standards. Price, 5 cents.

Electric Pumping, with Results of Tests and Operating Records. By H. W. Wagner. 80 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, as Bulletin No. 46.

Standard Cotton Mill Practice and Equipment. 204 pages, 6 by 9 inches. Published by the National Association of Cotton Manufacturers, 45 Milk St., Boston, Mass. Price, $1.50.

This is the first number of a publication which is to be published annually. It contains a review of the cotton trade in 1917, statistical tables relating to raw cotton, technical tables used in the industry, engineering data, and a buyer's index, which is a list of the best-known manufacturers of supplies used in textile mills.

Trade Specifications and Occupational Index. 240 pages, 6 by 9 inches. Published by the United States War Department, Washington, D. C.

The purpose of this manual is to standardize vocational terminology in the United States Army and to define the duties of specialists and skilled tradesmen required by its various technical organizations. In each case it gives first the duties to be performed, then the qualifications of a well-trained high-grade man or all-around journeyman, and last the nearest equivalent or substitute occupations that may be drawn upon as a source of supply if necessary. At the head of each paragraph is the standard occupational name and symbol used by the Adjutant General's office and a code or index word that may be used when telegraphing. Suitable indexes are provided for ready reference and location of the proper specification for any trade.

The Model T Ford Car; its Construction, Operation, and Repair. By Victor W. Page. 310 pages, 5 by 7 inches; 106 illustrations and two large folding plates. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $1.

In this book all parts of the Model T car and Ford tractor are described and illustrated by specially made drawings and photographs. The construction is fully treated and the operating principle is made clear. Especial attention is paid to the various attachments to the chassis by which it may be converted into a truck or tractor. The book is limited to the Ford cars as produced by the factory, and no attempt has been made to describe the many accessories offered for these cars, such as self-starters, lighting regulators, etc. As practically no mechanical changes have been made in the 1918 car, the instructions are as applicable to the newer as to the older cars. The six chapters are headed as follows: The Ford Car, Its Parts and Their Functions; The Engine and Auxiliary Groups; Details of the Ford Chassis Parts; Driving and Maintenance of Ford Cars; Overhauling and Repairing Mechanism; The Ford Tractor and Tractor Conversion Sets and Genuine Ford Tractor.

Bookkeeping and Cost Accounting for Factories. By William Kent. 258 pages, 8 by 11 inches; numerous illustrations, charts, and tables. Published by John Wiley & Sons, Inc., 432 Fourth Ave., New York City. Price, $4.

The author of this work, who was a bookkeeper and cost accountant for some years before he became an engineer and who, during his engineering experience, has had several occasions to install systems of bookkeeping and cost accounting and to audit books, has undertaken to prepare a systematic treatise on cost accounting which will start the student at the beginning with the elementary principles of double-entry bookkeeping and lead him through factory accounting to cost accounting. The work is a very comprehensive one, containing examples of methods of accounting and cost keeping in the form of tables, charts, sample pages of account books, etc. It is divided into twenty-one chapters, the headings of which indicate the scope of the work—Bookkeeping, Titles and Definitions of Accounts, The Evolution of Bookkeeping, The Column Ledger, Accounts for Retail Merchants, Selling Prices—Turnover, Factory Accounting, Cost Accounting, Cost Finding Methods—Use of the Job Ticket, Distribution of Burden, Depreciation, Inventory Valuation, Appraisals, Systems and Red Tape—Fundamentals of a Cost System; Daily and Monthly Records—Charting of Statistics—Cost of Idleness; Problems and Difficulties—Standard Cost; Uses of Costs—Various Opinions about Costs; Classification—Symbols—Bookkeeping by Machinery; Old-school Accounting; Iron Works Bookkeeping; Modern Accounting Systems for Steel Works; Foundry Costs—Cost of Coal; Hardware Factory and Machine Shop Accounting; Costs in a Woodworking Shop—A Bakery—A Textile Mill—A Power Plant; Costs in a Printing Shop; Reports to Stockholders—Education of Accountants—Cost of Idleness—Miscellaneous Forms—Bibliography. To anyone who has to do with factory cost accounting, the work should prove a most valuable manual, as it lays down fundamental theory in accordance with the views of the ablest modern accountants, and also warns against the time-worn methods of the older school which do not meet present-day requirements.

Elements of Machine Design. By Henry L. Nachman. 245 pages, 6 by 9 inches; numerous illustrations. Published by John Wiley & Sons, Inc., 432 Fourth Ave., New York City. Price, $2.

This book has been written primarily as a text-book for engineering schools and colleges, and comprises a course in elementary machine design. It is the result of the author's experience extending over more than fifteen years, both in practical design and in the teaching of this subject in the capacity of associate professor of kinematics and machine design at the Armour Institute of Technology, Chicago, Ill. Considering the comparatively brief space in which the subject is covered, the work is remarkably well done, because it contains a great deal of information in a compact and yet readable form. Of course, the theoretical side of machine design has been mainly emphasized, the major portions of the work being devoted to working formulas for determining stresses in, and dimensions of, machine details. The illustrations appear to have been carefully chosen to show typical constructions, but, on account of the limited space, a great variety of designs evidently could not be shown. Each chapter ends with a number of problems suitable for solution by the students. The range of the subjects dealt with in the work is best indicated by a review of the chapter heads, which are as follows: Strength of Materials; Screw Fastenings; Riveted Joints; Keys and Cotters; Shrink and Force Fits; Shafts and Axles; Couplings and Clutches; Journals and Bearings; Belts and Pulleys; Friction Wheels; Toothed Gears; Rope Transmission; Chain Gearing; Pipes and Cylinders; Valves; Flywheels; Crankshafts, Crankpins, and Eccentrics; Connecting-rods, Piston-rods, and Eccentric Rods; Pistons, Crossheads, and Stuffing-boxes; Hoisting Machinery Details; Springs; Materials of Machinery. While it is evident that the book does not give enough information on any one of these subjects to a designer who wishes to make a detailed study of one particular branch of machine design, it is a work that can be recommended for the class-room use for which it is prepared. It will give the student an excellent perspective of the subject of machine design and will aid him in obtaining facility in analyzing forces and resultant stresses in machine parts, and in applying proper methods and formulas in their design.

NEW CATALOGUES AND CIRCULARS

Buffalo Forge Co., Buffalo, N. Y. Catalogue 108, of stationary forges, giving dimensions and prices.

Peck, Stow & Wilcox Co., Southington, Conn. Catalogue of sheet metal worker's machines and tools.

Oliver Machinery Co., Grand Rapids, Mich. Circular descriptive of Oliver No. 62 motor-head face lathe.

National Tube Co., Pittsburg, Pa. Circular entitled "The Identifying Mark," advertising National pipe.

National Woodworking Machine Co., Dover, N. H. Bulletin 1 describing a new profile and bevel planer for woodworking.

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Volcano Torch & Mfg. Co., Erie, Pa. Booklet describing the Volcano 10 B torch, intended for heating and brazing processes.

Foxboro Co., Foxboro, Mass. Bulletin 82-1, descriptive of Foxboro liquid level gages. Bulletin 113, descriptive of Foxboro orifice meters for gas.

A. M. Byers Co., 235 Water St., Pittsburg, Pa. Chart showing graphically, by means of black and buff dots, the corrosion of iron and steel pipe in hot water mains.

Manufacturing Equipment & Engineering Co., Boston, Mass. Circulars of metal lockers and fireproof equipment for factories, sanitary drinking fountains, and sanitary wash bowls.

Barnett Foundry & Machine Co., Irvington, N. J. Pamphlet descriptive of "Winans' New Idea" vise, with stationary or swivel base. A table of dimensions and prices is included.

De Laval Steam Turbine Co., Trenton, N. J. Bulletin N, entitled "Centrifugal Boiler-feed Pumps," describing the De Laval combined steam turbine and centrifugal boiler-feed pump.

A. M. Byers Co., Pittsburg, Pa. Catalogue of Byers wrought-iron pipe for water, steam, air, gas, oil, or other fluids. This pipe is made in sizes from ⅛ inch up to 12 inches in diameter.

W. S. Rockwell Co., 50 Church St., New York City. Circulars 34 and 35, treating of forging and heating furnaces of the economizer shield type, and annealing furnaces of the rolling mill type, respectively.

Champion Tool Works Co., 4955 Spring Grove Ave., Cincinnati, Ohio. Catalogue of Champion tool-room lathes, quick-change-gear engine lathes, and double back-geared lathes, giving complete specifications for the various sizes.

Yost Mfg. Co., Meadville, Pa. Catalogue 8, of Yost machinists' and toolmakers' vises, pipe vises, woodworkers' vises, blacksmiths' anvils, and gas soldering furnaces. The catalogue gives dimensions, prices, and other essential data.

Gisholt Machine Co., Madison, Wis. Catalogue of Gisholt solid adjustable reamers, giving dimensions, prices, etc. Information is also given on adjusting Gisholt reamers, as well as instructions on sharpening and use of the reamers.

U. S. Ball Bearing Mfg. Co., Chicago, Ill. Booklet containing data sheets which furnish in a convenient form essential information regarding the dimensions of all types of Strom bearings. The revised price list is printed on blue sheets, pages 69 to 72.

Ingle Machine Co., Rochester, N. Y. Catalogue of Rochester gear tooth rounding machines, containing a detailed description of the machines, instructions for adjusting and oiling, and operating instructions, as well as specifications giving capacity, dimensions, etc.

New Departure Mfg. Co., Bristol, Conn. Sheets for loose-leaf catalogue on ball bearings, containing a complete revision of descriptive and dimensional data for New Departure double-row ball bearings, single-row ball bearings, "Radax" ball bearings, and magneto ball bearings.

Detroit Steel Products Co., Detroit, Mich. Catalogue describing "Fenestra" solid steel windows. Information is contained on "Fenestra" horizontally pivoted sash, continuous center pivoted sash, continuous top hung sash, horizontally rolling sash, worm and gear operator, and continuous operator.

Abbott Ball Co., Elmwood, Hartford, Conn. Catalogue describing the Abbott burnishing process, by means of which small metal parts are finished by being subjected to a tumbling process with a comparatively large quantity of hardened steel balls of various sizes. The balls do not remove any of the surface of the articles, but burnish and harden it.

American Bronze Corporation, Berwyn, Pa. Pamphlet entitled "How to Make Long-lived Bushings," describing "Non-gran" bronze for bearings. Information is given on how to machine "Non-gran" bronze and how to grind reamers for "Non-gran" bronze, and sketches are included illustrating the correct setting for "Non-gran" boring tools and turning tools.

National Workmen's Compensation Service Bureau, 13 Park Row, New York City, is issuing a pamphlet entitled "The Teaching of Safety in Technical Schools and Universities," prepared by a committee of the National Safety Council for the purpose of aiding universities in the introduction of safety education in the curricula. A list of subjects and speakers for safety lectures is given, and various other suggestions are included for the aid of those who desire to institute safety courses.

Cleveland Automatic Machine Co., Cleveland, Ohio. Publication entitled "Unexcelled Capacities," showing examples of a great many difficult and unusual production problems that have been solved with satisfactory results on the Cleveland automatic machines. The work to be done and the method of tooling the machine is shown in each case and on each opposite page is given a concise description of how the work is accomplished. The illustrations are unusually large and clear.

Wood Turret Machine Co., Brazil, Ind. Catalogue of the full line of "Tilted Turret" screw machines, turret lathes, brass working machinery, and extra capacity automatic chucking turret lathes. Specifications are given for the various types of screw machines and turret lathes, and the illustrations show details of construction. A considerable portion of the catalogue is given over to tooling equipment and various other equipments that could be furnished with or applied to the "Tilted Turret" machines.

Fafnir Bearing Co., New Britain, Conn., is issuing a new publication entitled "The Dragon," which contains information concerning Fafnir ball bearings and news of the plant. It is intended to include in each issue an article devoted to a discussion of some subject related to the advantageous use of ball bearings, such, for example, as a description of some interesting installation, and to present occasionally the results of experiments and tests which are continually being conducted at the plant. Copies will be sent regularly upon request to anyone who is interested in the subject of ball bearings.

Greenfield Tap & Die Corporation, Greenfield, Mass., has just issued the first number of its new factory magazine, entitled "The Helix," which will be published monthly for the benefit of the employes of the company. The first number contains sixteen pages and includes many interesting shop notes, views of the factory, news from the boys at the front, and other items of interest to the organization. The publication is edited by J. T. Seller, secretary of the corporation and head of the welfare department. It is hoped that the regular publication of this paper will tend to promote good fellowship among the employes.

Solvay Process Co., Syracuse, N. Y. Booklet entitled "Americanization, a Discussion of Present Conditions, with Recommendations for the Teaching of Non-Americans." The booklet consists of a report made by Charles H. Paull to the Solvay Process Co., and covers a review of agencies offering education to non-Americans; methods of administering education in industry; methods of securing attendance; location and equipment of school building; selection and organization of teaching staff; organization of course of study; relation of the English school to other activities of the industry; reaction of Americanization on labor; and recommendations for the organization of a school for non-Americans in connection with the Solvay Process Co.

Ingersoll-Rand Co., 11 Broadway, New York City. Form 876, descriptive of Ingersoll-Rand barometric condensing plants. Form 883 A, on class FP steam engines of the horizontal center-crank type with piston valves. Form 888, on "Little David" evaporator tube cleaner and other labor-saving pneumatic tools. Form 901, showing the complete line of "Little David" pneumatic tools. Tables of sizes and capacities are given, and the illustrations show all the tools and their applications. Form 901-1, on "Little David" calking machines. Form 3015-1, on ER-1 portable mine car air compressors. Form 4039, descriptive of Leyner shank and bit punch for punching out holes in bits and shanks of hollow drill steel. Copies of these bulletins will be sent free upon request.

New Departure Mfg. Co., Bristol, Conn., has just issued the first edition of the "New Departure Ball Bearing Manual," which comprises a complete but concise treatise for all users of ball bearings, discussing best installation practice as well as improved methods of lubrication and adjustment. The book includes full descriptions and dimensions of the New Departure double-row, single-row, Radax, and magneto ball bearings. In addition, the following subjects are treated: Securing bearing inner races; retaining ball bearing outer races; installing various types; applying and removing ball bearings; magneto bearing installation and removal; how to adjust Radax bearings; lubrication and enclosure; how to clean ball bearings; how to adjust bevel drive gearing; repairing worn shafts and housings; how ball bearings are abused by poor mounting; how ball bearings are mounted in automobiles; ball bearings in engines; ball bearings in clutches; ball bearings in engine auxiliaries; ball bearings in axle parts; ball bearings in truck wheels and axles; and ball bearings in change speed gearing. A number of tables are also included giving dimensions in millimeters and inches of the New Departure ball bearings, the load they will sustain, and prices. A table of comparative ball bearing data compares the sizes of New Departure ball bearings with those of other standard makes, both foreign and domestic. The comprehensiveness of this catalogue should make it of practical value to all users of ball bearings.

TRADE NOTES

Peerless Machine Co., Racine, Wis., manufacturer of high-speed metal-cutting saws, is erecting a large addition to its plant, which will double the present capacity.

Machinery Forging Co., Hamilton, Ave. and Marquette St., Cleveland, Ohio, has opened a branch factory in Cincinnati, Ohio, under the name of the Steel Forgings Co.

Cincinnati Gear Co., 1827-1833 Reading Road, Cincinnati, Ohio, manufacturer of all kinds of cut gears, is erecting a large addition to its plant which will practically double the present floor space.

Seneca Machine & Tool Co., Inc., manufacturer of special automatic machinery and small interchangeable parts, has moved its office and factory from 380 S. Fifth St., Brooklyn, N. Y., to 72-76 Grand Ave.

Scott-Spencer Automatic Tool Co., Inc., Cincinnati, Ohio, manufacturer of tools for automatic screw machines, announces that it will start within the next thirty days manufacturing independent lathe chucks.

Cincinnati Ball Crank Co., Oakley, Cincinnati, Ohio, manufacturer of lathe handles and screw machine products, is making extensive additions to its plant which will greatly increase the present capacity.

Acme Tool & Machine Co., Derby, Conn., manufacturer of tools, dies, gages, and special machinery, has purchased the Secor Mfg. Co. The officers are P. P. Haworth, president and treasurer, and Harry G. Williams, secretary.

National Clutch Co., Chicago, Ill., manufacturer of the National countershaft clutch pulley, has erected a large addition to its plant, and it is expected that the added facilities will enable the company to practically double its output.

American Hollow Boring Co., 1055 W. 19th St., Erie, Pa., is now in its new plant and has started work on the production of hollow-bored forgings, including lathe spindles, piston-rods, camshafts, hydraulic cylinders, steel pipe, and boring-bars.

Cisco Machine Tool Co., Cincinnati, Ohio, manufacturer of Cisco lathes, has completed a new shop, located opposite its old plant, which will more than double the former floor space. The old shop will be used as an office building and erecting room.

Smith & Hemenway Co., Inc., manufacturer of "Red Devil" tools, is erecting an addition to its plant at Irvington, N. J., which is largely given over to the making of tools for the Government. New machinery of the latest design is being installed, which, it is expected, will greatly increase the output.

New Britain Machine Co., New Britain, Conn., is erecting a one-story brick and steel addition to its plant, 100 by 340 feet, with concrete floor. The wall area will carry a large percentage of sash, and along one side of the building there will be a shipping platform, 14 by 340 feet. The Aberthaw Construction Co., Boston, Mass., has charge of the work.

Crawford Machine Tool Co., Inc., has taken over the business and assets of the Joseph Crawford, Jr., Co., Erie, Pa. The new company will be conducted by the same interests and without substantial change in policy. Joseph Crawford, Jr., is president, and Alexander Chessin, secretary and treasurer. Offices will be maintained at 21 Park Row, New York City, and at Erie, Pa. The sales office will be in New York City, and all inquiries and correspondence should be sent there.

J. C. Ulmer Co., Cleveland, Ohio, maker of engineering and ordnance instruments, tools, gages, jigs, fixtures, and dies of all kinds, and special machinery and models, and which for many years has been located at 113 Prospect Ave., N. W., Cleveland, has moved into a new up-to-date plant at 1791 E. 38th St. The new shop is unusually light, and equipped with new modern machinery for high-grade tool work.

Cleveland Milling Machine Co., Cleveland, Ohio, manufacturer of milling machines, cutter grinders, and milling cutters, is erecting a three-story building 32 by 300 feet, of steel and concrete construction, in order to take care of the increase in the company's business. The new building will be devoted to the milling cutter manufacturing department, which will make it possible to use the present building exclusively for the building of milling machines.

Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, is planning to build a new machine shop, which will be devoted almost exclusively to women workers. The new plant will be known as Shop No. 3, and will have a frontage of 90 feet on Colerain Ave. and will extend 550 feet toward Spring Grove Ave. It will be of one-story concrete construction and will contain, in addition to the shop departments, a restaurant and rest rooms for the women.

Sheffield Machine & Tool Co., Dayton, Ohio, has arranged to take over the manufacture of the Deming indicator, which has heretofore been made by the inventor, Charles M. Deming, in Hartford, Conn. The demand for the indicator has outgrown Mr. Deming's facilities, and so, in order to increase the output, the Sheffield Machine & Tool Co. will manufacture it under Mr. Deming's personal supervision, and will advertise and market it for him. No change in prices or sales policy is contemplated at present.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has purchased the property, business, and goodwill of the Krantz Mfg. Co., Inc., Brooklyn, N. Y., manufacturer of safety and semi-safety electrical devices. The Supply Department of the Westinghouse Electric & Mfg. Co. will act as exclusive sales agent for the products of the Krantz Mfg. Co., whose business will be continued under its present name. H. G. Hoke, of the Westinghouse Electric & Mfg. Co., will represent the Supply Department at the Krantz factory.

Doehler Die-Casting Co., Court, Ninth, and Huntington Sts., Brooklyn, N. Y., states that its Toledo plant, which was housed in a new factory building a little over a year ago, has outgrown its quarters, and in order to provide for adequate expansion, the company has found it necessary to take over the adjoining plant of the Ohio Electric Co., which will double the present capacity of the plant. Although the greater part of the plant's activities is devoted to government war work, the needs of the regular trade are receiving the usual attention.

Koch & Sandidge, 19 S. Wells St., Chicago, Ill., is a new firm, which will handle the sales engineering work for the line of "Jiffy" cutting tools made by the Universal Tool & Appliance Co., of Milwaukee, and similar products. Paul W. Koch, one of the partners in the new concern, will remain active as president and general manager of the Electrical Sales Engineers, Inc., of Chicago. John H. Sandidge, the other member of the firm, has been connected with the Cooper Hewitt Electric Co. for over six years, having been sales manager in the Chicago district for five years and recently Wisconsin manager with offices in Milwaukee.

Rivett Lathe & Grinder Co., Brighton District, Boston, Mass., has inaugurated a policy whereby those of the employes of the company who have been with the concern since June 30, 1917, are entitled to a 10 per cent special compensation in addition to their regular wages. Employes who have not been with the company for one year will also be entitled to this compensation when they have been employed for that length of time. Those who have been employed for three months will receive 2 per cent of the wages received; those who have been employed for six months will receive 3 per cent; and those who have been employed nine months, 4 per cent.

AUGUST
1918

MACHINERY

VOL. 24
NO. 12

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tical Speeds in Tapered Shaft Design—Derivation of Formulas and Examples Illustrating their Use. By Alfred Musso.

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Making the Mark III Detonating Fuse—First Article Ever Published on This New Fuse. By Edward K. Hammond.

Dies for Tape-measure Winder—Description of Interesting Development in Die Design.

THE INDUSTRIAL PRESS, Publishers, 140-148 Lafayette Street, New York, N. Y.

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ADVERTISERS INDEX, 433-434—PRODUCT INDEX, 408-432

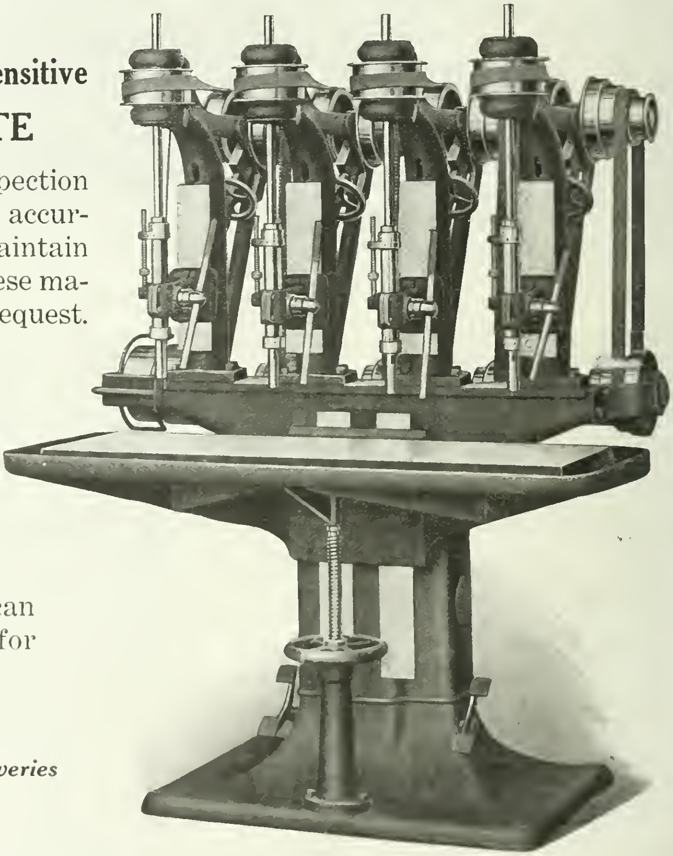
Leland-Gifford Sensitive Drilling Machines

For Large Production

Rigid-Powerful-Sensitive

ACCURATE

Our sample inspection sheet showing the accuracy which we maintain on every one of these machines sent on request.



All machines can be adapted for motor drive.

Ask us about deliveries

Built by

LELAND-GIFFORD COMPANY

WORCESTER, MASSACHUSETTS, U. S. A.

Branch Offices:

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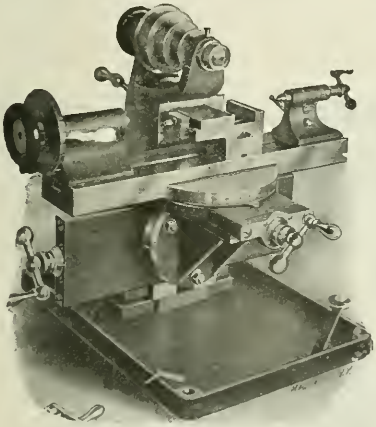
SNYDER UPRIGHT DRILLS
Are Being Bought by the World's Markets

Our Upright Drills need no introduction, as they have been in use for the past "thirty years." They are furnished for motor drive, either gear or belt connected. Also with compound table, and with tapping attachment. These drills are especially adapted to long boring purposes, where others fail to do the job.

J. E. SNYDER & SON Worcester, Mass., U. S. A.



THE SLOAN & CHACE
BENCH MILLING MACHINE

This Bench Milling Machine is economical, and a space saver, with an almost universal adaptability. Designed for tool room and experimental work, it is also valuable in light manufacturing. The spindle of this machine is interchangeable with the spindle of our No. $5\frac{1}{2}$ Bench Lathe—which permits transfer of work without change of setting.

Independent screw feed, accurately fitted tail stock, feed screws with dials graduated to read in thousandths, perfect alignment—all these points and many others make this miller a permanent economy in the shop.

Details of this and other precision machines in our catalogue

SLOAN & CHACE MANUFACTURING COMPANY, Ltd.
6th Avenue and N. 13th Street NEWARK, N. J.

WALWORTH "STILLSON"
One of a Famous Trio

The Walworth Genuine Stillson Wrench, in construction and operation, is ideal. As a unit of the famous Walworth Trio it has an added value. Each of these three wrenches has a distinctive purpose; together they serve all purposes. Put the Walworth Parmelee and the Walco Hex alongside your Walworth Stillson. Shall we send circular?

WALWORTH MFG. COMPANY
BOSTON, MASSACHUSETTS, U. S. A.
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The Walworth Genuine Stillson Wrench

NEW YORK BRANCH, 19-21 Cliff Street.
CHICAGO BRANCH, 218-222 N. Desplaines St.
SEATTLE, WASH., 414 First Ave., South.

MACHINE

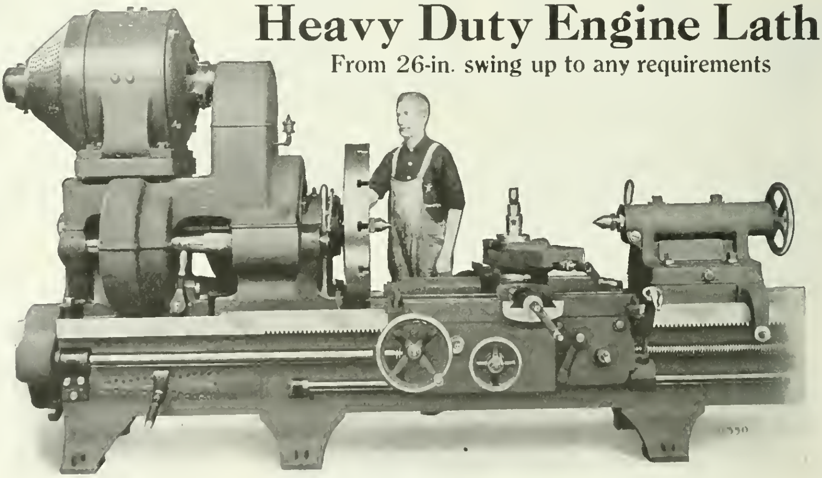
NILES-BEMENT-POND

Machine Tools, Steam Hammers, Traveling Cranes

We are in a particularly favorable position to furnish complete machine tool equipment for a general machine shop, railroad shop, shipyard, heavy ordnance or small arms arsenal.

Heavy Duty Engine Lathes

From 26-in. swing up to any requirements



30-inch Double Geared Engine Lathe

NILES-BEMENT

GENERAL OFFICE

OFFICES AND AGENCIES:—**Boston:** 93-95 Oliver St **Philadelphia:** 405 North Twenty-first St. **Pittsburgh:** Frick Buildin
Cleveland, O.: The Niles Tool Works Co., 730 Superior Ave **Hamilton, O.:** The Niles Tool Works Co. **Cincinnati:** The Nile
Tool Works Co., 33 W. Fourth St **Detroit:** Kerr Bldg **Chicago:** 571 W. Washington Blvd. **St. Louis:** 516 N. Third S

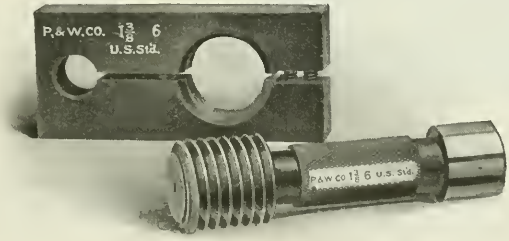
TOOLS

PRATT & WHITNEY

Precision Machine Tools, Small Tools, Standards and Gauges

For more than fifty years the Pratt & Whitney Company has been developing a line of Precision Machine Tools, Gauges and Small Tools, the predominating characteristics of which have always been accuracy and refinement.

U. S. Standard Thread Gauges



The exceptional merit of the United States Standard Thread System has long been acknowledged, and the importance of its general adoption has been persistently urged by the engineering profession. Its universal adoption as the standard for all government work in the United States and the Continental European countries, also by all railroads and practically all the other manufacturing industries in the United States, is largely due to the fact that it is the only form of thread by which interchangeability in manufacturing is possible.

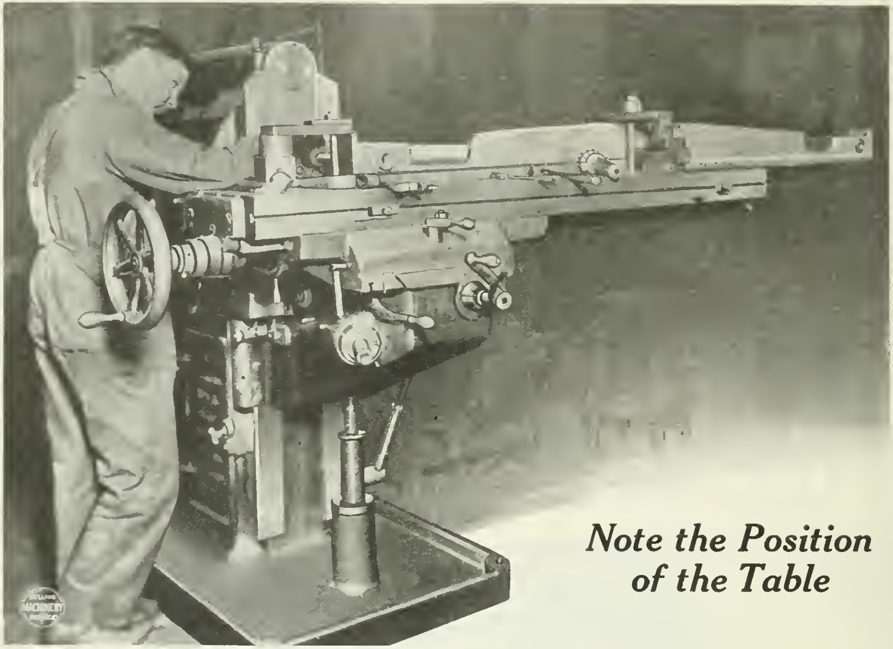
Write for a copy of our Catalog
"Standards and Gauges"

POND COMPANY

111 BROADWAY, NEW YORK

Birmingham, Ala.: 2015 First Ave. **San Francisco:** 16 to 18 Fremont St. **London, Eng.:** 25 Victoria St., S. W. **For Colorado, Utah, Wyoming and New Mexico:** Hendrie & Bolthoff Manufacturing & Supply Co., Denver. **For Canada:** The John Bertram & Sons Co., Ltd., Dundas, Montreal, Toronto, Winnipeg and Vancouver.

Only a Rigid Machine Could Perform This Job



Note the Position of the Table

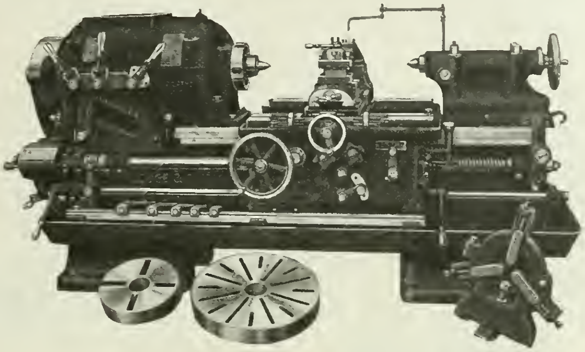
The work is a jeweler's draw bench. The operation, boring holes at each end of the casting, is one of extreme accuracy. Ordinarily the weight of the piece and the fact that it is necessary to use the table at the extreme end of its travel would be against accuracy. This makes no difference on the Milwaukee Milling Machine, however, on account of its rigidity.

The W. W. Oliver Manufacturing Company, Buffalo, N. Y., has used this machine on special manufacturing of a wide range for many years; when photographed recently on this particularly trying job it was working with original accuracy unimpaired. Accuracy in the work means rigidity in the machine. Both rigidity and accuracy are embodied in Milwaukee Milling Machines.

MILWAUKEE MILLING MACHINES

Let us tell you about Milwaukee construction in detail

KEARNEY & TRECKER CO., MILWAUKEE, WIS., U.S.A.



LATHES
GOOD LATHES ONLY
TRADE MARK

Conserve Your Workmen's Energy

THE LODGE AND SHIPLEY MANUFACTURING LATHE measures the pieces. The operator sets the diameter and length stops as he turns the first piece. Then the stops accurately and easily duplicate the rest of the lot. The operator does not have to use his scale, calipers and micrometer on every piece.

Front and rear tool rests for high duty, four-way or gang tool blocks, provide for enough tools to finish the piece in one set up. Pan, pump and tubing keep the floor clean and get maximum service from the tool steel.

You should know more about how the Manufacturing Lathe will increase your lathe production. Write us now.

LATHES
Good Lathes
Only

The Lodge & Shipley Machine Tool Co.
CINCINNATI, OHIO, U. S. A.

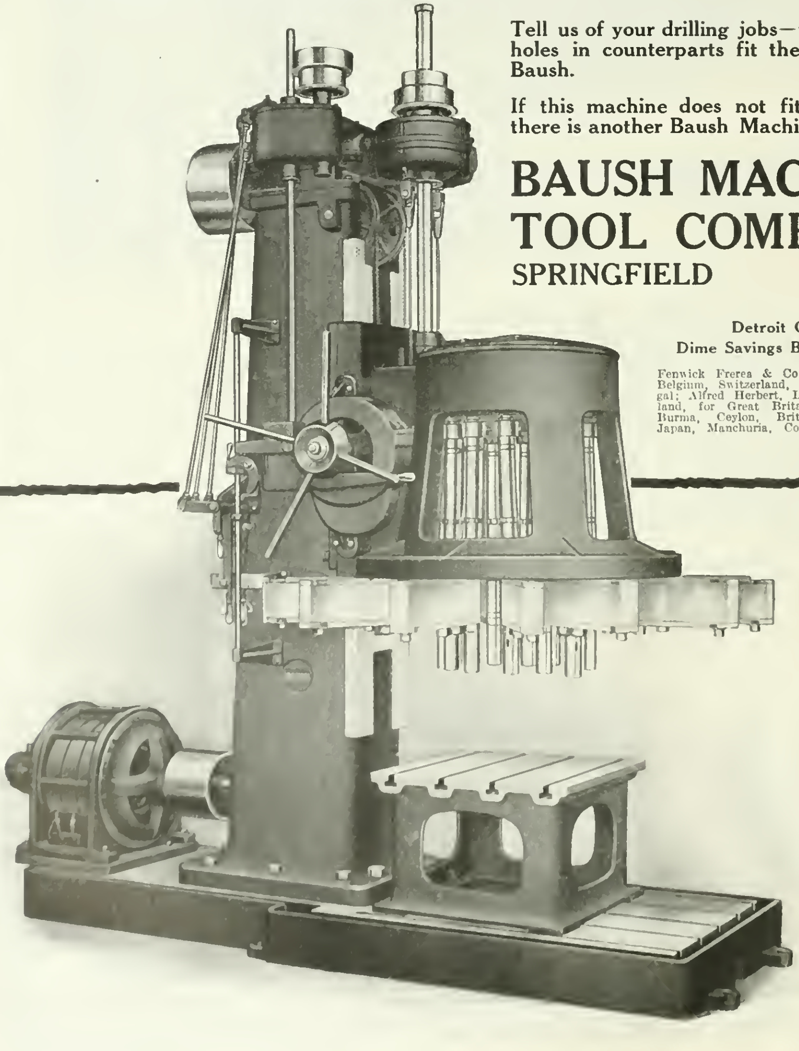
Baush High Speed Multiple Spindle Drill No. 4

This machine can be supplied with heads of various sizes, up to 30 inches round and 30 by 46 inches rectangular. It is capable of driving twelve 1¼-inch, sixteen 1-inch drills, etc., up to twenty-eight ⅝-inch drills in cast iron.

The drill spindles are adjustable over widely varying layouts, to suit the positioning of the holes in the work.

Convenience of operation has been considered in every detail of control. The belt shifter, the three speed changes and four feed changes are all at the instant command of the operator. The feed is provided with automatic trip; the head can be fed farther by hand if desired.

In fact, this Baush Multiple Spindle Drill has been designed throughout to secure the utmost speed in drilling many holes simultaneously.



Tell us of your drilling jobs—two or more holes in counterparts fit the job for the Baush.

If this machine does not fit your work there is another Baush Machine that will.

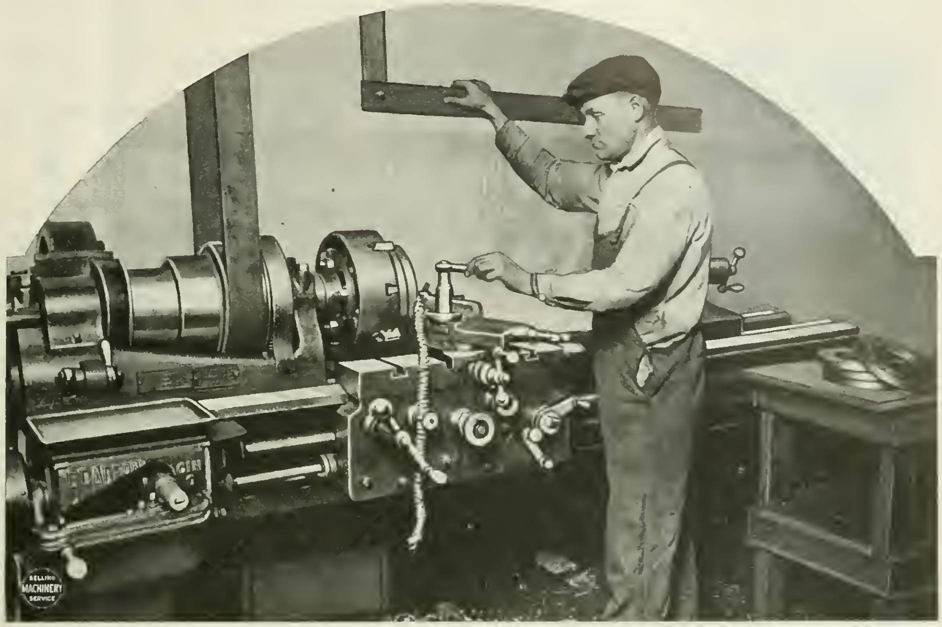
BAUSH MACHINE TOOL COMPANY

SPRINGFIELD MASS.

Detroit Office:
Dime Savings Bank Building

Fenwick Freres & Co., France, Holland, Belgium, Switzerland, Italy, Spain, Portugal; Alfred Herbert, Ltd., Coventry, England, for Great Britain, Ireland, India, Burma, Ceylon, British South Africa, Japan, Manchuria, Corea, Formosa.

BAUSH



Bradford Lathes

This Bradford Was Bought Before "Speed-Up" Became a By-Word—*But It Was Ready*

The Indianapolis Tool & Manufacturing Company of Indianapolis purchased this Bradford Lathe in 1910—long before the war demanded the supreme effort of machine tools. But the Bradford was ready. It was built to withstand unexpected strains, and after eight years of roughing out tough gear blanks, it is, not only in efficiency but even in appearance, the same *new* lathe it was the day it was installed.

It is the Bradford's ability to do the unusual that makes it so popular. Modern shop practice daily demands more rigid requirements. Are your machines prepared?

Bradford Lathes are made in sizes from 14" to 42" swing.
Get the catalog for full particulars

THE BRADFORD MACHINE TOOL CO.

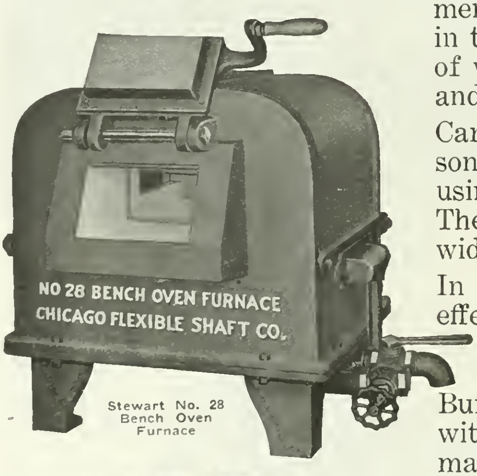
CINCINNATI OHIO, U. S. A.

AGENTS: Swind Machinery Co., Philadelphia. Taylor Machinery Co., Boston, Mass. Stocker-Rumley-Wachs Co., Chicago, Ill. Somers, Fitler & Todd Co., Pittsburgh, Pa. The E. A. Kinsey Co., Cincinnati, O., and Indianapolis, Ind. The Mine & Smelter Supply Co., Denver, Colo. Pacific Tool & Supply Co., San Francisco, Cal.

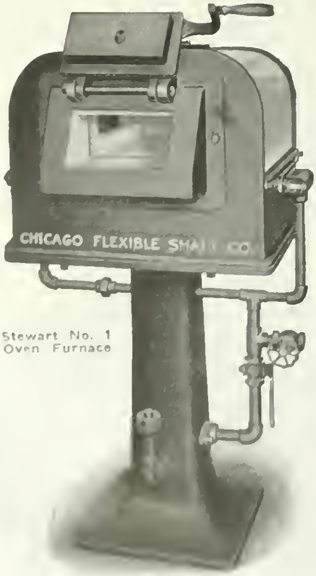
Why Manufacturers Choose

STEWART FURNACES

Stewart Soft Metal Melting Furnace



Stewart No. 28 Bench Oven Furnace



Stewart No. 1 Oven Furnace

Steel, fuel, tools and labor are higher to-day than ever before. When a piece of work is ready for heat treatment a considerable investment lies in the furnace, upon the correctness of which depends the profit on time and money already spent.

Careful manufacturers, for this reason, appreciate the importance of using the best furnaces obtainable. The same reason accounts for the wide adoption of Stewart Furnaces.

In Stewart Furnaces heavy linings effectively check radiation, and a quickly obtained temperature has permanent uniformity. Burners produce perfect combustion without smoke, soot or odor, thus making chimney connections unnecessary. Stewart Furnaces are clean, convenient and compact; durable, though simply constructed, and easy to operate.

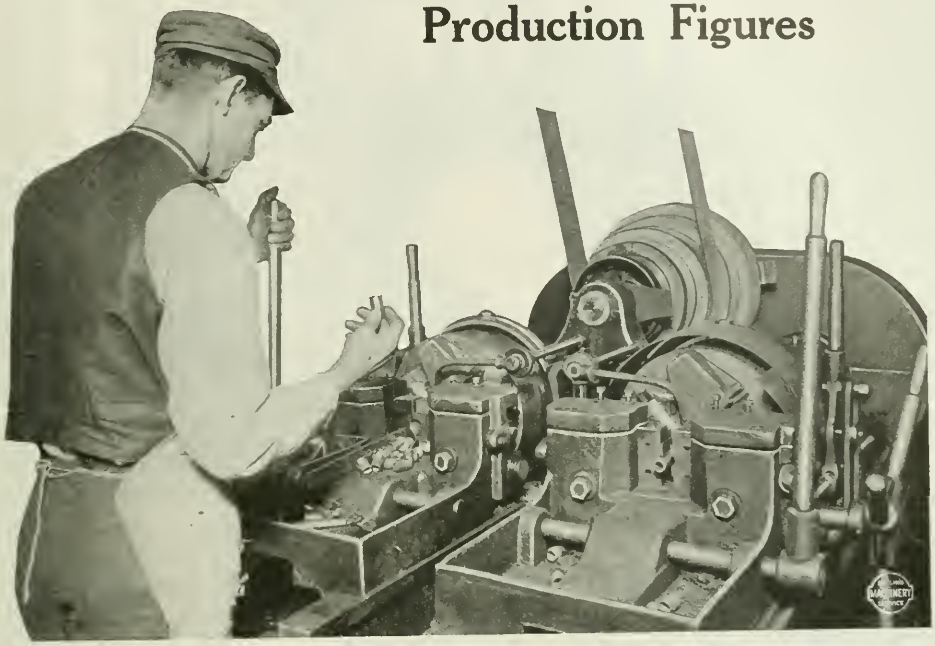
Stewart Furnaces are adapted for artificial, producer or natural gas, fuel oil or kerosene. They are made in types and sizes to serve most purposes. Special sizes made to your own specifications.

Let us send the complete catalogue and details of 30-day free trial offer.

CHICAGO FLEXIBLE SHAFT COMPANY

12th St. and Central Ave.
CHICAGO ILLINOIS, U. S. A.

The Richardson People Asked Us To Withhold Production Figures



But We Can Assure You Output Is—
Very Good Indeed

A Landis Double Head Threading Machine is always a cost cutter—whether on straightaway work or a two operation job such as the one photographed in the Edro Richardson Brass Company's plant. Work is ½ inch diameter brass nipples, threaded on both ends. For the first operation, nipples are held in the regular way and threaded for ¾ inch—half their length; but for threading the second end a threaded grip is used, which grips securely without damaging the threaded portion. Though we can't tell you just how good production is on this work, we can assure you it is highly satisfactory to all concerned.

Landis Double Head Machines save power and labor as well as time—points well worth considering in addition to the clean, accurate threads they cut. We make it our business to adapt them to every cutting problem within their range—how about yours?

LANDIS MACHINE COMPANY
WAYNESBORO PENNSYLVANIA
INCORPORATED

"The Dragon" is a publication issued monthly by The Fafnir Bearing Co. in the interest of Ball Bearings and their correct application.

We shall be glad to send a copy of each issue to the manufacturer or engineer

Please send me a copy of each issue of "The Dragon."

Name

Position

Company

Address

THE FAFNIR BEARING COMPANY

Conrad Patent Licensee

DETROIT Office
752 David Whitney Bldg.

New Britain, Conn.

CHICAGO Office
1919 So. Michigan Ave.

Beaman & Smith Engineers are Production Specialists

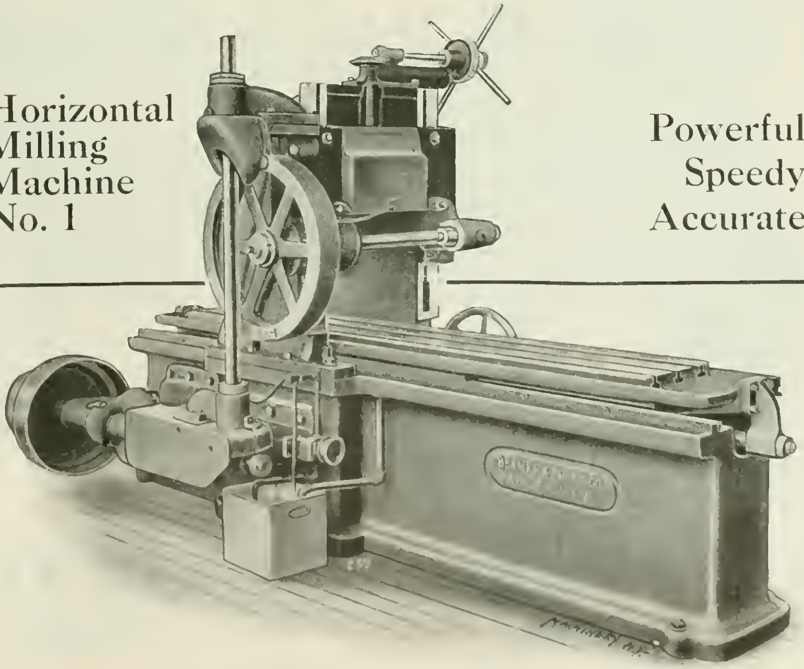
Their sole business is to design and build machines to perform any one operation or any series of operations better and faster than they have ever before been performed. The No. 1 Horizontal Milling Machine is one of the tools we have evolved. In this machine the arbor provides ample cutter space, the work surface is large, the drive powerful and dependable—for the quick removal of stock there isn't a more capable machine of its kind to be had. It's a wide range machine, too. It's one of a number of Beaman & Smith machines doing excellent work under conditions that test metal and build. We build machines for boring, milling, drilling, etc.; all sizes, all combinations; carry an efficient line of "regulars," and furnish special machines when these won't answer. Write us.

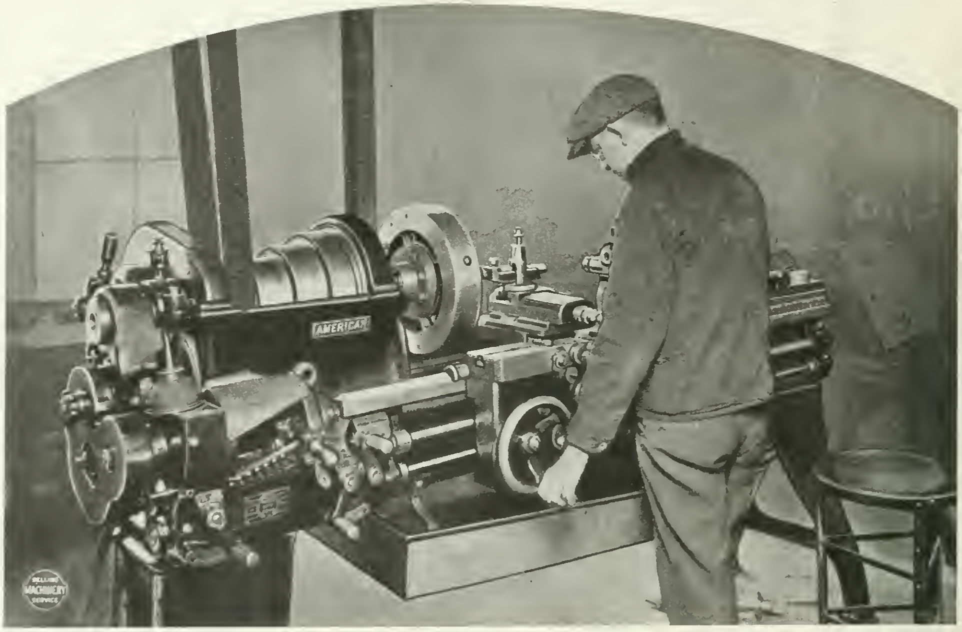
BEAMAN & SMITH COMPANY

PROVIDENCE RHODE ISLAND

Horizontal
Milling
Machine
No. 1

Powerful
Speedy
Accurate





AMERICAN

The AMERICAN Lathe

As a Valuable Factor in Automobile Transmission Production

The Durston Gear Company, Syracuse, N. Y., makes automobile transmissions for high grade motor cars—and the American Tool Room Lathe makes jigs and fixtures and tools for the Durston Company. It takes no great stretch of the imagination to see the value of the lathe in the production of the gears—for to make good transmissions all machines and tools must be top-notch. And when we asked the toolroom foreman at Durston's about the "American" he said: "I like them. I have used them for toolroom work for over a year—on all kinds of heavy jig and fixture work. They meet every requirement for accuracy."

THE AMERICAN TOOL WORKS

LATHES PLANERS

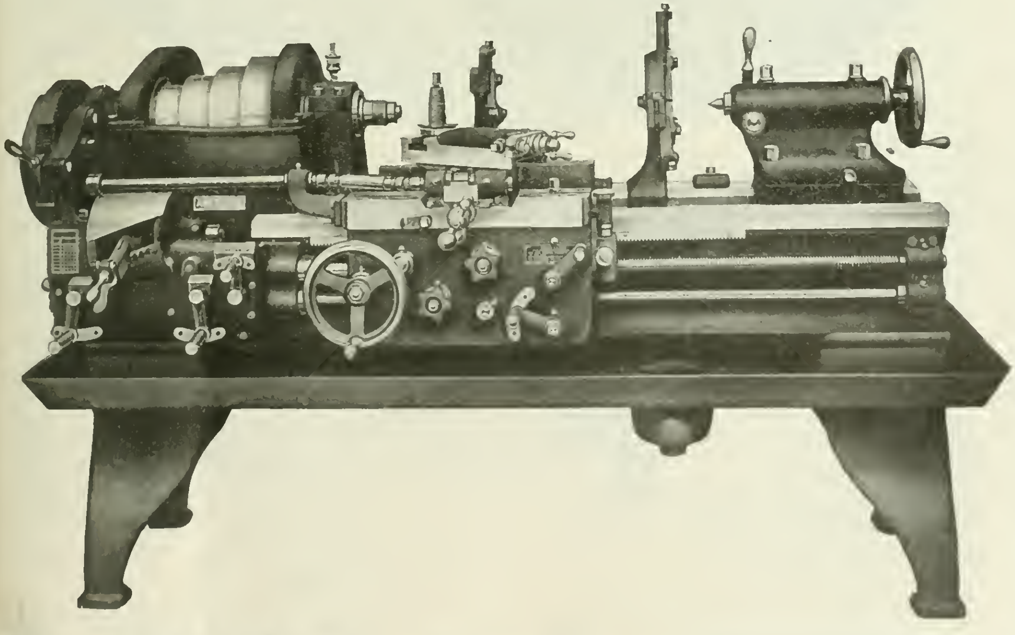
Progressive Tool Makers

Prefer the "American"

Where you find a progressive tool room the chances are you'll find "American" tool room lathes. "American" Quality is recognized and utilized by such people as the Ford Motor Company, General Electric, Brown & Sharpe, Winchester Repeating Arms, Pennsylvania R. R., Geometric Tool Company, Bausch & Lomb Optical Company and dozens more of the biggest and best concerns in the country.

There are good reasons why "American" lathes have the preference. Not only are they built to highest standards, but we have developed attachments for tool room along original lines and to close standards of accuracy—attachments which may be fitted when the lathe is purchased or added later on as occasion demands.

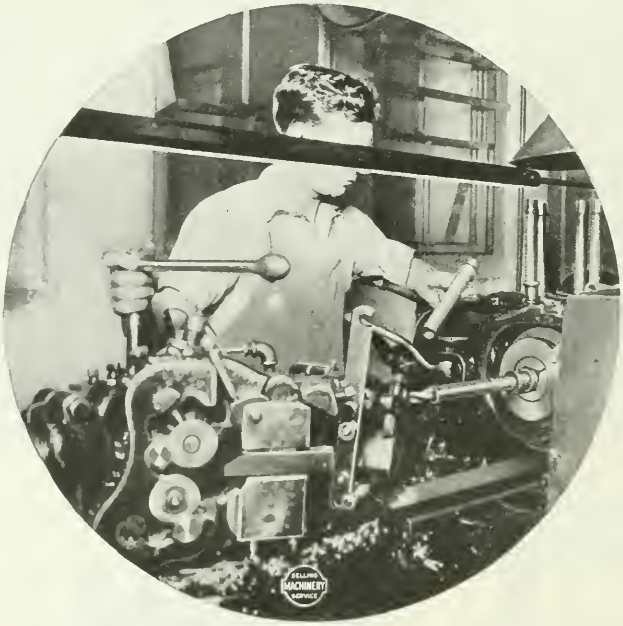
Let us tell you more about this machine.



COMPANY, Cincinnati, U. S. A.

SHAPERS **RADIALS**

The J & L Flat

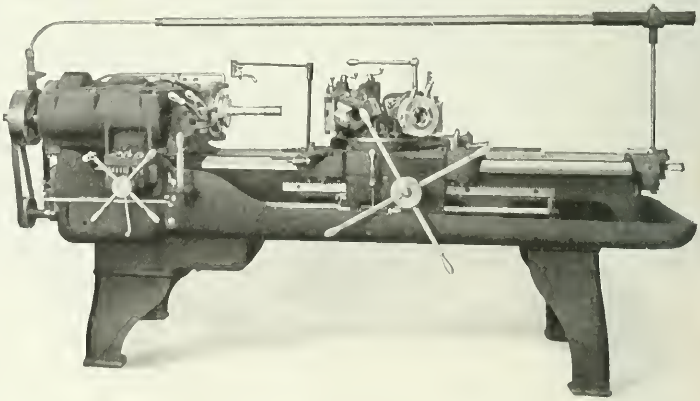


Lathe Spindles for the B. C. AMES COMPANY

The Ames Company will tell you its lathe spindles are as fine an example of accurate manufacture as can be found anywhere. And the machine selected for this work is a J & L Flat Turret Lathe.

For example — the hole through the spindle is 7½ inches, and must be straight and concentric. Production is not as interesting as the exactness of the work—both are good.

This particular machine has been installed for more than five years and used always on the finest of work. Its accuracy and durability have been demonstrated.



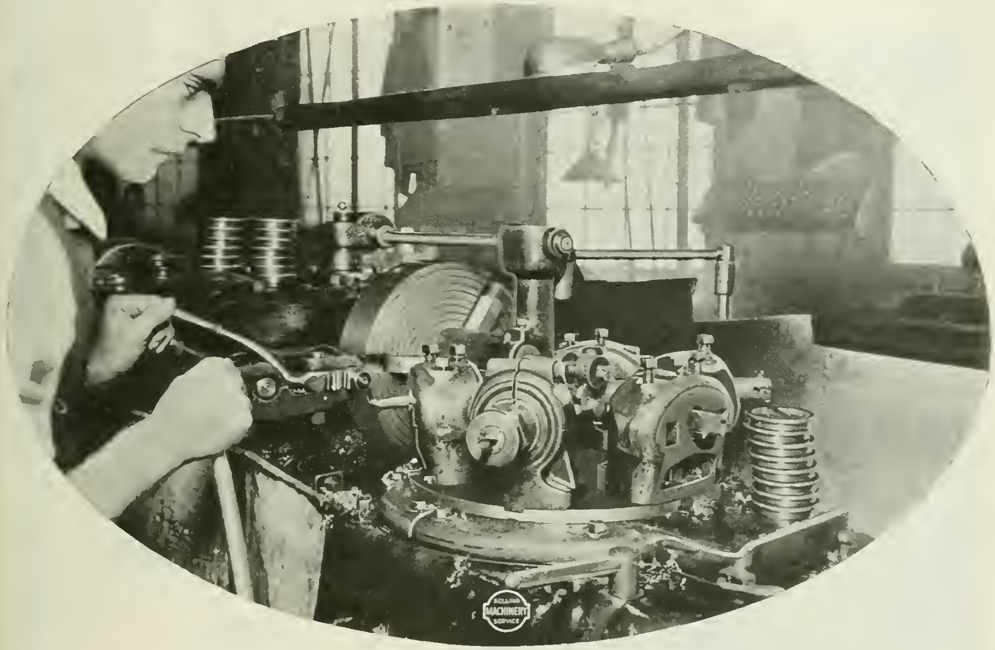
Send for more details.

Springfield, Vermont,
U. S. A.

Jones & Lamson

FRANCE, SPAIN, BELGIUM: F. Auberty & Co., 91 Rue de Maubeuge, Paris.

Turret Lathe



Water Heater Taps for the Stanley Steamer

We found this job in progress at the Stanley Motor Carriage Works, Newton, Mass., where they are using a J & L thread cutting attachment to cut threads on the feed water heater tap shown. This tool cuts 16 threads per inch on a 3.109 diameter to rigid inspection requirements.

The J & L automatic thread chasing tool cuts a wide range of threads; its internal range runs from 2¼ to 11 inches diameter; external 1 inch to 11½ inches diameter, any length under 4 inches. It is a standard tool—one of many developed for use on J & L machines.

The history of the J & L Flat Turret Lathe in this plant dates back fifteen years, and their success is due to the rapid finishing of duplicate parts at minimum costs.

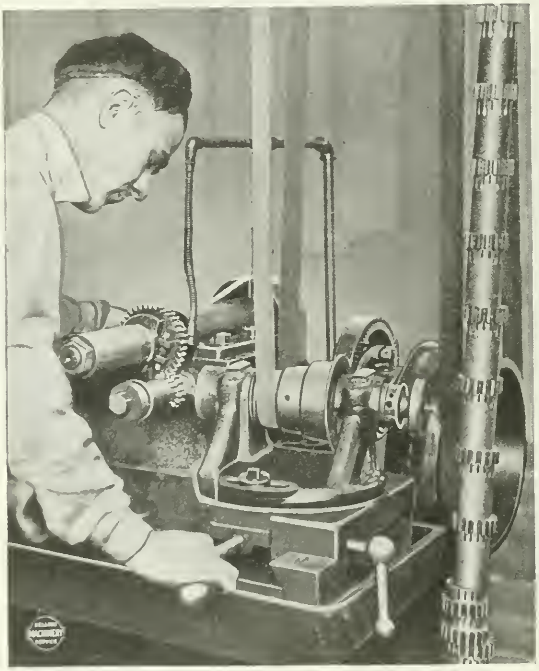
We'll be glad to answer inquiries.

Machine Company

109 Queen Victoria St.
London, E. C.

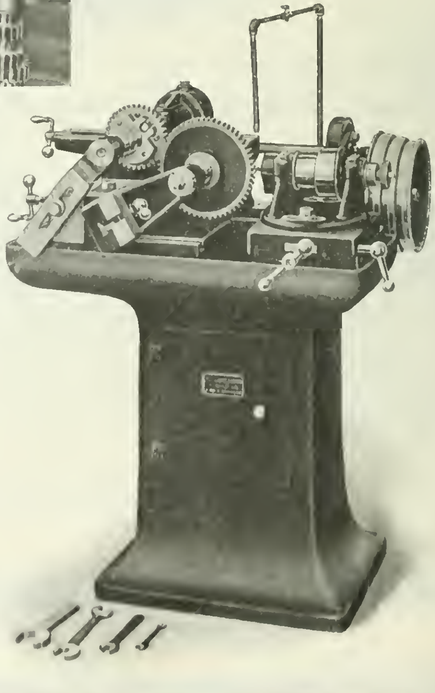
HOLLAND: Spliethoff, Beeuwkes & Co., Rotterdam.

Rochester
Gear Tooth Rounding Machines



Six Years of Steady Service

Here's a photograph which explains the smooth action and long life of sliding gears used in machine tools built by the Morris Machine Tool Company, Cincinnati. It shows one of the Morris operators rounding the teeth of a 9 pitch gear, having 16 teeth of 50-point carbon steel.



Rochester Gear Tooth Rounding Machines are manufactured to round the teeth of any type gear from 1½″ to 30″ diameter and practically any pitch.

They will do this work at manufacturing speed, automatically and with great accuracy.

They will also remove the burrs left by the cutters on spiral bevel gears and pinions and worm gears.

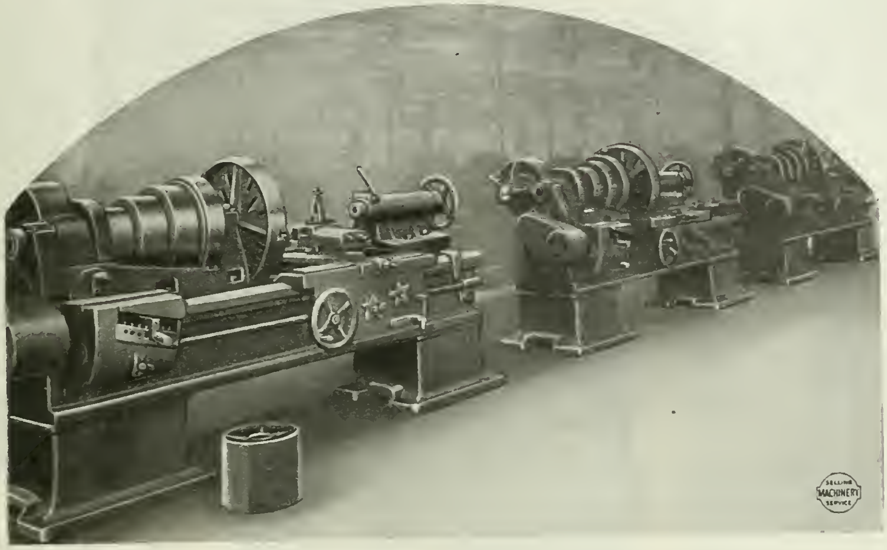
The new catalogue illustrates and describes these machines in detail. Send for your copy. It's free. And it will show you how to save money in rounding the teeth of sliding gears.

INGLE MACHINE CO.

371 St. Paul St. Rochester, N. Y.

BRIDGEFORD LATHES

Aids to the Field Pieces



THESE twenty-nine Bridgeford Lathes were recently installed in a new munitions plant, and in manufacturing high-powered projectiles will prove valuable aids to the other machines of war—"Over There."

Men who operate these tools pledge two new shells for every one their partners in France unloose. They have confidence in the ability of their machines as the gunner has in his Field Piece.

What Bridgeford Lathes have accomplished in every branch of the war's work of production proves that the confidence of their operators is not misplaced.

Make the limit of your tools the limit of your assistance.
Choose no-limit producers. Get the Bridgeford catalogue. Do it now!

BRIDGEFORD MACHINE TOOL WORKS

151 WINTON ROAD - ROCHESTER, N. Y.

MANUFACTURERS OF HEAVY DUTY LATHES FOR MORE THAN 20 YEARS.

For Range, Accuracy, Speed and Service

use a

"GIANT" KEYSEATER

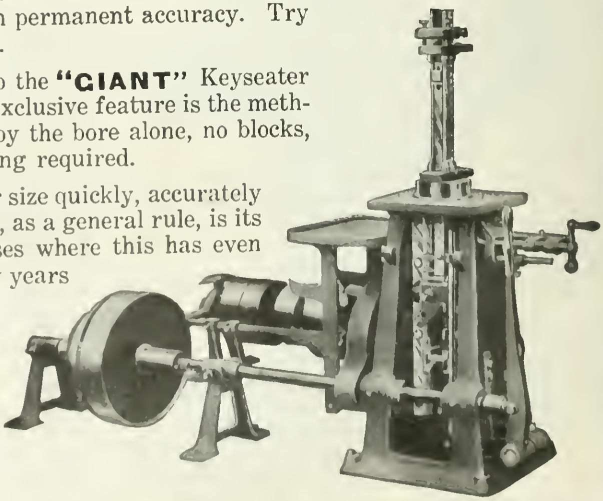
The accompanying photograph was taken in the plant of the Rochester (N. Y.) Barrel Machine Works, where this No. 2 **"GIANT"** Keyseater has been in daily use for the last seven years. Although it has been constantly employed to the extent of its capacity, it is in as good running order today as it was when first installed.

The "GIANT" Keyseater is made in styles and sizes to meet all requirements – your requirements.

All **"GIANT"** Keyseaters are noted for their first-class construction, which insures long service with permanent accuracy. Try to see an "old-timer" in action.

It takes but a minute to set up the **"GIANT"** Keyseater for a change in the work. An exclusive feature is the method by which the work is held by the bore alone, no blocks, fixtures or holding devices being required.

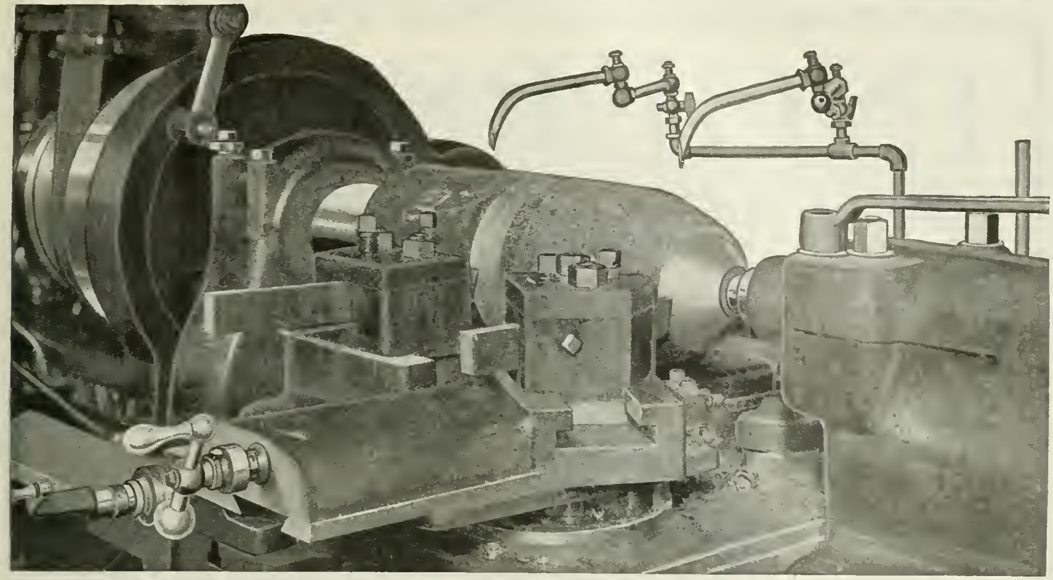
It cuts keyways of any shape or size quickly, accurately and economically. Its first cost, as a general rule, is its only cost, and we can cite cases where this has even been true for periods of twenty years or more.



Write today for further particulars

MITTS & MERRILL
843 Water Street, SAGINAW, MICH.

FOREIGN AGENTS: Burton, Griffiths & Co., Ltd., London, England. Leon Chapuis, Paris, France.



Rough Turning 9.2 British Howitzer Shells on the LeBlond Heavy Duty Lathe

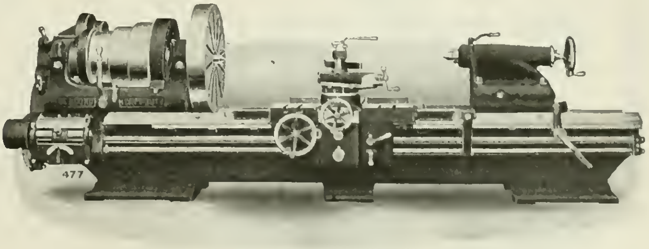
The parallel cut and nose radius are turned simultaneously. The radius is turned from the main cross slide by means of a forming attachment that picks up and overlaps the parallel cut at the end of the radius.

The straight diameter is turned from a supplementary slide.

***Time*—18 Minutes each**

***Machine*—30" LeBlond Heavy Duty Lathe**

Certain exclusive features in our design make the production possible. Positive clutch apron, patent double friction back gear, headstock, etc.



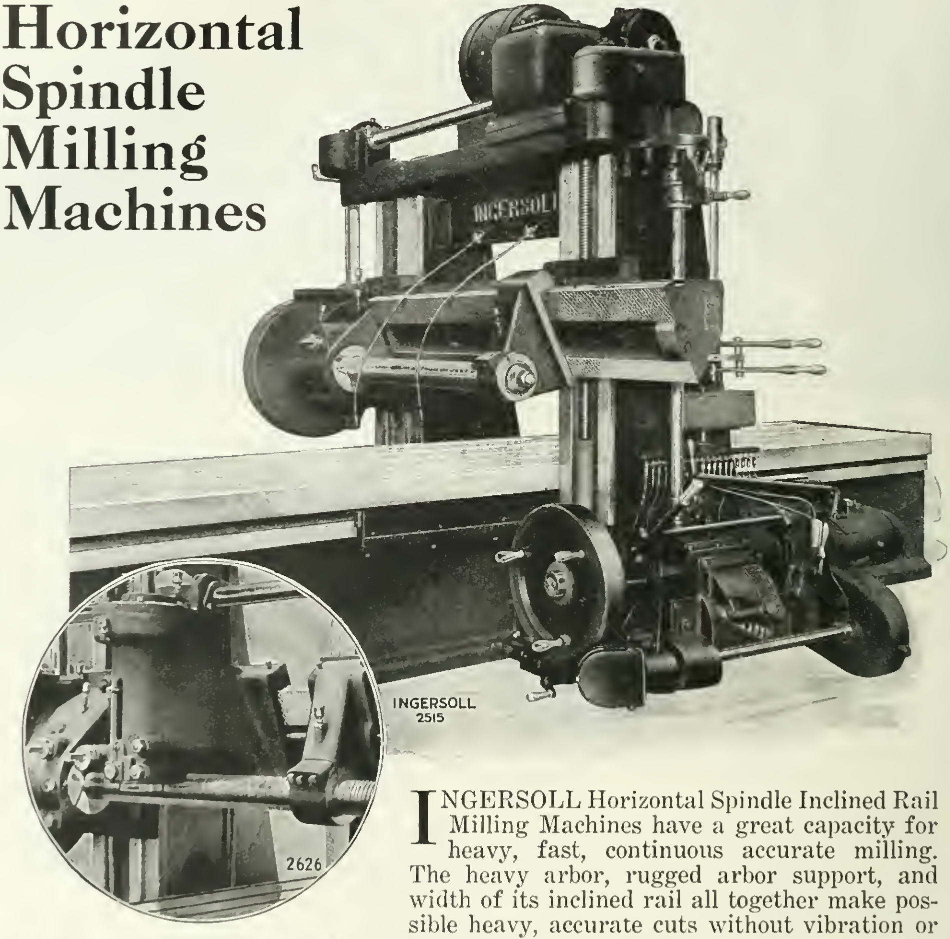
We can offer attractive deliveries

The R. K. LeBlond Machine Tool Co.

Cincinnati, Ohio, U. S. A.

INGERSOLL

Horizontal Spindle Milling Machines



INGERSOLL Horizontal Spindle Inclined Rail Milling Machines have a great capacity for heavy, fast, continuous accurate milling. The heavy arbor, rugged arbor support, and width of its inclined rail all together make possible heavy, accurate cuts without vibration or chatter.

In addition, when equipped with a vertical head, this machine is of peculiar value to shops that have large keyways to cut in heavy shafts. The keyway cutter is mounted on the arbor and the routing cutter is driven by the vertical head, producing a finished keyway at one setting. The vertical head may be moved to the end of the rail out of the way when not in use.

This carefully developed machine has the rugged strength and accurate precision found only in the highest class tools. All gears are cut from solid forgings and are heat-treated and carbonized. Thirty years' consistent growth has made Ingersoll Milling Machines the standard in shops where accurate tools are chosen.

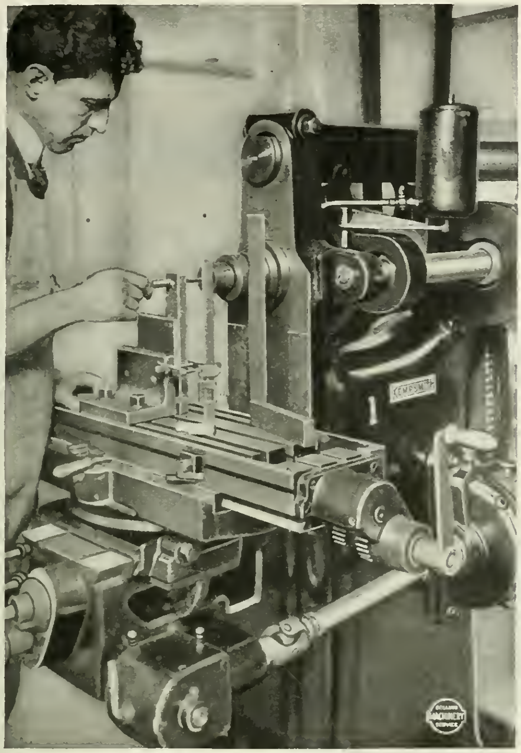
There are other types of Ingersoll Milling Machines—all built in the same rugged style and with the same finish.

The
Ingersoll Milling Machine Company

MILLING MACHINES AND
THEIR EQUIPMENT

Main Office and Works:
ROCKFORD ILL., U. S. A.

NEW YORK OFFICE: 50 Church St
The Walter H. Foster Co., Mgrs
DETROIT OFFICE: 1457 David Whitney Bldg
H. C. Rose, Mgr.



The KEMPSMITH Universal Miller *is a* Profitable Machine

In The Contract Shop

Accuracy to 0.0001″ is not simply a claim in the Atcheson & Barok Die Tool Company, it is a guarantee — to which the Kempsmith Miller is first aid.

Jig boring—shown in the picture—is one of the 0.0001″ jobs on which the "Kempsmith" distinguishes itself. There's also a large amount of government work executed in this plant—for which requirements are always exacting—and here again the "Kempsmith" takes a leading part. The same well-balanced construction and careful workmanship which have made the Kempsmith Miller's reputation for strength and rigidity, permit a degree of accuracy that is particularly appreciated in the toolroom. The universal features, convenient control and ready adaptability make it a profitable miller for the contract shop.

Kempsmith production data on work similar to yours at your disposal. Write.

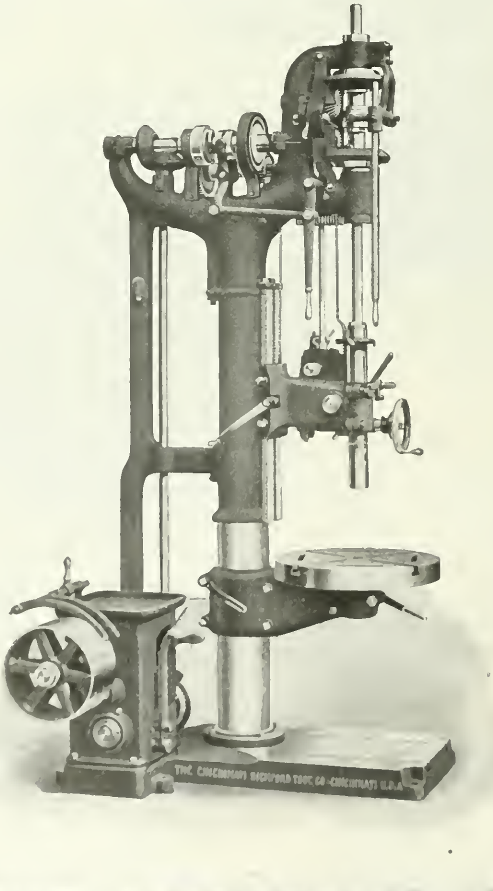
KEMPSMITH MILWAUKEE, U.S.A.

THE CINCINNATI

UPRIGHT DRILLING MACHINE

A Tool That "Grew Up"

The initial product of the Cincinnati Bickford organization made its appearance 44 years ago, and though crude in some respects, many of its type are still doing service in various lines of work. This machine had but three feeds and to change from one to another required the troublesome shifting of a belt on cone pulleys. Some builders have never departed from this construction.



The Cincinnati has "grown up." And now—it has "all geared" drive, conserving power and minimizing wear on bearings; sixteen speeds —38 to 534 r.p.m. in the 24″, 28″ and 32″ sizes and 33 to 428 r.p.m. in the 36″ and 42″ sizes; six positive, quickly obtainable feeds from 6 to 39 thousandths in the 24″, 28″ and 32″ sizes and from 7 to 49 thousandths in the 36″ and 42″ sizes; friction back gears and patent geared tapping attachment which engage without shock while machine is in operation.

And we'd like to go into details about that tapping attachment. It's a drilling machine feature which you ought to know about. Write us and we'll gladly send the full story in Circular U-4.

THE CINCINNATI BICKFORD TOOL

I 546

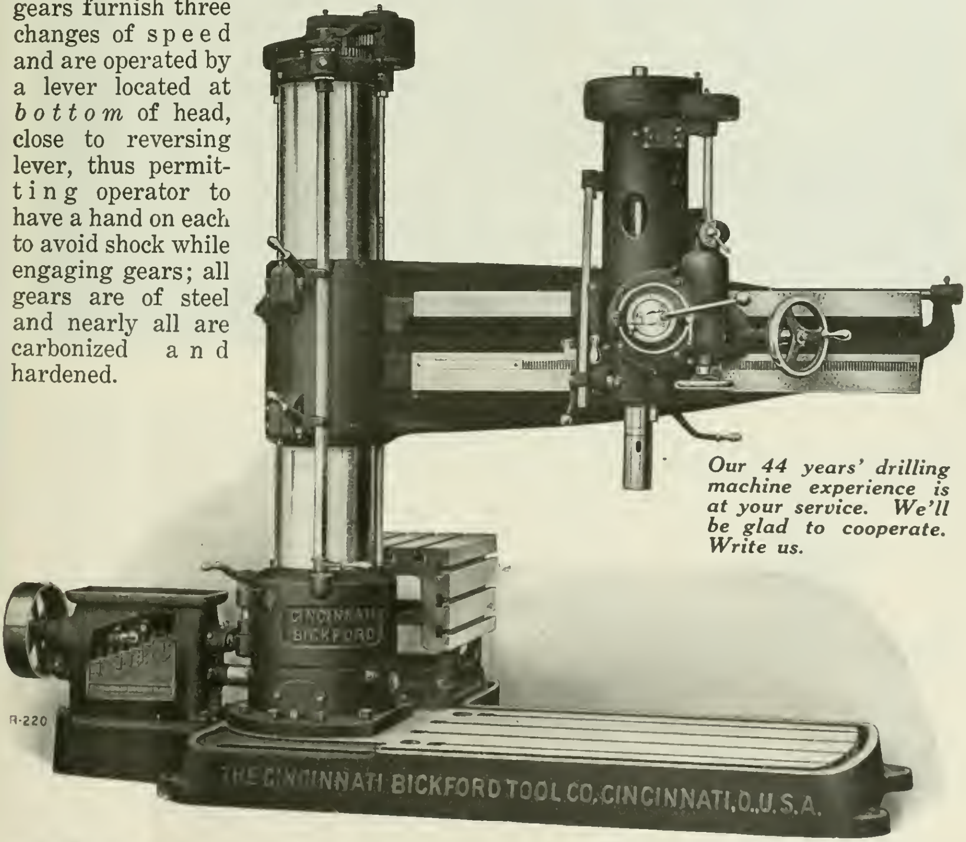
THE
CINCINNATI BICKFORD

RADIAL DRILLING MACHINE

As Adaptable As It Is Able

The Cincinnati Bickford was the *first* modern type radial, and the fact that it remains foremost today is significant of what years of specialization have accomplished. Twenty-four claims were allowed on the original tool and scores of others have been granted since—proof of the many improvements in the present design. It is unequalled in range and adaptability.

The arm, entirely enclosed on all sides, affords an unusual degree of stiffness, and is provided with a narrow guideway; "fool-proof" elevating mechanism prevents accidents; automatic trip is in full view and within convenient reach of operator; back gears furnish three changes of speed and are operated by a lever located at *bottom* of head, close to reversing lever, thus permitting operator to have a hand on each to avoid shock while engaging gears; all gears are of steel and nearly all are carbonized and hardened.



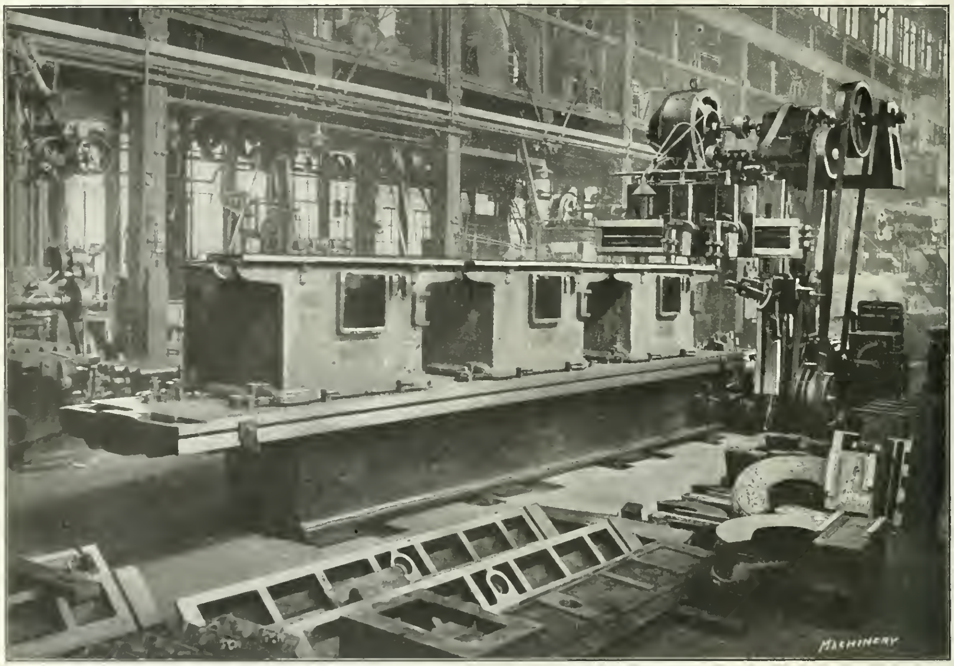
Our 44 years' drilling machine experience is at your service. We'll be glad to cooperate. Write us.

COMPANY, Oakley, Cincinnati, U. S. A.

R546

CINCINNATI PLANERS

Eleven of Them in This Plant



Efficiency Planers

Planer Efficiency

Send for the circular.

There are eleven Cincinnati Planers in this big "down East" grinder manufactory, each daily accomplishing work that is a credit to the installation.

The operation shown is machining the ways of three grinders at the same setting. Extreme rigidity and accurate alignment are vital to the successful completion of this job. The fact that Cincinnati Planers have seen many years' service in this plant is testimony for their efficiency.

Micrometer adjustments, graduated in thousandths on all vertical and horizontal screws, provide means for obtaining any depth of cut rapidly and accurately. Great variety of speeds is another important feature.

CINCINNATI PLANER COMPANY
CINCINNATI, OHIO, U. S. A.

Cincinnati-Acme

Combination Flat Turret Lathe

Cuts Out the "Preliminaries"

The operation shown in the photograph is machining an 18 inch gear blank and the particular advantage in using the Cincinnati-Acme Combination Flat Turret Lathe on this class of work is that much of the customary setting up can be eliminated.

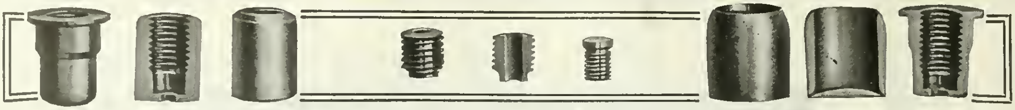
All dimensions on these gear blanks must be held to plus or minus 0.001″. That this is being satisfactorily accomplished is evident from the fact that the Union Gear and Machine Company of Boston, where the photograph was taken. has recently supplemented its Cincinnati-Acme equipment by still another machine.

"A watched Cincinnati-Acme needs no further advertisement."

When you want a time-saving, vibrationless lathe you should have the details of the Cincinnati-Acme handy.

THE ACME MACHINE TOOL CO.

CINCINNATI, OHIO, U. S. A.

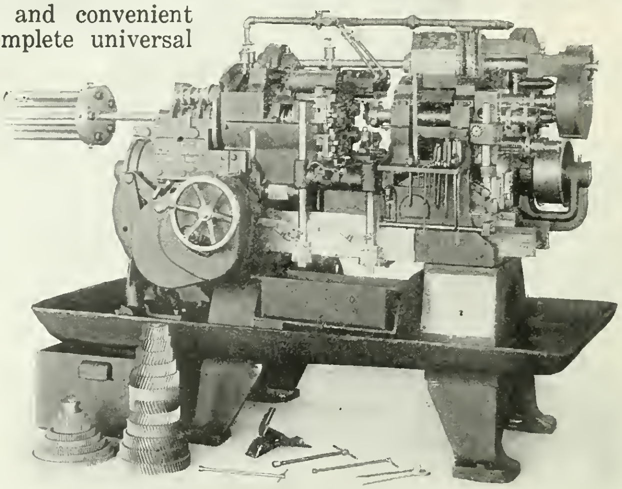


SIMPLICITY in design and convenient operation make this complete universal Automatic Screw Machine profitable for jobbing as well as manufacturing purposes. It will show a profit on even comparatively short runs.

THE

"HAYDEN"

has nine cutting tools—any one of which can be brought into position by a hand lever—a gage for the quick setting of circular tools and other distinctive advantages—47 in all—which make its records notable even in this day of unprecedented production.



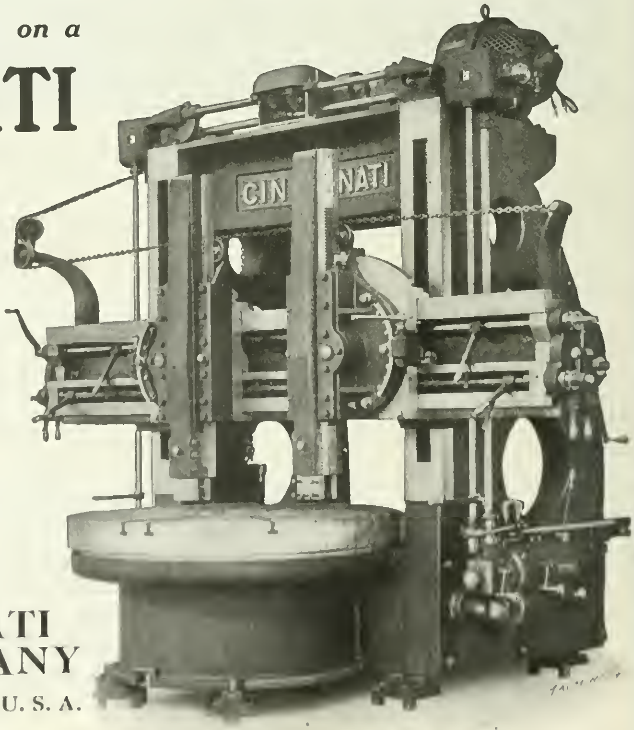
We claim it to be the best all round machine of its class and are ready to prove it. Catalog for details.

CINCINNATI AUTOMATIC MACHINE CO., Oakley, Cincinnati, Ohio, U. S. A.

Do Those Unusual Jobs on a

CINCINNATI

BORING MILL



The Cincinnati Boring Mill is more than its name implies—it is a most versatile general manufacturing tool—big, powerful, yet convenient and easy to operate and extremely accurate in its special field, machining work of large diameters.

It is particularly desirable in big, busy shops, where unusual jobs are certain to arise.

Sizes up to 16 feet.
Complete description upon application.

THE CINCINNATI PLANER COMPANY

CINCINNATI OHIO, U. S. A.

AUGUST *and the Coupon*

A list of the men who would rather run a lathe than an automobile during the month of August could be written on the back of a postage stamp with a paint brush.

The "boss" who knows and understands this truth has a much better chance of weathering labor conditions than the one who doesn't.

Though you can't furnish the automobiles and spare time, you can provide the lathe that's least likely to aggravate the situation—pick the lathe that will do the heavy work with a minimum strain on the operator.

It's your own fault if you don't know that this is a G-K specialty. For the last six months we've emphasized our willingness to send you the news on what's what in modern lathe building. However, we won't chide—get the coupon off now. We'll try to make deliveries before the "dog days" get monotonous.

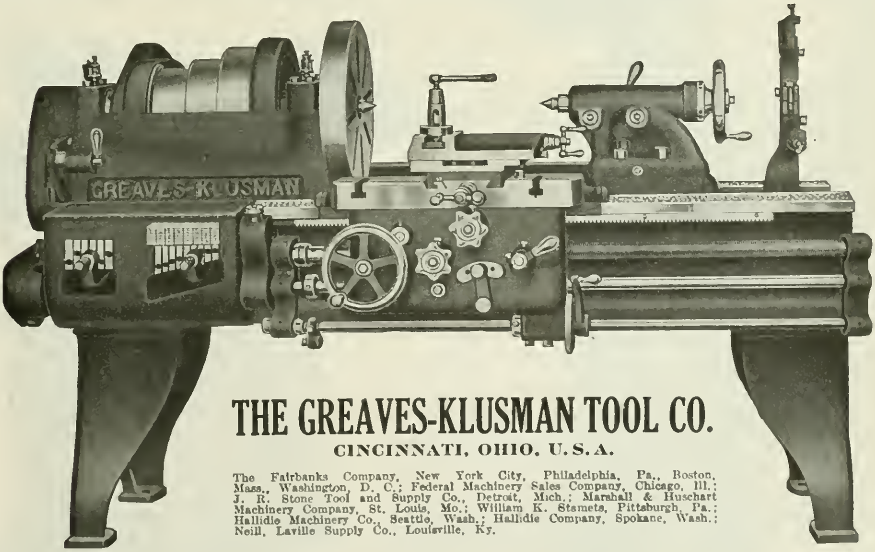
The Greaves-Klusman Tool Co.,
Cincinnati, Ohio, U. S. A.

Your advertising has interested me. Send the G-K story.

Name..

Address..

MACHINERY



THE GREAVES-KLUSMAN TOOL CO.

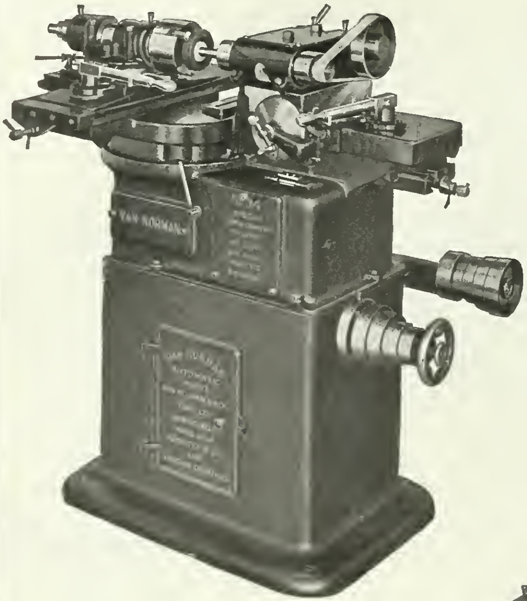
CINCINNATI, OHIO, U.S.A.

The Fairbanks Company, New York City, Philadelphia, Pa., Boston, Mass., Washington, D. C.; Federal Machinery Sales Company, Chicago, Ill.; J. R. Stone Tool and Supply Co., Detroit, Mich.; Marshall & Huschart Machinery Company, St. Louis, Mo.; William K. Stamets, Pittsburgh, Pa.; Hallidie Machinery Co., Seattle, Wash.; Hallidie Company, Spokane, Wash.; Neill, Laville Supply Co., Louisville, Ky.

GREAVES-KLUSMAN

HIGH QUALITY—LATHES.

FOREMOST



Model No. 34

The Highest Development in Modern Bore Grinders

The Van Norman Model No. 34 Bore Grinder is the highest development in machines for the accurate production of short straight or taper holes. It embodies many original features to meet the rigid requirements of ball and roller bearing race manufacturing and other instances where precision grinding of similar nature is performed.

It has the same refinement of cross feed and cut-out mechanism as is employed in the well-known Van Norman Oscillating Grinder.

This new Van Norman Grinder is rapid, accurate, compact and convenient. To illustrate the last mentioned qualification: a single movement against one hand lever disconnects latch and withdraws the wheel slide; similar action with the other hand carries the work head outward on cross slide ways at right angle to the wheel spindle, giving ample clearance for testing and loading.

We want to make you thoroughly acquainted with this machine. If you can't conveniently see it for yourself in actual operation, write us.

VAN NORMAN MACHINE TOOL COMPANY

Waltham Avenue, SPRINGFIELD, MASS.

VAN NORMAN

There's No Danger

When a tang twists off don't endanger the true taper and the axis of the tool by delicate grinding jobs. Insist on

Perfect Double Tang SOCKET

"Perfect Double-Tang" Sockets are easily applied—just grind a new tang below the old and broken one; almost any boy can do it—and without the least danger to the future performance of the tool.

In fact "Perfect Double-Tang" actually makes the tool 25-60% stronger than before, and is equally valuable in *preserving* new tools from tang troubles, or in *reclaiming* broken tanged tools.

Send for "Rob the Scrap Heap"

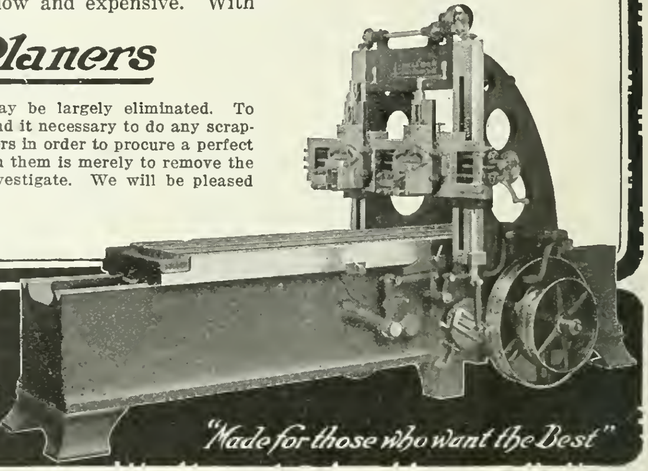
THE CLEVELAND
TWIST DRILL COMPANY
NEW YORK CLEVELAND CHICAGO

Gray Planers

If a job is not turned true, you can improve it by grinding. If it is not bored true you can improve it by reaming. But—if it is not planed true you can improve it only by hand scraping, which is slow and expensive. With

Gray Planers

and some "know how" scraping may be largely eliminated. To prove this, will say that we do not find it necessary to do any scraping on the beds or tables of our planers in order to procure a perfect bearing. The only scraping we do on them is merely to remove the "loose iron." It will pay you to investigate. We will be pleased to have you call.



THE G.A.GRAY CO.
CINCINNATI, OHIO.

"Made for those who want the Best"

"FOX" LATHES

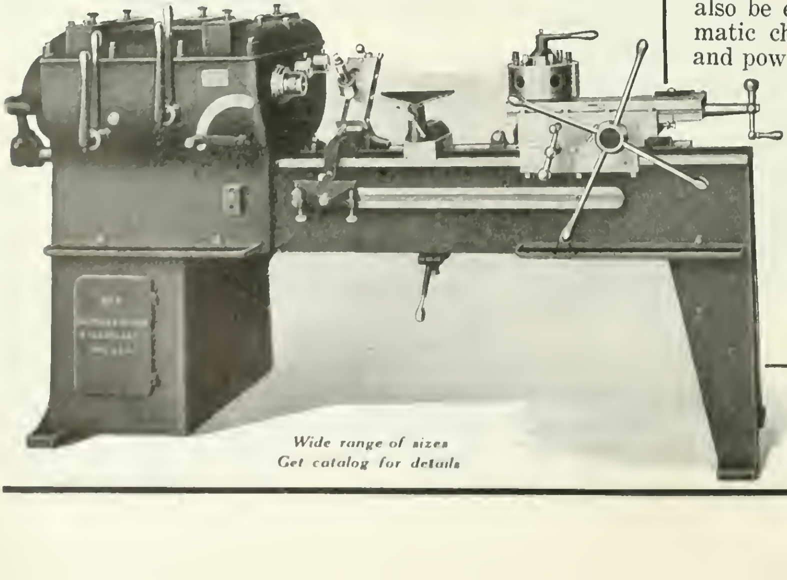
Motor Driven Lathes of Quality

Built by

BARDONS & OLIVER

CLEVELAND, OHIO, U. S. A.

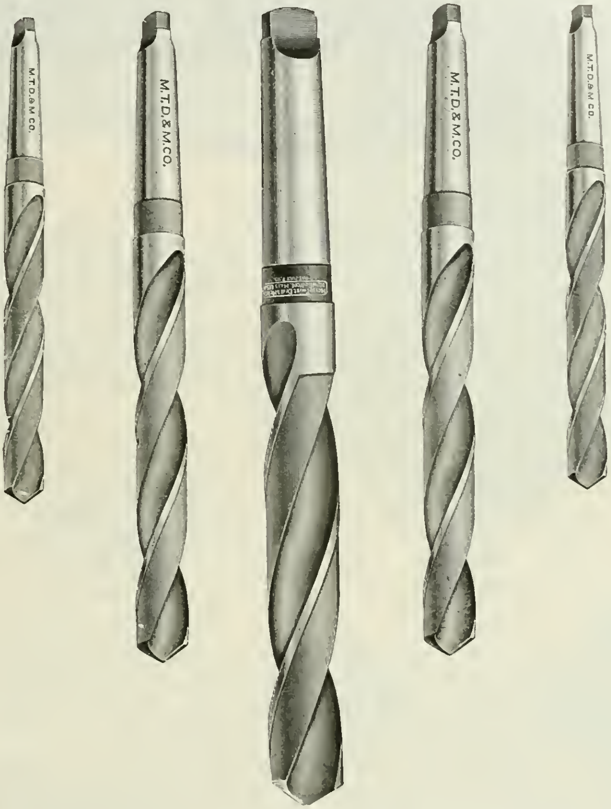
THIS "Fox" Lathe is noted for its exceptionally compact construction. Selective speed all-geared head eliminates overhead shafting. It has eight spindle speeds, chasing and taper attachments, universal turret slide and saddle with longitudinal and cross motion. It may also be equipped with automatic chuck and wire feed and power longitudinal feed to turret slide. Reverse is instantaneously obtainable by means of friction clutches, spindle only being reversed, motor and fast running shafts always turning in same direction.



Wide range of sizes
Get catalog for details

The "Fox" Lathe may be handled efficiently in any available part of the shop.

MAN-POWER


M.T.D.&M.CO.
M.T.D.&M.CO.
M.T.D.&M.CO.
M.T.D.&M.CO.

MAY BE CONSERVED

BY USING TOOLS THAT ENABLE THE INDIVIDUAL WORKER TO PRODUCE MORE. INCIDENTALLY SUCH TOOLS ALSO SAVE TIME AND POWER AS WELL

"MORSE" DRILLS ARE SUCH TOOLS
THE MEN WHO USE THEM KNOW

MORSE TWIST DRILL & MACHINE CO.
NEW BEDFORD, MASS.

NICHOLSON

A Shearing Cut Without Channels or Furrows

That is the kind Nicholson Files give. The teeth of Nicholson Files are so formed as to have a keen cutting edge combined with strength to withstand pressure, and ability to free themselves from chips.

NICHOLSON U.S.A. (TRADE MARK) NICHOLSON U.S.A. (TRADE MARK)

While we carry over 6000 varieties in stock, there are two grand divisions of Nicholson Files, namely, the Increment Cut Files for all ordinary work, and the X-F Swiss Pattern Files for jewelers, watch and tool makers.

Nicholson Files are not only the standard of America, they have a world-wide reputation. Some of New England's rugged honesty of character went into Nicholson Files 52 years ago—and has stayed there.

Send for a copy of "File Filosophy"—
it will help and interest you.

BY INVITATION MEMBER OF
NEW YORK U.S.A.

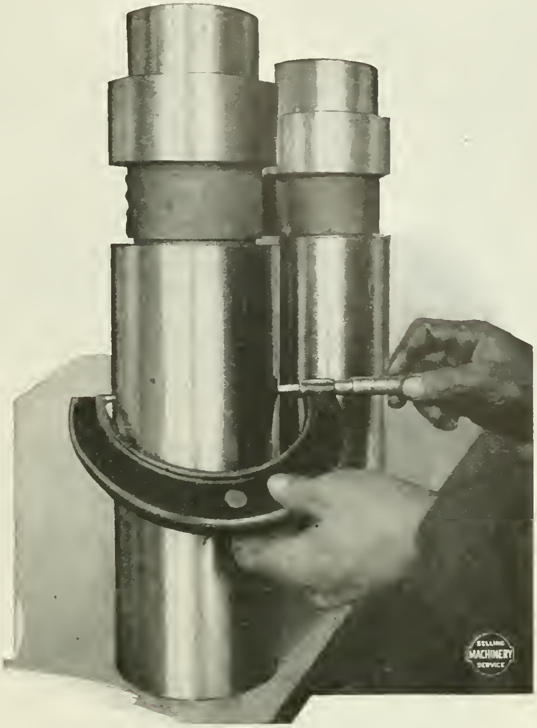
NICHOLSON FILE CO.
PROVIDENCE RHODE ISLAND

1893-1918

HARDLY more than a generation ago an order for shafting would be accompanied by a horseshoe closed together for calipering—the only "specification" other than the approximate length. It's a long way from this primitive gage to the

SLOCOMB MICROMETER

—from yesterday's slow and expensive rule of thumb methods of "fitting" to the speedy, economical, interchangeable manufacturing of today.

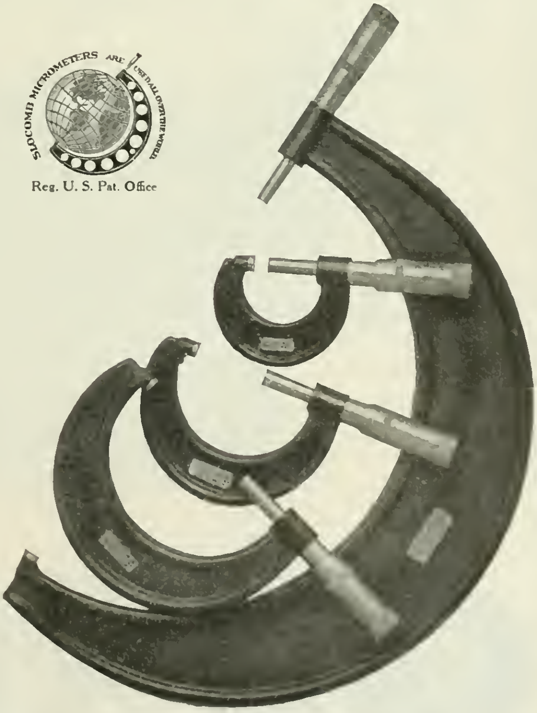


It is 25 years since the first Slocomb Micrometer made it's appearance. Today the line includes micrometers for testing any and all kinds of work from 0 to 30 inches—accurate to any required degree and used wherever requirements are exacting and standards high.

SLOCOMB MICROMETERS ARE USED ALL OVER THE WORLD

Reg. U. S. Pat. Office

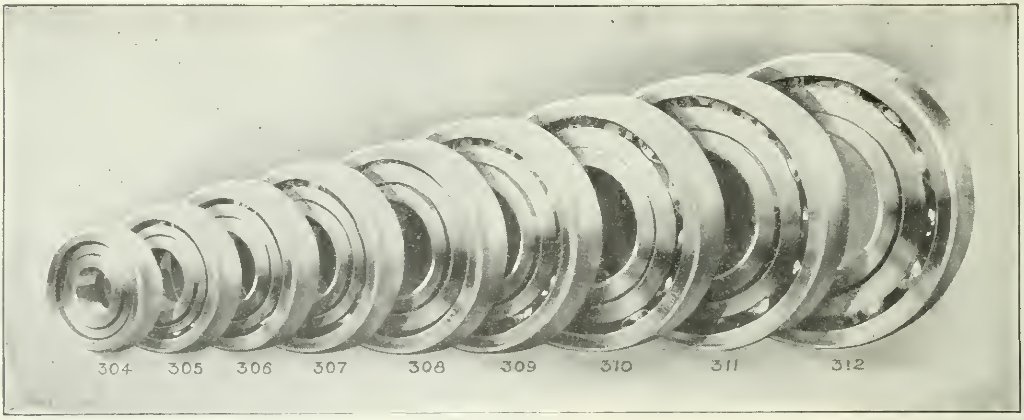
The Slocomb Micrometer has a tool steel screw with extra long bearing on nut and other distinctive features that make it "the longest lived micrometer that can be bought."



Details in Catalog 15.

J. T. Slocomb Co.
PROVIDENCE, R. I. U. S. A.

FOREIGN AGENTS: England: Chas Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Japan: Alfred Herbert, Ltd., Yokohama. Italy: Chas. Civita, Milan. Australia: Edwin Wood, Pty., Ltd., Melbourne and Sydney.



The Secret of the 57 Sizes of "Standard List" Ball Bearings

"Standard List" Bearings made to fit 19 shaft sizes

HEAVY-duty ball bearings were first manufactured in Continental Europe and were imported to this country in considerable quantities before any of the American manufacturers had become well established. Consequently American machinery manufacturers accepted the standard metric sizes in which the imported bearings were made, and these sizes were finally adopted as standard by the various American Ball Bearing manufacturers, and by the Society of Automotive Engineers.

The fifty-seven sizes on the "Standard List" are made to fit nineteen different shaft sizes, which vary by five-millimeter intervals from twenty millimeters (.7854 in.) to 110 millimeters (4.3307 in.). These nineteen shaft sizes will cover all ordinary requirements, but for heavy machinery "extra large sizes" for shafts up to 210 mm. (8.2678 in.) and for load capacities up to 44,000 pounds, are made to order.

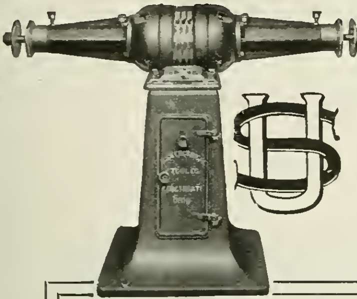
Each bearing size is identified by a number. The last two figures of this number indicate the size of the shaft which the bearing will fit, and in all the standard sizes, the last two figures of the bearing number, when multiplied by five, will give the bore of the bearing in millimeters. For example, the No. 304 bearing has a bore of twenty millimeters, the 310, fifty millimeters and the 319, ninety-five millimeters.

For each of the nineteen shaft sizes, bearings are furnished in three weights or series. The difference between the different series will be explained in our next advertisement in this publication.

Gurney Ball Bearing Company
Conrad Patent Licensee
Jamestown, N. Y.

274

GURNEY



Ball Bearing Buffing Machine

Some Advantages of U. S. Electrically Driven Tools

Type K Bench Grinder Four Sizes

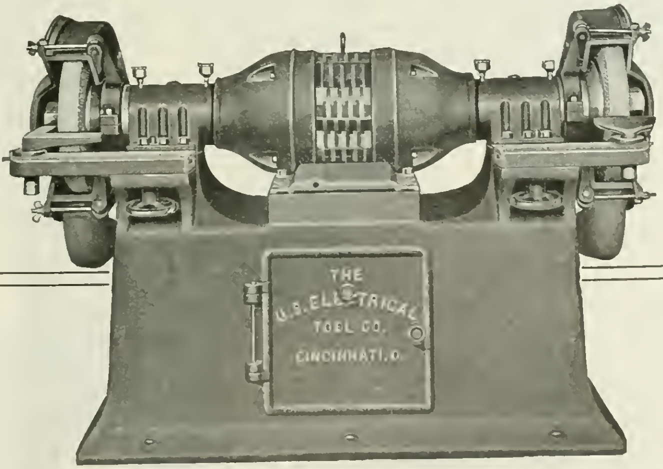
Combination Grinding and Buffing Machine. Two Sizes—Canvas or Wire Belts

U. S. Electrically Driven Tools are ready for immediate use as soon as they are uncrated. There is no delay for assembling, correcting or aligning and no expense for transmission equipment. They can be located and relocated at will; they utilize power only when actually at work; may be operated continuously without getting hot.

We have had over 30 years' experience in building electrical tools and design our motors specially to fit the machines.

Besides our well known Portable Drills and Grinders, U. S. Electrically Driven Tools include a comprehensive line of grinding, buffing and combination machines to which the heavy duty model, shown below, is the latest addition.

Accurate, durable and fully self-contained, details are fully set forth in our catalog, but to fully appreciate the wide range adaptability and efficiency of these machines, you must try them in your own shop.



HEAVY DUTY GRINDER

THE UNITED STATES ELECTRICAL TOOL CO.

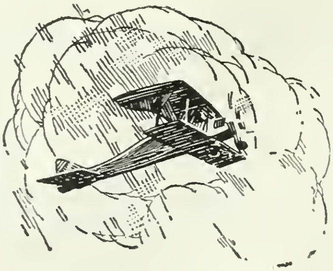
6th Ave. and Mt. Hope St., CINCINNATI, OHIO

STOCK CARRIED IN BRANCHES

New York Office
50 Church Street
Chicago Office
549 West Washington Boulevard

St. Louis Office
610 Commercial Building
Boston Office
12 Pearl Street

Detroit Office
18 Columbia St., West
Philadelphia Office
The Bourse

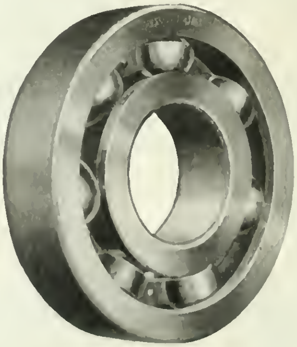


Strom BEARINGs

FORMERLY U.S. BALL BEARINGS

Where speed means life—and death darts above the clouds—there Strom Bearings keep ever at the flyer's command a steady flow of frictionless power. With their big balls and deep grooves without notches, they are chosen by engineers wherever most dependable and economical bearing service is required.

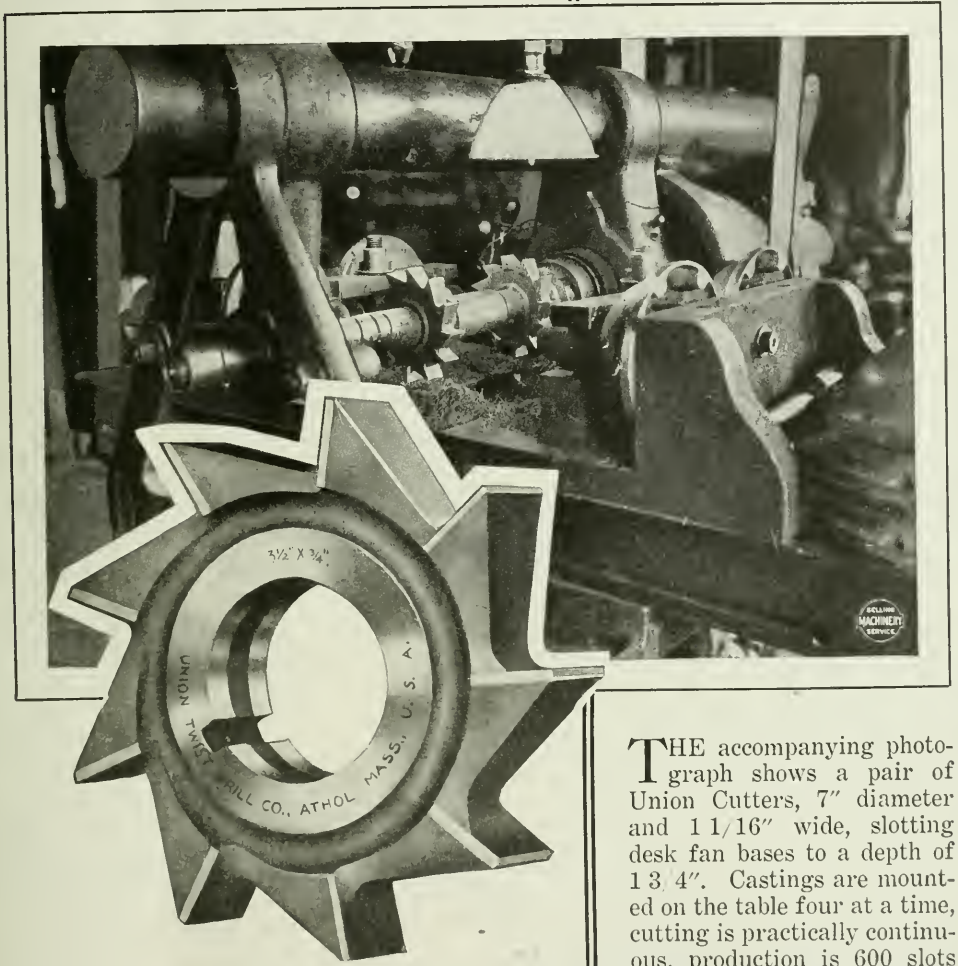
U. S. Ball Bearing Mfg. Co.
Conrad Patent Licensee
Palmer Street and Kolmar Avenue, Chicago, Illinois



UNION CUTTERS

With Wide-Spaced Teeth For Efficiency

SLOTTING DESK FAN BASES


3½″ X ¾″
UNION TWIST DRILL CO., ATHOL MASS., U. S. A.
SELLING MACHINERY SERVICE

THE accompanying photograph shows a pair of Union Cutters, 7″ diameter and 1 1/16″ wide, slotting desk fan bases to a depth of 1 3/4″. Castings are mounted on the table four at a time, cutting is practically continuous, production is 600 slots per day (10 hours).

The wide spaced teeth of Union Cutters insure free action, ample chip room, minimum power consumption and long service between grinds.

Try them and profit by these advantages

Send for Book of Information, Edition "G" for details of the complete line of cutting tools

Union Twist Drill Company
ATHOL MASS.

THE FINAL PROOF
F.G.S.
THE FELLOWS GEAR SHAPER
FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry, England;

OF ACCURACY

Don't fool yourself. You can't cut an accurate and efficient helical gear with an inaccurate cutter. Be the gear cutting machine ever so accurate, the cutter is the final arbitrator.

And speaking about cutter control, this must be positive and rigid, not flexible. If not positive, the best cutter that was ever made is no better than the worst.

In July Machinery we illustrated and explained the helical control mechanism which is used on the Fellows Helical Gear Shaper, and which guides the cutter in a positive and rigid manner.

The designer on the opposite page is now being shown the Helical Gear Shaper Cutter—*the secret of perfect helical gears.* This cutter has the involute curves of the teeth generated by a grinding process after hardening in the same manner as the Gear Shaper Cutter used for cutting spur gears.

This Point Is Important

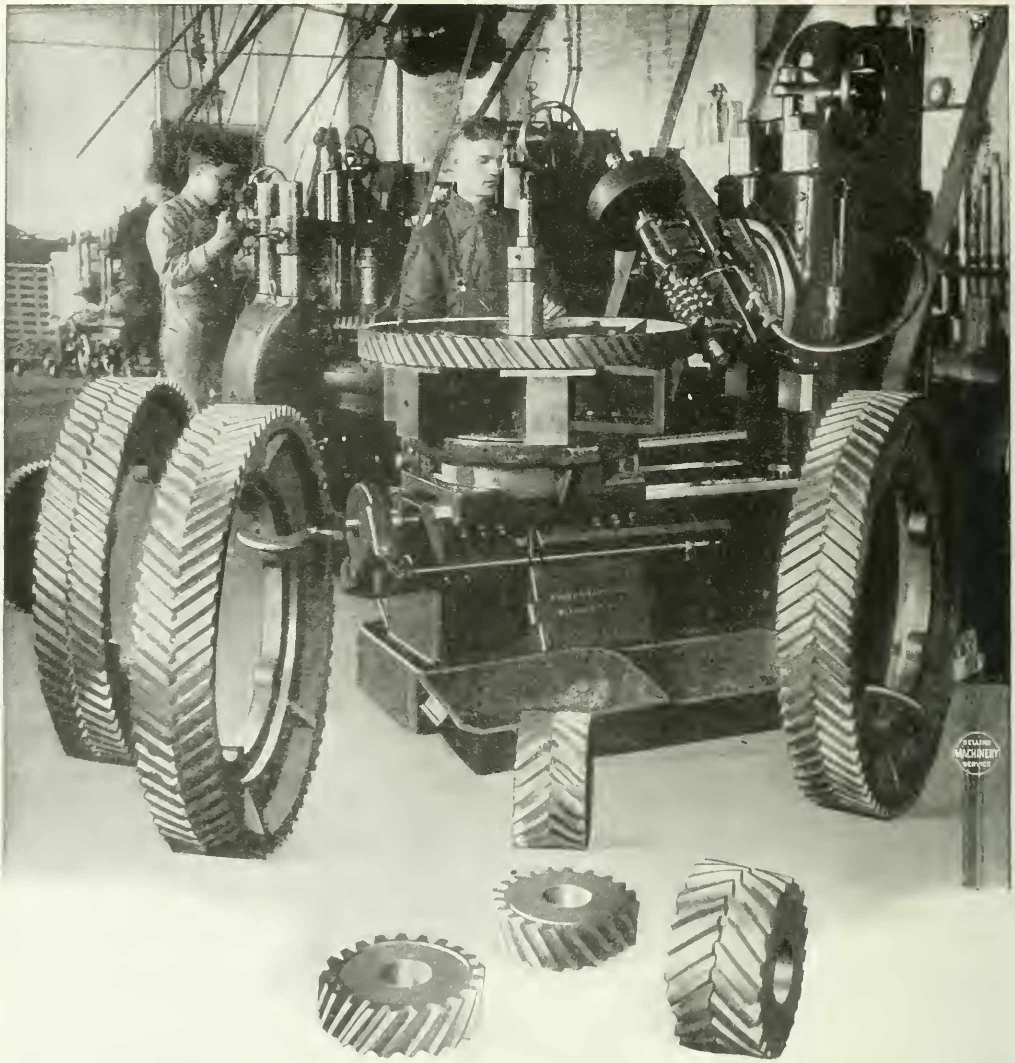
With the Helical Gear Shaper there are no "gears" to calculate. The feed of the cutter and the helix angle produced have no connection whatsoever. There is no jumping from pillar to post only to find in the end that you cannot get the helix angle you want. It is just as easy to cut a helical gear on the Gear Shaper as it is a spur gear, and the cutting of a spur gear is simplicity itself. Ask any owner of the Gear Shaper.

It is no exaggeration to say, therefore, that the Fellows Helical Gear Shaper has taken the "H—l" out of Helical and the "Myst" out of Mystery.

Don't fuss and worry along with the "old methods" any longer. There is a better way—the Gear Shaper way. Write now for our booklet, "The Fellows Helical Gear Shaper," which explains this most interesting machine.

COMPANY, Springfield, Vermont, U.S.A.

Paris, France, and Spain; Milan, Italy; Yokohama, Japan; Calcutta, India.



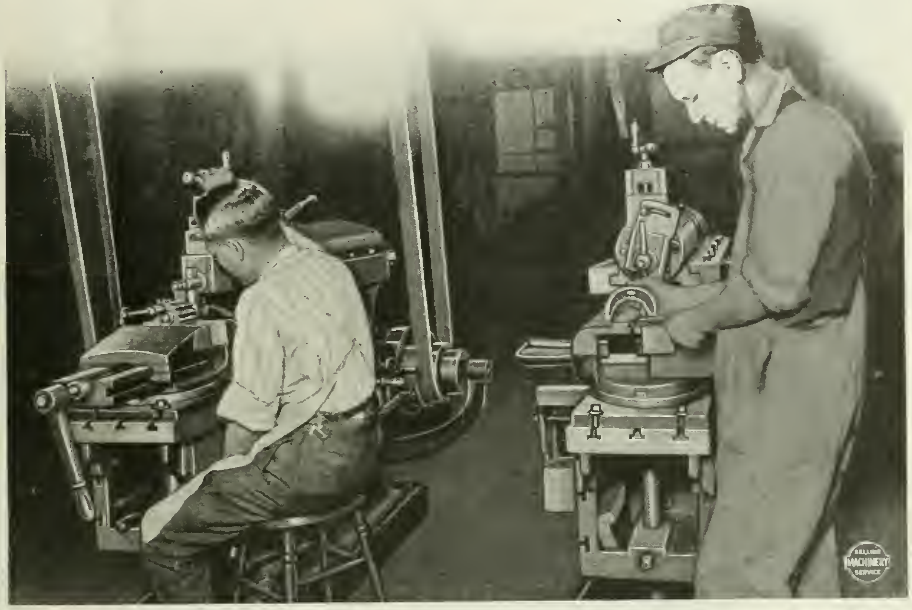
Few Concerns Demand More of Hobbing Machines than the Gear Manufacturers

Foote Bros. Gear & Machine Company, Chicago, Ill., maker of high-grade gears, uses Gould & Eberhardt Gear Hobbers; gives them hard service and finds them satisfactory from every standpoint. Hobbing these 36-degree, 52′ spiral, 75-tooth, 2½-pitch, 3″ face steel gears, which are bolted together to make herring-bone gears, gives a fair idea of what these machines are doing. The fact that Foote Bros. find six "Gould & Eberhardts" a profitable investment tells its own story of efficiency.

G & E Gear Hobbers are rigid, rapid, accurate, durable machines—therefore profitable. Let us tell you more about them.

GOULD & EBERHARDT
"HIGH DUTY" SHAPERS
AUTOMATIC GEAR AND RACK CUTTING MACHINERY
ESTABLISHED 1833 NEWARK, N.J. U.S.A.

"OHIO" SHAPERS



Always Busy

For more than two years "Rush" has been the commonest sign throughout the Holmes Manufacturing Company's plant at Shelton, Conn., where the accompanying photograph was taken—and truly remarkable are the number of so-marked jobs that have found their way to this concern's two "Ohio" Shapers.

The work varies greatly. One of the machines in the picture is cutting a keyway in a set of formed cutters, the other is machining a dovetailed slide for a fixture. The next job may be large jig castings and gear racks; but no matter what they are, the "Ohio" Shapers are expected to be ready, and if experience counts for anything, they certainly will be.

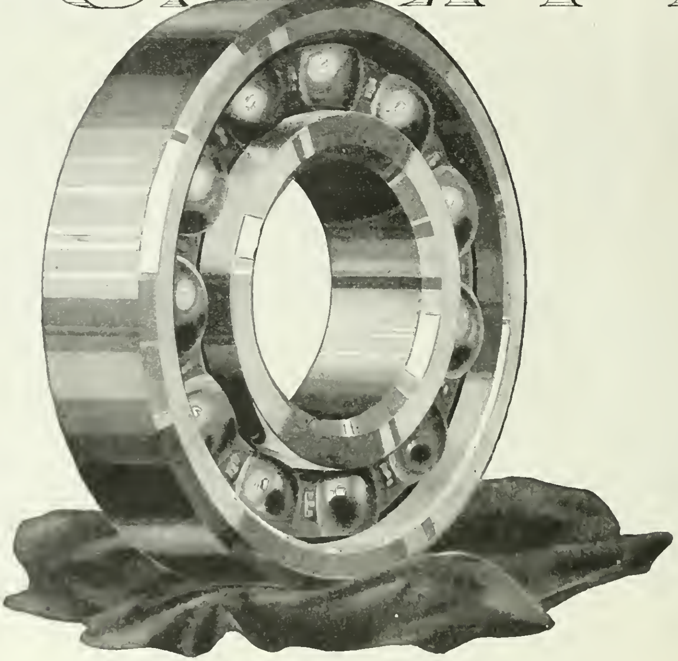
If you are looking for a machine you can keep busy ***always,*** a machine you know will be equal to whatever you give it, investigate the "Ohio." Start right now.

OHIO MACHINE TOOL COMPANY

KENTON Planers and Shapers Since 1887 OHIO, U. S. A.

Chicago, Federal Machinery Sales Co.; Toledo, Coghlin Machinery & Supply Co.; Cleveland, W. M. Pattison Supply Co.; Detroit, English-Miller Machinery Co.; Pittsburgh, Laughlin-Barney Machinery Co.; Buffalo, Laird Machinery Co., Syracuse, H. A. Smith Machinery Co.; Philadelphia, Eastern Machinery & Equipment Co.; New York, Garvin Machinery Co.; Providence, Brownell Machinery Co.; Hartford, Conn., Purinton & Smith; Boston, Factory & Mill Supply Co; Baltimore, Edwin L. Stringer; Minneapolis, Irvine Sales Co.; Huntington, W. Va., Banks Supply Co.; Omaha, Neb., Sunderland Machinery & Supply Co.; Montreal, Que., Standard Mchy. & Supplies Co.; Grand Rapids, Mich., McMullen Mchy. Co.; New Orleans, La., P. H. McArdle; Ottawa, Ont., General Supply Co. of Canada; St. Louis, Mo., Colcord-Wright Machinery Supply Co.;Tacoma, Wash., Sterling Machinery Co.; Portland, Ore., Pacific Engineering & Equipment Co.; General Machinery & Supply Co., San Francisco, Cal.; Gaston, Williams, Wigmore, France, England, Japan, China, Italy; Stokvis-Zonen, Petrograd.

QUALITY



New Departure Ball Bearings

Here are a few of many reasons for the QUALITY of this ball bearing:

Because it is of chrome alloy steel tubing specially made for us and *the best that money and skill can produce.*

Because our manufacturing processes exact dimensions that are accurate to a ten-thousandth part of an inch or *one-thirtieth the thickness of a human hair.*

Because each bearing is tested seventy-eight times during its development by precise instruments that assure maximum quality and accuracy.

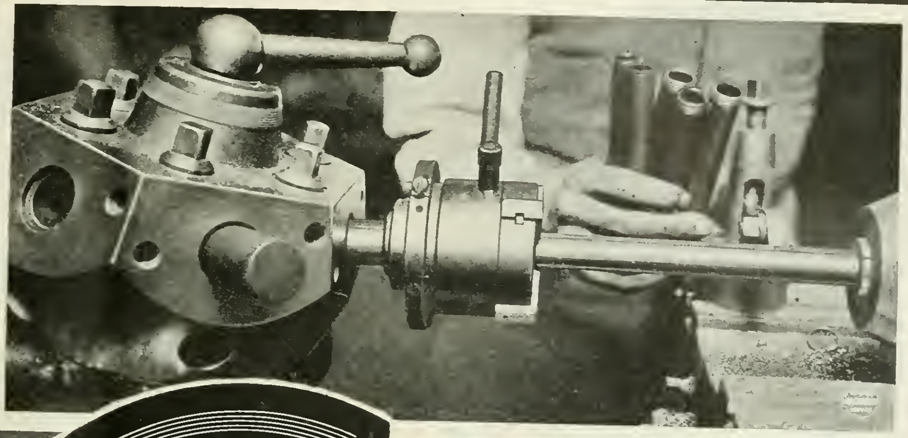
Because the steel balls are made by ourselves from the best chrome alloy steel procurable and are insistently tested for strength, sphericity and uniformity of size.

The quality of New Departure ball bearings is the reason for their extensive use in automobiles, motor trucks, aeroplanes and all kinds of machinery.

THE NEW DEPARTURE MANUFACTURING COMPANY, BRISTOL, CONN.

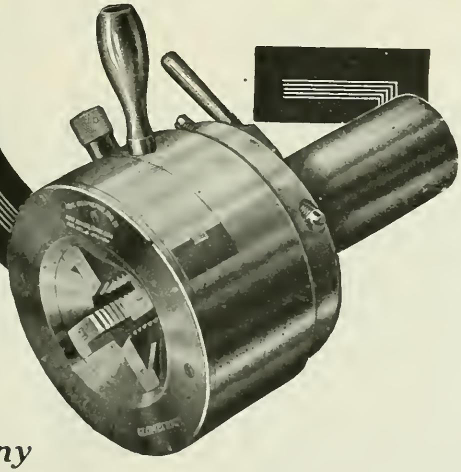
Conrad Patent Licensee.

346-A



Geometric

Die Heads



In the past four years, the Universal Tool Company of Springfield, Mass. has used Geometric Die Heads—1/2 to 1½ inch range—and reports that one set of chasers lasts a year.

The particular operation shown is threading brass hush tubes a distance of 1/2 inch. A "D" Geometric Pipe Threading Die is used and production runs 200 pieces per hour—1,000 between grinds.

For Any Machine

For All Screw Threading Operations

Geometric Die Heads are designed to handle any screw threading operation, to be used on any machine and to stand hard, continuous service. Geometric threads have set new production standards and cut the cost of close limit duplicate manufacturing of threaded parts.

Our catalog gives further data on threading "Geometrically."

THE GEOMETRIC TOOL CO. Chicago Office: 627 W. Washington Blvd. **New Haven, Conn.**

REGULAR AGENTS: The Chas. A. Strelinger Co., Detroit, Mich.; Hill, Clarke & Co., Inc., Boston; Vandyck Churchill Co., New York and Philadelphia, Brown & Zortman Machinery Co., Pittsburgh, Pa., The E. A. Kinsey Co., Cincinnati, O.; Strong, Carlisle & Hammond Co., Cleveland, O. PACIFIC COAST: General Machinery & Supply Co., San Francisco, Cal.; Smith-Booth-Usher Co., Los Angeles, Cal., Perine Mchy. Co., Inc., Seattle, Wash. CANADA: The A. R. Williams Machinery Co., Ltd., Toronto, Winnipeg and St. John, N. B.; Williams & Wilson, Ltd., Montreal. FOREIGN AGENTS: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne, Glasgow. E. Isbecque & Co., Antwerp and Brussels, Belgium. V. Lowener's Maskinforretning, Sverre Mohn, Norway. Bevan & Edwards Pty., Ltd., Melbourne, and White & Rae, Sydney, Australia. Andrews & George, Tokyo, Japan. Also all manufacturers of Screw Machines and Turret Lathes.

HEALD

Satisfaction

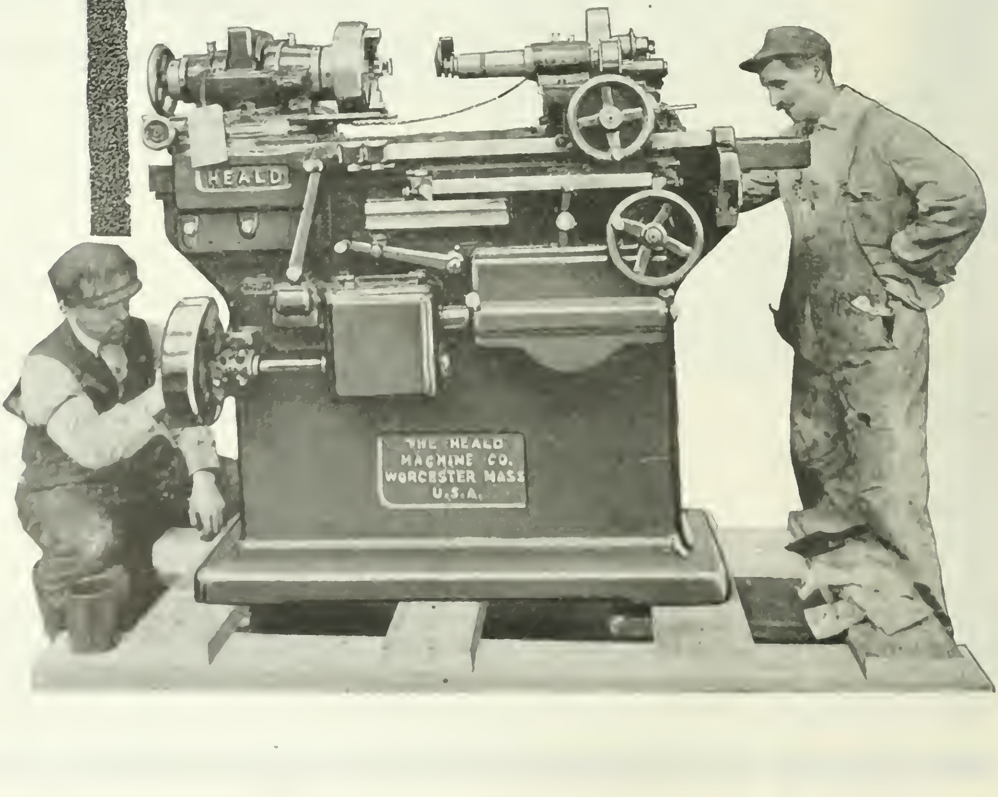
Here is machine No. 2000 of the HEALD STYLE No. 70 INTERNAL GRINDER.

On the opposite page the number plate shows very plainly, just to the right of the inspector's tag.

The painters were "caught in the act" of putting the finishing touches to the machine, so that its general appearance will measure up to the high grade workmanship in its construction.

Since the photograph was taken, the serial numbers have run above 2,200. This tremendous number of machines indicates clearly the satisfaction given to customers, wherever these machines are installed.

Repeat orders have formed a large proportion of this great output of grinders and it should be apparent to everyone that repeat



Given—Over 2,200 Sold

orders are not usually placed with any concern unless the original order measures up to the requirements of the work and the expectations of the buyer.

Communicate with our nearest Branch Office for full particulars on this DEPENDABLE grinding machine.

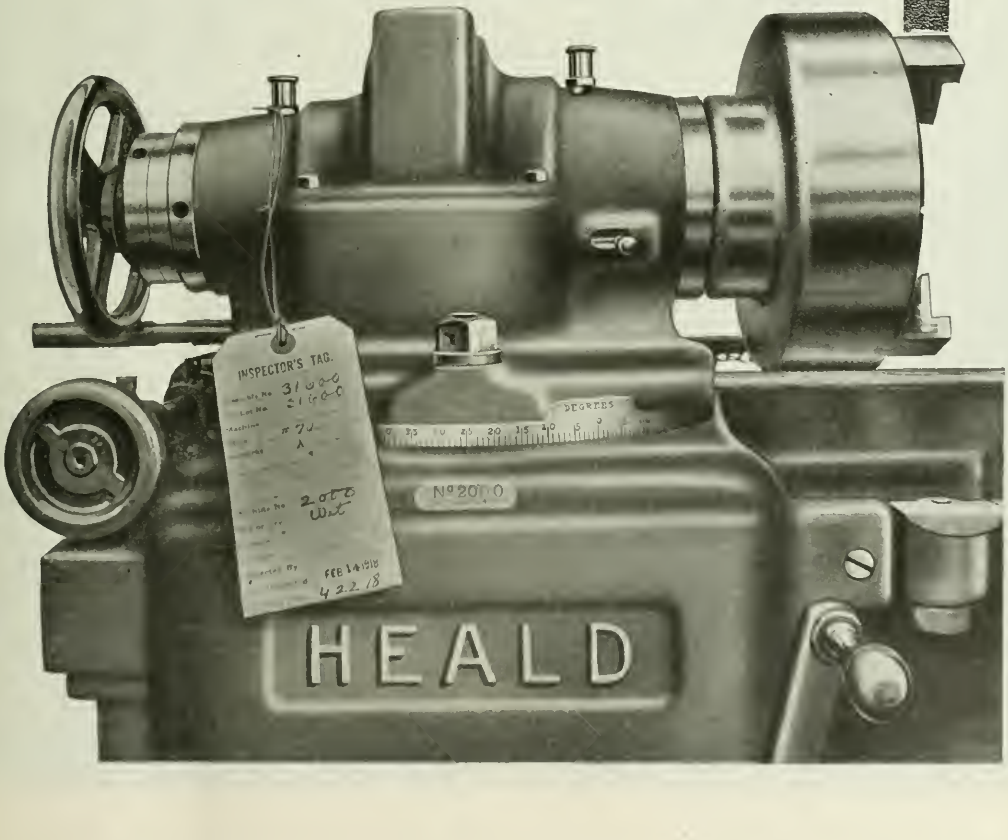
THE HEALD MACHINE COMPANY

NEW YORK, 839 Singer Bldg.
DETROIT, 911 Majestic Bldg.
PHILADELPHIA, 1408 Commonwealth Bldg.
CINCINNATI, 311 Provident Bank Bldg.
CHICAGO, 24 So. Jefferson Street
CLEVELAND, 710 Engineers Bldg.

WORKS: WORCESTER, MASS., U. S. A.

PACIFIC COAST AGENTS: Eccles & Smith Co., San Francisco and Portland. Smith-Booth-Usher Co., Los Angeles.

FOREIGN AGENTS: Alfred Herbert, Ltd., England, Italy, France, Switzerland, Spain and Portugal. F. W. Horne & Co., Japan.



THE NATIONAL

CLEVELAND OHIO
NEW YORK ~ BOSTON ~ CHICAGO

AT CLEVELAND: ACME AUTOMATICS &
AUXILIARY SCREW MACHINES·AUTOMATIC
THREADING DIES & TAPS·SCREW PRODUCTS

ACME COMPANY
WINDSOR VERMONT
DETROIT-ATLANTA-SAN FRANCISCO

NAMCO

BETWEEN THE
RAW MATERIAL AND
THE FINISHED PRODUCT

UPON the staunchness of machine tool depends the quality of the product.

The time required for the work is most important.

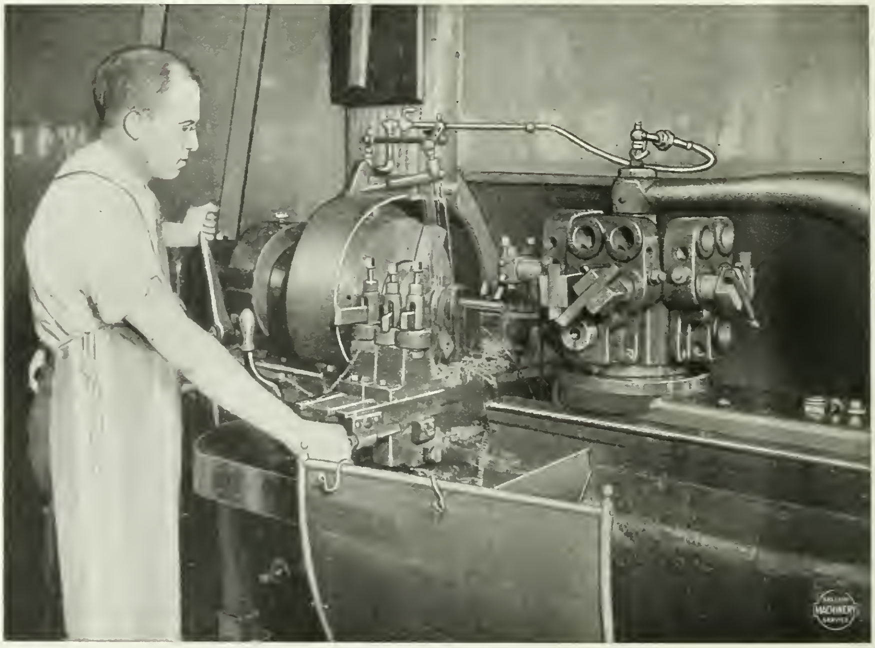
Production of duplicate parts on Acme Automatic Screw Machines means

- —reduction of secondary operations;
- —less dependence on a limited labor supply;
- —up-to-date production schedules;
- —economical production and the lowest cost per piece.

Twenty years' experience has proved their value as REAL PRODUCERS.

Complete Data on receipt of Samples or Blue Prints

T WINDSOR: GRIDLEY AUTOMATICS·
INGLE SPINDLE TURRET LATHES & MULTI-
LE SPINDLE SCREW MACH'S·PISTON & RING MACH'S



There are

Ninety-two

POTTER & JOHNSTON Automatics

in the Morrow Plant

They are all doing creditable work—the job shown herewith was selected because it was typical, not exceptional.

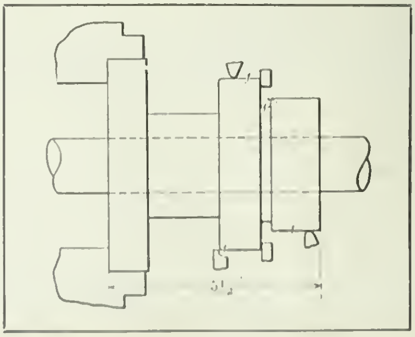
The part is a transmission gear blank, made from nickel steel. The first operation, bore, ream and face the large end and turn the largest and smallest diameters, is also a Potter & Johnston job; but the machine shown above is performing the second operation. The blank is chucked, the two diameters are turned, one of the diameters is rounded and the neck is rough and finish turned—all in eight minutes. The first operation is performed in eight minutes also—making a total of sixteen minutes for the completed piece.

You can safely follow the lead of the Morrow Manufacturing Company and buy Potter & Johnston Automatics. Let us send you the catalogue.

Potter & Johnston

Pawtucket, Rhode Island

OFFICES AND REPRESENTATIVES: Great Britain, France, [illegible] Spain and Portugal, 68 Avenue de la Grande Armée, Paris, J. Ryan, Manager. New York Office: [illegible] Bldg., 50 Church St., Walter H. Foster Co., Managers. Detroit Office: [illegible] Machinery and Engineering Co., 1511 Ford Bldg. Chicago Office: 1218 [illegible] Bldg., Chas. H. Shaw, Manager. [illegible] Office: 1501 Royal Bank Bldg., E. C. [illegible] Manager. [illegible] Chas. Churchill & Co., Ltd., London, Birmingham, Manchester and Newcastle-on-Tyne, England, and Glasgow, Scotland. [illegible] Vaghi, Corso Porta Nuova 11, Milan, Italy.

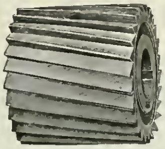


STANDARD
TOOL
CO.

STANDARD

SHIELD BRAND MILLING CUTTERS

STANDARD Shield Brand Milling Cutters meet all requirements. Made with the experience of thirty-six years behind them, in a plant equipped with every modern appliance.



Shield Brand Cutters are made from either carbon or high speed steel in all stock shapes and sizes and in special shapes to meet individual requirements.

Stock tools are carried at the factory and the New York and Chicago salesrooms.

Send for further information.

Look for the Shield.

THE STANDARD TOOL CO.

CLEVELAND, OHIO

New York, 94 Reade St. Chicago, 552 W. Washington Blvd.

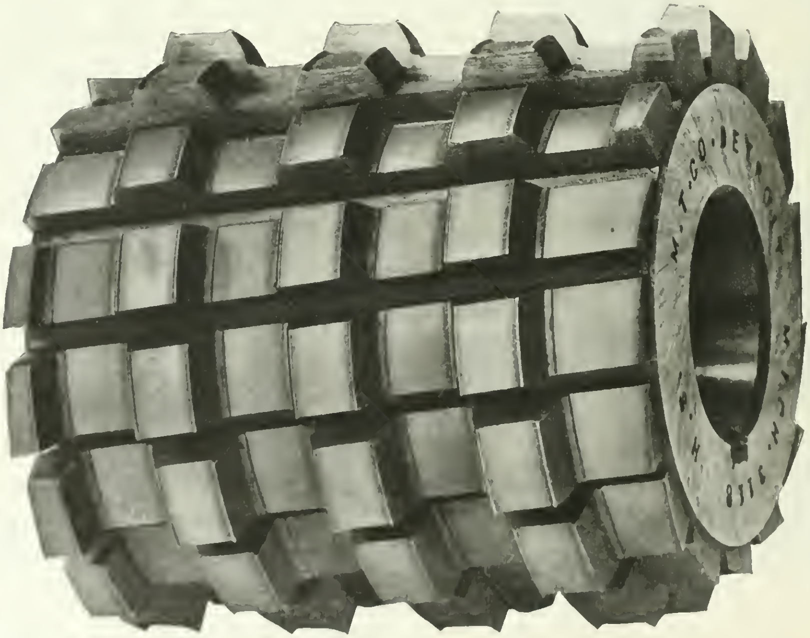
London—Burton, Griffiths & Co., Ltd.
Paris—Burton Fils.
Copenhagen—Nienstaedt & Co.
Geneva—J. Lambercier & Cie.
Tokio—The F. W. Horne Co.

Michigan Tool Co

Milling Cutters, Hobs and Special Tools

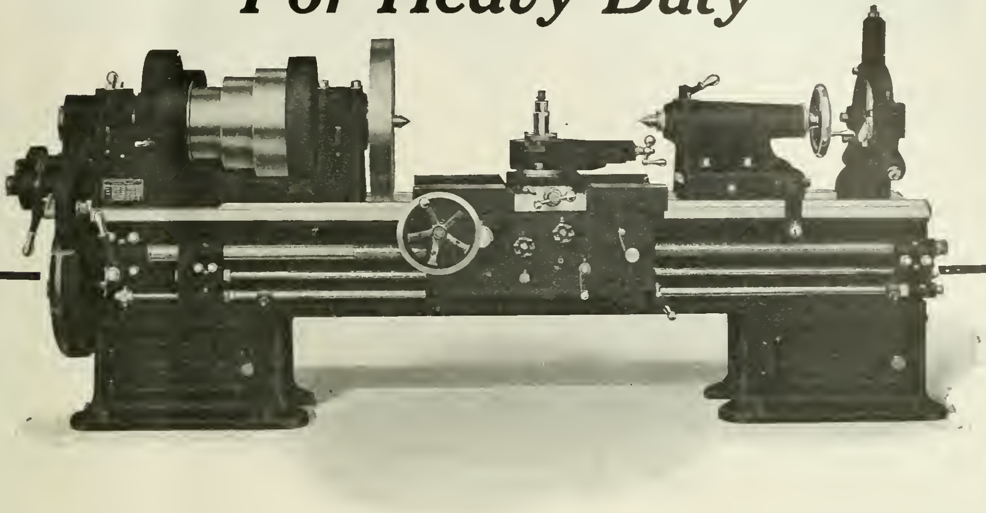
TOOLS THAT WILL SATISFY MODERN DEMANDS

MICHIGAN TOOL COMPANY
DETROIT, MICH., U. S. A.



HIGH POWER

For Heavy Duty



THE SPRINGFIELD "IDEAL" HEAVY PATTERN ENGINE LATHE

A lathe possessing all the distinctive qualities of the "Ideal" type and several special features essential to a machine of unusual power. This lathe will respond to the heaviest demands for speed, endurance and accuracy—in tool room or manufacturing plant.

Regular equipment includes three step cone, rapid change gear device (patented) automatic stop in either direction, recessed tailstock, steady and friction countershaft. This lathe is built in 24 and 26 inch swing and can be supplied with motor drive.

Circular No. 137 contains full information regarding dimensions, weights, special attachments, etc.

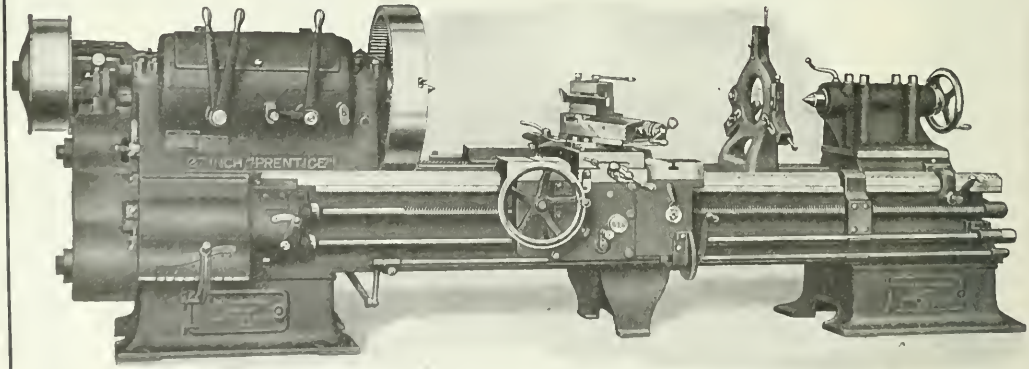
The Springfield Machine Tool Company

Manufacturers of Springfield Lathes and Shapers

631 Southern Avenue Springfield, Ohio, U. S. A.

REED-PRENTICE COMPANY

WORCESTER MASS. U.S.A.



27 INCH GEARED HEAD "PRENTICE"

REED-PRENTICE COMPANY

R-P C

WORCESTER MASS. U.S.A.

A Suggestion.

YOUR WORK MAY OFTEN CALL FOR A LATHE OF LARGE SWING, YET SUCH A MACHINE WOULD NOT AS A RULE BE CONVENIENT OR ECONOMICAL TO USE ON SMALL WORK.

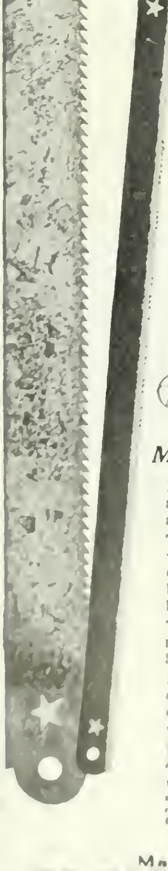
HERE IS A LATHE WITH A 30 INCH SWING AND A 12 SPEED HEAD WHICH WILL DO YOUR BIG WORK BETTER AND FASTER.

THE SPEED, FEED AND THREAD-CUTTING CHANGES ARE SO QUICKLY AND EASILY MANIPULATED THAT, WITH THE GREAT NUMBER OF CHANGES AVAILABLE, YOU WILL BE ABLE TO ALLOT SMALL WORK TO IT PROFITABLY.

WE WILL BE GLAD TO SEND YOU INFORMATION ON THIS LATHE.

MANNING, MAXWELL & MOORE, INC.
ALLIED MACHINERY CO. OF AMERICA
FENWICK FRERES
CANADIAN FAIRBANKS-MORSE CO., LTD.

Star Hack Saw Blades are used in the Peerless Motor Car plant (shown above) and in the National Lamp Works, Thomas Edisan plant, Bethlehem Steel, Pennsylvania Railroad, Standard Oil and hundreds of other of the leading industries of the country because the Star gives the lowest cutting cost.



What Do You Get When You Buy Hack Saws?

Don't forget that when you buy hack saws you don't buy blades at all in last analysis. You buy results—the greatest number of cuts at the lowest price.

Fast-cutting blades that break easily are expensive, and non-breakable blades that cut slowly are expensive too.

Star hack saw blades are neither one because they are fast-cutting blades that stand up and last. They give you the greatest production at the lowest cost because they are quick-cutting and tough too. You can't break a regular Star blade on ordinary work, but if there is unusual strain we have a fast-cutting flexible blade to fill the need.

And note this—when you buy the Star you don't have 150 or more sizes, gauges and pitches to select from. Every Star Saw is designed to cut a wide variety of materials. And any blade that needs a multiplicity of sizes is wrongly designed and inefficient or it would not need a half dozen saws to do the work of one.

When you are sawing by hand or machine you are usually cutting first one shape and material and then another. There is no chance to change saws every time. So the all-purpose Star Blade becomes a service necessity.

STAR HACK SAW BLADES

made of Tungsten Steel

Machine and Hand *Flexible and All Hard*

In the Star Saw we have worked out a tooth shape, a steel mixture and a heat treatment that give us a standardized blade that will cut a wide variety of work without change.

The tooth on the Star Blade has an acute cutting angle and a three-way clearance that is entirely different from the V-shape of the ordinary hack saw tooth. That is why the Star Blade can cut all kinds of material, stand up under fast sawing and heavy work and keep on cutting at a rapid rate after the teeth are worn way down.

The special tungsten chromium steel mixture in the Star Blade makes it faster-cutting and our different heat treatment gives the Star a greater toughness.

In some cases our tests have shown that the Star lowers the cutting cost as much as 20 per cent as compared with other blades. In every case there was a substantial difference in favor of the Star.

Whatever your present cutting costs, if you are using another saw you can make a substantial saving in using the Star Blade, as a comparison will readily demonstrate.

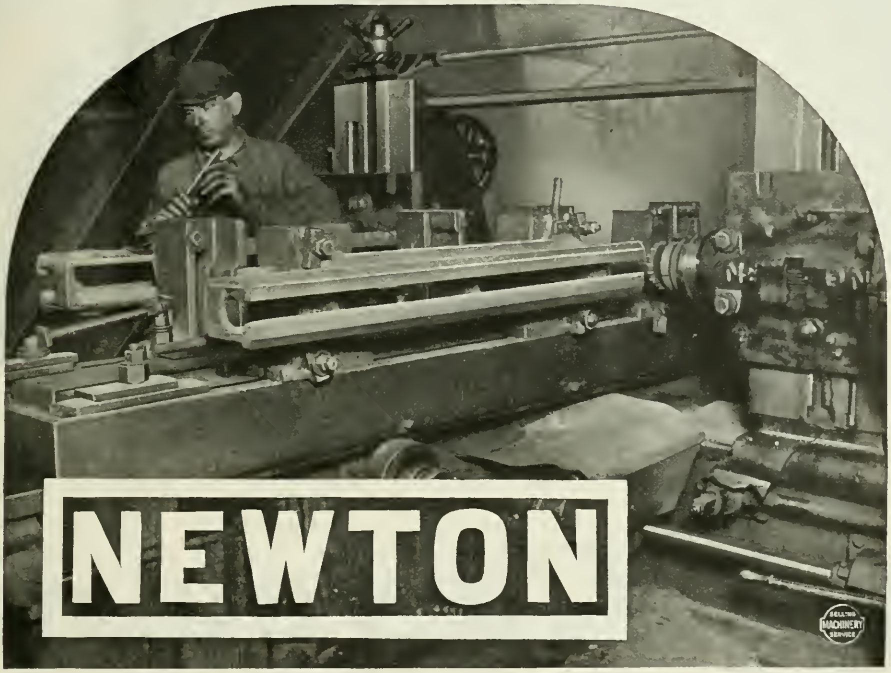
Write us the kind of cutting you are doing and the saw you are using and we will show you an easy way to make a hack saw comparison in the regular course of your work. Address the Engineering Department of the Millers Falls Co., 210 River St., Millers Falls, Mass.

Send today for our "Hack Saw Efficiency" handbook. It contains more vital information about hack saws and their use than was ever put into a book before. Free on request to every hack saw user.

Manufactured By
CLEMSON BROS. INC.
MIDDLETOWN, NEW YORK

Sole Distributors
MILLERS FALLS CO.
MILLERS FALLS, MASS.

This NEWTON Duplex Milling Machine Has a Busy Life



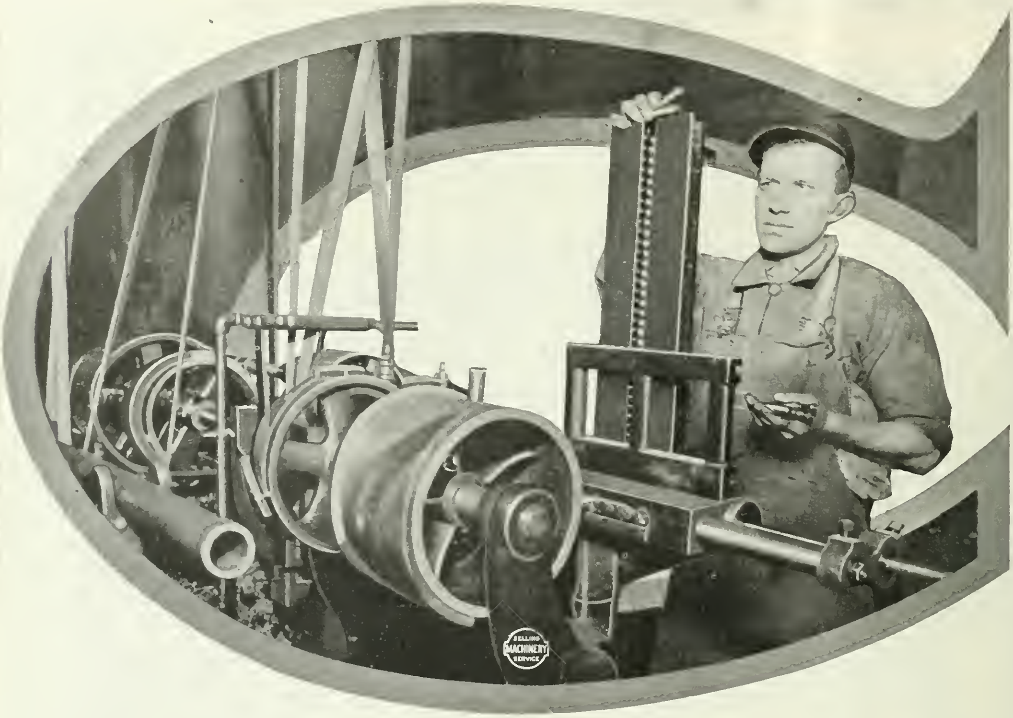
The Frick Company, Waynesboro, Pa., installed it about eight years ago—and it has been kept busy constantly ever since, on a variety of parts for agricultural and refrigerating machinery, gas and steam engines, tractors, saw mills and other machinery. The job shown is a saw-mill head block on which several operations are performed on from four to eight castings at a time. The two heads, each independently operated, give this machine its name "Duplex" and keep its operator busy setting up work. Let us tell you more about it.

Rotary Planing Machines, Slotting, Boring and Cold Saw Cutting-off Machines, Horizontal and Vertical Milling Machines and Portable Boring, Drilling and Milling Machines

Complete Catalog on Request

NEWTON MACHINE TOOL WORKS, INC.

23d and Vine Streets **PHILADELPHIA, U. S. A.**



THE CAMCO

The Cleveland Automatic

Empties That Magazine in Ten Minutes

contains 31 essays by the man who built the Cleveland Automatic. It is not a circular on the "Cleveland." Special literature takes care of that. Send for both.

CLEVELAND AUTOMATIC MACHINE COMPANY

CLEVELAND, OHIO, U.S.A.

[illegible]

The Buffalo Forge Company, Buffalo, N. Y., makes nuts, bushings, shafts, studs and bolts in large quantities—and uses the Cleveland Automatic to help to do it profitably.

The operator is shown loading the magazine of a Cleveland Automatic with 5/8″ stud blanks, 3½ inches long, which are threaded for a length of 3/4″ and delivered from the machine at 27-second intervals. It keeps the operator on the jump to maintain the magazine supply.

Cleveland Automatic speed is more remarkable when the quality of product is taken into consideration.

Can not *your* small part production be improved as to speed, quality or both?

TRY A NEW
WILLARD
On Approval

The proof of the pudding and the test of a machine are much the same. Both must be tried to demonstrate their worth.

Here's your chance to try out an accurate and productive High Power Engine Lathe—with readily controlled quick change mechanism of unusually wide and varied range, and durability assured by broad, pan style headstock, chilled V's, 65 point carbon spindle, steel gears, taper gibbed sliding surfaces and substantial reinforcements at every point of strain.

If you are already familiar with the sterling merits of the old "Willard" a detailed description of the "improvements" embodied in the new model will be sufficient; but to all "Missourians" whose work comes within its range, the above offer should have a strong appeal.

Details of machine and offer on request.

Three Styles:

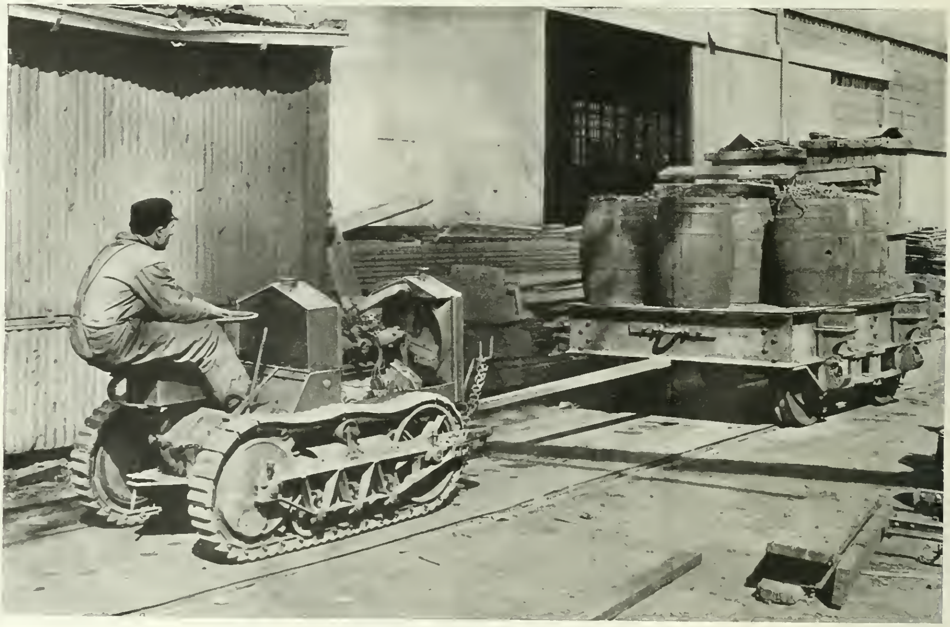
Standard Gap and Toolroom.

5, 6, 7, 8 and 10 foot beds.

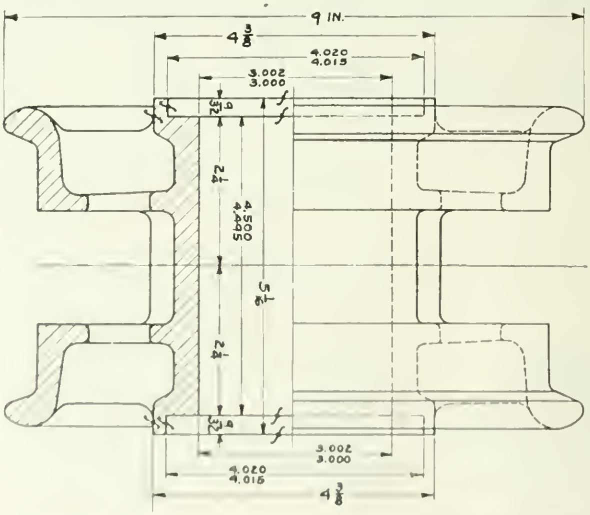
The Willard Machine Tool Co.

CINCINNATI
OHIO, U.S.A.

The Cleveland Tractor and



Cleveland Tractor Company Tractor



THE WARNER & SWASEY

TURRET LATHES—TURRET SCREW MACHINES—BRASS WORKING MACHINE TOOLS

New York Office—Singer Bldg
Detroit Office—Ford Bldg

Boston Office—Oliver Bldg

Buffalo Office—Iroquois Bldg

Chicago Office and Show Room—618-622 Washington Blvd.

Warner & Swasey Machines

Some of the Warner & Swasey Screw Machines in their Plant

The Cleveland Tractor Company, Cleveland, had to get busy with dependable tools to fill orders for their tractors. With the shortage of labor the farmers were in need of their machines and industrial plants wanted the most efficient means for transferring their work.

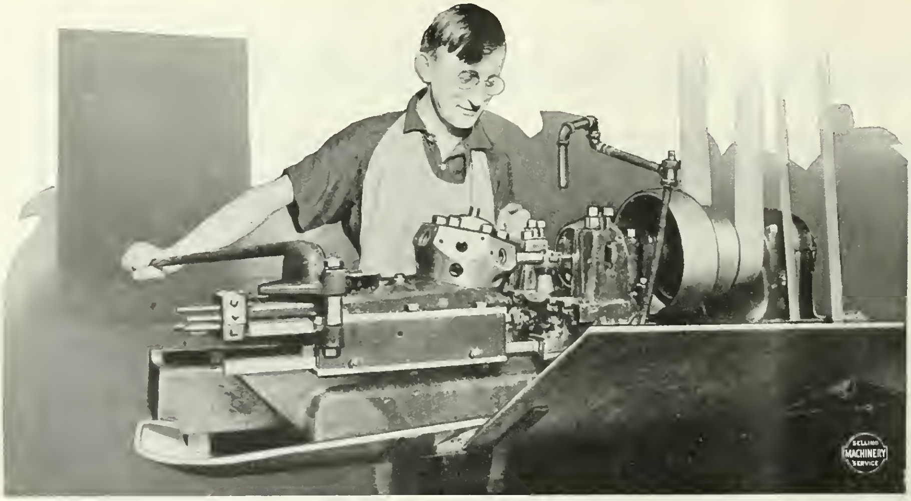
This lower truck wheel is only one of the many pieces produced better and faster on Warner & Swasey Machines. The time on another make of Screw Machine was 200 in 11 hours. A W. & S. No. 6 turns out 300 in the same time—*a saving of fifty per cent.*

If your work is less than 21½ inches in swing or 4½ inches in the bar, a Warner & Swasey machine is ready to help you out. The tools are wide in range and will let you get busy without delays or expense of special tooling.

Send us your problems for comparison with present output or for help in planning your new work.

COMPANY, Cleveland, Ohio, U. S. A.

FOREIGN AGENTS: Chas Churchill & Co., Ltd, London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Allied Machinery Company, Paris and Turin. Van Rietschoten & Houwens, Rotterdam. Yamatake & Co., Tokio. Benson Brothers, Sydney and Melbourne. A. Asher Smith, Sydney A. R. Williams Machinery Co., Ltd., Toronto, St. John, Winnipeg and Vancouver. Williams & Wilson, Ltd., Montreal.



THE TILTED TURRET

A CLEAR TRACK FOR THE STOCK

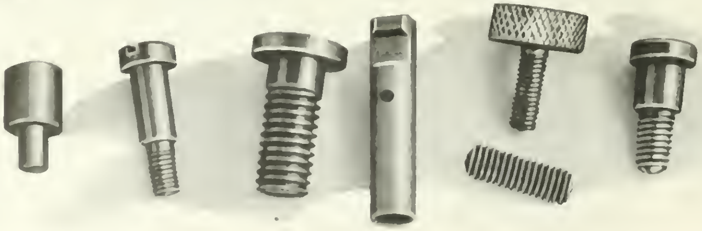
Selected Because of the Facility With Which It Can Be Changed From One Job to Another

Where machines are built in small lots—typesetting machines and similar intricate, high grade automatics—frequent set-ups and changes make heavy inroads on production costs.

The Unitype Company of Jersey City—after comprehensive experiments—found the solution of this problem in the quick change features of the Tilted Turret. They likewise killed two birds with one stone when installing it, because with their rigid system of inspection, any piece with a variation of more than .0005 plus or minus would be rejected, and the accuracy of the Tilted Turret Lathe has practically eliminated rejects in their plant.

Above is shown the machine in action—below some of the parts which insure the perfect functioning of the Unitype Company's machines.

Fifteen Years of Satisfied Users—Ask the User. Catalogue for details.



WOOD TURRET MACHINE CO.

BRAZIL INDIANA U.S.A

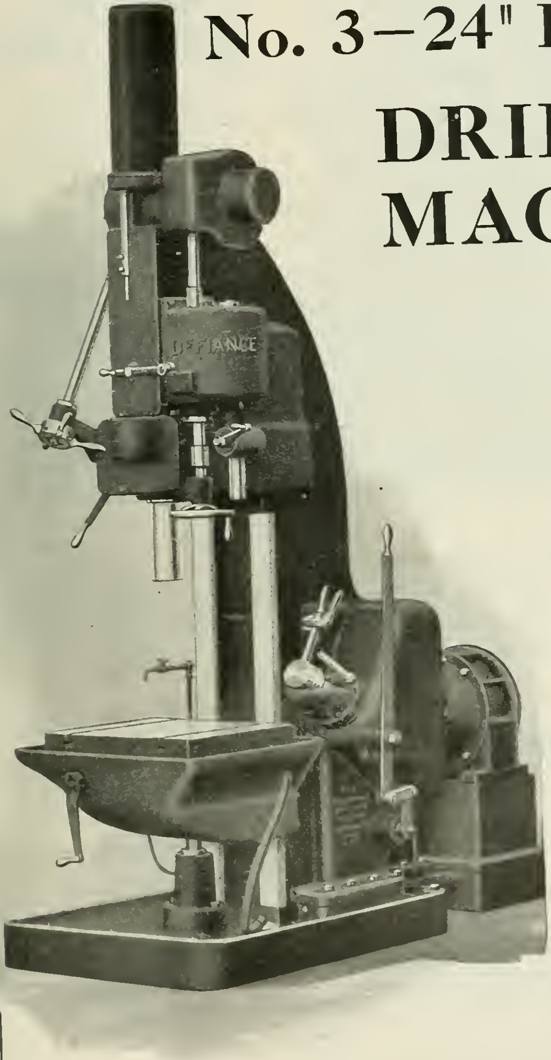
[illegible] Machinery Co., New York, N. Y.; [illegible] Co., Boston, Mass.; Hall, Clarke & Co. of Chicago, Chicago, Ill.; [illegible] Machinery Co., Philadelphia, Pa.; Wm. K. Stamets, Pittsburgh, Pa.; Syracuse Supply Co., Syracuse, Buffalo and Rochester, N. Y.; [illegible] Machinery Co., Baltimore, Md.; [illegible] Machinery Co., Providence, R. I.; English & Miller Machinery Co., Detroit, Mich.; Brandes Machinery Co., Cleveland, O.; [illegible] Machinery Co., Cincinnati, O.

Foreign Countries Write Factory Direct.

DEFIANCE

No. 3—24" Heavy Service

DRILLING MACHINE



Its Purpose is Big Production

Every unit of this most modern Heavy Service Drilling Machine has been subjected to severe tests rarely encountered in shop practice. Every unit has been made to stand the rough usage and strain that production tool operators demand. It drives a 3" high speed drill in solid steel with an unusual factor of safety.

The drive shafts are fitted with Hyatt roller bearings, and the spindle thrusts are taken by SKF thrust bearings. The spindle is driven close to the nose through helical gears arranged with ball bearings to eliminate thrust to the spindle gear and keys; this design positively prevents torsion, and effects a smooth, powerful drive.

The spindle, speed and feed mechanisms are tightly housed and oiled by a treble system consisting of a splash, force feed and gravity flow combined. A quick roll-in gear method is used in selecting speeds, which eliminates trouble common to change gear devices. The foregoing, together with other important features, are illustrated and described in a circular covering this machine.

THE DEFIANCE MACHINE WORKS

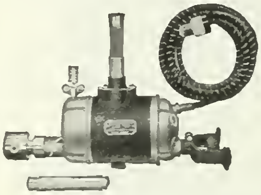
Designers and Builders of

Precision-Production Machine Tools

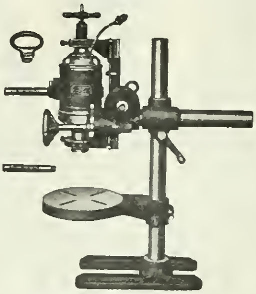
DEFIANCE **OHIO, U. S. A.**

NEW YORK LONDON

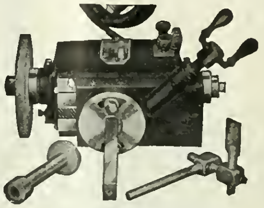
Cut Your Costs—"CINCINNATI ELECTRICS" will do it



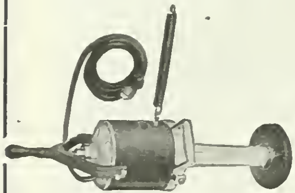
HAND OR BREAST DRILLS
¼", ⅜", ½", ¾" capacities. Weight from 7 pounds up. Ball and thrust bearings. Gears run in grease. Single and two speeds.



COMBINATION BENCH DRILLING STAND WITH DETACHABLE ELECTRIC DRILL
Made in various types, to carry drills from ½" to 1¼" capacities.



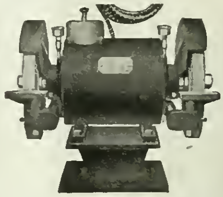
TOOL POST GRINDERS
¼ to 3 H. P. Weight from 16 pounds up. Free hand feed. Bearings adjustable to wear. Horizontal and vertical feeds. Different types for all purposes.



HAND AERIAL GRINDER
For cleaning castings or surface work of any kind. Made in four sizes, ¼ to 2 H. P. Weight from 18 pounds up. Guaranteed for hard usage.

SPECIAL FEATURES

Air cooled. Ball and Thrust Bearings. All working parts hardened. Overload Allowanee. Guaranteed Mechanically and Electrically.



BENCH GRINDER OR BUFFER
Five sizes, ¼ to to 3 H. P. Also Pedestal Floor Grinder, 1 to 3 H. P. Fully enclosed. Dirt- and dust-proof. Ball bearings.

CINCINNATI ELECTRICAL TOOL COMPANY

1501-3-5 Freeman Avenue **CINCINNATI, OHIO**

FOREIGN AGENTS, England: S. Wolfe & Co., London. Australia:. Parke & Lacey Co., Ltd., Sydney. Norway: V. Lowener, Christiania. France: R. S. Stokvis & Fils, Paris. Holland: R. S. Stokvis & Zonen, Ltd., Rotterdam. Japan: Yamatake & Co., Tokyo. Spain: American Machinery Syndicate, New York City.

New York Office, 50 Church Street **Stock and Service Department**

Don't Scrap
a Set of
Hartness Chasers
because of the
breakage of a
single chaser;
***replace the
broken chaser.***

It is only
necessary to
grind the set to
uniformity.

Hartness Chasers Are Interchangeable

This
Interchangeability
of Hartness
Chasers is
possible because
of our
special method
of manufacture.

JONES & LAMSON MACHINE COMPANY

Automatic Die Dept.

109 Queen Victoria St., London, Eng. Springfield, Vermont, U. S. A.

AMERICAN AGENTS FOR DIES AND CHASERS

[illegible] Mchy. Co., Bourse Building, Philadelphia
[illegible] Co., Detroit
[illegible] Mchy. & Supply Co., [illegible]

E. L. Essley Mchy. Co., Chicago, Milwaukee and Moline
The E. A. Kinsey Co., Cincinnati and Indianapolis
Machinists Supply Co., Pittsburgh

Pacific Tool & Supply Co., San Francisco and Los Angeles.
The W. M. Pattison Supply Co., Cleveland.
Robinson, Cary & Sands Co., St. Paul and Duluth.

FOREIGN AGENTS

For [illegible]
F. Auberty & Co., 91 Rue de Maubeuge, Paris

For Holland: [illegible] & Co., Rotterdam

For Australia: McPherson's Pty., Melbourne.
For Argentina: Maina & Cagnoni, Buenos Aires.

Testing the DILL SLOTTER on Testing Machines

The Tinius Olsen Testing Machine Company of Philadelphia makes machines that *must* be reliable. It stands to reason that the tools used in their construction must be equally reliable, for like begets like even in machine tool building.

As busy as, or more so than, any other machine in this plant is the Dill Slotter. It has been steadily "on the go" for the last twelve years and, by the looks of things, it's going to keep its successor out of a job for a long, long time.

Three principal features mark the Dill Slotter—it is absolutely dependable under all conditions; it is simple enough in handling its wide range of work to make it extremely profitable, and last, but perhaps most important in the average shop, it's hard to find a job it can't do—it's the substitute for special machinery nine times out of ten.

How far are you from here?

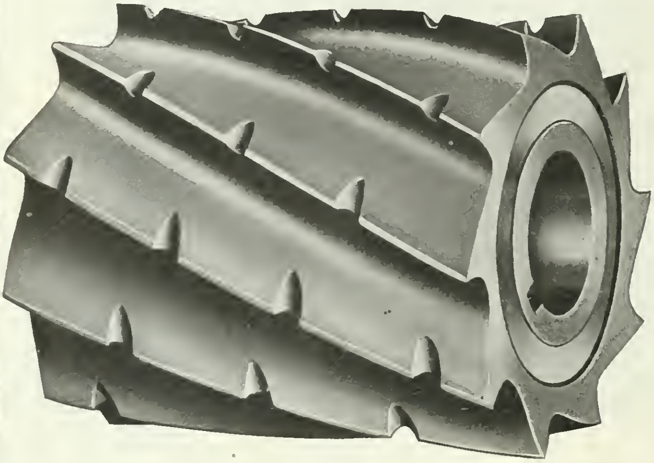
T. C. DILL MACHINE COMPANY

THE DILL SLOTTER PEOPLE

PHILADELPHIA PENNSYLVANIA, U. S. A.

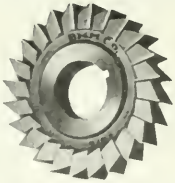
FOREIGN AGENTS: Coventry, London, Birmingham, Leeds, Manchester, Newcastle-on-Tyne and Glasgow; Alfred Herbert, Ltd. France: Alfred Herbert, Ltd. Italy. Alfred Herbert, Ltd. Japan Alfred Herbert, Ltd. Yokohama. Germany and Austria Heinrich Dreyer, Berlin, Germany. Holland R. S. Stokvis & Zonen, Ltd., Rotterdam. Belgium: R. S. Stokvis & Fils S. A. Brussels.

BECKER



Milling Cutters

Increase the Efficiency of Any Milling Machine



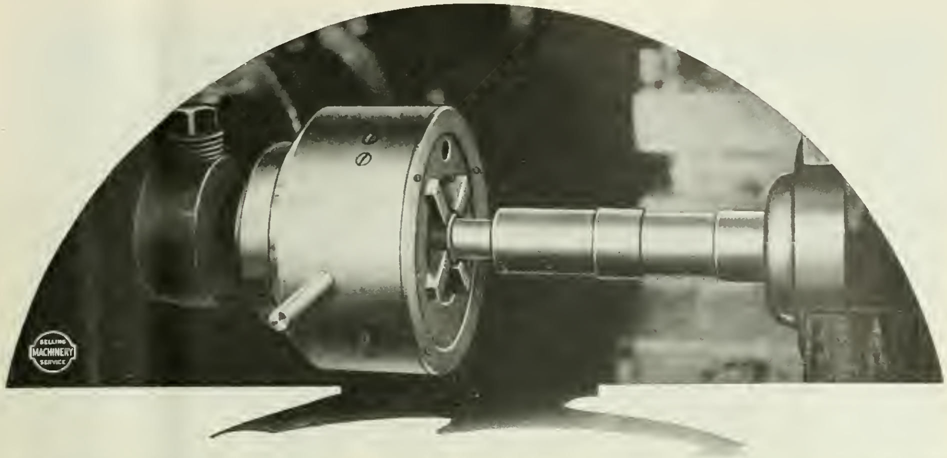
The efficiency of a milling machine depends largely on the quality and condition of its cutters. Becker Milling Cutters are designed to take big cuts without chatter, to stand up under hard, continuous service and to hold their cutting edges with a minimum of grinding. With ample chip clearance and the stamina which permits driving at full capacity, they increase the efficiency of any milling machine and cut production costs as well.

Stock list issued monthly. **Is your name on our mailing list?**

THE BECKER MILLING MACHINE CO.

HYDE PARK, BOSTON, MASS.

Detroit Branch: J. I. Loftus, Mgr., [illegible] Majestic Bldg. The Whitman & Barnes Mfg. Co., 61 Reade Street, New York. H. A. Smith Machinery Company, Syracuse, N. Y., W. M. Pattison Supply Company, Cleveland, Ohio, E. L. Essley Machinery Company, 551 Washington Blvd., Chicago, Ill., New England Sales Agent, H. A. West, 10 High Street, Boston, Mass.



MODERN

Modern Die Heads

Cut Clean On Drop Forgings

Two characteristics identify the efficient self-opening die head, (1) it must hold to size under all conditions and not cut tapering threads, and (2) it must produce sharp, clean threads regardless of what the stock may be.

The photograph illustrates one of the most trying jobs that could come to a die head—the cutting of a 1″ 18-pitch thread for a length of 1¼″ on a drop steel forging to be used in automobile construction.

As a general rule no one likes to handle stock of this kind, but in the present instance the operator knows the Modern Die Head will perform the job *as usual.* He knows the chasers won't retreat.

If you have trouble in threading difficult materials, give the Modern Die Head a trial. You may be assured by the way it "came through" in other plants. Write us.

MODERN TOOL COMPANY, MAIN OFFICE AND WORKS SECOND AND STATE STS., **ERIE, PA.**

NEW YORK OFFICES, 50 Church Street and 2 Rector Street.
DETROIT OFFICE, 1223 Dime Bank Building. CHICAGO OFFICE, 32 North Clinton Street.
CINCINNATI OFFICE, 2 Greenwood Office Exchange. F. WESLEY PARKER, Export Manager, 2 Rector Street, New York.
Agencies in London, Paris, Stockholm, Barcelona, Milan.

TRADE
W.F.
AND
J.Co
MARK

Complete Line

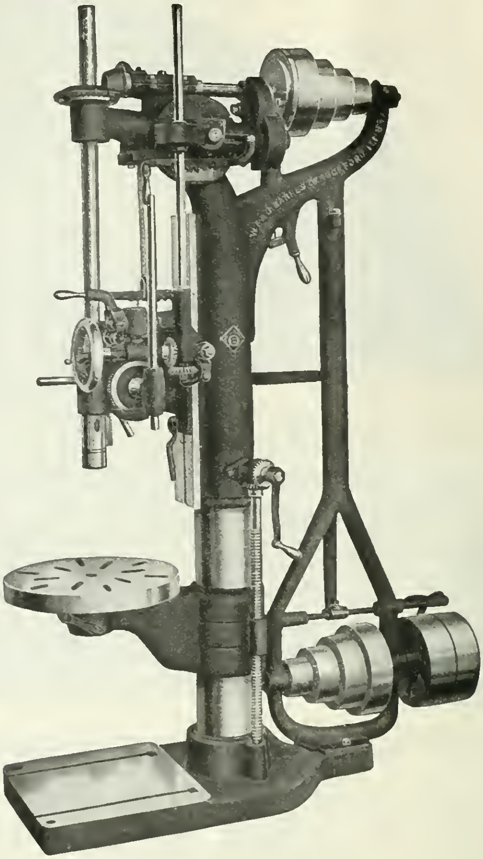
8-inch to 50-inch Swing

(With or without Tapping Attachment)

Upright Drills

Horizontal Drills

Gang Drills

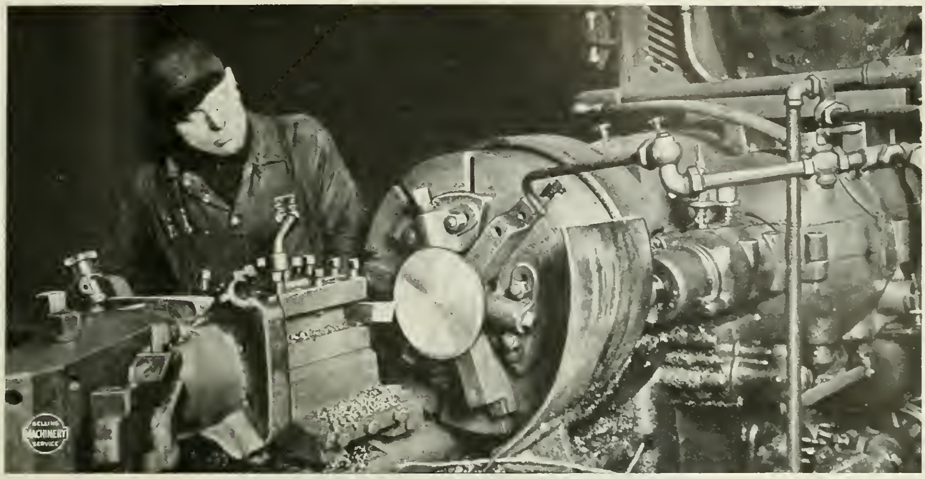


BARNES DRILLS

Accuracy
Convenience of Operation
Strength

MADE BY

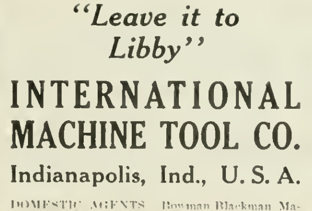
W. F. & John Barnes Company
231 Ruby Street
Rockford, Ill., U. S. A.



The Libby Lathe

and The Drive for More Locomotives

Story and pictures come from a large railroad shop in Pennsylvania where Libby Lathes play an important part in speeding up transportation facilities and incidentally add to their reputation for efficiency in meeting emergencies. The work in process is open hearth steel forgings machined to specifications shown in the accompanying sketch. The "before and after" photos give a pretty good idea of the extent and completeness of the several operations, which include: 1st, chuck by stem and true off edge of flange; 2nd, chuck by flange and finish stem end—using tool mounted in turret and having three cutters. Then thread end of stem. 3rd, chuck once more by stem, face flange and chamfer.



The pieces are put through in lots—each operation carried out on a dozen or more parts before the set up is changed for the next—and when all are completed and the time figured, it averages 14 minutes for each piece—by no means spectacular but interesting. Have you a troublesome multi-operation job?

"Leave it to Libby"

INTERNATIONAL MACHINE TOOL CO.

Indianapolis, Ind., U. S. A.

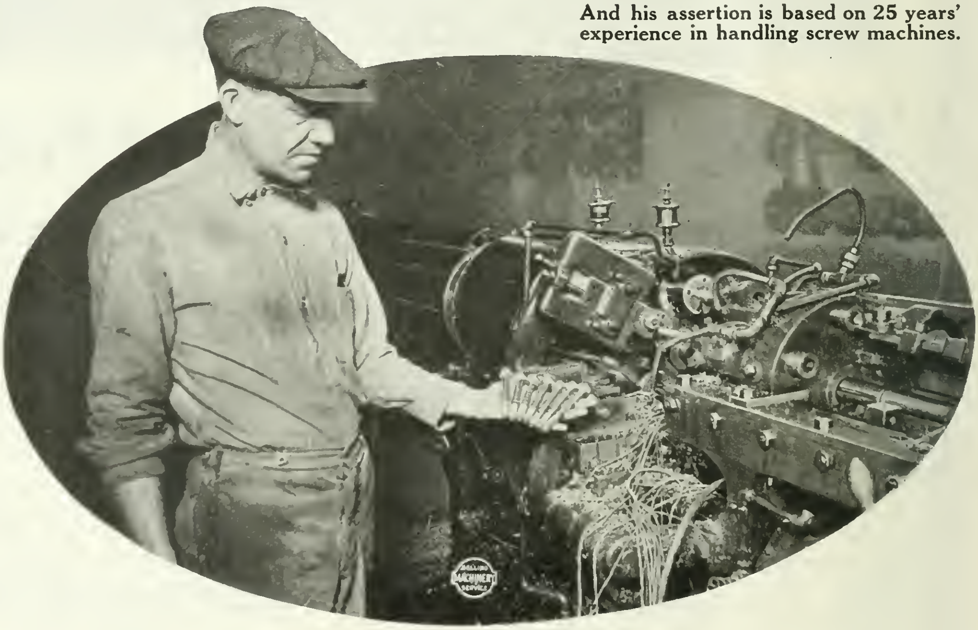
DOMESTIC AGENTS Bowman Blackman Machine Tool Co., St. Louis, Mo. Brown & Zortman Machinery Co., Pittsburgh, Pa. Eccles & Smith Co., San Francisco, Cal., Los Angeles, Cal., Portland, Ore. E. L. Essley Machinery Co., Chicago, Ill., Milwaukee, Wis., and Moline, Ill. Strong, Carlisle & Hammond Co., Detroit, Mich., and Cleveland, Ohio. Vandyck Churchill Co., New York, N. Y., New Haven, Conn., and Philadelphia, Pa. Syracuse Supply Co., Syracuse, N. Y., and Buffalo, N. Y. Ammen Machinery Co., Baltimore, Md. Northern Machinery Co., Minneapolis, Minn. FOREIGN AGENTS Coats Machine Tool Co., Ltd., London, Eng. Iwasskoff & Co., Petrograd, Moscow and Ekaterinburg, Russia. Hijo De Miguel Mateu, Barcelona, Spain. Isbecque & Company, Belgium. Moetch & Rounnet, Paris, France.

NEW BRITAIN

"Best Automatic Screw Machine On The Market"

A. WATKINS, Manager
THE ATLANTIC MFG. CO.
Bridgeport, Conn.

And his assertion is based on 25 years' experience in handling screw machines.



The operator is showing you some motor truck bolts just finished on the "New Britain." They are made from 7/8" hex cold rolled stock, on which a 1/2" body is turned for a length of 4⅜" and threaded 1¼" with 20 pitch threads.

Sixty bolts an hour are picked from the chip pan—accurate to within plus or minus 0.001".

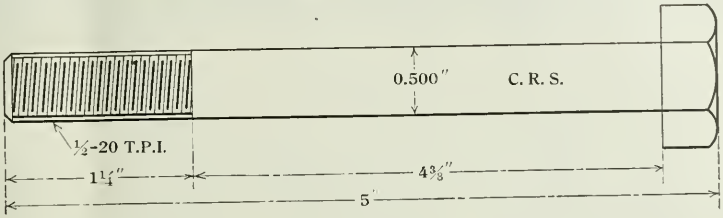
Is Mr. Watkins justifiably enthusiastic over "New Britain" production? What do *you* think?

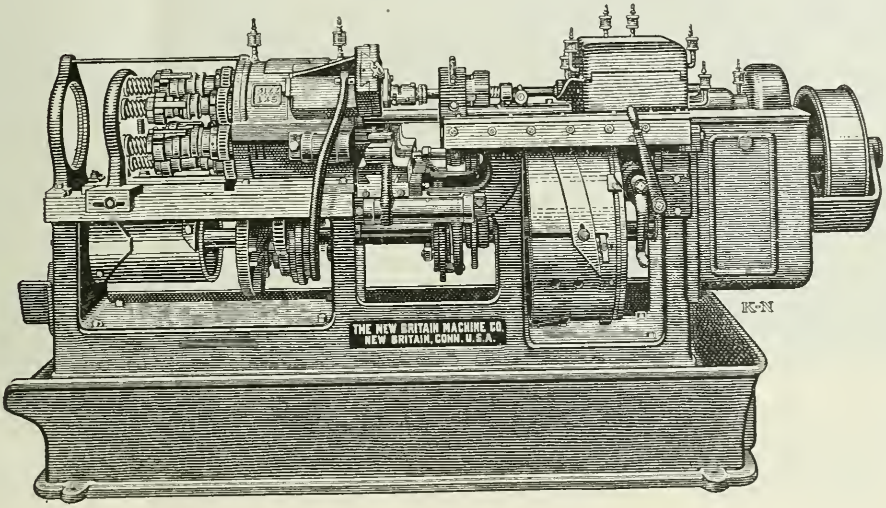
NEW BRITAIN NB NONE BETTER

THE NEW BRITAIN

Automatic Chucking Machines **NEW BRITAIN,**

AUTOMATICS




THE NEW BRITAIN MACHINE CO.
NEW BRITAIN, CONN. U.S.A.
K-N

“New Britain” Automatics are turning out parts for tanks, automobiles, motorcycles, phonographs, fuses, typewriters and for other machines of war, commerce and amusement. For speedy work they have no superior.

Our engineer will be glad to call on you and show you what “New Britain” Automatics can do for you on such jobs. And he'll also come around after you buy *to see that they do it.*

Write us today for more details.

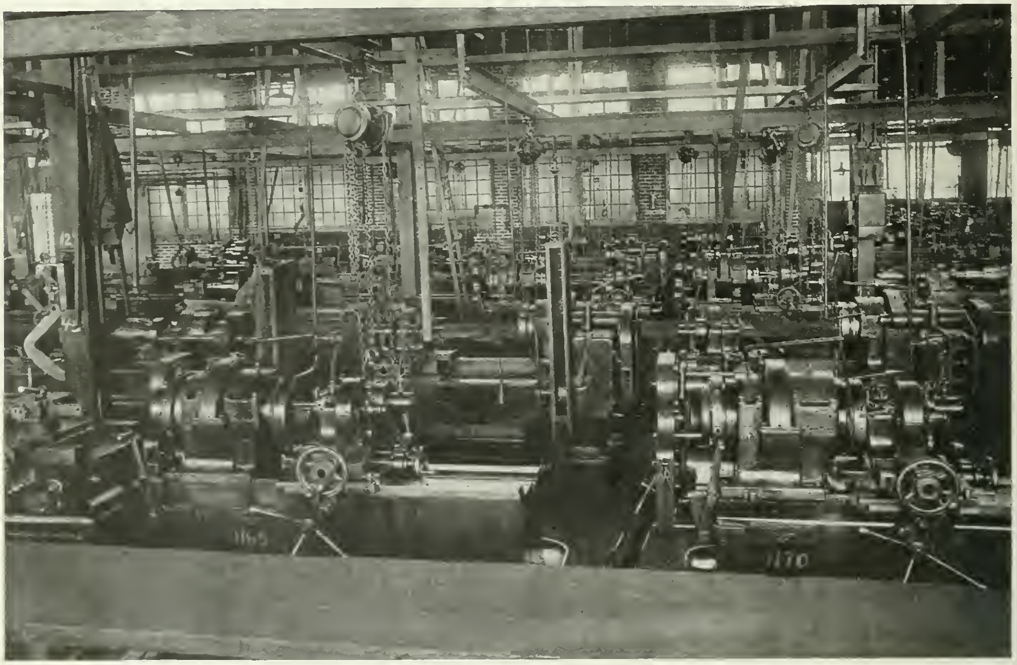
MACHINE COMPANY
CONNECTICUT

Automatic Screw Machines

“New Britain”
NB
None Better

LEES-BRADNER

COLLET TYPE THREAD MILLERS



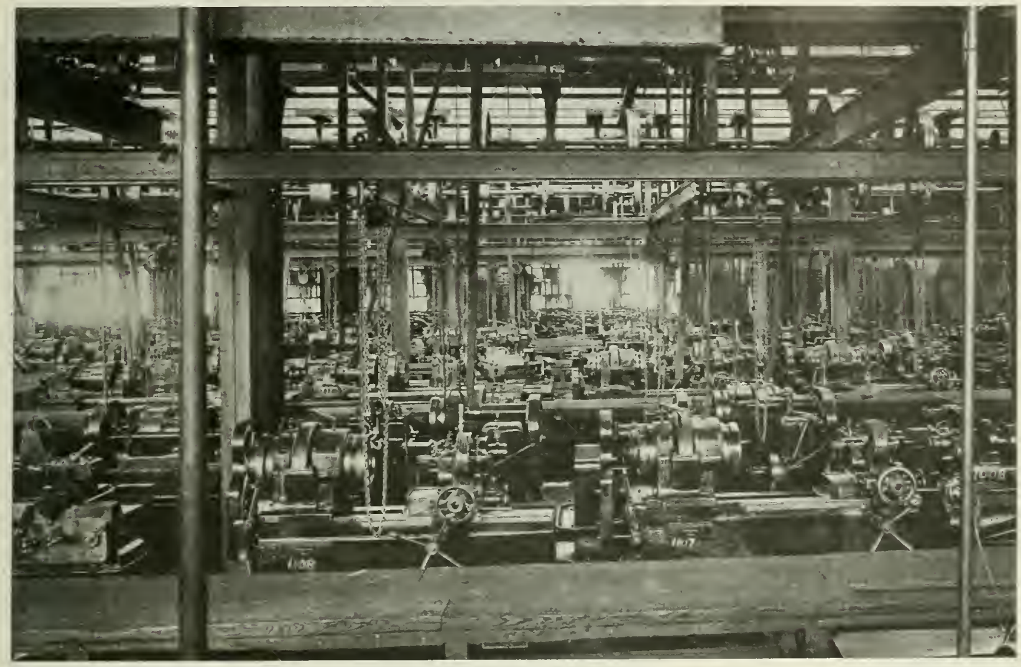
Part of the Total Installation of Lees-Bradner
The Accepted Standard For Munition Manu

THESE machines will cut a full thread up to a shoulder. In operation there is no reversal of rotating parts so that no time is lost on account of back lash. The lead screw is reversed once for about fifty pieces. These Collet type thread millers are adapted for milling internal or external

THE LEES-BRADNER COMPANY
CLEVELAND, U. S. A.
THREAD MILLERS GEAR GENERATORS

LEES-BRADNER

COLLET TYPE THREAD MILLERS



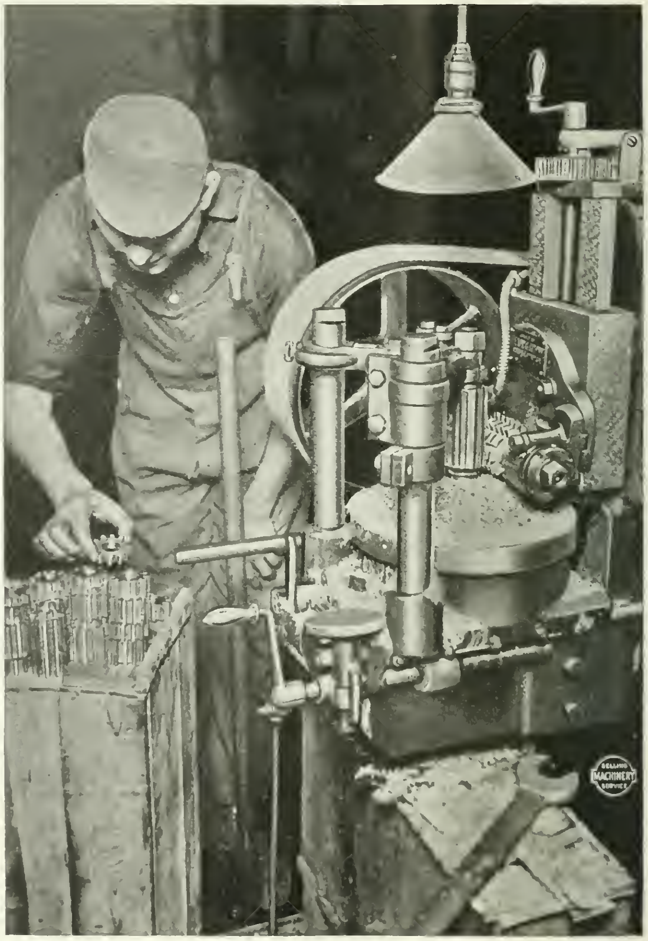
Collet Type Thread Millers in One Plant facturers; Approximately 1000 in Operation

threads with a hob type cutter in one revolution of the work. The work is supported in a positive opening and closing Collet. Remarkable accuracy and production are obtained. Built in sizes up to 9½-inch Collet capacity. Send us blue prints of the work under consideration.

THE LEES-BRADNER COMPANY
CLEVELAND, U. S. A.
THREAD MILLERS GEAR GENERATORS

FARWELL

Farwell Gear Hobbers Boost Production Always



This Farwell Gear Hobber is one of three owned by the Pittsburgh Gage and Supply Company, Pittsburgh, Pa. One man handles all three machines—and has time for other work besides.

The pinions shown are for electric washing machines, and have 12 teeth, of 6 diametral pitch, ½-inch face. The material is 35 point carbon steel. Eight pinions are mounted on the arbor of the Farwell Hobber at one time. Without crowding the machine production is 200 finished pinions per nine hour day.

The foreman says, "The Farwells certainly are great machines for bringing up production. We do not push them and still they give us the work in very good time."

The ease and rapidity with which it may be set up for work or changed from one job to another is a feature which makes the Farwell highly esteemed at this plant.

If you have gears to cut let us show you
the many advantages of Farwell methods.

THE ADAMS COMPANY, 1901 MARKET STREET
DUBUQUE, IOWA, U.S.A.

Immediate Deliveries

IT is not very patriotic—and is no longer necessary—to tie up a tool-shop with the making of snap gages. Tool-makers' time is too valuable in these days to be used up in *making* what can better be *manufactured.*

Our stock of JOHANSSON Adjustable Limit Snap Gages has not been so complete in months. WE ARE NOW MAKING IMMEDIATE DELIVERIES.

There is, of course, no guarantee that this condition will continue. But "immediate delivery" is the order for the present, and our many customers will be interested to learn of it.

Johansson

Adjustable Limit Snap Gages

THE SWEDISH GAGE COMPANY, Inc.
245 West 55th Street, New York
Canadian Branch, 10 Cathcart St., Montreal

Capacity from 0 in. to 12 in.

Ball bearing
countershaft
withdrawn
from hanger
showing the
SKF
Ball Bearing

Ball Bearing Countershafts

Countershafts equipped with SKF Self-Aligning Ball Bearings have the distinct advantage of requiring very little attention and operating with the least loss of power. They can be run at high speed and heavy load without any danger from heated bearings. Oil tight housings prevent the leakage of lubricant, and the high speed at which they may be operated permits the use of narrower and lighter belts.

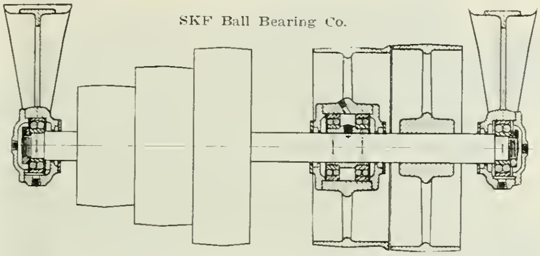
SKF BALL BEARING CO.

HARTFORD 445 CONNECTICUT

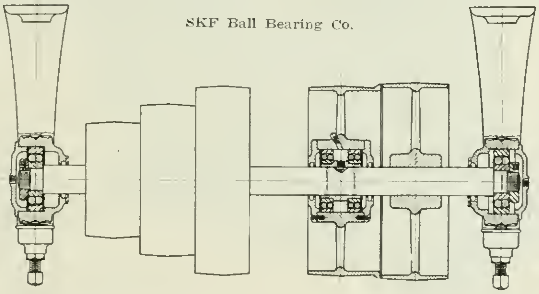
No. 3 of a Series of Recommendations from the SKF Engineering Service Department to Machinery Designers and Builders

COUNTERSHAFTS

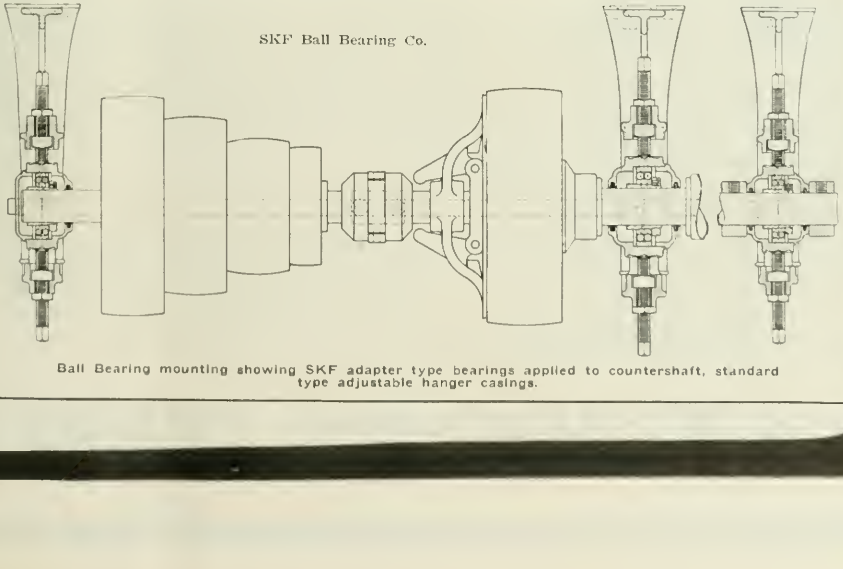
This series of suggestions started in the June issue of MACHINERY. Other mounting suggestions will follow. We shall be glad to furnish reprints if desired.



Rigid type hanger and standard type SKF radial bearings. The aligning feature of the SKF bearing allows the use of rigid hangers. No other bearing will give satisfaction when used with rigid type hangers.



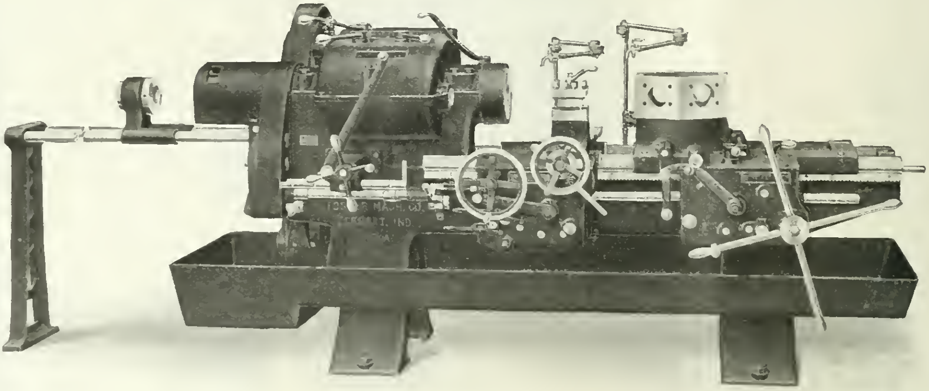
Adjustable type hanger and standard type SKF radial bearings.



Ball Bearing mounting showing SKF adapter type bearings applied to countershaft, standard type adjustable hanger casings.

THESE ARE

Foster 2-B Universal Turret Lathe



Foster 2-B Universal Turret Lathe with Automatic Chuck and Bar Feed

THE FOSTER LINE

No. 1-B UNIVERSAL TURRET LATHE
Bar Cap. 2" Swing over Carriage, 14" over Cross Slide, 8"
No. 2-B UNIVERSAL TURRET LATHE
Bar Cap. 3¼" Swing over Carriage, 20" over Cross Slide, 13½"

No. 0 PLAIN HEAD SCREW MACHINE
Bar Cap. 9/16" 10" Swing
No. 1 PLAIN HEAD SCREW MACHINE
Bar Cap. 13/16" 11" Swing
No. 2 PLAIN AND FRICTION HEAD SCREW MACHINES
Bar Cap. 1 1/16" 13" Swing
No. 3 PLAIN, FRICTION AND ALL GEARED HEAD SCREW MACHINES
Bar Cap. 1 5/16" 14" Swing
No. 4 FRICTION HEAD SCREW MACHINE
Bar Cap. 1 9/16" 17¼" Swing
No. 5 ALL GEARED HEAD SCREW MACHINE
Bar Cap. 1 13/16" 17¼" Swing
Nos. 6, 7, 8, 9, 10 FRICTION HEAD SCREW MACHINES
Bar Cap. 2 1/16"; 2 5/16"; 2 9/16"; 2 13/16", 3 1/16", respectively 20" Swing

No. 2 FRICTION HEAD UNIVERSAL TURRET LATHE
Bar Cap. 1 5/16" 14" Swing
No. 2 FRICTION SET-OVER TURRET LATHE
Bar Cap. 1 5/16" 14" Swing
No. 3 FRICTION HEAD UNIVERSAL TURRET LATHE
Bar Cap. 1 9/16" 16" Swing
No. 3 FRICTION HEAD SET-OVER TURRET LATHE
Bar Cap. 1 9/16" 16" Swing

Thread Millers manufactured under the Holden-Morgan patents

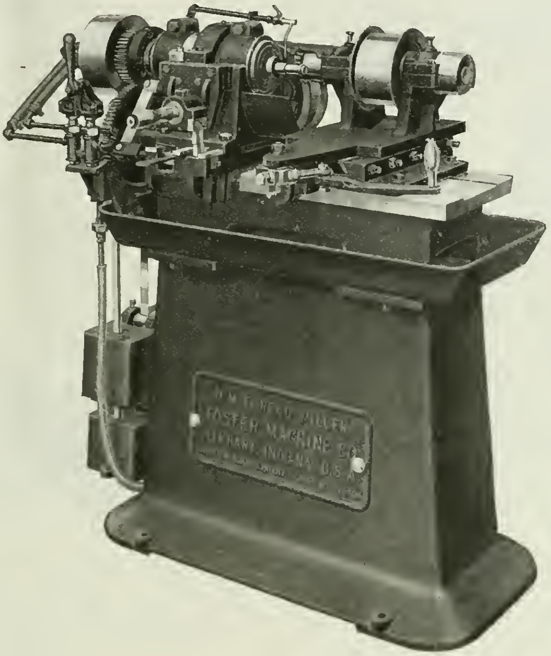
With our 2-B Universal Turret Lathe now ready for delivery, we have one of the most complete lines of screw machines and turret lathes upon the market. The general construction of the 2-B is the same as that of our famous 1-B Universal Turret Lathe, but is of a much heavier construction. It has a bar capacity of 3¼" and a chucking capacity of 13½" over the cross slide. This machine is also equipped with a full line of tools and attachments. It may be arranged for motor drive, if desired, or a special countershaft can be furnished at an additional charge.

Our Engineering Department is at your service and if you will mail us blue prints of your production problems we will be glad to furnish you all necessary information free.

FOSTER MACHINE COMPANY

PRODUCERS

H. & M. Thread Miller



The H. & M. Thread Miller is now being manufactured by us under the Holden and Morgan Patent License No. 125804. This machine has won a reputation for itself in the ammunition plants of the foreign countries and has universally been adopted by the American Engineers as the quickest and most accurate method of producing threads in all metals at this time. The H. & M. Thread Miller is as accurate as a micrometer. This machine has no lead screw where there might be a possible chance for error and back lash, but the master thread is cut directly on the main spindle and is engaged by a bronze block which is fastened securely to the head casting. The complete thread is cut on the piece with slightly over one revolution of the spindle. The extremely short overhang of the spindle and the large shaft carrying the cutter entirely eliminates all chatter and allows a high rate of production to be obtained.

The standard equipment calls for an air operated chuck, but this may be substituted by a mechanically operated chuck. These machines are adapted to all styles of ammunition work from the smallest to the largest projectiles.

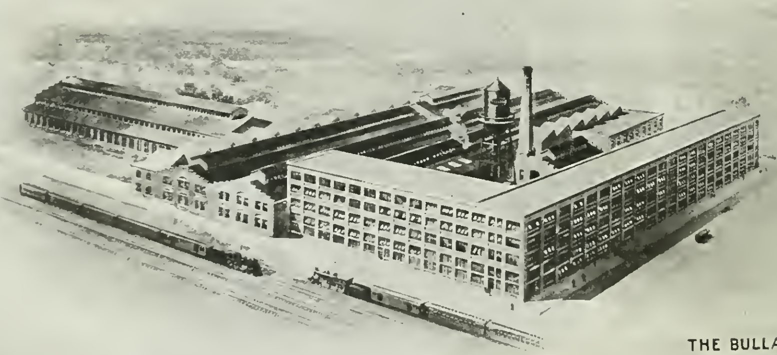
Write today and send us blue prints of your threading problems and let our Engineering Department solve them for you.

ELKHART, INDIANA, U. S. A.

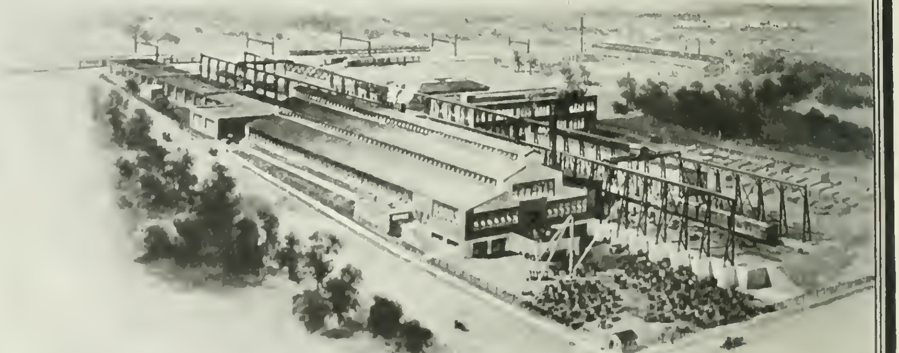
IN THE NATION'S SERVICE

BULLARD

THE BULLARD
FORGE SHOP

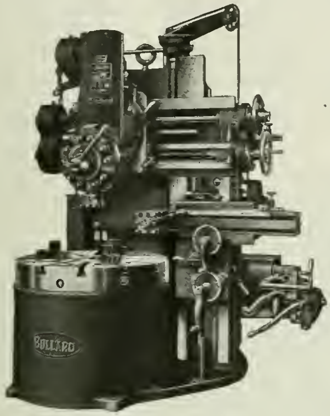


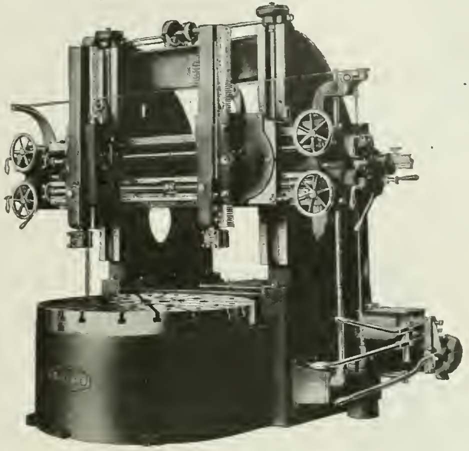
THE BULLARD
MACHINE SHOP



THE BULLARD
FOUNDRY

"In the Nation's Service"





The Bullard Organization, as well as its product, is truly "In the Nation's Service."

The Main Plant has been more than doubled in productive capacity as a result of new buildings, new equipment and an unequaled *esprit de corps.*

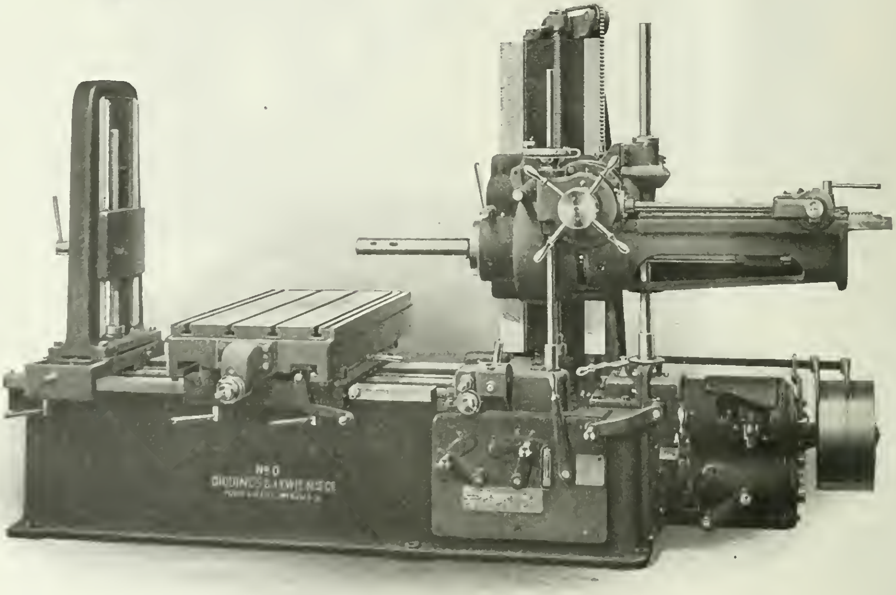
A new Foundry and a new Forge Shop, completed within the year, are proving to be big factors in meeting the demand for Bullard product—they insure a prompt and continuous supply of castings and forgings of the quality required for Bullard Tools.

BULLARD

VERTICAL TURRET LATHES
24-Inch 36-Inch 42-Inch
and 61-Inch MAXI-MILLS
are in line for early delivery

The Bullard Machine Tool Company
BRIDGEPORT CONNECTICUT, U. S. A.

Horizontal Boring, Drilling and Milling Machines



INCORPORATING many exclusive features and brought down to date by experienced engineers, G. & L. Precision Horizontal Boring, Drilling and Milling Machines undoubtedly offer the greatest efficiency in machine tools of this class.

The photograph shows No. 0, the smallest of a complete line. Specifications sent upon request.

GIDDINGS & LEWIS MANUFACTURING COMPANY

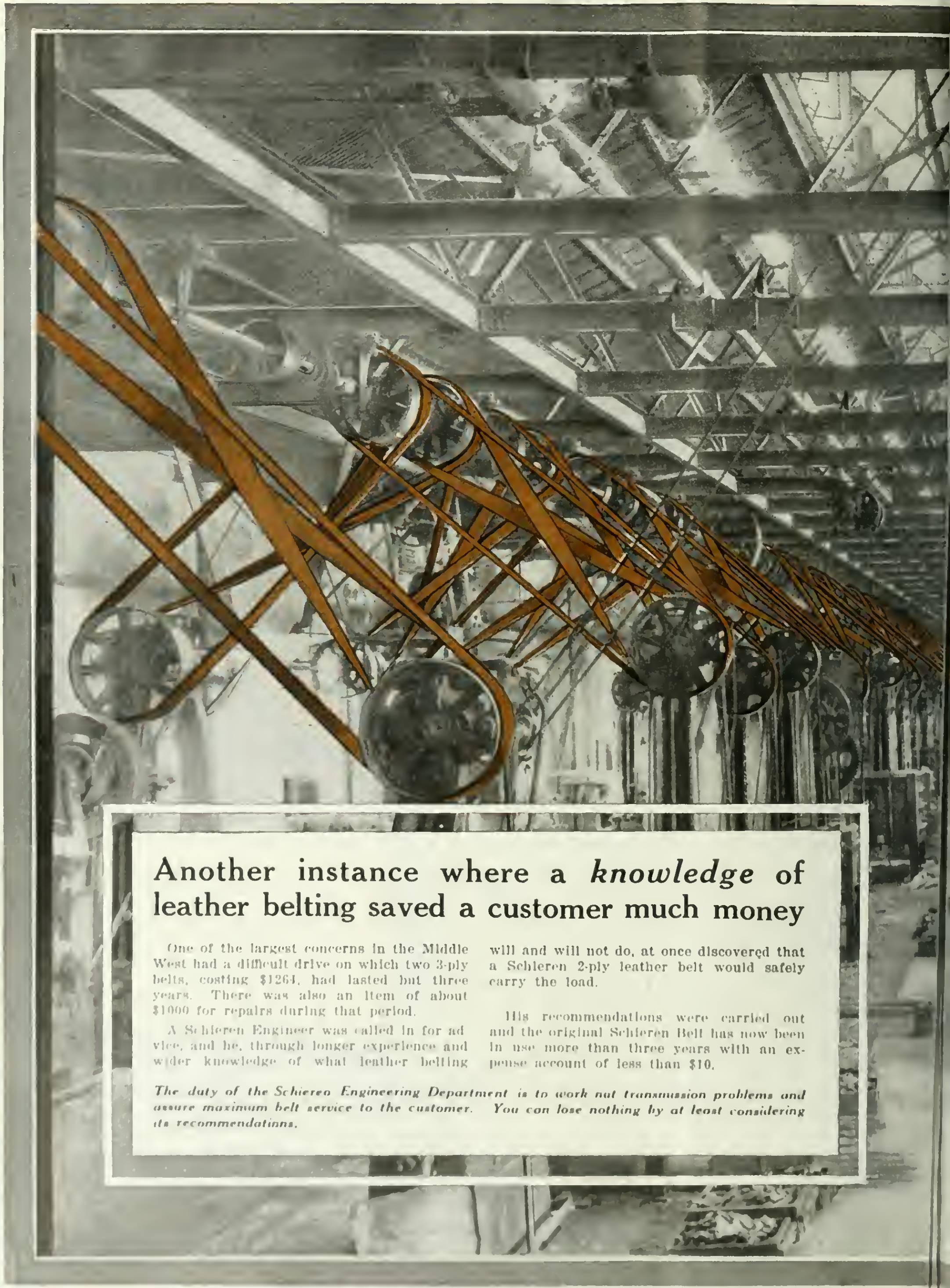
FOND DU LAC WISCONSIN, U. S. A.

DOMESTIC AGENTS: Taylor Machinery Co., Boston; Fairbanks Co., New York, Albany, New Orleans, Hartford; H. A. Smith Machinery Co., Syracuse; Swind Machinery Co., Philadelphia; Sherritt & Stoer Co. (Virginia Territory), Philadelphia; Somers, Fitler & Todd Co., Pittsburgh; E. A. Kinsey Co., Cincinnati, Indianapolis; Motch & Merryweather Mchy. Co., Cleveland, Detroit; Bowman-Blackman Mch. Tool Co., St. Louis; Strecker-Rumley-Wachs Co., Chicago, Milwaukee; English Tool & Supply Co., Kansas City; Sunderland Machinery & Supply Co., Omaha; Hendrie & Bolthoff Mfg. & Supply Co., Denver; Salt Lake Hdwe. Co., Salt Lake City; [illegible] & Smith Co., San Francisco, Los Angeles, Portland.

FOREIGN AGENTS: Canadian Fairbanks Morse Co., Canada; Fenwick Freres & Co., France, Italy, Belgium, Switzerland, Spain, Portugal; Burton Griffiths & Co., England; Rylander & Asplund, Sweden; Wymalen & Hausmann, Holland; R. L. Scrutton & Co., Ltd., Australia.

AUTHORITIES agree that the old-fashioned long-time process of tanning with pure oak bark best preserves the original texture of the hide and keeps the fibres intact.

We tan for belting purposes only and our tanneries were specially located in the heart of a vast oak-bark section to insure an indefinite continuance of these methods.



Another instance where a *knowledge* of leather belting saved a customer much money

One of the largest concerns in the Middle West had a difficult drive on which two 3-ply belts, costing $1264, had lasted but three years. There was also an item of about $1000 for repairs during that period.

A Schieren Engineer was called in for advice, and he, through longer experience and wider knowledge of what leather belting will and will not do, at once discovered that a Schieren 2-ply leather belt would safely carry the load.

His recommendations were carried out and the original Schieren Belt has now been in use more than three years with an expense account of less than $10.

The duty of the Schieren Engineering Department is to work out transmission problems and assure maximum belt service to the customer. You can lose nothing by at least considering its recommendations.
]

DUXBAK

For Crossed Belt Drives

DUXBAK has the pliability necessary for continuous turning and bending, and the closely knit fibres in its properly tanned leather to insure retention of original length.

These features, added to its *natural* pulley-gripping characteristic, assure nearly perfect power transmission over most convenient centers.

This is a combination to be had only in

DUXBAK

©C.A.S CO.

"John, that is the fourth carload of Schieren leather that has passed here today."

"Well, Harry, how does that interest you?"

"In this way, John. It can mean but one thing—that there is an enormous demand for DUXBAK Leather Belting.

"We have used nothing but DUXBAK for years for all drives where there is any chance of moisture, and it surely has paid us.

"Now it looks as though others were getting wise to the same fact, and also to the fact that DUXBAK is a darned good belting to use even where there is no moisture on account of its great pulling power."

"Harry, those are facts worth remembering. To tell the truth, I don't know what kind of belting we use, but I am going to look into the matter and have a say as to what kind we buy hereafter."

DUXBAK
BELTING
TRADE MARK
Reg. U.S. Pat. Off.

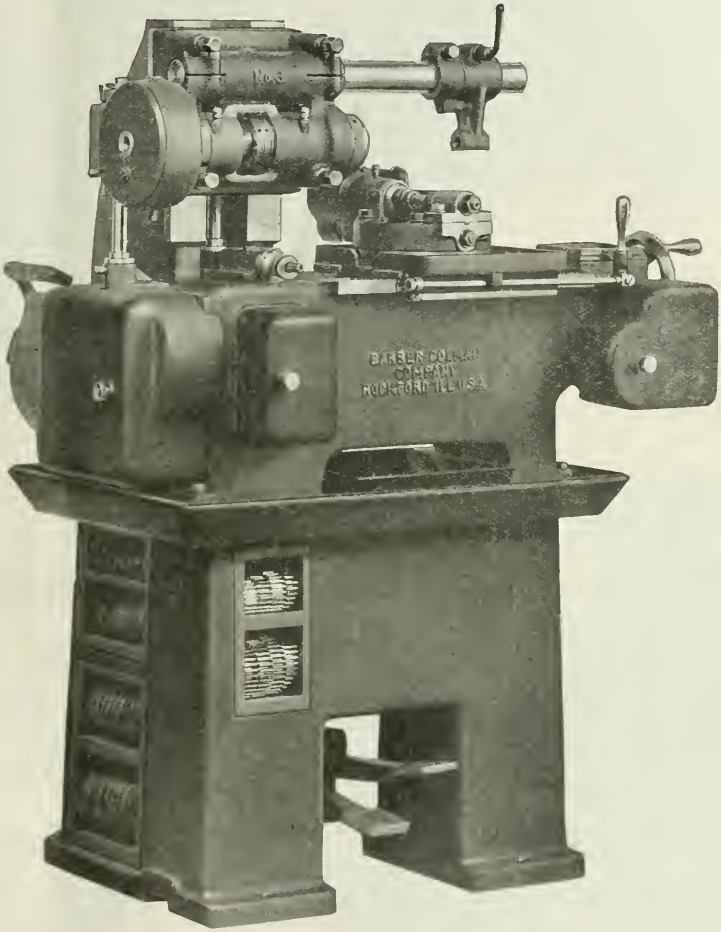
Chas. A. Schieren Company
ESTABLISHED 1868

Tanners
Belt Manufacturers
73 Ferry Street, New York

Atlanta, Ga. 190 Marietta St.
Boston 232 Summer St.
Chicago 128 West Kinzie St.
Cleveland 777 Rockwell Ave.
Dallas, Tex. The Texas Chas. A. Schieren Co. Inc., Murray & Williams Sts.
Denver 1752 Arapahoe St.
Detroit 72 Congress St., West
Kansas City 1321 West 12th St.
Memphis, Tenn. 175 So. Main St.
Philadelphia 226 North Third St.
Pittsburgh 337 2nd Ave.
Salt Lake City Dooly Bldg.
San Francisco 257 Mission St.
Seattle 305 First Ave., South
St. Louis 507 Pontiac Bldg.
Oak Leather Tanneries Bristol, Tenn.

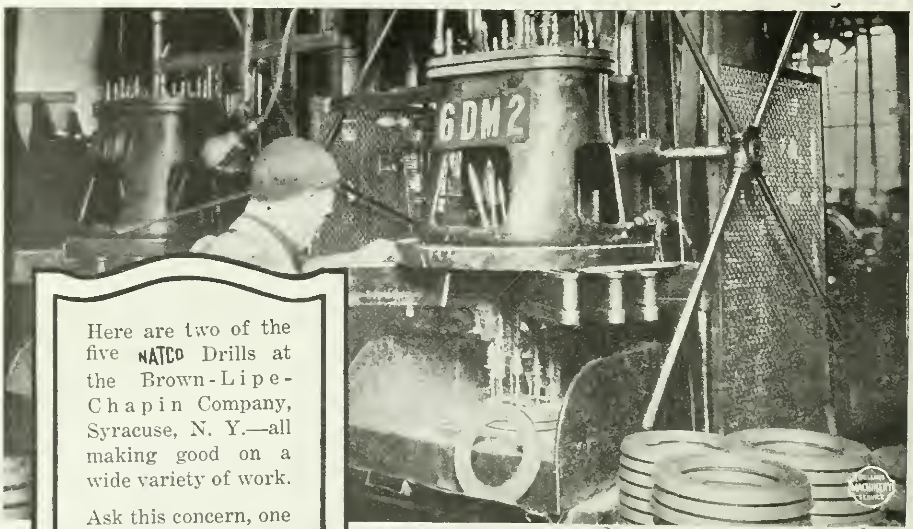
BARBER-COLMAN

No. 3 Gear Hobbing Machine



The hobbing process is the modern, accurate, economical way to cut gears. Rapidity is assured by the continuous cutting action of the hob. Accuracy can be held within closest limits. Our No. 3 machine is designed for spur and spiral gears—ratchets, sprockets and similar forms—and with our vertical feed attachment, worm gears can also be hobbed. Ask us how much this machine can increase your production. Catalog on request.

BARBER-COLMAN COMPANY
ROCKFORD, ILL., U. S. A.



Here are two of the five NATCO Drills at the Brown-Lipe-Chapin Company, Syracuse, N. Y.—all making good on a wide variety of work.

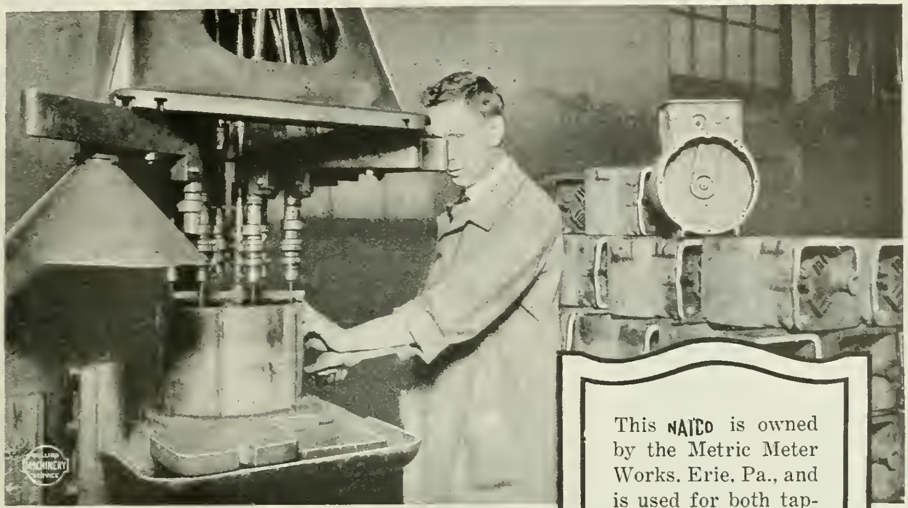
Ask this concern, one of the most progressive in the country, about NATCO machines.

"There's a Drill Speed for Every Need"

WHEREVER THERE ARE MANY HOLES TO DRILL

NATCO

DRILLS ARE USED



This NATCO is owned by the Metric Meter Works, Erie, Pa., and is used for both tapping and drilling.

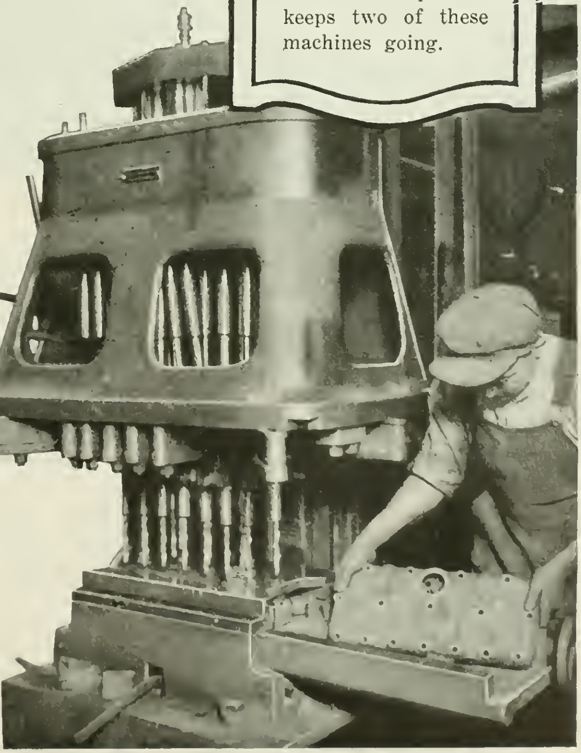
And here we see a NATCO drilling Hup Motor Car cylinder covers. One operator keeps two of these machines going.

"There's a Drill Speed for Every Need"

NATCO
MULTIPLE
DRILLS

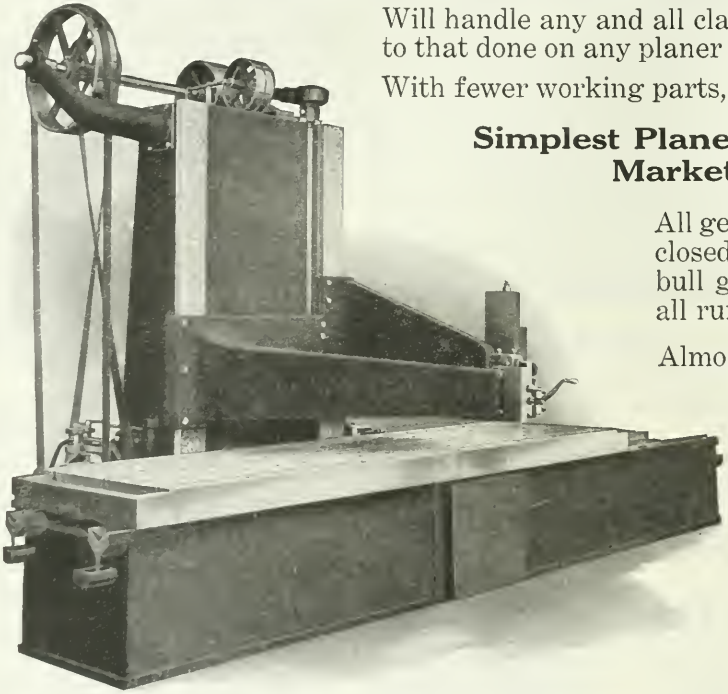
The NATCO Multiple Drill has patented independent spindle speeds—every tool gets its correct speed and feed. The machine is a wonderful producer. Types and sizes for all purposes. Let us show you.

THE NATIONAL
AUTOMATIC TOOL
COMPANY
RICHMOND, INDIANA, U. S. A.



Rigid and Accurate

The "Cleveland" Open Side Planers



Will handle any and all classes of work equal to that done on any planer of any type.

With fewer working parts, it is the

Simplest Planer on the Market

All gears in drive are enclosed, and except the bull gear and its pinion all run in oil.

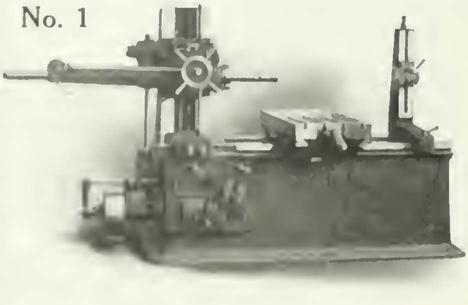
Almost fool-proof.

May we send you a catalog?

The Cleveland Planer Company

3152 Superior Ave., CLEVELAND, OHIO, U. S. A.

No. 1



The Cleveland Horizontal Boring, Milling and Drilling Machine

Is a rapid tool room machine of the most improved type Simplicity of design and ease of operation are outstanding features; 12 changes of speed, and 16 changes of feed, can be made while the machine is in motion and control is by a single lever. The spindle head and outer support of this high grade machine are positively aligned by means of scales and verniers graduated to 001

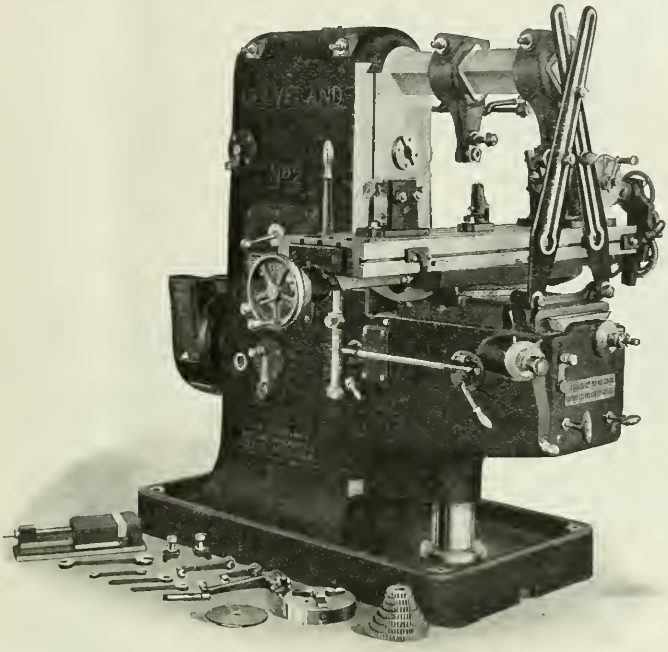
Circular?

The Cleveland Machine Tool Co.

CLEVELAND OHIO, U. S. A.

The Cleveland Milling Machine Co.

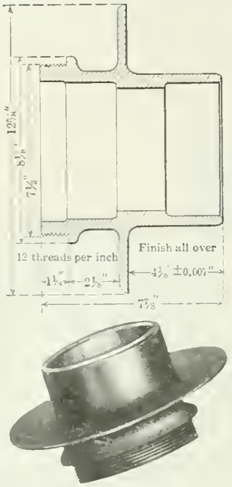
Milling Machine



- Square over-arm.
- Constant speed or single pulley drive.
- Sixteen changes of speed.
- Sixteen changes of feed.
- All sliding gears, no tumbler gears.
- All gears and shafts hardened and ground.
- Feed box in knee.
- All operating levers within easy reach of operator.
- Bronze bearings throughout.
- One piece elevating screw for knee.
- No universal joint for feed drive.
- Column and knee automatically lubricated.

THE CLEVELAND MILLING MACHINE COMPANY
CLEVELAND, OHIO, U.S.A.
NEW YORK OFFICE: 1760-2 Woolworth Building

Milling Cutters Milling Machines Relieving Machines



40 MINUTES

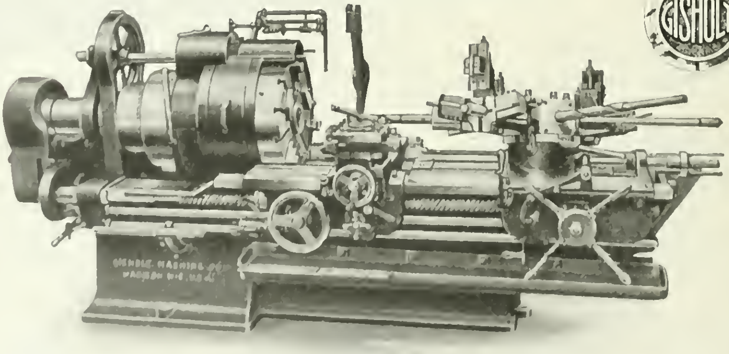
GISHOLT
Turret Lathes

Another Gisholt
Hub Job
Forty Minutes

Standard Tools Lower Costs

Standard tools lower costs not only because they cost less, but because of the time they save. When a job like the above, for instance, can be produced with standard chucking tools, you will see the advantage.

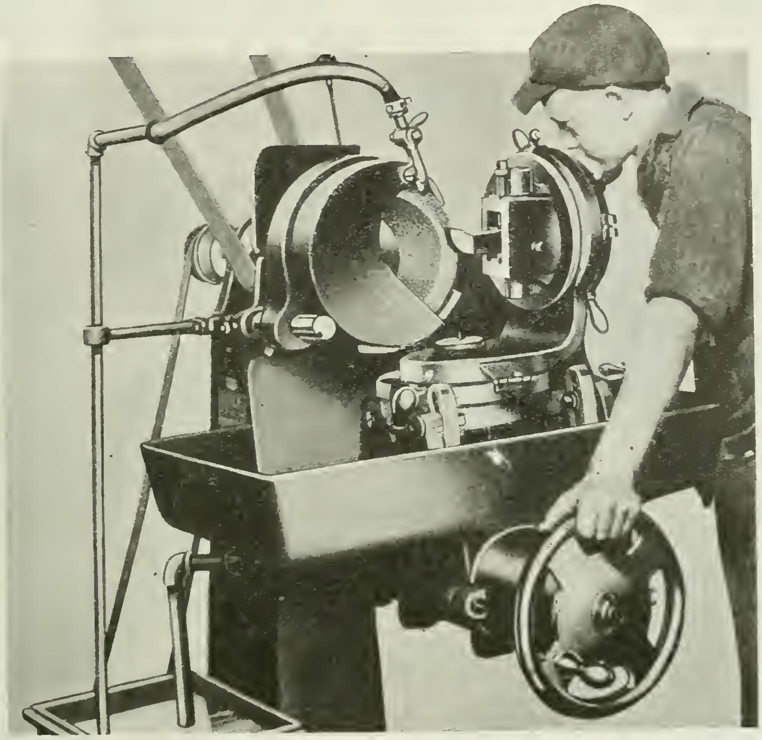
Have you any work that is similar?
Compare our production time with yours.



GISHOLT MACHINE CO.

Eastern Sales Office: 30 Church St., New York.

1200 E. WASH



The More Varied the Tools
The More Profitable is the

GISHOLT
TOOL GRINDER

The greater the variety of tools and number of angles to grind the more apparent are the speed and accuracy of the Gisholt Tool Grinder. A boy can grind more tools with this grinder, and with less effort, than a skilled mechanic can grind by hand. He will duplicate angles perfectly. He'll jump from one tool to the next without waste effort or loss of time.

Ask for the complete Grinder story.

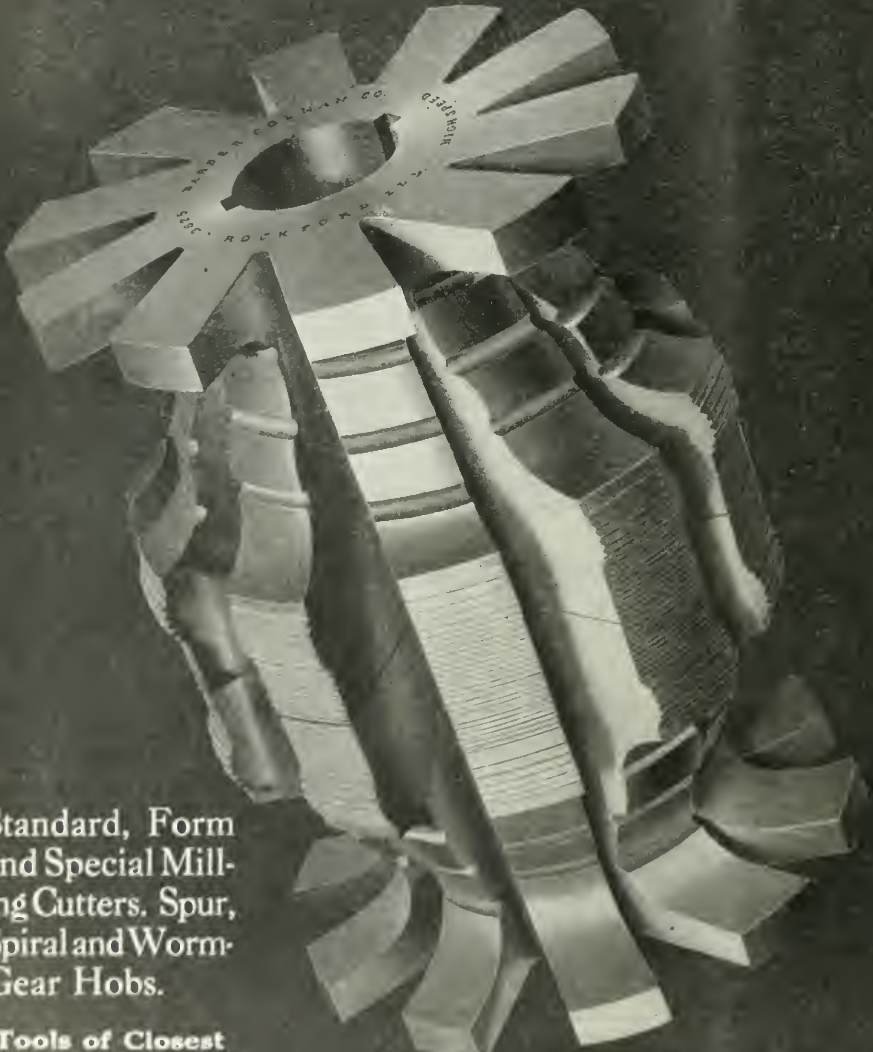
Madison, Wisconsin, U. S. A.

INGTON AVENUE

Works: Madison, Wis., Warren, Pa.

Barber-Colman

Interlocking Cutters



Standard, Form and Special Milling Cutters. Spur, Spiral and Worm-Gear Hobs.

Tools of Closest Accuracy

BARBER-COLMAN COMPANY

ROCKFORD, ILLINOIS, U. S. A.

Bradley Hammers

Weight From 800 to 13,200 Pounds Each

THE variety of forging and hammering operations which may be profitably performed on Bradley Hammers is amazing—we frequently find them doing things we never dreamed of. Also, the quantity of work being produced by Bradley Hammers is remarkable—there are more of these hammers in use to-day than all other makes of belt driven hammers combined. And as for the quality of Bradley forgings, you can rest assured that Bradley Hammers are there—if they were not you wouldn't find them in the big plants everywhere.

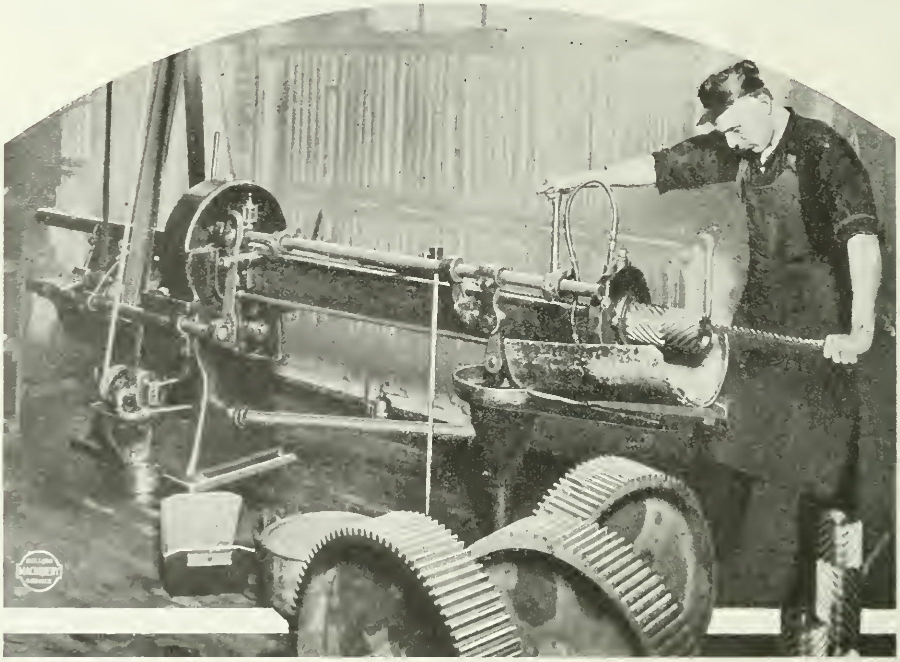
A 30 Ounce Bradley Hammer, The Only One In Existence

These are "samples"—perfect working models—weight 30 to 38 ounces. Would you like to see one in action?

Many are the reasons for Bradley popularity — range, convenience, adaptability and economy being among the more important. They are one-man machines with simple, conveniently located and responsive controls which permit a close degree of accuracy. They are durable hammers—built to stand hard, constant use. Let us send complete specifications.

C. C. BRADLEY & SON, Inc.
SYRACUSE, N. Y.

FOREIGN AGENTS: Brazil, France, Belgium, Switzerland, Spain and Portugal: Fenwick Freres & Co., 8 Rue de Rocroy, Paris. Italy, Taddeo, Giusti, Modena, Italy. England, Buck & Hickman, Ltd., London.



J. N. Lapointe Co. Broaching Equipment

is the Answer to Keyseating Problems

For Instance: The J. N. Lapointe Co. Broaching Machine shown in the accompanying photograph is broaching 5/16″ keyways in spiral gears of 4″ length. Two gears are handled at one time, and as each pair is intended ultimately to operate as a unit, it is essential that the keyseat alignment be perfect.

J. N. Lapointe Co. Broaching Equipment is again the answer, as it is on all particular keyseating jobs, and it takes but 40 seconds for the actual broaching time on a pair of these gears.

The Albaugh-Dover Company of Chicago is noted for quality and speed in gear production. Keyseating, though a small operation, is indeed an important one. This company acknowledges the need of good equipment and employs two J. N. Lapointe Co. Broaching Machines.

Are you aware of the full possibilities of broaching on large and small parts? May we send you the complete story? Write.

THE J. N. LAPOINTE COMPANY
NEW LONDON CONNECTICUT

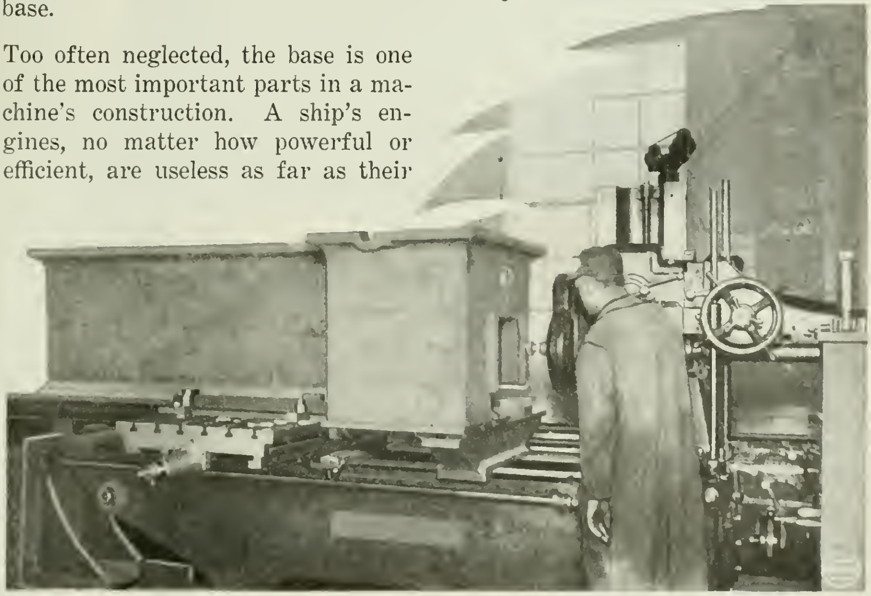
UNIVERSAL *Horizontal* Boring Machine

A Good Foundation for Your Choice

We have prepared a series of six advertisements, taking you through our plant during the construction of the Universal Boring Machine and showing you the good foundation for making this the machine of your choice. The first picture logically concerns the machine's own foundation, the base.

Too often neglected, the base is one of the most important parts in a machine's construction. A ship's engines, no matter how powerful or efficient, are useless as far as their assistance in navigation is concerned unless the ship's keel has been properly laid. Durability, strength, rigidity and correct proportions are the characteristics of a good machine base. They are instantly apparent in the Universal Boring Machine. Further particulars will convince you. Get them.

The photograph shows the huge close-grained base casting, mounted on an auxiliary table to be end milled and drilled by another Universal Boring Machine.

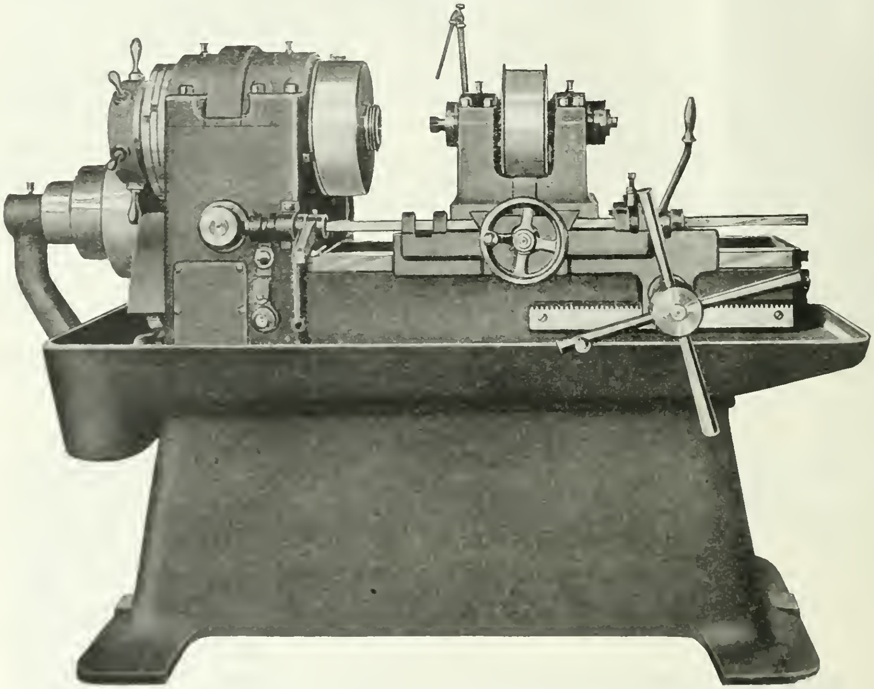


UNIVERSAL BORING MACHINE COMPANY

HUDSON MASSACHUSETTS U. S. A.

The New Biggs-Watterson Thread Miller

Under the old method the operator sometimes forgets. Why not use our Universal Automatic Thread Miller, eliminate all losses and increase your production?



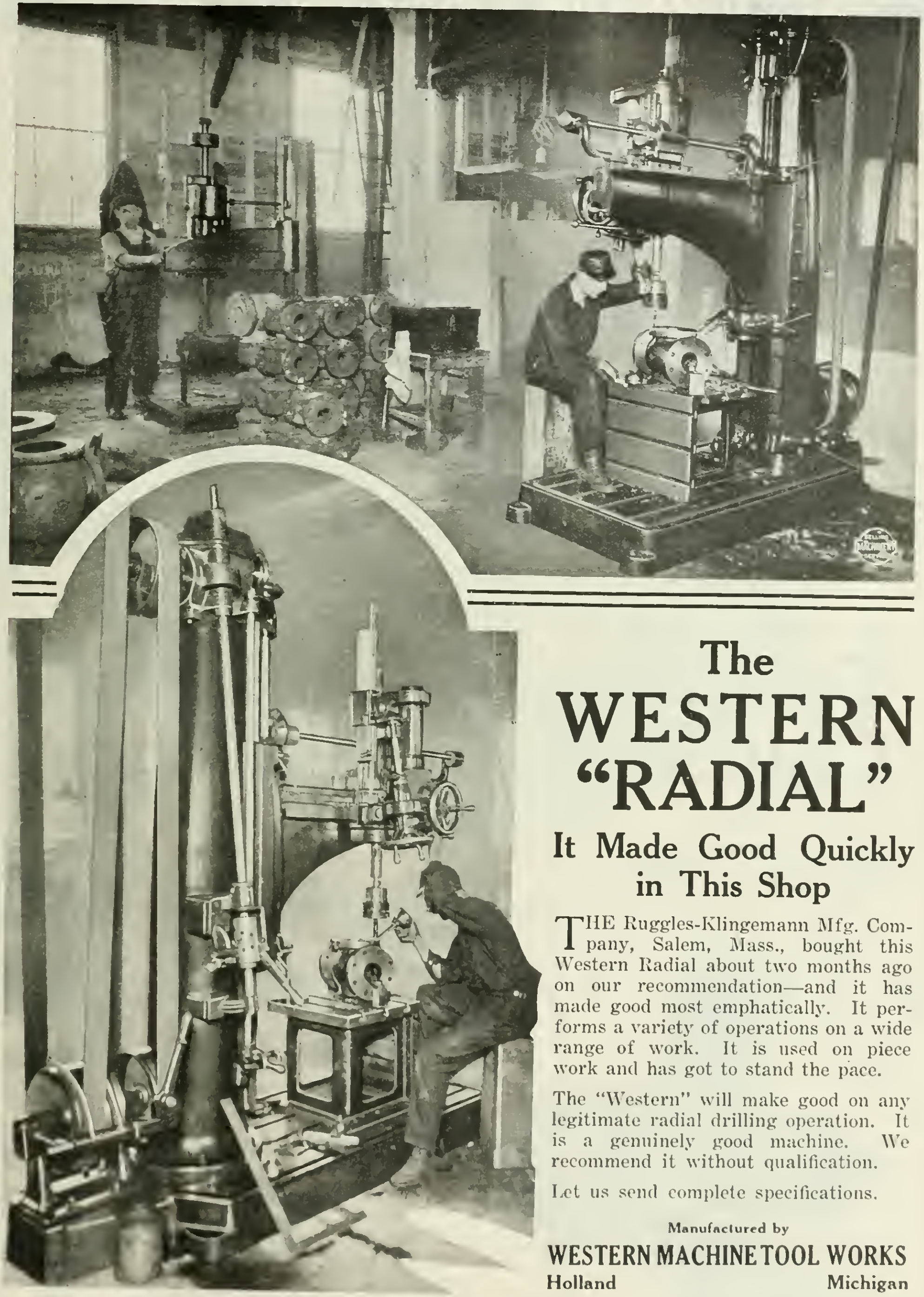
All operating mechanism is automatic. Operator chucks work only. Prompt deliveries assured. Honest service.

This machine is built in four sizes. The capacity through the spindle or spring chuck can be 3", 6", 9" or 12". Long pieces are chucked from the back end, while short pieces are chucked from the front.

Machine is controlled by a single lever which engages the drive of work spindle, brings the cutter to proper depth, engages lead screw, and starts lubricant pump. After work spindle completes one revolution, power is disengaged, cutter is backed away, and carriage nut released from the screw, retaining the lead positively. Any threads, either Metric or U. S. Standard, right or left hand, internal or external, can be cut through our system of change gears.

THE BIGGS-WATTERSON CO.

CLEVELAND, OHIO



The WESTERN "RADIAL"

It Made Good Quickly in This Shop

THE Ruggles-Klingemann Mfg. Company, Salem, Mass., bought this Western Radial about two months ago on our recommendation—and it has made good most emphatically. It performs a variety of operations on a wide range of work. It is used on piece work and has got to stand the pace.

The "Western" will make good on any legitimate radial drilling operation. It is a genuinely good machine. We recommend it without qualification.

Let us send complete specifications.

Manufactured by

WESTERN MACHINE TOOL WORKS
Holland Michigan

Manufacturers' Agents

HILL, CLARKE & COMPANY, Inc.

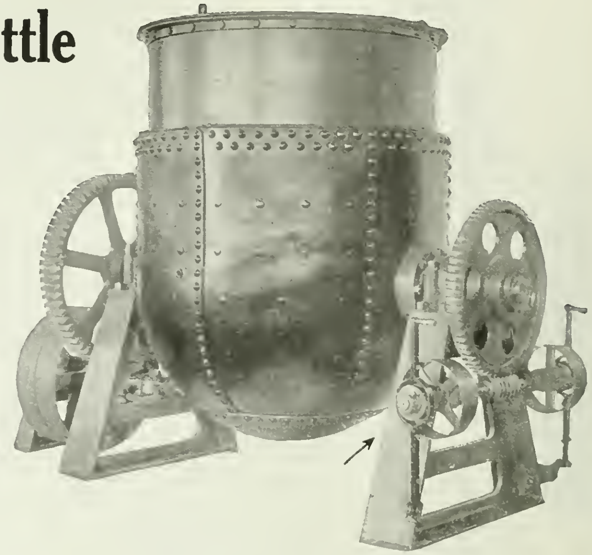
156 Oliver St., Boston, Mass. THE MACHINERY MERCHANTS 136 Cedar St., New York City

THE JOHNSON FRICTION CLUTCH

A Big Steam Kettle

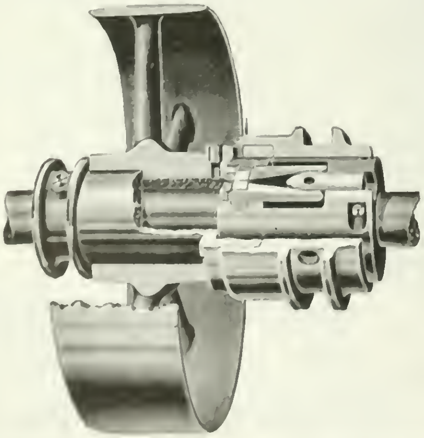
The Action of which Must be Instantaneous

This is a tilting kettle for "cooking" linoleum compositions, and in action it must respond instantly and positively to the wishes of its operator.



The Johnson Friction Clutch Does the Trick

Johnson Clutches are fitted to these kettles because they are dependable clutches—they do what they are required to do, quickly, positively and economically—and more than this you cannot ask of any device. There is no more adaptable device of its class on the market than the JOHNSON FRICTION CLUTCH. We can make it fit anywhere; it answers every friction clutch requirement; it is small, simple, powerful, *safe;* it operates easily and quietly; is absolutely interchangeable; has no bolts, nuts, links, etc.



Write now for Catalog A and complete details

AGENTS:

CANADA: Williams & Wilson, 320 St. James St., Montreal. The Canadian Fairbanks-Morse Co., Ltd., Toronto and branches. ENGLAND: The [illegible] Co., 22 Newman St., Oxford St., London, W. 1, Sole Agents for British Isles. AUSTRALIA: Edwin Wood Pty., Hardware Chambers, 231 Elizabeth St., Melbourne, Victoria. JAPAN: Andrews & George Co., 10 Takegawa-cho, Kiobashi-ku, Tokyo. SOUTH AFRICA: D. Drury & Co., Main St., Johannesburg. FRANCE: Anciens Etab. Glaenzer & Perreaud, 18 Faubourg du Temple, Paris.

THE CARLYLE JOHNSON MACHINE CO. MANCHESTER CONN.

The
INFUSO PROCESS

One of Our Secrets---Wide Open to Public Inspection

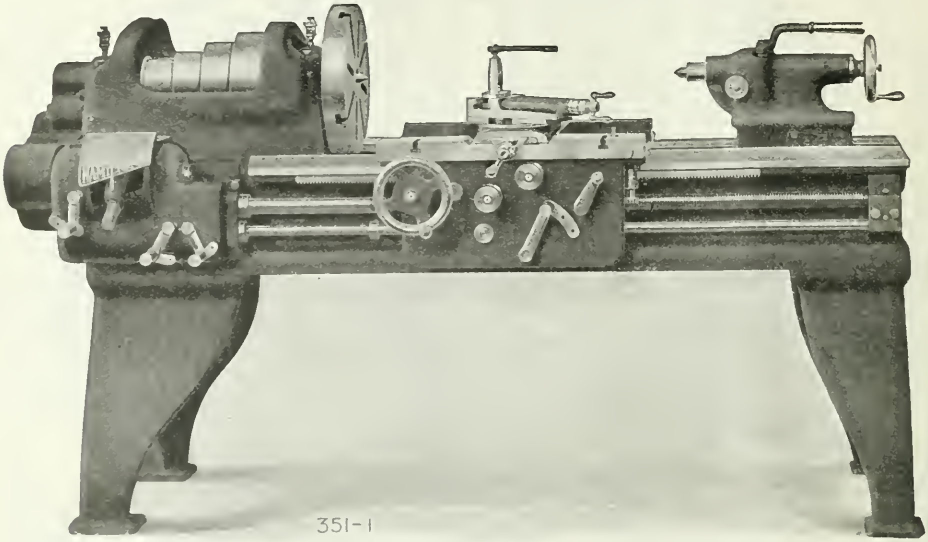
Proving an answer in mathematics won't make it any more correct than it was, neither will subsequent testing of metal help in its heat treatment.

But when you're dead certain you've done a thing correctly, you're glad to have the opportunity to say "I told you so."

That's our only excuse for calling the careful inspection of parts a feature of the Infuso Process. It only proves the correctness of our process.

The Steel Improvement and Forge Company
CLEVELAND OHIO, U. S. A.

HAMILTON



The New 16" Rapid Production Lathe

Rapid Production
HAMILTON
Machine Tools

The New Hamilton 16″ Rapid Production Lathe combines features which make it the most powerful, accurate lathe of its dimensions on the market. Improved gear box, semi-steel bed with its wide V, box type headstock, chrome-nickel steel spindle, double apron and drop-forged apron gears are a few of the points which insure the accuracy and durability of this up-to-date machine.

Friction is reduced to the minimum by means of a central oiling system of the gear box and apron, sight-feed spindle oilers and bronze bushings throughout. Swings over ways 18¼″.

Bulletin No. 316 gives complete details
Send for a copy

THE HAMILTON MACHINE TOOL CO.
HAMILTON, OHIO, U. S. A.

[illegible] Boston, Mass. Machine Tool Engr. Co., New York. Syracuse Supply Co., Rochester, N. Y., Syracuse, N. Y., [illegible] Laughlin-Barney Mchy. Co. (Lathes), Pittsburgh, Pa. J. H. Miller Mchy. Co. (Planers), Pittsburgh, Pa. [illegible] Columbus, O. Wolverine Machinery & Supply Co., Detroit, Mich. Strecker Rumley Wacht [illegible] Indianapolis, Ind. W. C. Johnson & Sons Mchy. Co., St. Louis, Mo. F. E. Satterlee Co., Minneapolis, Minn. [illegible] General Machinery & Supply Co., San Francisco, Cal. Herberts Machinery & Supply Co., Los Angeles, Cal. [illegible] Charlotte, N. C. Cotton States Belting & Supply Co., Atlanta, Ga. Oliver H. Van Horn, Inc., New Orleans, La. CANADIAN AGENTS: H. W. Petrie, Ltd., Toronto, Ont.

WILLIAMS' "AGRIPPA" TOOL HOLDERS

BACK OF THE FRONT
OVER HERE AND "OVER THERE"

The mechanical advantages which gave Williams' "AGRIPPA" Tool Holders the preference over other tool holders at San Francisco in 1915 continue to give them a like preference in the demand for government service in 1918.

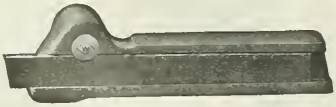
One by one, from the British Empire, from France, Italy, Russia and Japan came the war calls for the "AGRIPPA" —The Modern Tool Holders—and they went forth.

Now Hear America's Call! She too must save time, labor and high-speed steel, and our Government has therefore

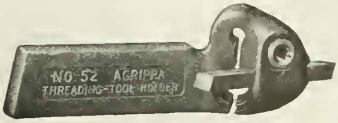
Drafted the "AGRIPPA" by the Thousands

for use overseas and at home, because they alone save the most machine time on the job, lose the least repair time off the job and need the least shifting between the jobs.

They're "doing their bit"—they'll make yours easier.



A tool that performs both cutting-off and side work by the mere substitution of suitable cutters tells its own story of economy.



The Threading Tool with lockable-spring head will do roughing, finishing and threading at one setting of the tool post.

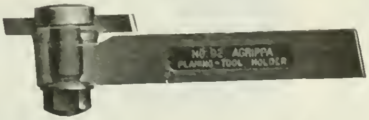
J. H. WILLIAMS & COMPANY

"The Drop-Forging People"

61 Richards St., Brooklyn, N. Y.

Western Office and Warehouse:
61 So. Clinton St., Chicago

The Boring Tool takes any size or shape of bar and requires no bushings.



The Planing Tool's serrated ring affords varied and rapid adjustment. The ring is hardened against wear. The body is heat-treated to prevent breakage.

CARD TAPS

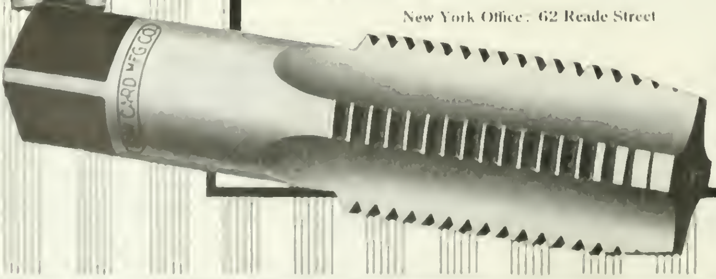
The CARD Quality

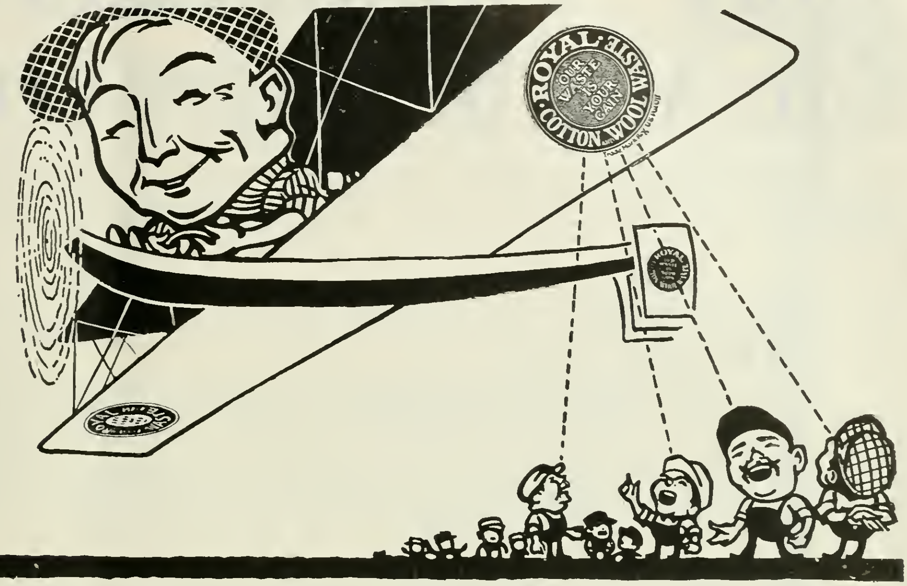
CARD Taps are on the Honor Roll, lined up with the nation's best in men, machines and tools; doing their part to carry on successfully the most tremendous task the American people have ever undertaken; economically cutting the clean, true threads required for high grade work.

The Card line, providing for every thread cutting requirement, includes Taps, Dies and Screw Plates—every tool made by experts, every tool guaranteed for quality and workmanship. Forty-four years on the market.

S. W. CARD MFG. CO.
MANSFIELD MASS., U. S. A.
New York Office: 62 Reade Street

Our latest
Catalog
No. 29
on request





Above all, remember R-o-y-a-l

DON'T be like the man who knew a nice girl but forgot her 'Phone number. Don't forget the trade mark on that baleful of cotton waste that satisfied you down to the last handful.

—that was so absorbent
—that was so free of dirt and splinters
—that proved its standardization by guarantee of uniform quality, even weight and 6% "tare" (wrappings).

Say to the buyer "I want Royal."

Don't forget which of the 12 Royal grades proved best for your need of service and price.

If it was WHITE, it was Baron, Count, Czar, Duke, Earl or Emperor.

If COLORED, it was King, Marquis, Mikado, Prince, Rajah or Sultan.

Write us for the great little book, "Producing the Fittest in Waste." Ask your jobber or us for Royal Sampling Catalogue or for samples of resilient Royal Wool Waste. The imposing Royal Magazine Campaign is worth your notice.

ROYAL MANUFACTURING Co

ROYAL COTTON WOOL WASTE
OUR WASTE IS YOUR GAIN

General Sales Offices and Plant
RAHWAY, N. J.
LOOK FOR THE BRAND ON EACH STEEL BAND

New York Office—2 Rector Street
St. Louis Office—Pontiac Bldg.
Chicago Office—People's Gas Bldg.
Pittsburgh Office—Oliver Bldg.
San Francisco Office—Wells Fargo Bldg.

Your Countershafts Can Also Be Improved—

WHEREVER you have a high-class machine connected up to an old-fashioned plain bearing countershaft there is a double loss—loss of production and loss of power.

The Rockford Drilling Machine Company has permanently solved its countershaft problems by equipping countershafts with Hyatt Roller Bearings. So can you.

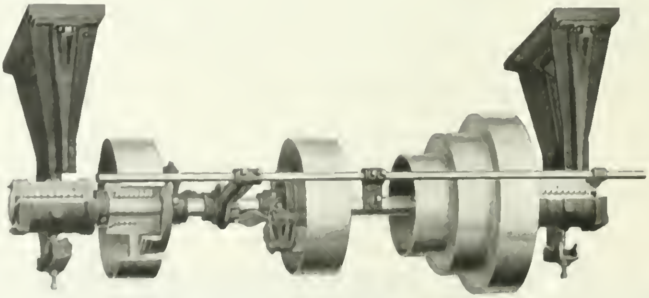
Hyatt Roller Bearings insure smooth and dependable operation at all times. By eliminating at least 50 per cent of the friction of plain bearings, they speed up shop production and reduce power and lubrication expenses wherever they are used.

You can get many years of satisfactory service from a Hyatt Roller Bearing Countershaft. The only attention it requires is a single charge of lubricant three or four times a year.

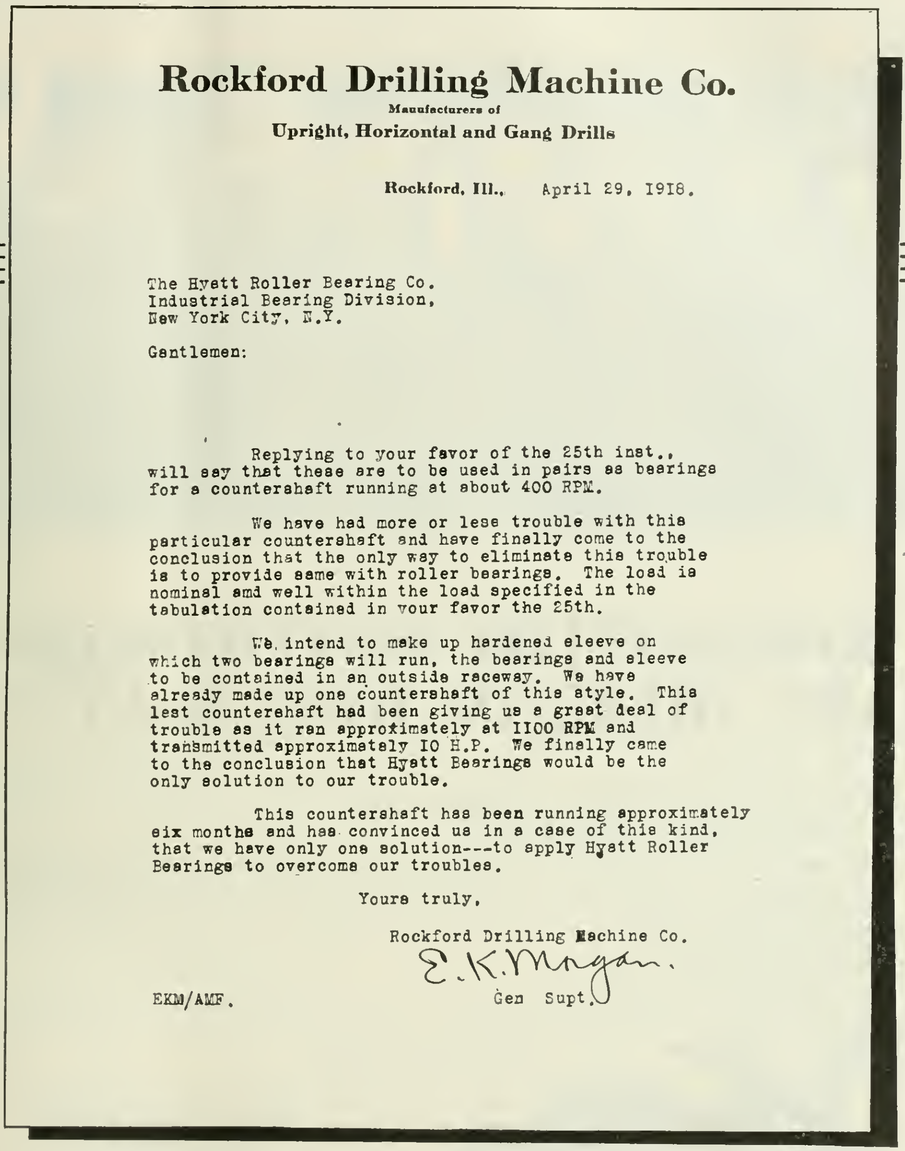
The manufacturers of machine tools of all kinds are now furnishing Hyatt Roller Bearing equipped countershafts as a standard part of their product and have thereby improved machine tool operation to a profitable extent.

You can obtain Hyatt Roller Bearing equipped countershaft boxes and unbreakable steel hangers from the Standard Pressed Steel Company and complete Hyatt Roller Bearing equipped countershafts with Standard Clutch from the Standard Pulley Company. Hyatt Roller Bearing equipped countershaft clutches are furnished by the Foster Machine Company, the Brown Engineering Company and the Edgemont Machine Company.

You will find that our Countershaft Bulletin contains complete engineering data of real practical value to you. Send for it today.



HYATT BEARINGS



Rockford Drilling Machine Co.
Manufacturers of
Upright, Horizontal and Gang Drills

Rockford, Ill., April 29, 1918.

The Hyatt Roller Bearing Co.
Industrial Bearing Division,
New York City, N.Y.

Gentlemen:

Replying to your favor of the 25th inst., will say that these are to be used in pairs as bearings for a countershaft running at about 400 RPM.

We have had more or less trouble with this particular countershaft and have finally come to the conclusion that the only way to eliminate this trouble is to provide same with roller bearings. The load is nominal amd well within the load specified in the tabulation contained in your favor the 25th.

We intend to make up hardened sleeve on which two bearings will run, the bearings and sleeve to be contained in an outside raceway. We have already made up one countershaft of this style. This last countershaft had been giving us a great deal of trouble as it ran approximately at 1100 RPM and transmitted approximately 10 H.P. We finally came to the conclusion that Hyatt Bearings would be the only solution to our trouble.

This countershaft has been running approximately six months and has convinced us in a case of this kind, that we have only one solution---to apply Hyatt Roller Bearings to overcome our troubles.

Yours truly,

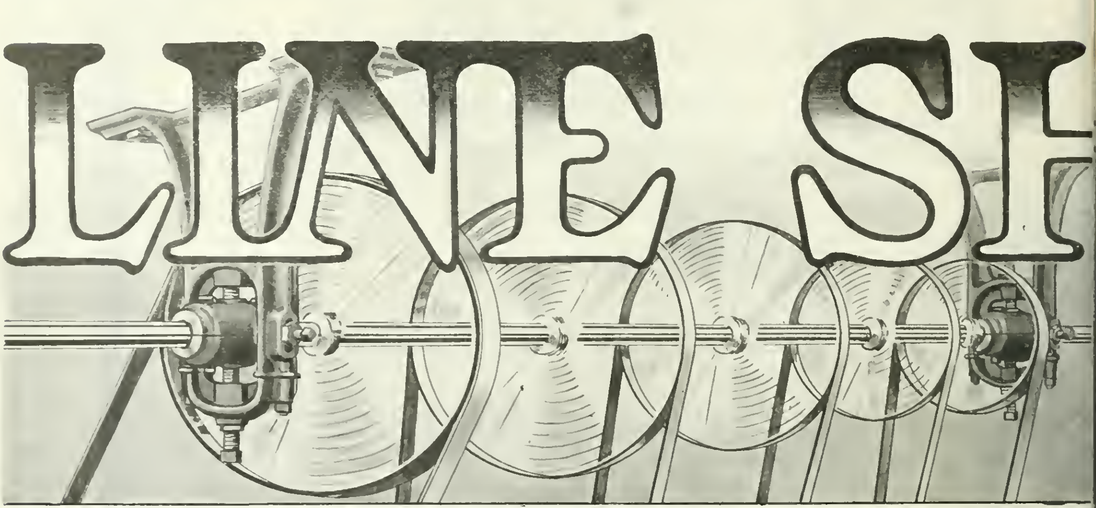
Rockford Drilling Machine Co.
E. K. Morgan
EKM/AMF. Gen Supt.

HYATT ROLLER BEARING CO., Metropolitan Tower, New York

Manufacturers of bearings for steel mill cars and roller tables, trolleys, cranes, hoists, machine tools, line shafts, concrete machinery, all kinds of trucks and cars, textile machinery, conveyors, etc.

425

FOR COUNTERSHAFTS

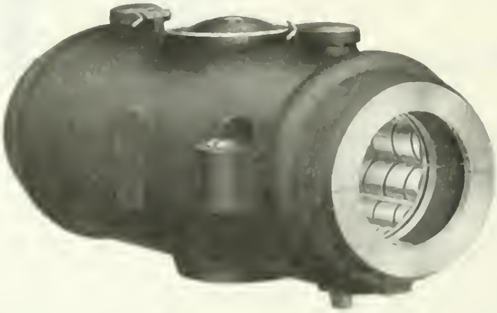


HOW MANY LINE SHAFT HANGERS ARE THERE IN YOUR PLANT?

If every hanger in your plant consumes one horse power in friction every ten hour day, how much power do you waste in one year and what does it amount to in tons of coal or in dollars and cents?

Engineering tests have shown that the usual babbitted hangers waste at least 30 per cent of your total power. At least 50 per cent of this waste can be eliminated by the use of Hyatt Line Shaft Roller Bearings. Thus your total power bill can be reduced 15 per cent or you can run additional equipment with your present power plant.

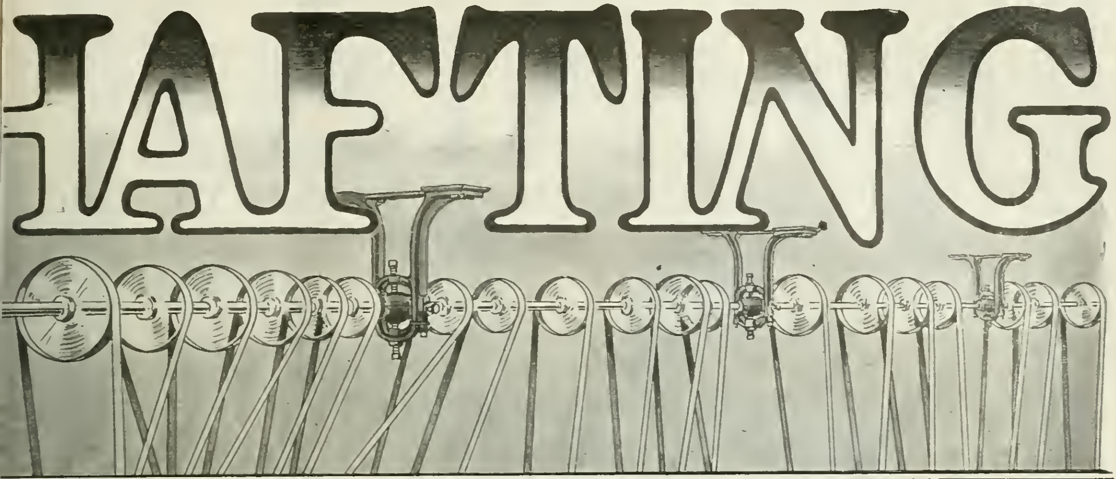
Hyatt Line Shaft Roller Bearings provide a true rolling motion in place of the dragging friction of babbitted bearings. The hollow flexible steel rollers revolve directly on the shaft without the need of inner sleeves.



The Hyatt Line Shaft Box, assembled.

Note the flexible rollers within and how box is completely split.

HYATT BEARINGS



Hyatt Line Shaft Roller Bearings are SPLIT throughout and can therefore be slipped easily into position on a shaft without removing any pulleys, collars or couplings.

These easily applied line shaft bearings hold sufficient oil for several months lubrication and the helical openings in the rollers constantly bathe the surfaces in oil.

The first cost of a Hyatt Line Shaft Roller Bearing is very little more than the first cost of a babbitted bearing. The maintenance cost is far less and the replacement cost practically zero, for Hyatt Bearings have been in operation in some plants for 25 to 30 years and are still giving satisfactory service.

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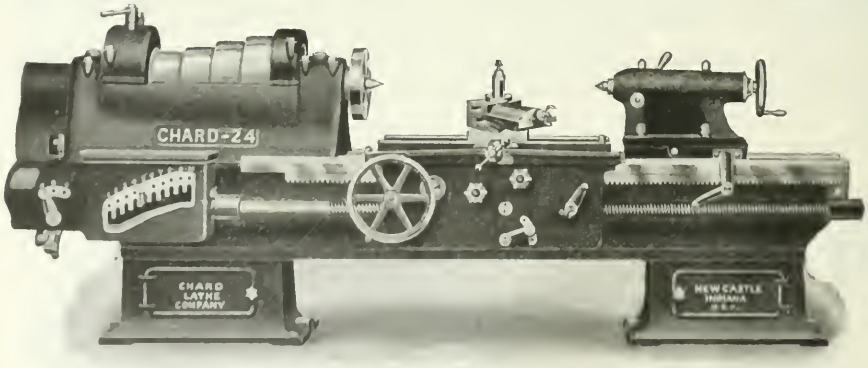

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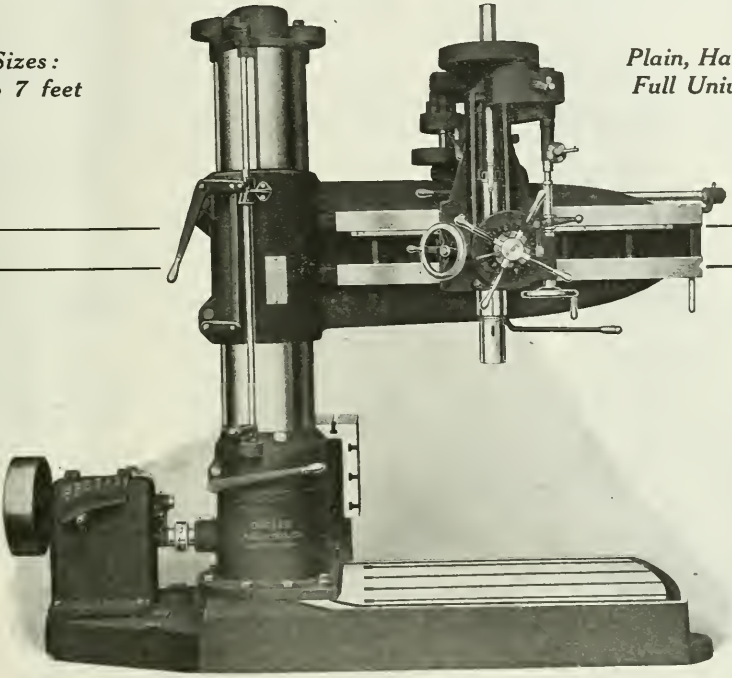

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Pulley shaft on speed variator has annular ball bearing, gears are of steel and hardened and run in oil baths.

Base has oil groove so designed to increase the working surface.

Column is greatly enlarged at lower end and has a third bearing in the middle, doubling the strength and rigidity.

Arm has double webbed box shaped lower rib, preventing twisting.

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Friction bevel gears and worm wheel run in oil bath.

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Friction for starting, stopping and tapping is double expanding, powerful in gripping, easy to operate and adjust.

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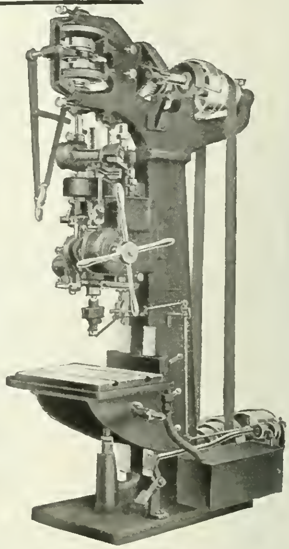

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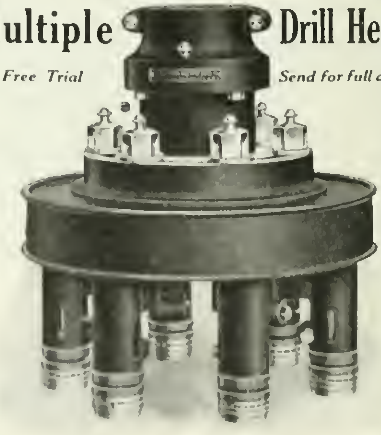

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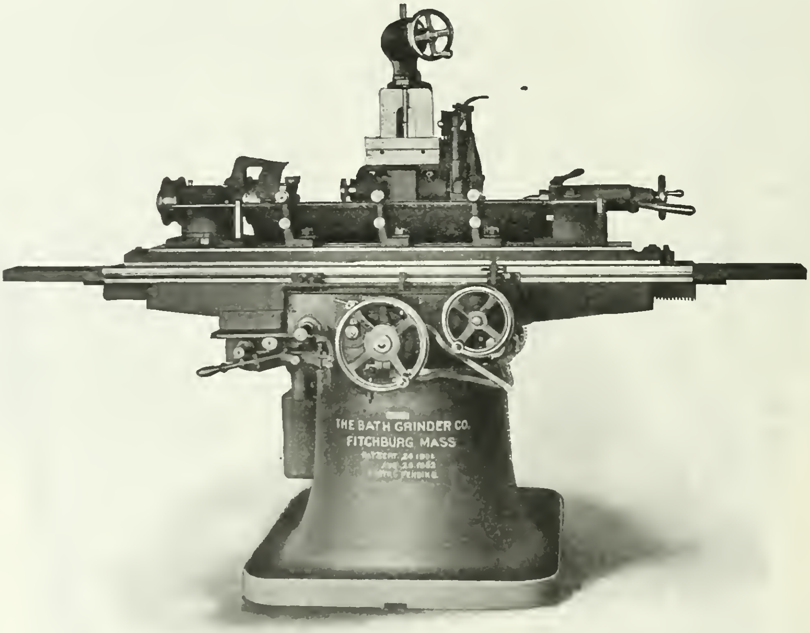

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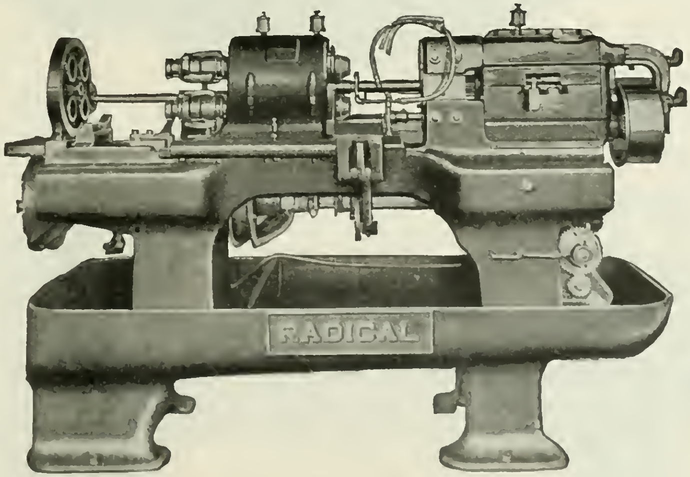

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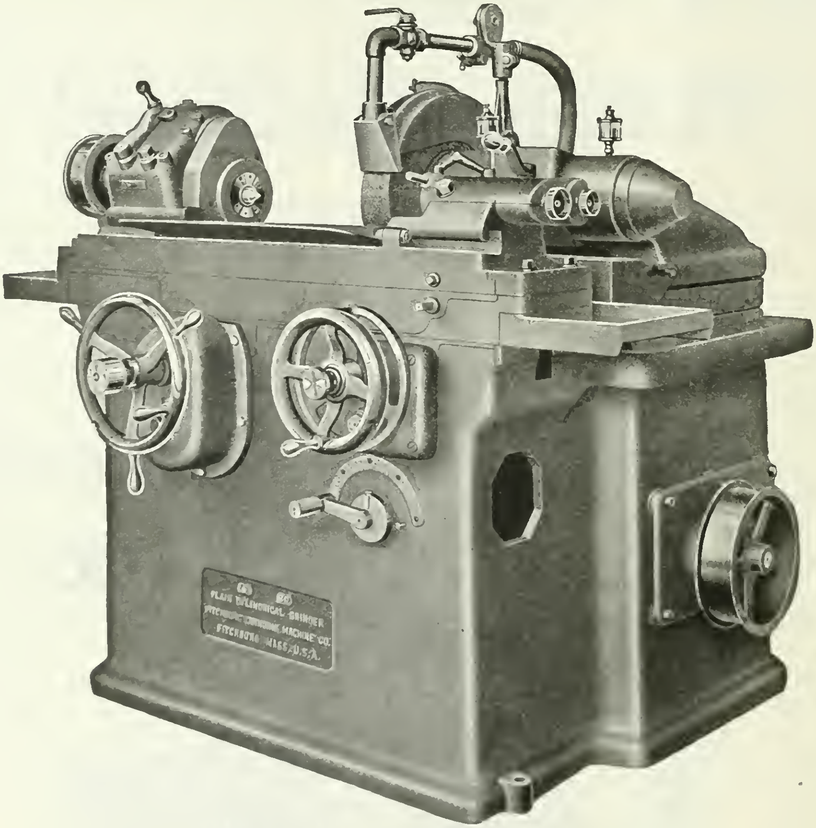

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Distance between centers	20"	20"
Swivel Table Graduated to angle of	10°	10°
Swivel Table Graduated to Grind Taper per foot	4"	4"
Head and Footstock Spindles bored to fit Morse Taper	No. 4	No. 4
Number of Work Speeds	(10)	(10)
Number of Traverse Table Feeds	(10)	
Number of Grinding Wheel Speeds	3	3
Size of Grinding Wheel	16" x 3"	16" x 3"
Size of Grinding Wheel Pulley	6" x 4"	6" x 4"
R. P. M. of Tight and Loose Pulley	640	640
Horse Power Required	7½ to 10	7½ to 10
Floor Space Required	52" x 66"	52" x 66"
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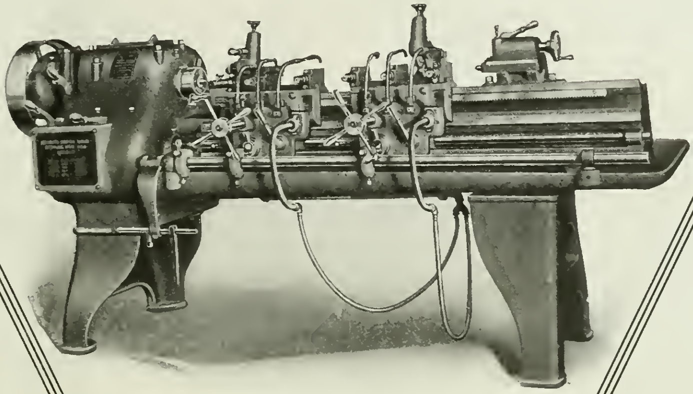

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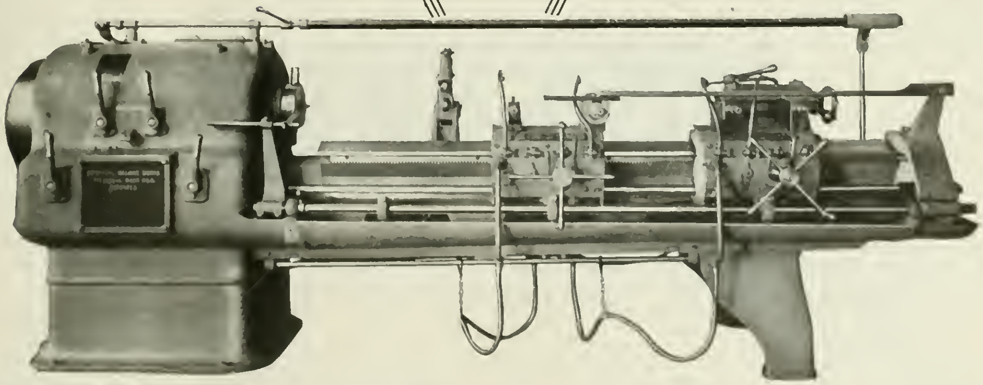

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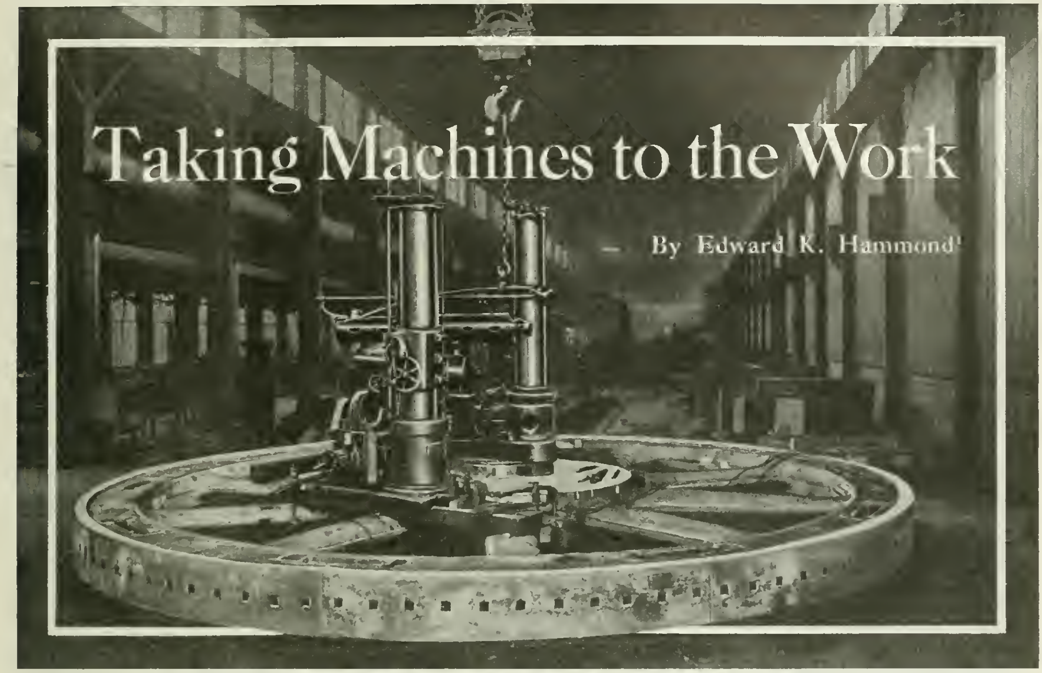
AUGUST MACHINERY 1918

Taking Machines to the Work

By Edward K. Hammond[1]



In planning methods of handling government work which involves the performance of machining operations on pieces of large size and heavy weight, careful consideration has been given to the possibility of using portable machines which are carried to the work instead of following the usual method of taking the pieces which are to be machined to stationary machine tools. This article explains methods used by prominent manufacturers for applying portable machines in the performance of shop operations and describes various advantages that are secured through their use. It will suggest ways in which the same principle could be applied by manufacturers who are at present working out methods of machining heavy work for the Government.

FACTORIES engaged in building power plant engines and similar equipment, where a year's business seldom includes orders for many engines or other products of the company which are of the same design, must handle their work differently from plants engaged in manufacturing large numbers of a standard product. In such factories, the highly organized manufacturing practice of shops engaged in the performance of repetition work on large numbers of similar parts is replaced by methods developed with the view of saving time and labor in handling extremely heavy castings, in utilizing floor space, and in saving as much time as possible in the actual performance of machining operations. There are many factories in which all of these results are secured through the use of portable tools that are taken to the work instead of following the usual practice of taking work to stationary machines; and in the present article it is intended to explain the beneficial results which certain manufacturers have secured through adopting the use of portable tools.

In addition to their use on production work, portable machines are often employed to advantage on repair work and for making slight alterations on factory equipment. In such cases, the great advantage derived from the use of a portable machine lies in the fact that it is often found possible to set it up on a shaft or other machine member without the necessity of removing the part to be machined from its operating position. Obviously, where such a practice can be followed it is the means of saving a substantial amount of time which would otherwise be consumed in tearing down the machine, transferring the member to be repaired to the machine shop, and then bringing the part back and setting it up in place after the machining operation has been completed. There are many examples of this kind that are familiar to the average mechanic, among which may be cited the re-boring of engine cylinders, re-turning of crankpins, and cutting of keyways in shafts.

In this article four classes of portable machines will receive consideration: (1) Machine tools intended for the performance of production machining operations on general classes of work, which are either mounted on wheels so that they may be pulled about the shop, or provided with convenient means of carrying from place to place with a traveling crane. (2) Special-purpose machine tools, such as portable cylinder boring-bars, portable keyseating machines, etc. (3) Electric or pneumatic tools which are of such small size that they may be easily carried; these are adapted for general classes of work. (4) Tools of the same general type as those referred to under (3), but which are intended for the performance of specific operations, such as grinding lathe centers, grinding shear blades, etc., while set up on the machine.

Electric Traveling Cranes Used to Carry Portable Machines

In shops engaged in building engines and similar work, where there are exceedingly heavy castings to be handled, an important advantage may be secured through the use of portable machines, owing to the possibility of obviating difficulty that is likely to be experienced in setting up these heavy castings on stationary machine tools. With portable machines of the proper design it is often found possible to take the machine to the work and set it up in position for performing a given operation in far less time than would be consumed in carrying the work to a machine. This will be obvious when one bears in mind that the machine is likely to weigh from 1500 to 4000 pounds, so that it is easily carried by a crane, while an engine bed casting or similar part will often weigh from 50 to 75 tons.

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[1] Associate Editor of MACHINERY.

An example of this kind is seen at the plant of the Mesta Machine Co., in Pittsburg, Pa. This shop is engaged in building steam and gas engines, condensers and air pumps, rolling mill machinery, and similar heavy equipment. It is not unusual for some of the castings that must be machined to weigh in excess of seventy-five tons, so that they are too large for the capacity of one crane. Aside from the extreme difficulty of transferring heavy work of this kind, the use of portable machines allows several machines to be operating on a casting at the same time, which is a matter of importance when the execution of rush orders is in question. In the case of these excessively large pieces, it would be out of the question to attempt to set them up on an ordinary machine tool; but the trouble has been effectually overcome by adopting the use of portable machines. The heading illustration shows a view in the Mesta plant, where two radial drilling machines built by the American Tool Works Co., of Cincinnati, Ohio, are at work on a flywheel casting, the simultaneous use of two machines providing for unusually rapid handling of the work.

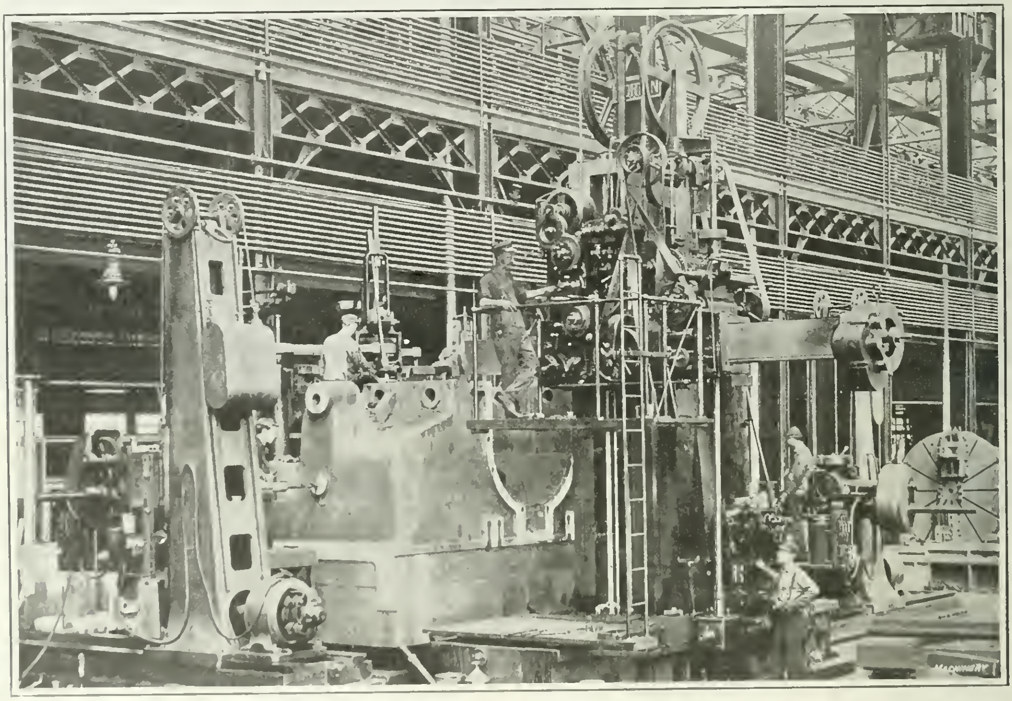

Fig. 1. View in Shops of Allis-Chalmers Mfg. Co., showing Three Morton Portable Traveling-head Planers working on Engine Bed Casting

In the plant of the Allis-Chalmers Mfg. Co., in Milwaukee, Wis., the same general conditions exist which have been outlined in the case of the Mesta Machine Co.'s shops. For the performance of machining operations on large engine frame castings, etc., the Allis-Chalmers production engineers have adopted the use of portable traveling-head planers built by the Morton Mfg. Co., of Muskegon Heights, Mich. It will be apparent from Figs. 1 and 2 that both the work and portable machines used in these shops are set up on floor plates which provide an adequate foundation. An advantage of these traveling-head planers for such work as machining engine frames lies in the wide range of machining operations for which they are adapted. Primarily, these machines are "draw-cut" planers with the tool-head mounted on a reciprocating ram, but adjustment may be rapidly made to provide for having the tool cut on the forward stroke if so desired, and, in addition, attachments are provided which adapt planers of this type for the performance of boring, drilling, milling, and rotary planing operations. From this it will be evident how useful the machines are found for carrying on those operations which are met with in machining large engine frames and similar classes of work. Fig. 1 shows a large traveling-head planer at work planing the joint in a pillow-block of a large Allis-Chalmers engine, while at each side of this machine there will be seen two smaller sized tools engaged in drilling.

In this connection, the reader's attention is directed to the provision made for adjusting the position of the column on the bedplate of the machine, and for regulating the location of the saddle on the column, in order to provide for reaching any position on pieces of work of considerable size. Fig. 2 illustrates the same job taken from the opposite end, where it will be seen that, in addition to the three Morton machines, there are a radial drilling machine and a special facing head working on this engine casting. This brings out to excellent advantage the idea of saving time through having a number of machines at work on one casting at the same time. Figs. 3 and 4 illustrate detail views of provision made for the performance of milling and boring operations with the Morton traveling-head planers. These attachments for the Morton traveling-head planers have been described in MACHINERY, so that a detailed description of the mechanism is not called for. It will be of interest to note, however, that the design has been worked out in such a way that the attachments may be quickly applied or removed from the machines.

For handling certain operations at the plant of the Canadian General Electric Co., in Peterboro, use is made of an 84-inch-stroke portable slotting machine built by the Newton Machine Tool Works, 23rd and Vine Sts., Philadelphia, Pa. One of these machines is shown in operation in Fig. 5, where it will be seen that a yoke is furnished at the top of the column to enable the machine to be readily picked up by the hook of a traveling crane, which is used to transport it from one part of the shop to another. This machine is equipped with reversing electric motor drive, so that it may be connected to a power circuit in any part of the shop where it is to be used. These portable slotting machines are built in several types, with strokes from 36 to 96 inches, inclusive.

Portable Machines Mounted on Wheels

The portable machines to which attention has been called up to the present time are of the type that are adapted for transfer around the shop with a traveling crane, and they are intended to be set up on a floor plate on which the work is also mounted in order to obtain a solid foundation, which is essential if it is hoped to obtain accurate alignment of the various bearings and finished surfaces on the work. There is another type of portable machine which is mounted on wheels so that it can be pulled around the shop like a truck. An example of this kind of equipment is illustrated in Fig. 10, which shows a portable engine lathe built by the R. K. LeBlond Machine Tool Co., of Cincinnati, Ohio. In handling the work of railroad shops, arsenals, and on board battleships, it is often found desirable to have a portable lathe which can be readily moved from one position to another, so that the lathe will be available for the performance of turning and boring operations on parts which are being repaired, or for making new pieces to replace parts which have been so badly damaged that they are unfit for further service. The application of portable lathes is limited to handling repair work and to other cases where an occasional machining operation has to be performed; obviously, they are not adapted to the requirements of manufacturing plants where lathes are engaged in the performance of repetition work. In Fig. 10 there is shown the method of applying constant-speed motor drive on a portable lathe, and owing to the conditions under which a machine of this type is used, it will be apparent that an individual electric motor constitutes the ideal method of driving. This lathe swings 17 inches and is furnished with an all-geared headstock, all changes of speed being made by shifting gears in the head. The motor is mounted at the back of the machine and the drive is through a Morse silent chain, which is completely enclosed. The spindle is started and stopped mechanically from the apron, and the electrical equipment consists of a slate-front starting panel in cases where a direct-current motor is employed. An alternating-current motor can also be used, and if so, a starter is not required. Lathes of this type can be equipped for screw cutting or they may be furnished with a sliding gear feed mechanism. The handle at the end of the machine is counterweighted in such a way that when it is released it rises to a vertical position and causes the machine to be secured to the floor. With the handle in the vertical position that it occupies at such times, the machine takes up no more space than a standard lathe. Although this type of lathe is built only in 17-inch swing, the R. K. LeBlond Machine Tool Co. builds another type of portable lathe, which is furnished in 14-, 16-, 17-, and 19-inch sizes.

Carrying Machines on Elevating Trucks

So far we have considered the advantages of portable machines for performing operations on work of such large size that difficulty would be experienced in carrying it about the shop and setting it up on stationary machine tools. Another important advantage of the portable machine lies in the fact that in cases where it is only required at intervals, it may be stored in some out-of-the-way place when it is not in use. A good case of this kind is seen in the plant of S. F. Bowser & Co., Inc., of Fort Wayne, Ind. In the manufacture of parts for gasoline pumps, this firm uses a battery of twenty-eight high-duty Baker drilling machines which are tooled up for performing operations that would ordinarily be handled on turret lathes. The idea is to transfer work from one machine to another, instead of rotating a turret to bring successive tools into the operating position.

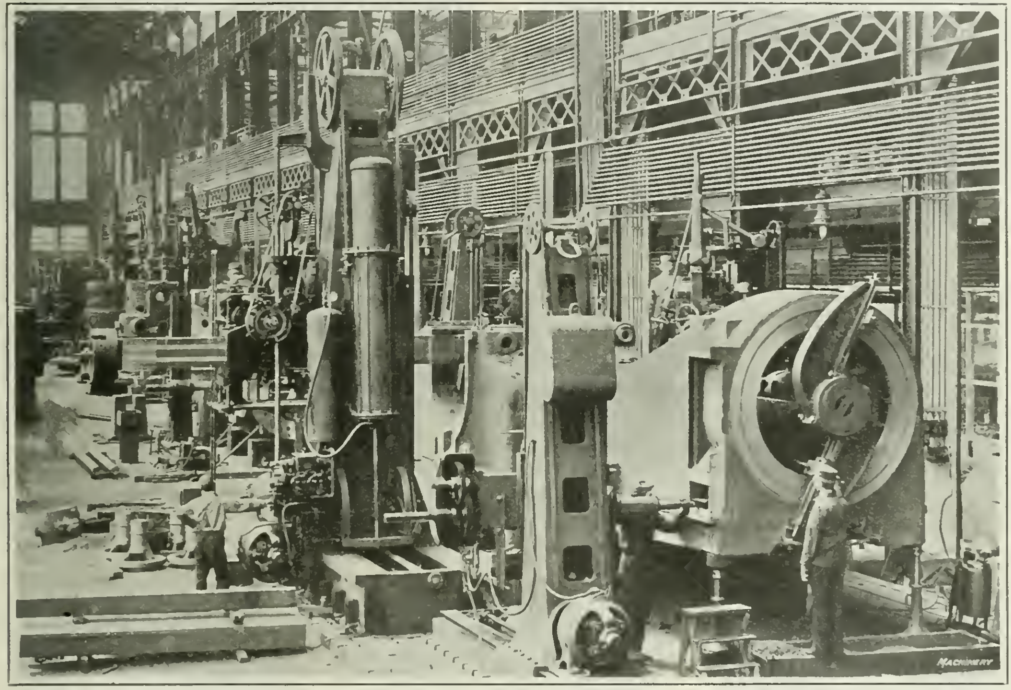

Fig. 2. View from Opposite Side of Work illustrated in Fig. 1, showing Radial Drilling Machine and Facing Head working on Same Casting

In connection with the production of certain parts machined on this equipment, the bearing is bored and reamed to receive a brass insert, after which it is required to press this insert into place on an arbor press, and then ream the hole in the brass bushing. Time would be lost if it were necessary to first transfer the work to an arbor press located in some other part of the shop and then bring it back to the drilling machines for the performance of the final operations. At the same time, the parts into which these brass inserts have to be pressed are only machined at intervals of several weeks, and if the arbor press was permanently located beside the battery of drilling machines, it would be taking up valuable space during a great majority of the time when it was not in use. This difficulty has been effectually overcome by adopting the use of a portable arbor press, which consists of a machine

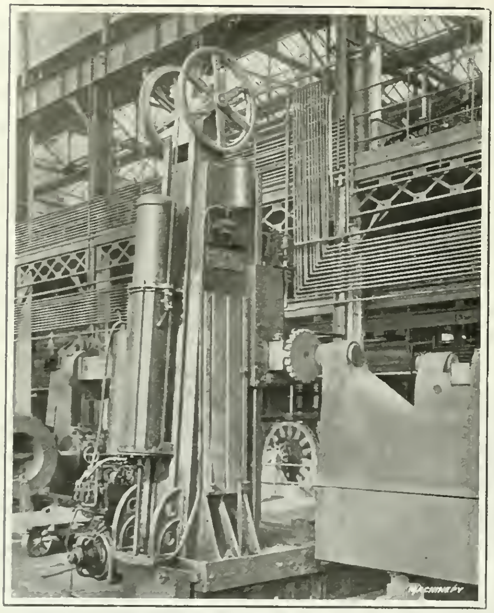

Fig. 3. Morton Traveling-head Planer equipped for performing Milling Operation on Allis-Chalmers Engine Bed

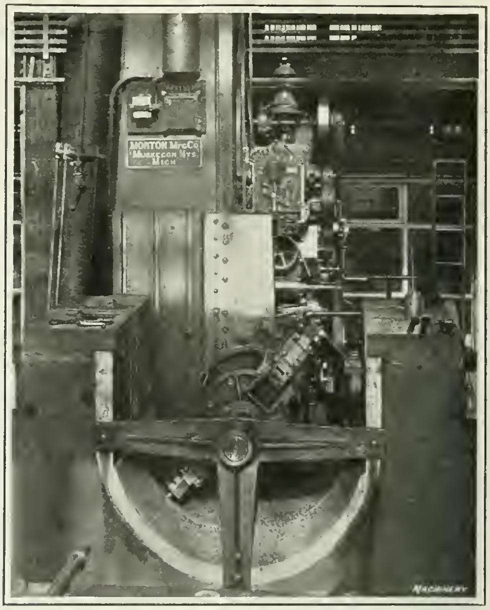

Fig. 4. Morton Traveling-head Planer equipped for performing Boring Operation on Allis-Chalmers Engine Bed

built by the Lucas Machine Tool Co., of Cleveland, Ohio, mounted on a skid so that it may be carried on an elevating truck. In this way, it is an easy matter to bring the arbor press up into line with the drilling machine on which the reaming operation is performed, preparatory to pressing the bushing into place, and when these bushings have been pressed into all of the parts to be machined, the arbor press is taken away to a position in the shop where it can be stored without being in the way of any of the machine operators.

Similar advantages are secured in the Bowser shops through the use of a tapping machine built by the Garvin Machine Co., of New York City, which is mounted on a skid for transfer with an elevating truck. In operating the battery of high-duty drilling machines, to which reference has been made, it has been found advisable to divide the machines into groups of four and to never have more than four machines working on any one job. It quite often happens that separating the machines into groups of four works out in such a way that there is a tapping operation to be performed for which a machine is not available. This is particularly the case on parts where there are, say, five, nine, or thirteen operations to be performed, that is, where there is one operation in excess of some multiple of four. In such cases, the work is divided into groups of four operations and the odd tapping operation is taken care of by the portable machine, which is brought up to the proper place in the shop, while it is actually required, and then taken away at once, so that it does not obstruct the shop at other times.

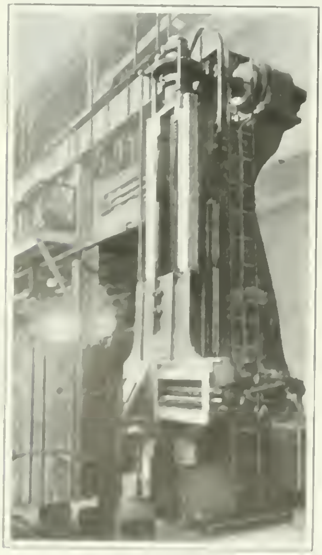

Fig. 5. Newton Portable Slotting Machine with 24-inch Stroke, used in Plant of Canadian General Electric Co.

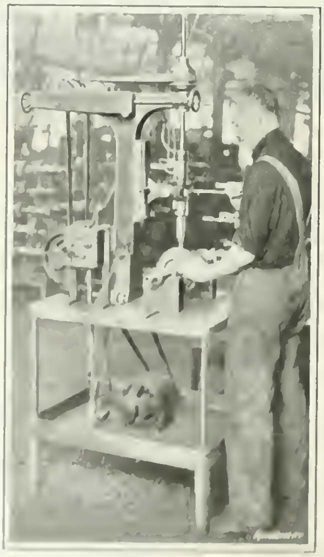

Fig. 6. Portable Drilling Machine used in Headstock Assembling Department of Jones & Lamson Machine Co.

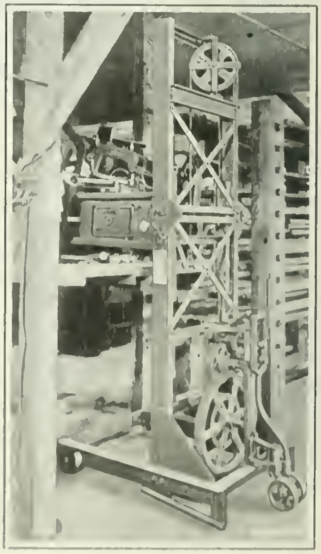

Fig. 7. Economy Portable Elevator supporting Racine Hacksaw Machine for cutting Bar Steel in Racks

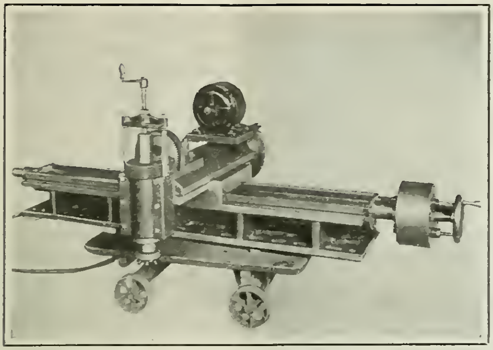

Fig. 8. Portable Milling Machine made by the Pedrick Tool & Machine Co.

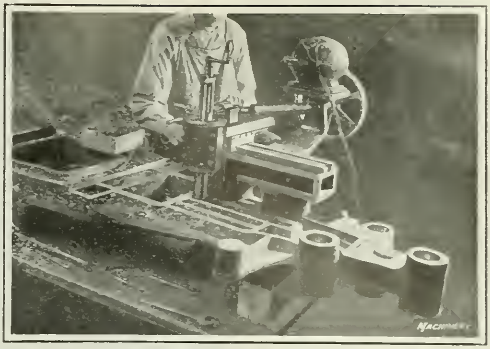

Fig. 9. Smaller Type of Pedrick Portable Milling Machine in Use

Somewhat similar use is made of portable machines in the headstock assembling department of the Jones & Lamson Machine Co.'s factory, in Springfield, Vt. This firm has worked out its methods in such a way that all parts required by the men employed in this department are delivered to them to avoid loss of time which would result through having employes go to the stock-room to get the necessary supplies. In assembling headstocks in this shop, there are certain minor machining operations which have to be performed after the work is partially set up, a case in point being the drilling of pin-holes. Carrying out the same idea of avoiding loss of time on the part of men employed in assembling, the idea was conceived of using portable drilling machines in the assembling department, which could be taken right to the spot where a man is working at the time he has drilling to do. With the use of such machines, the workman can use an elevating truck to take the drilling machine to his bench and perform all drilling operations on the parts in which holes must be machined, thus avoiding the necessity of going back and forth between his bench and the machine. Then when the next man is ready to start drilling, he can take the machine to his bench. Fig. 6 shows one of the portable drilling machines in use in the Jones & Lamson shops.

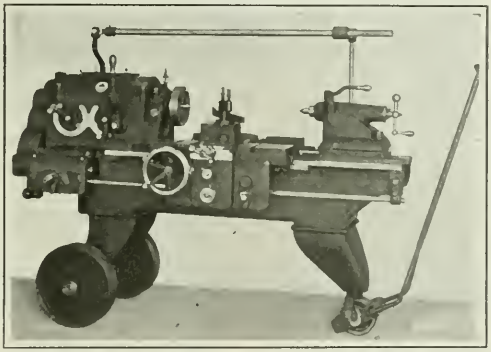

Fig. 10. R. K. LeBlond Portable Engine Lathe adapted for Use in Railroad Shops, Arsenals, on Board Battleships, etc.

Mounting Machine on Portable Elevator

Doubtless there are men who have been through a great many American manufacturing plants without seeing any important use that has been made of portable machines for cutting up bar stock. Still there is a field for the portable machine in doing this work. An interesting example is shown in Fig. 7, where it will be seen that a hacksaw machine is set up on the platform of a portable elevator or "tiering machine" built by the Economy Engineering Co., of Chicago, Ill., to provide for cutting off short lengths of tool steel carried in the familiar form of rack, without requiring the long bars to be pulled out of the rack and taken to a machine on the floor. Not only is this the means of saving the time of one or more men who would be required to do this work, but it also saves confusion and consequent delay sometimes caused in a shop through having long pieces of steel moved around in it. This outfit is used at the plant of the Mechanical Appliance Co., in Milwaukee, Wis., where it has been found the means of saving enough time to fully warrant the use of this special equipment.

Portable Milling Machines

In Figs. 8 and 13 there is shown a portable type of milling machine built by the Pedrick Tool & Machine Co., 3639 Lawrence St., Philadelphia, Pa. This machine was designed for the performance of miscellaneous milling operations where it is more desirable to take the machine to the work than to set the work up on a stationary milling machine. It has been found particularly useful for truing up hammer blocks, and in Fig. 13 there is shown an illustration of the way in which such an operation is performed. This illustration shows the work of truing up a hammer block in

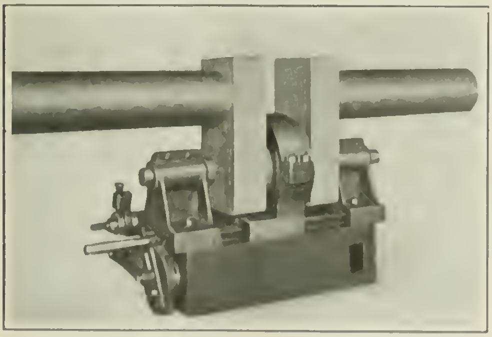

Fig. 11. Pedrick Portable Turning Machine truing up Center Crankpin

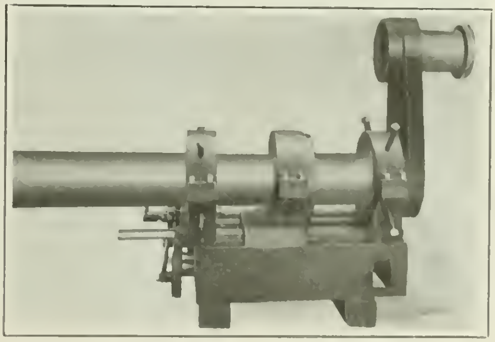

Fig. 12. Pedrick Portable Truing Machine arranged for Turning Operation

the plant of the Spicer Mfg. Co., of South Plainfield, N. J. Evidently the casting on which the milling operation is being performed is of such size and weight that the use of a portable machine, which can be set up on the work without requiring it to be moved, affords a far more efficient method of doing the work than to take this heavy piece to a stationary milling machine. The Pedrick portable milling machine is substantially constructed and an important feature of its design is the simplicity of the feed mechanism. Three changes of feed are available in either direction, for both the longitudinal and cross-feed movements, and the feed mechanism may be operated by either hand or power. Fig. 9 shows a smaller type of portable milling machine built by the Pedrick Tool & Machine Co., engaged in machining recesses in a large casting. Portable machines of this type may be used to advantage for milling pads on large castings and for machining the slide-valve seats of small pumps. In addition to these two typical operations, the machines are used in many other cases where the work is of such a character that it is inconvenient to transport it to a stationary milling machine.

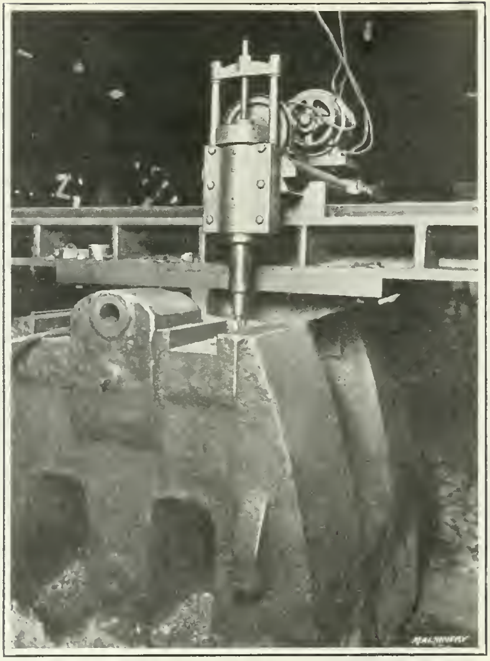

Fig. 13. Pedrick Portable Milling Machine shown in Fig. 8, engaged in truing up Hammer Block in Plant of Spicer Mfg. Co.

Application of Portable Turning and Boring Machines

In Figs. 11 and 12 there are shown two applications of a portable turning and boring machine which is also built by the Pedrick Tool & Machine Co. This machine may be used for a variety of purposes, among which may be mentioned turning crankpins of locomotives and other side-crank engines, turning center crankpins, journals, shafts, and axles, and reboring crankpin holes. In most cases, it is unnecessary to remove the crankshaft or other part from its regular position on an engine, in order that it may be trued up by this portable turning machine. Space is furnished for clamping bars and other means of attaching the machine to the work; and the cutter-head is split to provide for putting it over the work that is to be trued up, and the tailstock may be located at any point along the bed of the machine to meet the requirements of different classes of work. When used for reboring crankpin holes, the tailstock is placed in front of the cutter-head where it affords a rigid guide for the boring-bar. The setting heads are bored concentric with the center of the machine and they are provided with set-screws by which the machine can either be attached to an unworn part or set according to the center in the tailstock to provide for obtaining the desired alignment.

Fig. 11 shows the equipment used for truing up center crankpins. For the performance of this operation, center holes are located and drilled on the outside cheeks of the crank, after which the machine is set up with two tailstocks which engage these center holes. Cutting tools can be used on either side of the cutter-head and where the distance be-

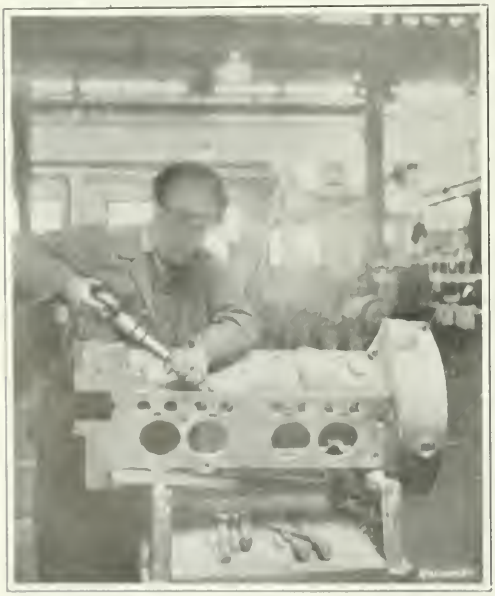

Fig 14 Snagging an Aluminum Crankcase Casting with Ingersoll-Rand Co.'s "Little David" Pneumatic Hammer in Plant of International Motors Co.

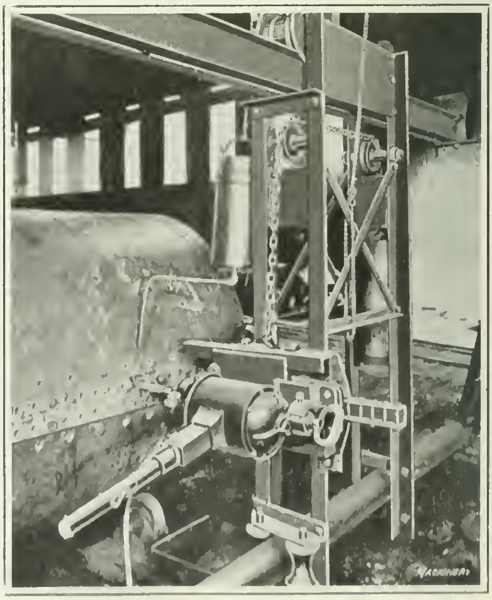

Fig 15. Equipment developed by Kroeschell Bros. for reaming Holes in Boiler Shells with Electric Drill made by Chicago Pneumatic Tool Co. Vertical and Horizontal Movements enable the Tool to reach All Holes

tween the cheeks is small, a cut can be started at the middle of the pin and run over to one side, after which the tools are placed on the opposite side of the cutter-head and run across to the other cheek of the crankshaft. Fig. 12 shows how the machine is used for truing up large shafts, axles, and similar parts. In this illustration it will be seen that the machine is equipped with two setting heads and a cutter-head, all three of these parts being split so that they may be placed around the work to be trued. The machine may be fitted to the work by set-screws in the setting heads or by making sleeves with their outside diameter the right size to fit the setting heads, and the inside diameter of suitable size for the work. Where the latter method is used, the sleeves are split and placed around the shaft, after which the machine is set up in the usual way. As the setting heads are bored concentric with the machine, the work can be aligned as accurately as if it were chucked in a lathe.

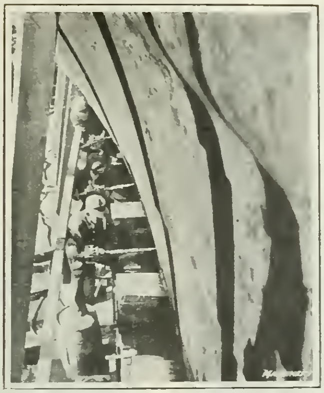

Fig. 16. Portable Tools find Wide Application in handling the Work of Shipyards. In this Picture we see a "Thor" No. 42 Drill, made by the Independent Pneumatic Tool Co., working on a Ship Hull

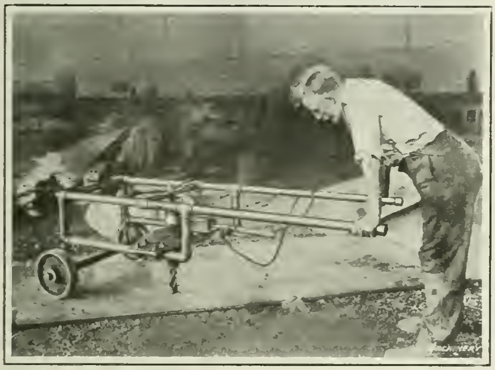

Fig. 17. Van Dorn & Dutton Co.'s Electric Drill supported in Portable Frame developed by Pusey & Jones for drilling Holes in Steel Plates

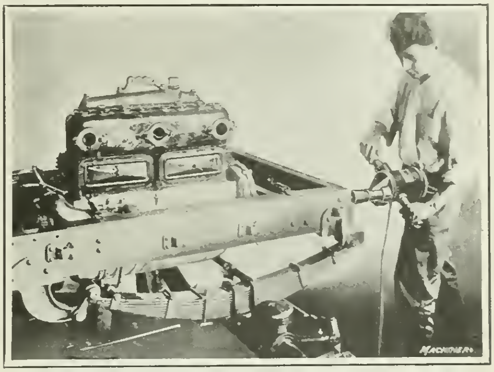

Fig. 18. Hand and Breast Type of Electric Drill made by Standard Electric Tool Co. at Work in a Motor Truck Factory

Use of Portable Electric and Pneumatic Tools

In the previous discussion of advantages secured through the use of portable tools, mention has only been made of those types of machine tools that are arranged for transfer to the work. There is another general class of tools which are driven by power, and these are light enough to be easily carried about the shop. These tools find wide application in the performance of many different machining operations, such as drilling, reaming, grinding, buffing, riveting, etc. They may be either electrically or pneumatically driven. Even where the greatest care is taken in handling foundry work, castings are almost sure to come out of the molds with a number of small burrs and other surface defects which must be removed by snagging. There is no better way of doing this work than to use an air chipping hammer, and Fig. 14 shows the use of one of the "Little David" tools built by the Ingersoll-Rand Co., of 11 Broadway, New York City, engaged in removing slight imperfections from the surface of an aluminum crankcase casting in the plant of the International Motors Co., in Plainfield, N. J.

Drilling and Reaming with Portable Tools

Reaming holes in boiler shells with an ordinary portable drill is quite a tiresome operation; it is also difficult to hold the reamer squarely against the shell, and unless this is done, accurately reamed holes will not be produced. When the men engaged in this work become tired, they are very apt to let the drill drop slightly, which results in producing oblong shaped holes. To overcome trouble from this cause, E. A. Anderson, superintendent of the boiler department of Kroeschell Bros., of Chicago, Ill., designed a simple frame for holding portable electric or pneumatic drills in the proper position for reaming holes in boiler shells. In Fig. 15 it is shown equipped with a No. 4 Duntley electric drill made by the Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill., and it will be apparent from this illustration that the tool is rigidly held so that it is impossible to ream the holes inaccurately through movement of the tool while the operation is being performed. Most of the holes to be reamed are from 11/16 to 15/16 inch in diameter, and the plates though which they are reamed are about 1½ inch in thickness. It will be apparent from the illustration that the frame holding the portable electric drill can be adjusted to different angles and that it can also be raised or lowered, a counterweight being provided which facilitates making such adjustments. The frame is made high enough to take boiler shells from 30 to 96 inches in diameter, and sufficient length is provided to enable holes to be reamed in a seam up to 10 feet in

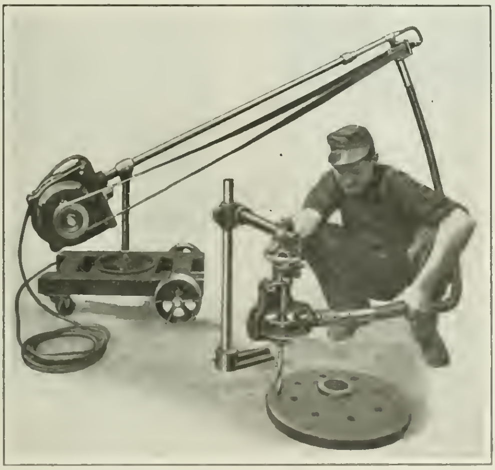

Fig. 19. Flexible Shafts are used to Advantage for driving Portable Tools. In this Illustration there is shown a Driving Unit, made by the Stow Mfg. Co., driving a Portable Drill

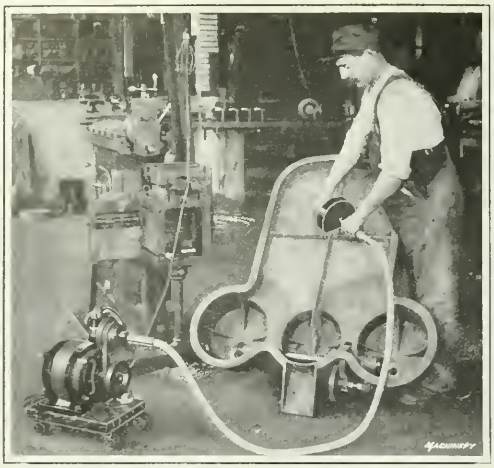

Fig. 20. Flexible Shafts may be used to Equal Advantage for driving Portable Grinding Machines. In this Illustration, Such an Outfit made by R. G. Haskins is shown in Operation

length without requiring the boiler shell to be moved after it has once been set in position. Attention is called to the fact that a tank and delivery pipe provide for supplying lubricant to the reamer and that there is a drip-pan which catches the used lubricant so that it may be utilized many times.

An ingenious application of a portable electric drill made by the Van Dorn & Dutton Co., of Cleveland, Ohio, is illustrated in Fig. 17. This outfit was developed in the shops of Pusey & Jones, of Wilmington, Del., for drilling a large number of holes in a steel plate, and the illustration explains the method of doing the work quite clearly, without calling for more than a very brief description. It will be seen that the portable electric drill is supported in a frame with two truck wheels at one end and two handles at the opposite end. The holes are first laid out on the steel plate, and then this truck is wheeled around to locate the drill point in the proper positions for drilling successive holes in the work. Feeding the drill is accomplished by simply pushing down on the handles, which results in swinging the frame about a center corresponding to the axle that supports the truck wheels. The radius from the drill point to the axis about which the frame swings is sufficiently great so that the error introduced through this method of feeding is negligible.

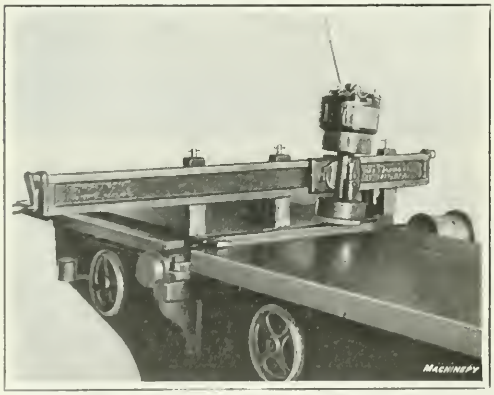

Fig. 21. Much Time can be saved by sharpening the Knives of Woodworking Machinery, etc., if the Work can be done without dismantling. This Illustration shows the "Quick Sharp" Knife Grinder made by the Stockbridge Machine Co. for handling Such Work

Fig 18 shows one of the portable electric hand and breast drills manufactured by the Standard Electric Tool Co., of Cincinnati, Ohio, in use in a plant engaged in building motor trucks. Standard electric drills are made in all sizes from 3/16 up to 1¼ inch, and like other manufacturers of this type of tools, the Standard Electric Tool Co. provides motors which are adapted for use on either direct- or alternating-current circuits.

There are many cases where the use of portable tools is a matter of absolute necessity. For instance, consider the case shown in Fig. 16, where it is required to drill holes in a hull standing on the ways of a shipbuilding yard. Here the use of a portable machine could not be avoided, and the work is very satisfactorily performed by a "Thor" No. 42 "shipyard special" drill built by the Independent Pneumatic Tool Co., of Chicago, Ill. This tool weighs only 28 pounds and it may be run at 700 revolutions per minute, the light weight of the tool adapting it for use by one man. This tool is suitable for drilling holes up to 13/16 inch in diameter and for reaming holes up to 15/16 inch in diameter. Among the operations for which it is adapted there may be mentioned the drilling of bull heads, shell clips, intercostals, and the performance of deck-reaming operations.

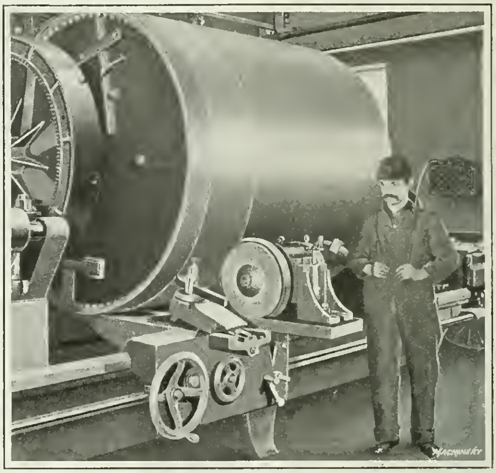

Fig. 22. Portable Tools can often be used to Advantage in Connection with Cutting Tools. Here we see a Portable Grinder made by the Hisey-Wolf Machine Co., working in Conjunction with a Thread Chasing Tool

Application of Flexible Shafts for Driving Portable Tools

Flexible shafts may be used to advantage for driving portable tools. One satisfactory method of using a flexible shaft

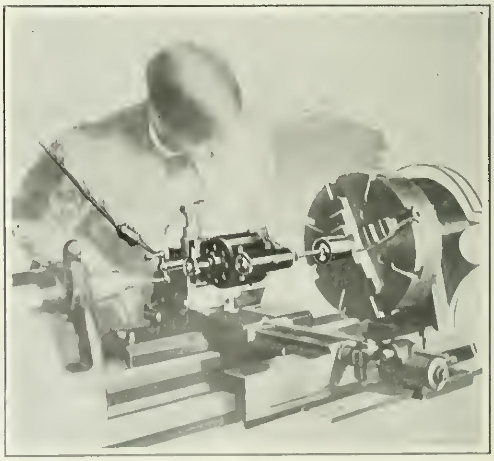

Fig. 23. The "Dumore" Grinder made by the Wisconsin Electric Co. gives Good Results in the Performance of Internal Grinding Operations with the Work and Machine set up on a Lathe as shown in this Illustration

for this purpose is to employ an electric motor for furnishing power and to transmit this power through a flexible shaft to the portable tool. The important advantages of this method are that the weight of the electric motor does not have to be borne by the operator and that the flexible shaft allows considerable latitude for reaching different positions on the work without requiring the driving motor or work to be moved. In Fig. 19 there is shown an outfit built by the Stow Mfg. Co., of Binghamton, N. Y. It will be seen to consist of a truck supporting an electric motor that is furnished with a cable for making connection with the electric power circuit. From the electric motor, power is transmitted to a pulley at one end of the flexible shaft by means of a belt, and the opposite end of this flexible shaft is connected to a portable drilling machine which is light enough so that it can be conveniently carried around the shop to any point where it is to be used. The same arrangement is employed for driving a portable grinding machine built by this company.

In Fig. 20 there is shown another application of the combination of an electric motor and flexible driving shaft, the outfit in this case being connected to a portable grinding machine built by R. G. Haskins, 541 W. Washington Blvd., Chicago, Ill. The use of this flexible shaft drive for a portable grinding machine possesses all of the advantages to which reference was made in connection with the operation of portable drilling machines. In the present case, the grinding machine is shown engaged in the removal of slight surface defects from a casting. The same outfit is used for driving a portable drilling machine built by this manufacturer.

Use of Portable Tools on Stationary Machines

On wood-planing machines and other types of equipment where the necessity arises for sharpening knives, a great deal of time and expense can be saved by the use of a portable grinding machine which may be used to sharpen the knives without requiring them to be removed from the machine on which they are used. A very little thought will be sufficient to show that such a procedure not only saves the expense of labor involved in dismantling the machine and setting it up again after the knives have been sharpened, but that there is an additional advantage through avoiding the necessity for shutting down an expensive machine at times when there is a lot of work for it to do. Trouble is also likely to be experienced through improper adjustment of knives when they are put back into the machine, which results in inefficient operation. Fig. 21 shows a portable knife grinding machine built by the Stockbridge Machine Co., of Worcester, Mass. This machine is driven by an individual electric motor with provision for connecting to any convenient power circuit. It is carried by a saddle furnished with a split nut that engages a feed-screw mounted at the top of the bridge. In this way, the saddle can be fed along the full length of the bridge in either direction and at any desired speed. This bridge is supported at the ends by two angular brackets bolted to the bed of the wood-planing machine, so that the knife grinder is held perfectly rigid. The grinding wheel can be raised or lowered by a thumbscrew and set to grind the required amount from the knives. With an outfit of this kind, sharpening of the machine knives can be quite rapidly accomplished, thus justifying the name "Quick Sharp" which has been given to this portable Stockbridge grinding machine.

In handling work on lathes and other types of machine tools, it will quite often be found advantageous to employ a portable grinding machine in conjunction with the regular cutting tools. A case of this kind is shown in Fig. 22, which illustrates the application of an electrically driven grinding machine built by the Ilsey-Wolf Machine Co., of Cincinnati, Ohio, used in conjunction with a tool employed for chasing a thread on a large piece of work set up on the engine lathe. It will be apparent from this illustration that the portable grinding machine is supported by a bracket attached to the lathe carriage, so that this machine finishes the surface of the work while the cutting tool chases the thread at the same traverse of the carriage. Such an arrangement is naturally the means of saving a considerable amount of time because it enables two operations to be performed simultaneously.

Another application of a portable grinding machine in connection with an engine lathe is shown in Fig. 23. In this illustration it will be seen that the grinding machine is engaged in the performance of an internal grinding operation. The machine shown is one of the "Dumore" tools built by the Wisconsin Electric Co., 1431 Dumore Bldg., Racine, Wis., and to provide an efficient cutting speed for the 9/16-inch grinding wheel that is employed, provision is made for driving the spindle at 30,000 revolutions per minute. It will be apparent that provision is also made on this type of grinding machine for the use of a large wheel for the performance of operations where it is not necessary for the wheel to work inside of a hole of limited size.

In many different industries, new uses are constantly being found for portable electric and pneumatic tools. A great deal of time is saved with a corresponding reduction in machining costs, through the use of portable tools on many classes of work; and the possibility of taking a small tool to a heavy piece of work saves time and expense in handling. Another important factor is the avoidance of the necessity of lifting a large piece of work with a crane and carrying it through the shop to a stationary drilling machine. Regardless of the care which is taken in organizing a shop, the handling of large pieces with a crane is sure to cause a certain amount of commotion, which means lost production from men and machines all through the department where such work is being handled.

* * *

THE EDUCATION OF WOUNDED SOLDIERS FOR INDUSTRIAL WORK

Congress has delegated to the Federal Board for Vocational Education the task of training and educating wounded soldiers and sailors who may, in that way, be made self-supporting and useful in the industries. Available statistics show that the number of wounded soldiers who can be trained and educated for useful occupations averages about 10,000 per each million men in the Army, per year. In other words, with the present strength of the Army and Navy, it is likely that there will be 30,000 men during the first year who will return on account of having been wounded, and who will be able to take their place in civil life after having been properly trained. The experiences of our allies indicate that over 80 per cent of the permanently disabled men can enter useful self-supporting employment if properly trained.

The training will be entirely voluntary on the part of the wounded men, but it is expected that, with the facilities placed at their disposal, most of those incapacitated in the fighting will be glad to take up an occupation that will enable them to become self-supporting in the industries. The training does not, in any way, affect the soldier's or sailor's income under the War Risk Insurance, to which he is still entitled. C. A. Prosser, director of the Federal Board for Vocational Education, Washington, D. C., is in charge of this work, and any inquiries relating to it should be directed to him. The board has just issued a bulletin entitled "Evolution of National Systems of Vocational Education for Disabled Soldiers," which is a volume of 320 pages giving a great deal of information relating to the subject.

* * *

According to the *Scientific American*, an interesting series of tests was recently made by a manufacturer to determine the effect of temperature on the strength of iron and steel. These tests showed that the greatest ultimate strength of wrought iron is found at 450 degrees F. and its greatest elastic limit at 350 degrees. The tensile strength of cast iron increases uniformly until a temperature of 400 degrees is reached, when it gradually falls. The ultimate elastic strength of steel is reached at 575 degrees F., while the elastic limit decreases continuously, though not uniformly, as the temperature rises above 60 degrees F. At 1000 degrees, the steel will sag of its own weight.

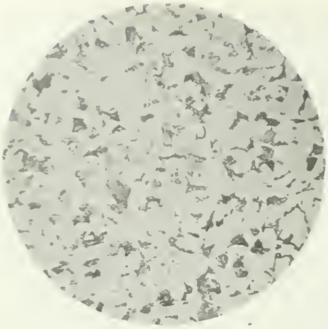

Fig. 6. Original Material—0.3 Per Cent Carbon Steel—before Welding; magnified 150 Times

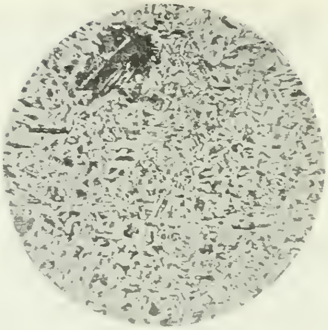

Fig. 7. Original heated to 1500 Degrees F. for One-half Hour and then cooled in Air; magnified 150 Times

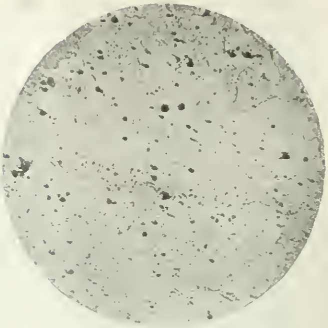

Fig. 8. Weld heated to 1500 Degrees F. for One-half Hour and then cooled in Air; magnified 150 Times

FUSION WELDING FALLACIES—2

SOME COMMON BELIEFS AND WHY THEY ARE UNSOUND

BY S. W. MILLER[1]

IN the July number of MACHINERY several of the commonly accepted, but erroneous, opinions about fusion welding were dealt with. Among other common fallacies are the ideas that a weld that is not heat-treated is suitable for any engineering structure, no matter how important; that any thermal disturbance or change in structure in or near a weld is negligible or easily corrected; that the structure of a weld can be made as good as that of the original material; that the materials used at present are entirely suitable; that a welded piece is equal to a forged piece; that welding problems can be solved by hit-or-miss methods; and that an electric weld is superior to an oxy-acetylene weld.

Non-heat-treated Welds are not Suitable for all Engineering Structures

It is a common belief that a weld that is not heat-treated is suitable for any engineering structure no matter how important. The writer's tests and experience, however, indicate that if successful and safe results are desired it is absolutely necessary to heat-treat both the weld and all metal in its vicinity. In the case of small pieces, this can be done in a crude, but effective, way with the welding torches; but for larger pieces, special furnaces or other apparatus is needed.

Where low-carbon welding wire is used to weld ordinary soft steel, there may be a difference in the temperatures required for the weld and original material of 300 degrees F., as a steel casting requires a higher refining temperature than forged steel of the same carbon content. This means a double heat-treatment; a high temperature to refine the weld, and a lower one to refine the coarsened original. The double treatment should be avoided, if possible, on account of the cost, so the welding material should have such proportions of carbon and other necessary elements as will produce a clean, sound, deoxidized weld; the material, when cast into the weld, should require the same refining temperature as the material welded, and in the refined condition, it should have the proper physical characteristics as given in the first installment of this article.

Figs. 6 to 14 show the effect of temperature on an oxy-acetylene weld and the adjacent material. The pieces were all taken from the same weld, but subjected to different treatments. The original was about 0.3 per cent carbon steel, and the welding wire was low-carbon steel wire containing about 0.08 per cent carbon. The fields in the original were taken about ½ inch from the weld. It is not claimed that the temperatures used were absolutely correct, but the tendency of the treatment is shown. Figs. 6 and 7 show the original material before welding and after being heated to 1500 degrees F. for one-half hour and then cooled in air; Fig. 8 shows that the grains were not refined in the weld. In the cases shown in Figs. 9 and 10, the steel was heated to 1600 degrees F. for one hour and then cooled in air; the grain in the original was coarsened, but the weld was not affected. By heating the steel to 1700 degrees F. for one-half hour and then cooling in air, the grain in the original, as shown in Fig. 11, was made still coarser, but the weld, as shown in Fig. 12, was refined. When the steel was heated to 1750 degrees F. for fifteen minutes, cooled, heated to 1400 degrees F. for fifteen minutes, and cooled in air, both the original and the weld were refined, as shown in Figs. 13 and 14.

Thermal Changes in Structure are not Negligible nor Easily Corrected

The belief that thermal disturbances or changes in structure in or near the weld are negligible or, if not, are easily cor-

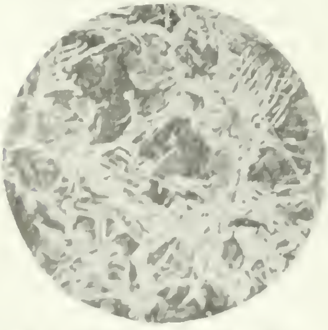

Fig. 9. Original Material heated to 1600 Degrees F. for One Hour and then cooled in Air; magnified 150 Times

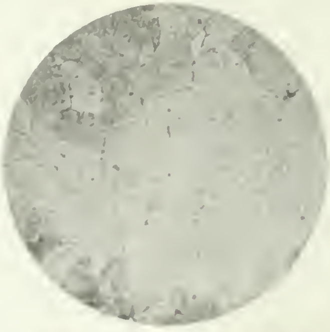

Fig. 10. Weld heated to 1600 Degrees F. for One Hour and then cooled in Air; magnified 150 Times

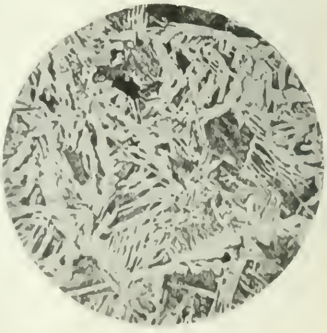

Fig. 11. Original Material heated to 1700 Degrees F. for One-half Hour, and then cooled in Air; magnified 150 Times

rected, is wrong. The heat of any welding process changes the structure of the original material greatly; this change extends farther from the weld in the case of oxy-acetylene welding than in the case of electric welding, and the grain growth is greater, but the zones of changed material are not so distinct. As the writer believes in properly heat-treating all welds, he does not think there is much difference in this respect between the two welding methods. There are, though, other important structural differences. The exact influence of these is not known nor, as far as the writer knows, have they been studied very much; in fact, even their nature has not been fully determined.

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[1] Address: Rochester Welding Works, Rochester, N. Y.

The coarsening of the grain reduces the ductility and resistance to shock of the metal. These conditions cannot be entirely overcome by heat-treatment, but a very great improvement can be made. Successful heat-treatment of the work requires a knowledge of the critical points of the steels used, and these points depend mostly on the carbon content. Besides, for accurate work, the proper temperatures for the proper time and the proper rates of cooling must be carefully maintained. It is not hard to get accurate results with small pieces in a small furnace, but in the case of large pieces the variations in furnace temperatures, the inaccuracies of pyrometers, and other variables materially affect the results. Still, as it is now possible to use heat-treatment methods in ways believed impossible a few years ago, the writer sees no reason why such work could not be carried out on large pieces, tanks for example, even when viewed from a commercial standpoint. At first a factor of 50 per cent, for instance, of the plate strength might be all that would be safe, but certainly the welding industry would not be satisfied with that result and, as in all similar cases, improvement would be certain.

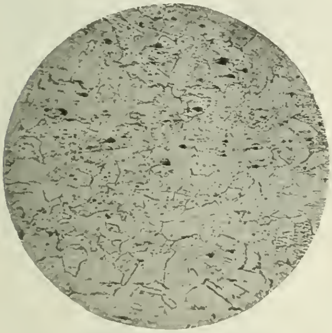
Fig. 12. Weld heated to 1700 Degrees F. for One-half Hour, and then cooled in Air; magnified 150 Times. Note that Weld has been refined

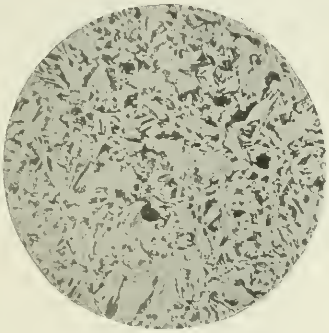
Fig. 13. Original heated to 1750 Degrees F. for 15 Minutes, cooled, and then heated to 1400 Degrees F. for 15 Minutes and cooled in Air; magnified 150 Times

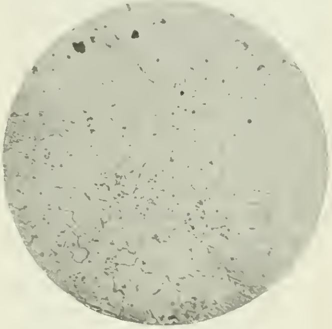
Fig. 14. Weld heated to 1750 Degrees F. for 15 Minutes, cooled, and then heated to 1400 Degrees F. for 15 Minutes and cooled in Air; magnified 150 Times

The Structure of a Weld Cannot be Made as Good as that of the Original Material

It is commonly stated that the structure of a weld can be made as good as that of the original material. This, however, cannot be done, for the finest grain, and therefore the best physical qualities, can only be obtained by using both heat-treatment and forging, or other mechanical treatment. As forging cannot be done in most welds it is evident that the best results cannot be secured. The most that can be expected is what can be obtained in a properly heat-treated steel casting, and this is not equal to a heat-treated forging.

Material now Used is not Entirely Suitable

Contrary to the general belief, all material now used for welding is not entirely suitable. Much of it is likely to carry impurities into the weld so that good results can be obtained only when great care is used. However, suitable materials for all purposes will, no doubt, eventually be found.

A Welded Piece is not Equal to a Forged Piece

A customer frequently asks if a piece of forged steel will be as good after it has been welded as it was before; and he is assured by the welder that it will be. While the welder may be honest in his belief, the piece will not be as good, for a weld is a steel casting and therefore must be inferior to a forged piece even though it is heat-treated. A weld in alloy steel is even poorer and less satisfactory than one in straight carbon steel.

Welding Problems Cannot be Solved by Hit-or-miss Methods

The writer has many times stated his belief that, because of the tremendous commercial development of the welding industry, the scientific problems involved have not received the attention they deserve and require. Steel manufacture is carried out under the guidance of chemical and physical laboratories; if this had not been so the great improvement during recent years in the quality of steel would have been impossible. Making a good weld is nothing but making a good casting, and it should therefore be controlled by the laboratory. For this reason, welding problems cannot be solved by a hit-or-miss method of trial and error. This matter is purely a metallurgical one, although there are many practical problems that must be solved in the shop. The basis of all welding is the production of a sound weld of desirable physical qualities.

An Electric Weld is not Superior to an Oxy-acetylene Weld

Although the writer does not think that an electric weld is superior in quality to an oxy-acetylene weld, he willingly admits that in many cases electric arc welding may preferably be used. Neither does he think that it is impossible to improve the quality of the welds, for he knows that it is. Electric welding has four disadvantages: It is impossible to see clearly what is going on during the operation; all material in the pencil must go into the weld; it is impossible to go back over the weld to correct any imperfections that may exist; there is an enormous amount of oxide in this weld. The first of these disadvantages is probably insurmountable, if due regard is given to the safety of the operator's eyes; but scientific study may overcome it to some extent. The second disadvantage may be overcome by the production of a specially clean wire. The third is a very unsatisfactory condition and probably cannot be entirely overcome, although skillful operation tends to eliminate imperfections. The fourth may be overcome by the use of a welding wire of such composition as will eliminate the oxide. Figs. 15 and 16 show the relative amounts of oxide in oxy-acetylene and electric welds made with low-carbon steel wire; the magnification in each case is 320 diameters.

The writer, personally, has never seen a perfectly sound electric weld, and he knows electric welds can be improved because some are better than others. As a matter of fact, both oxy-acetylene and electric welding practices need careful revision if they are to have the confidence of responsible engineers. The unanimous opinion of engineers is that in the present state of the art, while some good welds are made, there is such a serious lack of uniformity in the quality of the work as to throw suspicion on all welding. They, therefore, refuse to use it, for example, in boiler construction, where theoretically its uses would be of great benefit. These im-

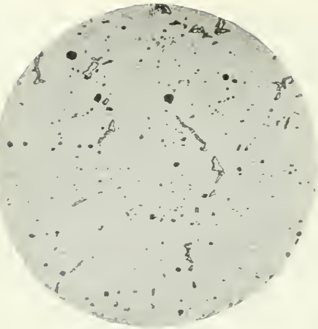

Fig. 15. Oxy-acetylene Weld, showing Oxide as Black Specks; magnified 320 Times

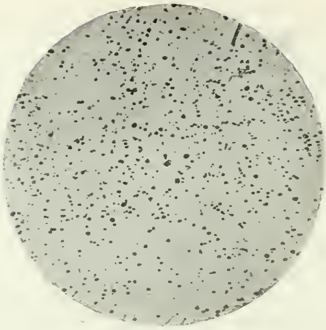

Fig. 16. Electric Weld, showing Oxide as Black Specks; magnified 320 Times

provements will have to be made with the greatest rapidity possible, and work incompatible with the fundamental principles of metallurgy must not be done. No welding operation must be performed unless there is an absolute assurance of safety in the result, where life is involved. It will not do to say that because the percentage of accidents that have occurred is very small, and smaller than occurs with other methods of joining, the present methods of welding are good enough. Such an argument was used in connection with industrial injuries; but the safety-first campaign has proved that accidents which were at one time considered unavoidable can be prevented if proper means are taken. It has also proved that the adoption of such preventive measures has more than paid all the expense connected with their introduction. In the same way the adoption of the best possible welding methods and the restriction of such methods to proper applications will result in a great increase in the amount of welding, and in the long run will be much less expensive than following the present methods.

• • •

BELT-SHIFTING APPLIANCE

In the installation of textile machines where the product passes directly from one machine to another in an unbroken condition, it is necessary that some provision be made for stopping and starting the machines in unison from several different positions. As the distance between the extreme positions at which it is desired to locate the belt-shifting controls is often 50 or 60 feet, it requires a shifting appliance of unusual strength and mechanical design.

The following method was used to provide the necessary stopping and starting control for three textile machines *M*, *N*, and *O*, arranged as shown in Fig. 1. As it is necessary that frequent adjustments be made at the positions opposite the points *S*, it was desired that stopping and starting could be accomplished at these positions. As will be seen in the illustration, all three machines are belt-driven from pulleys on shaft *F* which, in turn, is driven by a 5-inch belt connecting flat-face driving pulley *G* with tight pulley *H*. Shaft *F* is stopped by shifting belt *I* from tight pulley *H* to loose pulley *J*. The one-inch shaft *K* is suspended from the ceiling by bearings *L*. Cast-iron pulleys, about 10 inches in diameter, are keyed to the shaft at the points *S* as shown. On these pulleys is a section of belt provided with rods of the shape shown at *W*, the length of which is such that the handles are at a convenient height from the floor. The belt *T* is held to the face of the pulley by a stud *U*. Now it will be seen that by a downward pull on the rod at the right-hand side of the pulley the shaft can be rotated through one-half revolution. At point *P* on shaft *K* is a sprocket connected by a link chain with the sprocket *C* on the shifting device shown in Fig. 2.

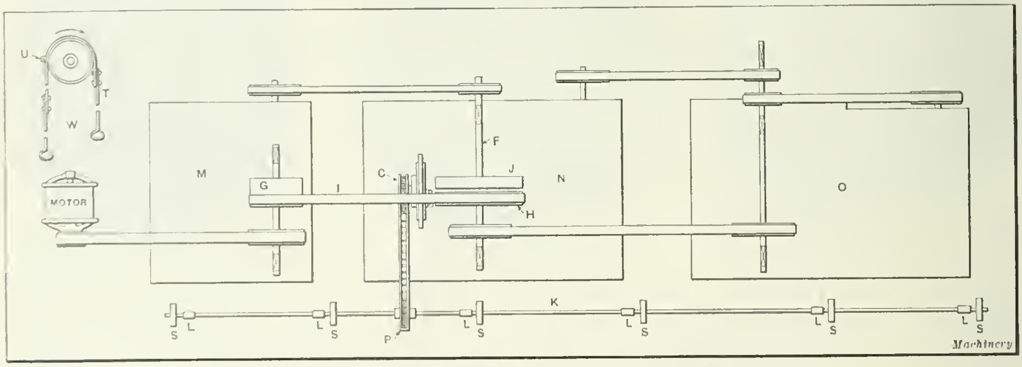

Fig. 1. Arrangement of Belt-shifting Mechanism for Three Textile Machines

Sprocket *C* is keyed to shaft *D*, which has a bearing in the cast-iron body *E*. Disk *F* is keyed to shaft *D* and is provided with a stud *G* which fits into a slot in slide *H*. Slide *H* is held in place by the pieces *I*. To slide *H* is attached the plate *J* which carries the two guide forks *K*. Now by rotating shaft *D* to the right in the direction shown by the arrow, pin *G* will cause slide *H* to move to the right the width of the belt plus a slight clearance. The casting *E* is suspended from the ceiling by two flat iron pieces *T*. It will be noticed that the slide *H* is prevented from moving a greater distance by the pin *G* coming in contact with the bottom of the slot in *H*. This feature not only limits the travel of slide *H* to the proper distance, but also serves as a positive stop against which it is impossible for a crawling belt to shift itself to the tight pulley and start the machine at a time when the operator may become caught in some moving part. In the same way the device prevents the belt from creeping from the tight to the loose pulley when the machines are in operation, thus eliminating that source of annoyance which is common with the usual type of belt shifters. F. C. D.

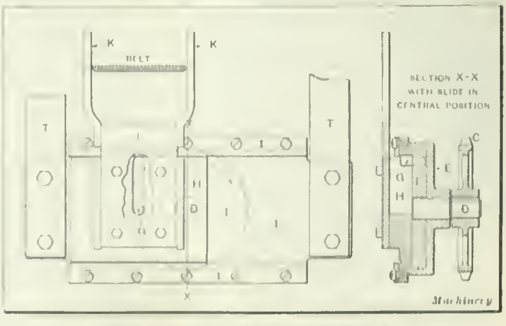

Fig. 2. Details of Belt-shifting Appliance

CHARTS GIVING TIME REQUIRED TO HOB SPUR GEARS

BY V. P. RUMELY [1]

Many factors affect the production of gear-hobbing machines. Among these are the condition of the machine, the work supports, the condition of the hob, the nature of the material, the cutting compound, the finish of the gear, and the type of hob used. The bearings of the machine must be in good adjustment, the change-gears free from excessive backlash, and the hob carriage well adjusted on its ways. The work supports should be of the most rigid type possible to guard against chatter. The hob should have the proper temper and sharpness. The cutting qualities of the material are affected by alloy compositions, heat-treatment, hard spots, seams, and sand-holes. The value of the cutting compound depends on its quality as a coolant and lubricant, and the amount furnished at the vital places on the hob. The finish of the gear depends on whether the hob has a gashing or a finishing cut. The hob may have a single, double, or triple lead.

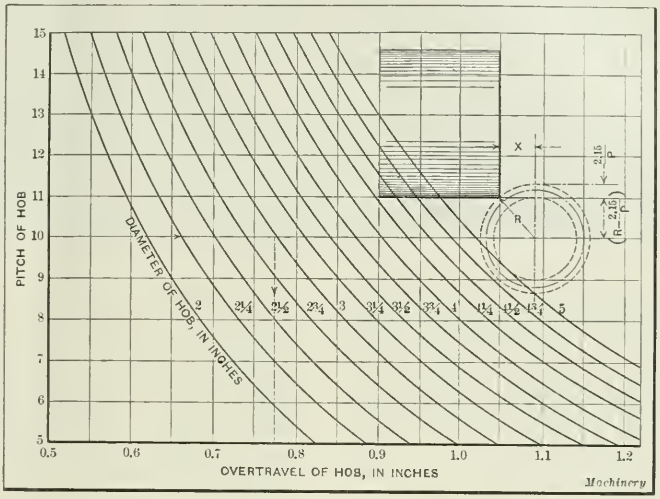

Fig. 1. Chart giving Over-travel of Hob

The greatest possibilities lie in gashing such work as transmission and timing gears where the hob can be forced close to the limit all the time, with little regard for the resulting finish. The recent practice in this line of hobbing tends toward triple-lead and double-lead hobs, with three streams of cutting compound applied to the hob. There are three to five shifts of the hob between grindings, and the hobs are ground at least once every eight hours. One firm has determined that the economical life of a hob is from fifteen to twenty-two days, running two shifts per day. The time required for hobbing a gear may be determined by any one of the following methods: By estimation, relying upon experience on similar jobs; by calculation, which is confusing to the novice and cumbersome for many mechanics; and by a graphic method, such as is illustrated by the accompanying charts. When using these charts the cutting speed and feed are first selected. The cutting time is found for the entire load upon the arbor, and this is divided by the number of gears to find the cutting time for each gear. It is necessary for the hob to travel a distance equal to the total width of the gear face plus the over-travel *X*, Fig. 1, due to striking the gear blank some distance in advance of the hob

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[1] Address: 589 Navahoe Ave., Detroit, Mich.

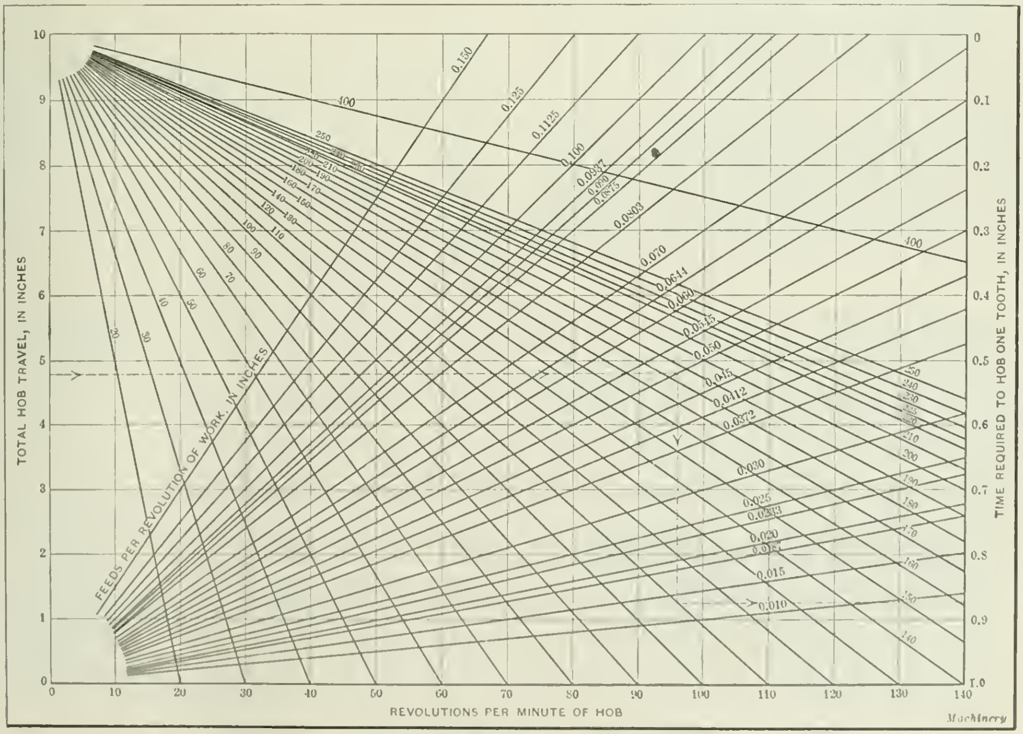

Fig. 2. Chart giving Cutting Time of One Tooth

center. This over-travel varies according to the diameter and pitch of the hob and may be calculated by the formula:

$$X = \sqrt{R^2 - \left(R - \frac{2.15}{P}\right)^2}$$

This value may be found directly by referring to Fig. 1. Add to this the total width of the gear face, in inches, and locate this sum in Fig. 2 in the column indicating the total hob travel. From this position, move horizontally to the right to the intersection with a diagonal feed line equivalent to the chosen feed, and move vertically, up or down as may be necessary, to the intersection with a diagonal line representing revolutions per minute of hob. Then move horizontally to the right-hand column and read in minutes the exact cutting time of one tooth of the load. Multiply this value by the number of teeth in one gear; this gives the total cutting time. If the load consists of a number of gears, divide the cutting time found by this number. If a double- or triple-lead hob is used, the cutting time will be one-half or one-third, respectively, of this value.

Example—What is the cutting time of one gear having 30 teeth, 10 diametral pitch, if four blanks 1 inch wide are placed on the arbor? The teeth are cut by a triple-lead hob 3 inches in diameter, running at 110 revolutions per minute and the feed of the work is 0.05 inch per revolution of the work. By using the chart in Fig. 1, the over-travel is found to be 0.775 inch. Add this to 4, the face width of the gear blanks, and the total hob travel will be 4.775 inches. In Fig. 2, find the value 4.775 inches in the left-hand column and move horizontally to the right to the intersection with the 0.05 inch feed line; then move vertically to the intersection with the line showing 110 revolutions per minute; by moving horizontally to the intersection with the right-hand column, the cutting time of one tooth will be found to be 0.87 minute. Multiply this value by the number of teeth and divide by the number of threads of the hob; $\frac{0.87 \times 30}{3} = 8.7$ minutes, cutting time of four gears; $8.7 \div 4 = 2.175$ minutes, cutting time of one gear.

* * *

APPRENTICE DEPARTMENT OF THE AMERICAN LOCOMOTIVE CO.[1]

BY C. K. OETCHELL

The apprenticeship courses of the American Locomotive Co. provide an opportunity for young men to learn a trade or profession while earning their own living, either in the drawing-room or in the shops, at work which is actually used in the design or construction of locomotives. There are several different branches in which an apprentice may specialize. These include the following: drafting; machine operation, including toolmaking and die-sinking; patternmaking; coremaking; molding; boilermaking; carpentry; printing; and electrical maintenance.

Drafting-room Apprenticeship

Applicants for the course in drafting should be between sixteen and nineteen years of age; in special cases young men slightly older have been taken. Previous education required includes one year of high school and at least one term of algebra. A preliminary examination is given, covering elementary mathematics, sketching and several problems of a mechanical nature. No grade is given, the general aptitude for work along the line of machine design being the basis for acceptance or rejection. Apprentices are taken on trial for a month.

The course is planned to cover four years. There are forty-four working hours each week, of which three are spent in the schoolroom. The course covers machine design, based upon actual practice in designing locomotives, and certain problems relating thereto are assigned for each week's study. Frequent reference is made to existing designs and drawings, and there are several problems which require measurements of parts under construction in the shops, with calculations showing how their dimensions were determined. Completion of these problems in the scheduled time is estimated to require about eight hours of study outside of the time spent in school.

No regular classes are held, each apprentice having an opportunity for such personal instruction as he may require during his class hour. In this way he is not held back to accommodate others who may be slower in their work, and his progress depends entirely upon himself. Apprentices have frequently been able, on this account, to complete the course in less than four years. The pay is based upon the amount of work completed and the standing or grade attained. Grades are determined as follows:

A Grade	85 per cent and over
B Grade	70 per cent to 85 per cent
C Grade (or base)	Below 70 per cent

Those apprentices who attain a rating of B grade receive two cents more per hour than the base rate, and those who attain A grade receive three cents more per hour. The base rate is advanced at the completion of each six months' assignment of problems and is independent of the time spent on the course. Credit is also given for over-time and occasionally for previous experience when warranted by the proficiency shown. Two weeks' vacation is also allowed each year, and it is desired that these be taken for rest rather than as an occasion for extra study. Opportunity is provided for evening study in the general drawing-room, where access may be had to the company's standards, which are frequently referred to in the studies. Provision is made for the transfer of each apprentice from one section of the general drawing-room to another, affording an opportunity for him to familiarize himself not only with detail design, but also with general assembly or elevation drawings. Grouped according to the progress made in their work, the apprentices make an hour's visit each month to the shops and take notes, which are later discussed in class.

While the majority of drawing-room apprentices are at the Schenectady works, there are several at the other plants who have the same problems, receiving instruction by mail, and who obtain such personal assistance as they require from the chief draftsman at those plants.

Shop Apprentice Courses

Applicants for the shop apprentice courses should be between the ages of sixteen and nineteen, and while one year's high school education is desirable, it is not absolutely required. All these courses require four years, except that in electrical maintenance, which requires only three. There are fifty working hours each week, except in the coremaking and molding trades, which require forty-five hours. Class hours include one and one-half hour per week for the machine and patternmaking trades, one hour of this on the company's time and the half hour on the apprentice's own time. Instruction is given in shop mathematics, together with such shop principles as apply to the different trades, and particular attention is given to blueprint reading. Frequent trips to the various shops afford an opportunity for each apprentice to learn how the work he is doing is used in the final construction of locomotives. In this way he is able to become more interested and to work more effectively. Transfer of machinist apprentices from one shop to another affords chances for them to learn the manipulation of the several types of machines.

Graduate Apprentices

Upon the completion of each course the apprentice receives a certificate and is given an increase in pay, with such an opportunity for further advancement as his ability warrants. In addition to this, the drawing-room graduate receives a substantial cash bonus. Although, like many other industries, this company has lost a number of men on account of the war, there are still about 35 per cent of our graduate apprentices in the general drawing-room and about 45 per cent in the various shops, many of whom are holding responsible positions.

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According to the *Arizona State Safety News*, industrial accidents cost this country 35,000 lives annually. In addition, there are 350,000 dismemberments and other serious injuries, and over 2,000,000 minor accidents that cause a loss of time.

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[1] Abstract of an article published in [illegible] May, 1918

Equipping A Shop Laboratory

Arrangement of Shop Laboratory and Brief Explanation of Methods Used in the Analysis of Iron and Steel

BUILDERS of machinery and manufacturers of tools are undoubtedly desirous of having a full knowledge of the chemical ingredients of the raw material which they buy and use in their product, and of being assured that these ingredients conform to recognized standards and specifications, within practical limitations. Hence, it is rather surprising to note the large percentage of metal-working shops in this country that are without the proper facilities for ascertaining these chemical elements—the more so as this need was felt and many years ago met by European manufacturers through the installation of chemical laboratories in their plants, which have adequate (although not necessarily expensive) facilities for handling routine analytical work. Many a manager will claim that he does not buy enough raw material and that he does not have trouble enough with it to warrant incurring the expense of a laboratory. However, in times of close competition, when his product does not always measure up to that of his competitor, he will generally find after a close study of the cause of his trouble that, outside of poor workmanship, the fault can usually be traced to the use of poor or improper raw materials.

Which Customer Gets the Poor Raw Material?

Furthermore, he should not forget that the steel mills occasionally produce inferior products that will have to be disposed of somehow; and it is certain that the customer who is known to have a laboratory for testing his raw materials will not receive any of the inferior steel. It may be claimed that there is not enough raw material to be tested to warrant the expense of a laboratory and that it is a better plan to send the few specimens that must be tested to a professional chemist. This is not only very costly (at least fifty cents per element), but it will also cause serious delays, as the chemist does not work for only one client; each one will have to wait his turn. The most serious consideration, however, is the delay that is caused. Often, when raw material is received by a manufacturer, it has been waited for so long, and customers are so urgent for delivery, that the material has to be used immediately, making it impossible to wait for a report from an outside chemist. It should also be remembered that the proper time for making an analysis is before the material has been made into parts—not after trouble has developed.

Cost of Equipping Laboratory

Considering the preceding facts from all standpoints, readers of MACHINERY will readily concede that a chemical laboratory is quite necessary, not only for large manufacturing establishments, but also for small shops, as the cost of equipping it is comparatively small (about $400 or $500 even at present advanced rates). The most suitable place for a laboratory is the basement of a building, for the reason that the room should first of all be free from vibration, which, it will be readily understood, may seriously affect the use of the chemical weighing balance and the other extremely sensitive apparatus used by the chemist. The room should preferably be sheathed with wood so that no trouble will be experienced from particles of plaster or whitewash falling into evaporating dishes and other apparatus with which the chemist is working. In weighing out materials used in chemical analysis, all weights are taken to 0.0001 gram, from which it will be seen that the addition of even a minute particle of whitewash would cause a serious error. The laboratory benches should be well built and made of well-seasoned wood, and their tops should be covered with acid-proof asbestos, to prevent the hot evaporating dishes, etc., from sticking and to protect the woodwork against the action of acid that may be spilled. If the above suggestion is followed, the benches will always be neat and clean.

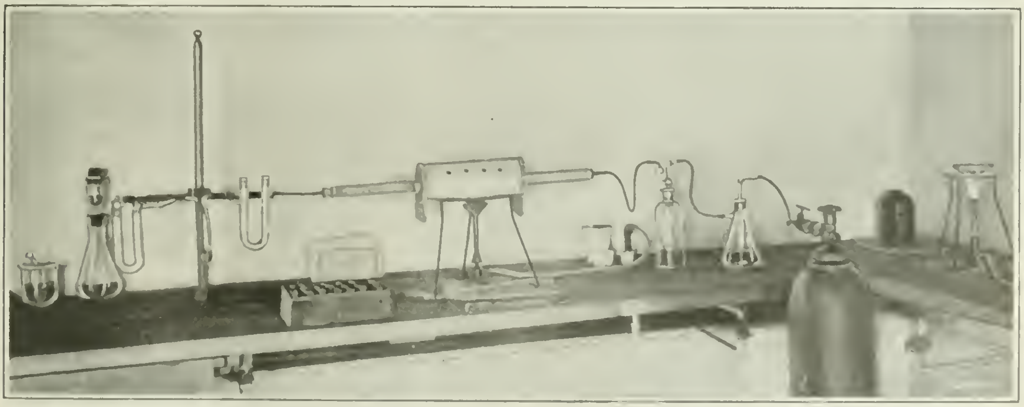

Fig. 1. Arrangement of "Carbon Train" which is employed for determining Percentage of Carbon in a Steel by Combustion Method

Lay-out of Shop Laboratory

Although not absolutely necessary, it is desirable to divide the laboratory into two parts—the laboratory proper and the balance room. If this is not feasible, the balance should be placed on a bench fastened only to the wall of the building. This will prevent any jars or vibrations, except those caused by the building itself, from being transmitted to the balance while it is in use. An arrangement of this kind will be found absolutely necessary, if, for some reason, the laboratory must be located on any of the upper floors of the building. A convenient arrangement for a laboratory is shown in Fig. 2. It will be seen that the store-room and balance room have been combined so that supplies may be kept outside the laboratory proper, which should be not smaller than 20 by 10 feet. It should have a bench on one, if not both, of the longer sides and should also contain an earthenware sink with a draining board, gas stove, still (all water used in chemical analysis must be distilled), iron slab, and two draft hoods. The latter consist of two adjoining compartments, about 2 by 6 feet in size, built out from the wall with ventilating shafts running to the outside. Windows should be provided in the front which can be easily opened and closed. In this manner, a good draft is provided to carry off the noxious fumes. Eight or nine shelves should be placed on the wall to hold reagent bottles and a few drawers should be provided to hold the glass tubing, cork and rubber stoppers, etc. When not in use, such apparatus as glass beakers, flasks, evaporating dishes, etc., should be stored in a closet.

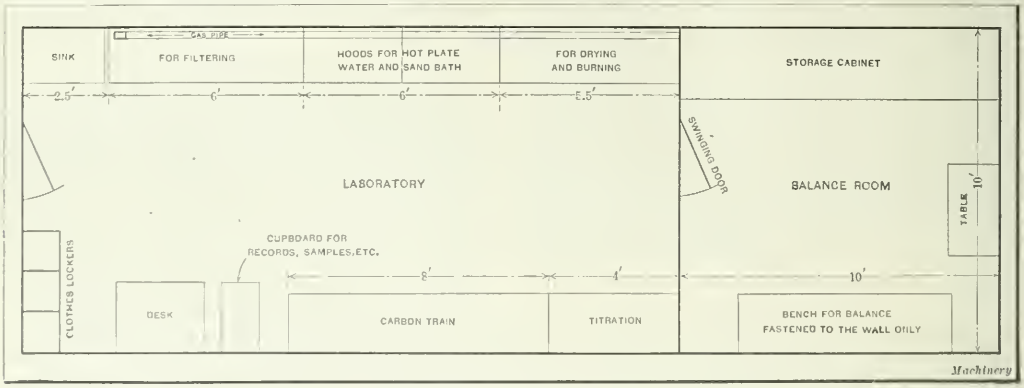

Fig. 2. Floor Plan of Shop Laboratory. Attention is called to Location of Filtering Bench next to Sink and Drying and Burning Bench next to Balance Room

All the measurements used in iron and steel analysis (and in practically all laboratory work) are expressed in the metric system; therefore, it is absolutely necessary for the chemist to know the tables of weights and measures and to be able to think in terms of the metric system. One reason for using this system is that it is very easy to change from units of volume to weight and vice versa.

The analysis of iron and steel may be divided into two parts—the determination of the different constituents that are present in the material, which is called "qualitative analysis"; and the determination of the proportion or percentage of each of these different constituents which is called "quantitative analysis." Qualitative analysis is of no real practical value for iron and steel, because it does not give the actual percentages of different constituents, and takes just as much time as quantitative analysis.

Methods of Taking Sample for Analysis

It is absolutely important that the sample of steel or iron to be analyzed should represent all the impurities, etc., that are present in the metal. As some metals vary in the composition of impurities, it is necessary to take a sample from the different parts of the specimen. Extreme care must be taken to see that the chips that are to be analyzed are absolutely free from oil, grease, water, etc. Turnings or drillings must be produced dry—without lubricant or cutting compound of any kind being used. This has led many to use filings as suitable chips for analysis, but the practice is dangerous, as some of the file teeth may break off and become mixed with the steel chips, which may make the whole analysis inaccurate. The man who takes the sample should always bear the importance of his work in mind. If the sample used by the chemist is not representative of the material as a whole, the analysis cannot possibly give reliable information. When it is possible, the chemist should always take his own sample for analysis.

Enough chips (about two ounces or 55 grams) should always be made so that there will be at least an equal quantity left to make a check analysis or test. These should be placed in small boxes or envelopes with a number, which is entered in a record book or card index that should give the history of the metal. The method of sampling steel adopted by the Society of Automotive Engineers is as follows:

1. Wire, tubing, sheets, and rods less than 1¼ inch in diameter or thickness should be sampled across the entire section.

2. Forgings or pieces of irregular shape should be sampled by drilling or cutting at the thickest and thinnest sections or lengthwise and across the entire section.

3. Bars and billets or other shapes above 1¼ inch should be drilled at a half radius, that is, half way between the center and the exterior surface.

Constituents of Iron and Steel that are Determined by Analysis

For the purpose of quantitative analysis, steel may be classified as carbon steel, low-carbon alloy steel, and high-speed steel. These classes are distinguished, in a great degree, by the particular elements included in their composition and by their after treatment. A change in the composition of a steel usually means a corresponding change in its properties. For instance, the addition of certain metallic elements to a carbon steel causes a change in the hardening temperature. Therefore, it is important to know the constituents of the steel, the quantity of each constituent that is present, and the influence of each. It has been explained that qualitative analysis determines what constitutes are present in a substance and quantitative analysis, the quantity of each constituent. Practically all steels contain carbon, silicon, manganese, sulphur, and phosphorus, the silicon and manganese being added to the steel when it is poured from the furnace in which the refining process is conducted; although attention is called to the fact that basic steel in most cases is free from silicon. The determination of these elements in carbon steel constitutes a complete analysis. In the case of a chromium steel, the percentage of chromium must be determined, in addition to the other elements; and in the case of a vanadium steel, the amount of vanadium, etc., must be found. In addition to carbon, manganese, silicon, sulphur, and phosphorus, high-speed steel should also be analyzed for tungsten,

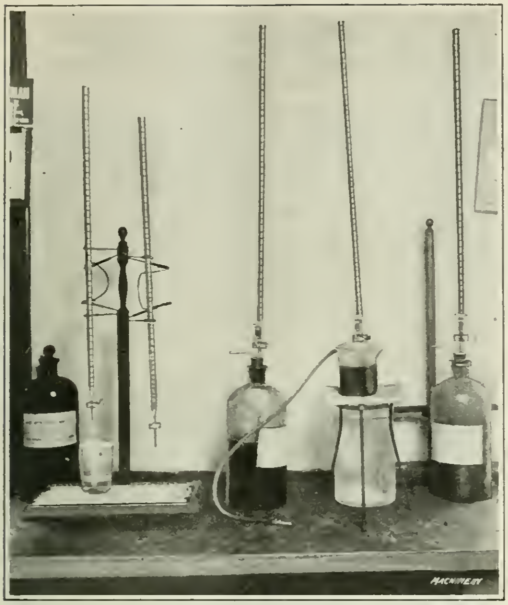

Fig. 3. Burettes set up for Use in determining Amount of Phosphorus, Manganese, Chromium, and Vanadium by Titration

Fig. 4. Draft Hood arranged to carry off Noxious Chemical Fumes given off during Evaporation of Solution, etc.

chromium, vanadium, and, in the case of some high-speed steels, nickel and molybdenum.

Gravimetric and Volumetric Analysis

There are two methods of quantitative analysis, both of which are in quite general use. These are known as "gravimetric" and "volumetric" analysis. A sample weighing exactly 1.0000 gram is usually weighed out in making an analysis because of the ease with which the results of the analysis of such a sample can be converted into percentages. It should be noted, however, that for the analysis of silicon and sulphur, one gram is not quite enough to obtain accurate results, and for phosphorus (gravimetric) 1.63 gram is used (then one milligram of the weight = 0.001 per cent phosphorus). As the name implies, gravimetric analysis consists of determining the percentage of a constituent, say carbon, in the sample of iron or steel which is to be analyzed by first accurately weighing out a sample and then treating it chemically, so that the steel is dissolved and the constituent that is to be determined is converted into an insoluble chemical compound, (called a "precipitate") which can be filtered out of the solution, dried, and weighed. This compound has a definite composition, and with a knowledge of this composition and the weight of the compound, the weight of the required constituent of the steel may be calculated and hence the percentage of that constituent present in the original sample of the steel. The precipitate is filtered through a porous paper held in a funnel and after filtration has been completed, the filter paper and precipitate are dried and the filter paper burned in a weighed crucible. The crucible and precipitate are then weighed and the weight of the precipitate is found by deducting the weight of the empty crucible. In volumetric analysis, a sample is weighed in the same way as for gravimetric analysis. It is then dissolved in acid, and after receiving suitable chemical treatment is subjected to an operation known as "titration." This is done by adding to the steel in solution a chemical solution which will react with the chemical compound into which the required constituent of the steel has been converted. The solution used for titration is contained in a measuring vessel known as a "burette"

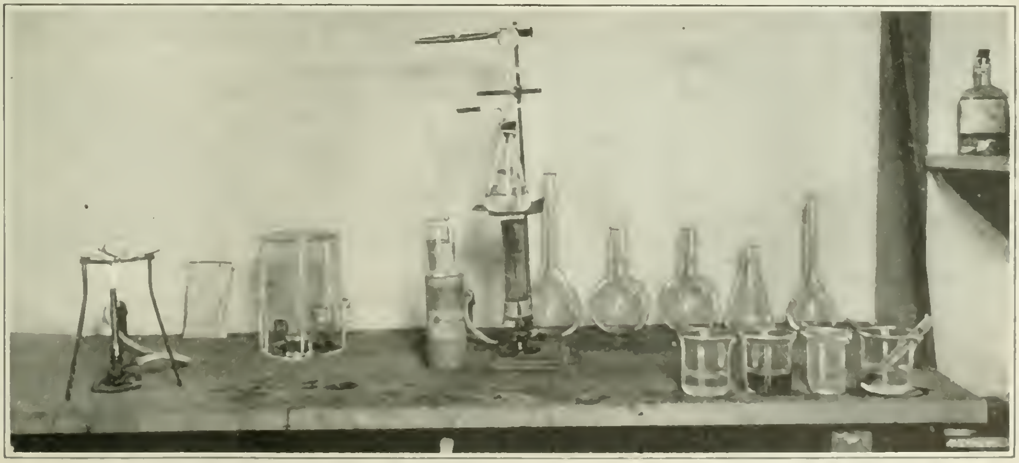

Fig. 5. Arrangement of Apparatus used by Chemist for igniting Precipitates, Evaporating Solutions, etc.

(see Fig. 3) which is graduated to show the number of cubic centimeters of the solution that are used for titration. The solution is of known strength so that each cubic centimeter corresponds to a certain fraction of a per cent of the constituent (say manganese) which is to be determined in making the analysis of the steel.

In conducting any form of chemical analysis, it is necessary to perform a certain number of operations, such as weighing, drying, evaporating, and precipitating, the latter being the name given to the process of treating a solution chemically so that an insoluble compound is formed which may be isolated by filtering it out of the liquid. Great care must be taken in the performance of all these operations to avoid making any mistakes in weighing out the sample taken for analysis or losing even a minute part of the original sample or the compounds into which the sample has been converted through treatment with suitable chemical reagents. All weighing must be done very carefully, and in order to do this it is important to have the pans of the chemical balance perfectly clean and in proper adjustment. The chemist ordinarily weighs to 0.0001 gram, so that a few grains of dust on one of the balance pans would vitally affect the accuracy of the result.

Colorimetric Analysis

Of all the methods used in making a quantitative analysis, there is probably none that is more unreliable than the colorimetric method, which consists of comparing the color of a solution containing the unknown sample to be analyzed with that of a solution containing a sample of known composition. This method is sometimes used to ascertain the percentage of carbon in steel. The sample is dissolved and, after suitable chemical treatment, it is placed in a glass tube beside a tube containing a similarly prepared solution of a steel containing a known percentage of carbon. These two tubes are placed in a colorimeter where they can be viewed by transmitted light through a frosted glass. The solutions are a light straw color, and from the relative intensity of color of the two solutions, the amount of carbon in the steel that is being analyzed can be ascertained. The colorimetric method is almost sure to be unreliable when used by other than thoroughly experienced chemists, and it is not at all unusual for this method to give results that are from 10 to 50 per cent wrong when a man of moderate experience attempts to make determinations in this way. The colorimetric method is never used for a final or checking test, and its findings are never recognized in an argument or controversy by anyone with a sound knowledge of the principles of chemical analysis. Hence, this method is one that should be avoided in deciding upon the ways in which work is to be conducted in a laboratory that is installed for the purpose of analyzing steel and iron in shops engaged in building machine tools or manufacturing cutting tools.

Methods of the Bureau of Standards

The Bureau of Standards in Washington, D. C., publishes methods for determining the percentage of various constituents in iron and steel. These methods are certainly capable of producing accurate results, but in some cases they are unnecessarily slow, and it requires such a long time to make a determination as to render the method practically valueless for use in laboratories doing commercial work where "time is money." The chemist in the average shop laboratory will usually find it more desirable to employ methods that have been developed by industrial chemists who have had plenty of experience in learning the requirements of analytical work done for manufacturing establishments. These methods give perfectly reliable results and can be completed in practically the minimum time required for making the analysis.

• • •

The U. S. Employment Service reports that the campaign for enrollment of the "public service reserve" of workers cost about [illegible]. As [illegible] men were enrolled and 13,000 were placed, the cost per worker enrolled was 8 cents, and the cost per worker placed $1.77.

A. S. M. E. COMMITTEE FOR READJUSTMENT OF INDUSTRIES FOR WAR WORK

The American Society of Mechanical Engineers through its president, Charles T. Main, has appointed a "Committee for the Readjustment of the Industries for War Work" with a view to aiding directly in the placing of all the industrial resources of the country—especially those in the mechanical engineering field—in touch with one another and with the proper governmental bureaus, so as to make it possible for all of them to use their facilities to the best advantage for the winning of the war. The work of the committee, at first, would be to list names of manufacturers, especially those of small capacity, that are able to perform some kind of war work and who have found it difficult to obtain direct government contracts. These manufacturers would be placed in touch with larger contractors or with the government bureaus with a view to furnishing them with such work as is necessary at the present time. In this way, it is hoped that the facilities of non-essential industries may be more than ever mobilized for essential war manufacture.

The American Society of Mechanical Engineers has undertaken this work, because it is believed that the mechanical engineers of the United States are more closely in touch with the manufacturing facilities than any other organization, and with the cooperation of the membership of the society it is expected that the work planned for can be carried out in an effective manner. Representatives of the society have been appointed in various districts corresponding to those into which the country is divided by the War Industries Board with regard to munitions manufacture.

The committee appointed by the society for carrying on this work consists of George Kingdon Parsons, president, G. K. Parsons Corporation, 29 Pine St., New York City, who is the chairman; Frederick A. Scheffler, sales engineer, Babcock & Wilcox Co., 85 Liberty St., New York City; and Erik Oberg, editor of MACHINERY, 148 Lafayette St., New York City. The duties of the committee will be to direct all of the society's work along the lines of the readjustment of the industries for war work and to assist in discovering the proper means for cooperating in the several regions with the United States Chamber of Commerce and the War Industries Board or other governmental agencies, as well as to arrange for the selection of specialists for certain phases of the work. One of these specialties has already been partially cared for through the activities of the Machine Shop Committee of the American Society of Mechanical Engineers of which Ralph E. Flanders, manager of the Jones & Lamson Machine Co., Windsor, Vt., is chairman. This committee will handle the conservation and production of heavy machine tools for Ordnance work.

It is believed that this step of the American Society of Mechanical Engineers is of considerable importance, as the engineer is coming more and more to be recognized as the most important factor for the organization of the home forces for war work, and his training as an organizer and executive should be brought into play at this critical time. The engineer, as such, must take his place among the forces that are active in accelerating the production of war materials.

Temporarily, the headquarters of the committee will be at the offices of G. K. Parsons, the chairman, at 29 Pine St., New York City, and all correspondence relating to the committee's work should be directed to this address. All organizations who are working along similar lines are asked to communicate with this committee of the American Society of Mechanical Engineers so that the work of all similar committees may be coordinated and the greatest effectiveness be obtained by unifying the work of all. The American Society of Mechanical Engineers is not in this work for any other purpose than to *serve* and *cooperate*, and in order to obtain the greatest efficiency all overlapping of activities by various organizations should be avoided.

Manufacturers who have equipment that is idle or that is not employed on regular war work, and who would like to have it so employed, as well as makers of munitions of war and other war material who have contracts to sublet, are also asked to communicate with the committee.

UNUSUAL OPERATIONS ON DRILLING MACHINES[1]

USE OF DRILLING MACHINES FOR MILLING, BROACHING, DRIVING STUDS, AND ASSEMBLING

BY EDWARD K. HAMMOND[2]

IMPROVEMENTS which have been made in the design of drilling machines, and a better understanding of the possibilities of these machines by shop superintendents and others who decide upon methods of performing machining operations, have led to a remarkable extension of the range of work handled on this type of machine tools. In recent articles published in MACHINERY, information has been given concerning the performance of facing, hollow-milling, and other operations which are a little in advance of what is usually regarded as drilling machine work, although such operations are handled in a great many shops that are under the management of progressive men. In the present article there will be described several unusual methods of applying drilling machines for the performance of operations that are ordinarily handled by more laborious or more costly methods.

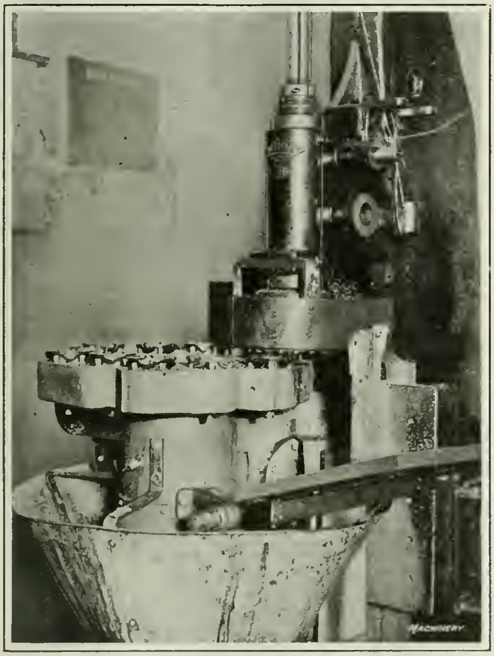

Fig. 1. Rockford Drilling Machine equipped with Continuous Milling Fixture for milling Universal Joint Rings

Drilling Machine Equipped for Milling Operation

In Fig. 1 there is shown the way in which the Rockford Drilling Machine Co., of Rockford, Ill., has equipped a high-duty drilling machine of its manufacture for use in milling universal joint rings. It will be apparent from this illustration that the work-holding fixture is so designed that the operation is conducted on what is commonly known as the "continuous" principle, that is, the fixture revolves so that forgings are constantly being fed under the milling cutter; and the operator has plenty of time to remove the milled universal joint rings from the fixture and substitute rough forgings. These forgings are made of 0.25 per cent carbon steel and are held in place on the fixture by means of T-clamps. The drilling machine used for this job is equipped with a special spindle of suitable design for driving the large inserted-tooth face milling cutter, which can just be seen projecting down below the guard that is furnished to protect the operator against injury.

Broaching Operation on Drilling Machine

Regardless of the views held by any man who plans methods of performing machining operations concerning what constitutes drilling machine work, there are few of these men who will not concede that the use of a drilling machine for simultaneously broaching eight slots is somewhat unusual. Fig. 2 shows the way in which the Willys-Overland Co., of Toledo, Ohio, has equipped a 42-inch reversing type of drilling machine, built by the Cincinnati Machine Tool Co., of Cincinnati, Ohio, for broaching eight slots in an aluminum crankcase to receive the push-rod guides, all of this work being finished by one feed movement of the drilling machine spindle. For the performance of this operation the work is located by plugs on the fixture which enter the camshaft bearing holes at each end of the crankcase. Carried by the main spindle of the drilling machine there is a pinion which drives two gears carried in cases *A*. These gears are threaded onto screws *B*, the pitch of which is such that as the gears are turned they feed down the holder carrying the eight broaches *C* at the same rate that the drilling machine spindle carries down the driving pinion. When the broaches have reached the bottom of their downward stroke, lever *D* is manipulated to reverse the direction of rotation of the drilling machine spindle, which results in backing out the broaches. The broaches are fed into the work at the rate of 12 inches per minute, with a feed of 0.006 inch per tooth, and with this equipment 120 crankcases are broached per hour.

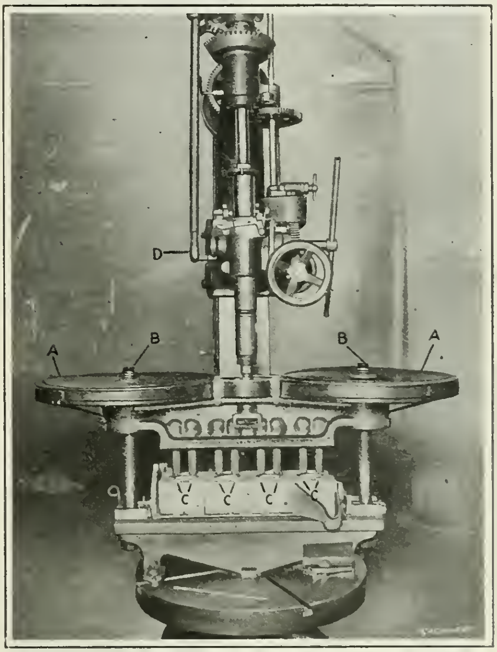

Fig. 2. Cincinnati Reversing Drilling Machine equipped by Willys-Overland Co. for broaching Push-rod Guide Slots in Crankcases

Driving Studs by Power

The Errington Mechanical Laboratory, 39 Cortlandt St., New York City, makes a stud setter of the type which opens automatically. It is equipped with two threaded jaws or half-nuts which are released and open after the stud is set, in practically the same way that an automatic die opens at the end of a cut. The opening of the stud setter is controlled by a stop-collar which is placed around the stud. When the lower end of the stud setter engages this collar, the body of the stud setter is prevented from further downward movement, but as it continues to revolve the two jaws or half-nuts screw themselves onto the stud until a collar at the lower end moves down opposite a recess or counterbored part of the stud-setter body. As this collar normally supports the half-nuts, they are released when the supporting collar enters the enlarged part of the stud-setter body. The entire tool is then raised as it continues to revolve in the same direction as for driving in the stud. The half-nuts are reset for the next stud by sliding another collar upward. This collar is recessed on the inside and engages the projecting ends of pins connected with the jaws or half-nuts, and simply serves to move them upward so that the supporting collar will be caused to enter the smaller bore of the stud-setter body and once more close the jaws ready to engage the next stud. This tool may be rotated either in a drilling machine or by means of a portable pneumatic or electric drill. Flexible shafting is also used in some cases. The general method of setting studs is to start them by hand and then drive them in by power. If a stud is too tight and requires an unusual amount of power for driving it, the stud setter can be released at any time by simply raising the machine spindle, as this moves the outer shell of the stud-setter body upward and brings the half-nuts into the releasing position. Fig. 3 shows one of these Errington stud setters being driven by a drilling machine.

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[1] For articles on drilling practice previously published in MACHINERY, see "Intensive Production on Drilling Machines," June and July, 1918, and articles there referred to.

[2] Associate Editor of MACHINERY.

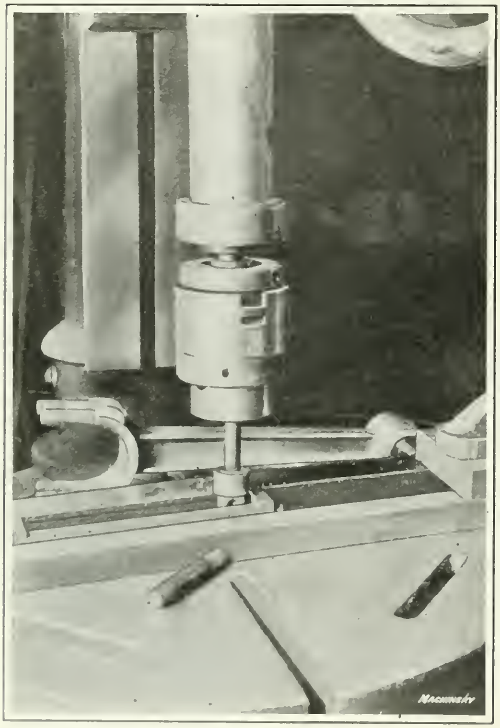


Fig. 3. Errington Stud Setter operated by Vertical Drilling Machine.

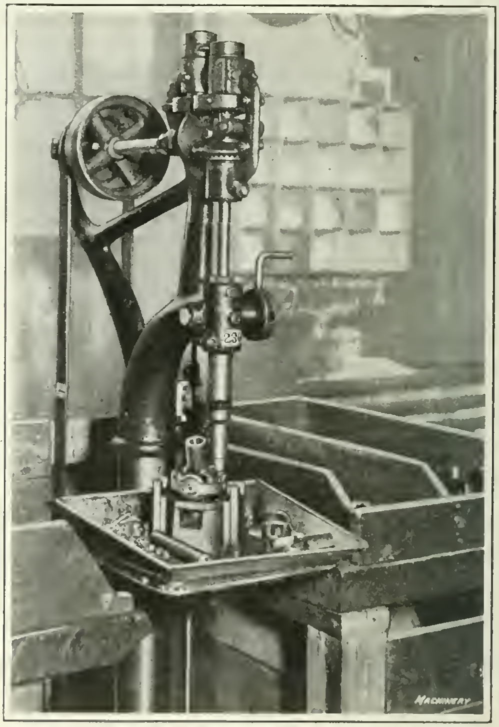


Fig. 4. Rockford Drilling Machine in Use assembling Universal Joints

Assembling under Drilling Machine

A large part of the labor of assembling machine parts that are held together by screws, bolts, and nuts is spent in the act of screwing the parts together with a wrench. When a nut is started on a screw thread there is no reason why manual power should be employed to screw it in, provided there are a sufficient number of one size to warrant the use of power apparatus. In the manufacture of motor cars, special appliances are employed for assembling, especially for setting studs and screwing up nuts. In some cases as many as sixteen nuts are driven in simultaneously by multiple-spindle drilling machine attachments. While it is necessary for the operator to test each nut with a wrench to see that it is screwed in firmly, the power apparatus saves a great deal of time and strength. However, the use of power apparatus for setting studs and screwing up nuts is not necessarily confined to the manufacture of machinery built in large quantities. It is quite feasible to employ an ordinary single-spindle drilling machine effectively for assembling simple parts that are made in quantities, especially if they have a number of nuts of the same size that may be screwed up consecutively during one operation. The drilling machine may be used as an assembling machine in many plants where the idea has never been employed or even suggested.

Fig. 4 shows a drilling machine built by the Rockford Drilling Machine Co., of Rockford, Ill., which is used in this company's plant for tightening the four nuts on the bolts that hold together the parts of a motor car universal joint assembly. The universal joint is mounted in a fixture of the form shown in Fig. 5, which holds the ring level and thus presents the nuts to be tightened in a horizontal plane. The operator starts the nuts on the screws by hand, having all four nuts ready before placing the joint in the fixture for screwing them down. The wrench carried by the drilling machine spindle is then applied and the nut is screwed up as far as it will go or until the belt slips. After this has been done, the fixture is indexed to the next position and the operation repeated. The fixture is essentially simple, consisting of a base that is bored and faced to receive the member on which the universal joints rest. A hardened steel ball and a coiled spring seated in a hole in the base constitute the indexing and locating plunger. It offers sufficient re-

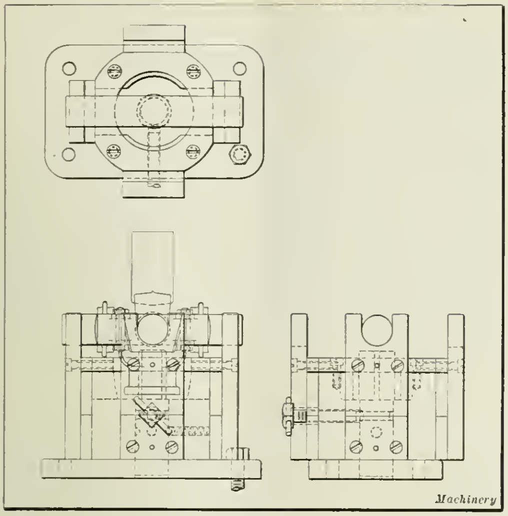


Fig. 5. Fixture for assembling Universal Joint Rings on Drilling Machine as shown in Fig. 4

sistance to hold the fixture in place, but not enough to prevent the operator from easily turning the indexing member of the fixture around to the next station.

Fig. 6 shows another method of employing a power-driven machine to assist in the rapid assembling of machine parts. Here there is shown a No. 33 "Little David" portable pneumatic drilling machine made by the Ingersoll-Rand Co., 11 Broadway, New York City, which is used in the plant of the H. H. Franklin Mfg. Co., of Syracuse, N. Y., for "running in" cap-screws. It will be seen that the pneumatic drill is suspended in such a way that the operator is relieved as far as possible from the work of lifting the tool. In this way, the fatigue factor is reduced to a minimum, enabling the operator's efficiency to remain as nearly normal as possible during the entire working day. The speed at which cap-screws may be run in by this method, as compared with the laborious method of driving them by hand, will be perfectly obvious.

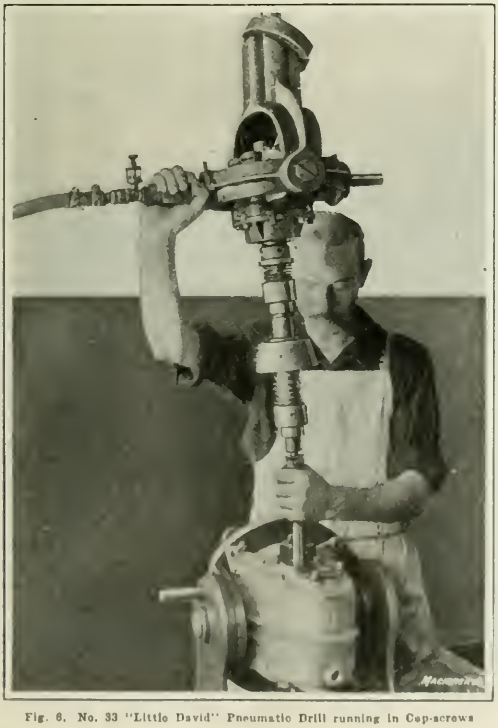


Fig. 6. No. 33 "Little David" Pneumatic Drill running in Cap-screws

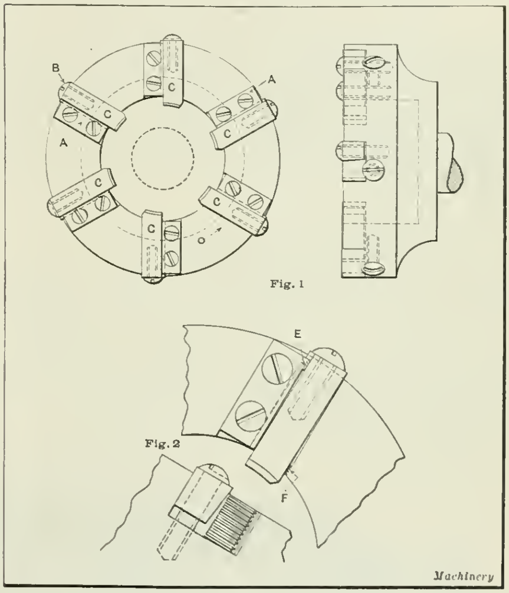
* * *

ADJUSTABLE DIE AND METHOD OF RELIEVING CHASERS

BY HENRY DAUT[1]

In the accompanying illustration, Fig. 1 shows an adjustable threading die which was designed for cutting threads on carbureter parts. The die thread is 2¾ inches in diameter and has sixteen threads per inch. The chasers *C* are made from 1/2- by 1/2-inch high-speed steel and have a 1/16-inch taper on the front side. The clamps *A* are drawn into slots by two 1/4-inch screws having twenty-four threads per inch, which hold the cutters firmly in place. Adjustment of the chasers is accomplished by screws *B* on the outside of the die-head, which also act as safety screws to hold the chasers in place.

Fig. 2 shows the method employed in relieving the chasers. Before the thread was cut, shims 1/32 inch thick and 1/8 inch wide were placed behind the chasers on the inner end, and also between the chasers and the clamps on the outer end, as shown at *E* and *F*. After the thread was cut, the shims were taken out and the chasers hardened and ground. The chasers were then put back into place without the shims, thus obtaining the desired clearance.



Figs. 1 and 2. Adjustable Threading Die and Method of relieving Chasers

* * *

Metallography has stepped down from the halls of science to the work-shop. It is being applied today in hundreds of metal-working plants. By means of it one may obtain some of the most definite indications of the correct heat-treatment of metals and of their physical characteristics. It shows many things that cannot be determined by tests along other lines. Yet the literature of metallography has not quite descended to the level of the average practical man; the atmosphere of the laboratory still clings to it; it does not employ an everyday vocabulary. Here is a chance for practical metallurgists to provide treatises on the microscopical study of metals, in language suited to the needs of the average practical man. Heads of engineering schools should devote much more careful attention to this subject and see that all courses in practical engineering include it.

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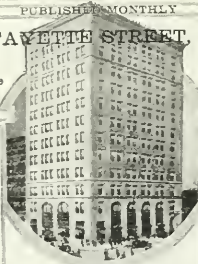

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

GOVERNMENT CONTROL OF LABOR

The President's proclamation urging all employers engaged in war work to refrain, after August 1, from recruiting labor in any manner except through the United States Employment Service of the Department of Labor was more than an urgent request. It was an order; because, in effect, after August 1 no employer whose plant is working on war materials and who has a force of more than one hundred workers will be permitted to employ labor except through the United States Employment Service. Employers needing men will state their demands to this Labor Bureau and they will be filled according to the general needs of the country in the prosecution of the war. The authority of the Government will be exercised through the War Labor Policies Board of the Department of Labor, and the Government's request to employers will be enforced through its control over raw materials, as manufacturers who refuse to heed the President's request are likely to find themselves shut off from such supplies as coal, steel, and other essentials.

Centralized control of labor has become necessary, and employers in general will welcome the new departure. Different industries are now forced to outbid each other and under present conditions there is virtually no limit to the wages paid. It is hoped that government control will remedy this condition, and if it is exercised intelligently and not handled as a political weapon it will probably work out satisfactorily.

* * *

ELECTRIC STEEL

One of the most remarkable of the many industrial developments during recent years is connected with the production of steel and has been made possible by the electric furnace. The demand for steel of the highest quality was never greater than at the present time, partly because of the exacting requirements for materials used in the construction of ordnance, airplane motors, and other equipment needed in connection with the war. Large quantities of steel used for purposes requiring absolute reliability and uniformity in composition and strength, are now produced by the electric process, and for this reason the article in the current number of MACHINERY, dealing with the making of electric steel and various types of furnaces used, is of unusual interest. The subject treated is not generally understood, and few men in the mechanical field not directly engaged in the making of steel realize what an important factor the electric process has become within the last decade.

The industrial importance of the electric furnace is especially marked in the production of special alloy steels, tool steel, and steel castings. With this process, it is not only possible to produce steel of exceptional purity, but it is also easy to control its constituents in the making and to reproduce accurately steel of a given composition. The phenomenal growth of this process has been greatly accelerated by the abnormal demand for steel in the last four years, but many metallurgists and steel makers believe that the present rapid expansion of the electric steel industry will continue, and that eventually this steel, which a few years ago was regarded as a kind of novelty, will comprise a large part of the entire steel output.

* * *

CONGRESS OPPOSES EFFICIENCY

The National House of Representatives went on record as being opposed to efficiency in engineering work, when it voted to over-ride the mature judgment of the Committee on Military Affairs and added an amendment to the Army Appropriation Bill prohibiting time studies and premium payments in manufacturing establishments conducted by the Government. Time studies to the House majority apparently imply that labor is driven to its task, when in fact, their general effect is quite the contrary, because only by such scientific study can useless operations and wasteful methods of doing work be eliminated. Time and motion studies make it possible to concentrate the skilled worker's efforts upon work that he can do to the best advantage, leaving other work to be performed by less skilled men, so that the skilled worker can earn a higher wage without greater exertion. Our law-makers, no doubt, thought that they were protecting labor in recording their opposition to scientific management, time studies, and premium payments; but, in fact, this vote operates as a check to the economical development of our industries, an action sufficiently bad in time of peace, but indefensible now, when the maximum production is an absolute necessity.

* * *

ENGINEERING EDUCATION DURING THE WAR

How to keep our engineering colleges working at normal pressure is one of our many war problems. Many of our young men who, under ordinary conditions, would take engineering courses, have either enlisted or been drafted; many engineering professors and instructors are also in the service of the Government. The alarming condition which confronts the country, as a consequence, is shown by M. E. Cooley, dean of the University of Michigan, writing in *The Michigan Technic*. As winning the war depends largely on our having competent engineers, it is indeed a serious matter if young men suited to the engineering profession do not complete their courses; and it is equally serious if other young men do not begin to take these courses for the purpose of fitting themselves for engineering work. Attendance has fallen off at the engineering schools and teachers are giving up their positions; but if men are to be adequately trained for engineering work both in war and peace, they must be induced to attend college, and the necessary teachers must be provided for training them.

President Wilson, in a letter to the dean of the College of Engineering of the University of Michigan, pointed out not only that technical training had become of enormous importance in military operations, but that the work of the engineer was becoming more and more important in every process of industrial life, and he expressed the hope that, so far as possible, all concerned should cooperate toward keeping young men in the engineering schools until they had finished their studies. This is a phase of the war situation that has not been given as much attention as its importance merits.

Training Men for Shop Work

WHEN the owner of a large factory was asked, "How do you fit a new man to his work?" he replied: "I say to the man, 'There is your machine; make good or quit!'" That method, with modifications, used to be the guiding principle in the employment of workers in our factories; but there has been a gradual change during recent years. It has become clear that, with the present shortage of labor, both men and women must be especially trained for the work that they are to do, if the plants where they are employed are to be run successfully.

In one factory producing time fuses for shells, which employs six thousand operators, the output has been more than doubled by the systematic training of each operator. Without this, it would have been necessary to double the plant in order to reach the present production; and, more remarkable still, the factory's labor turnover is very small, because the workers, having been carefully trained, earn high wages and, therefore, feel no desire to change their positions.

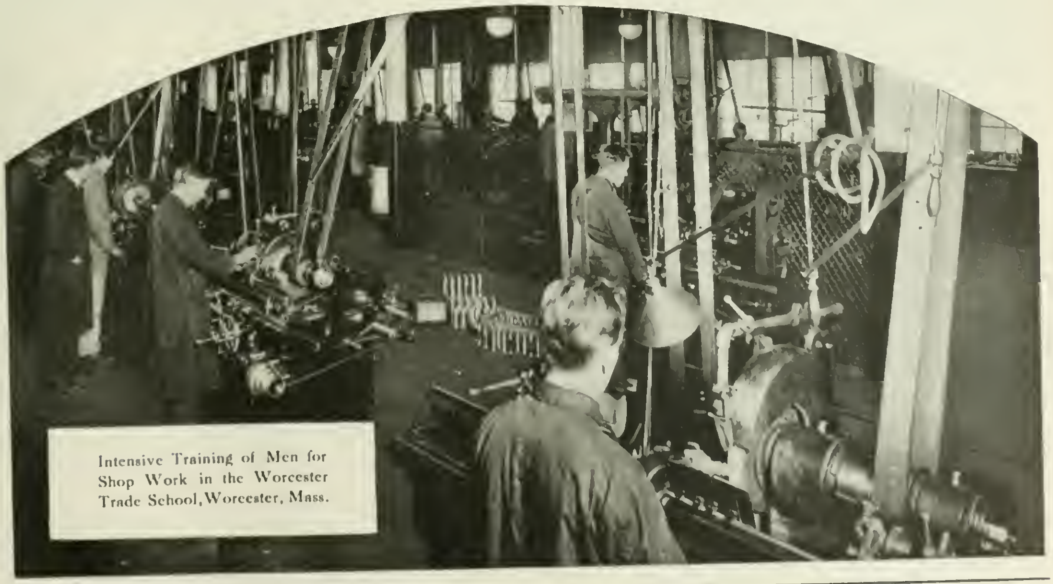
The training of operators should not be looked upon merely as a war measure, but as something permanent, something that will prove most important in solving many of the industrial and labor problems confronting employers. A properly trained worker is less likely to become dissatisfied, to dwell upon imaginary wrongs; and the wage problem as well as the question of working hours can be met satisfactorily with such workers, because their production will be increased in a ratio formerly thought well-nigh impossible.

The particular method of training that seems to have met with the most approval is this: at a factory some space is set aside in which the machines are of the same type as those on which the workers will be regularly employed later on. Able and conscientious operators from the regular staff of the factory are assigned to train new workers in the best possible methods of operation. The novices, while being trained, are, nevertheless, engaged on actual productive work; and it has been found that, owing to the instruction received, they are able to produce more, even during the training period, than ordinary operators in a factory managed in the old way. It is said that new operators, who have received from three to eight days' training, have been able, after three weeks' further experience on regular production in the factory, to produce from 20 to 50 per cent more than the old-time, self-taught operators.

The training space may be in a single room for the whole shop, or it may consist of a few machines in each of the shop's departments. In large factories, the best possible place for this training is in a department especially set aside for the purpose; in smaller factories—those that employ, say, from fifty to two hundred men, and only occasionally need a few new operators—such a training department might prove too heavy a burden. In that case, cooperative training schools for serving a number of factories in the community might be established, following the example of England, where ten thousand toolmakers, we are told, have been trained in public trade schools during the war.

A new England trade school claims that it can train screw machine operators in three days to handle their machines satisfactorily, when these are set up by experienced men, and that, on the fifth day, it can begin to teach them how to set up the machines for new jobs. The driver of a laundry wagon, for example, was taken into this training school, and, in a week, was taught to run a milling machine and to read blueprints, so that he could turn out ordinary plain milling work satisfactorily. The school is provided with material by manufacturers in the town where it is located, who want to use the men trained at the school, and, consequently, desire to have them instructed to work with material and parts identical with those with which they will work when hired. This method has reduced the labor turnover, because the men fit into their places, are successful at their work, and get good pay.

The war has taught us that, to achieve efficient production, it is just as necessary to train industrial workers even for the simplest tasks, as it is to train soldiers in order to make them efficient fighters at the front. No problem now facing our manufacturers is of greater importance than this.



Intensive Training of Men for Shop Work in the Worcester Trade School, Worcester, Mass.

THE MACHINE TOOL TRADE AFTER THE WAR

BY A. W. HENN

President, The National Acme Co., Cleveland, Ohio

THE opinions regarding the machine tool trade after the war vary considerably. There are some who claim that the machine tool business will be almost at a standstill owing to the necessity for readjustment when the war is over and to the great number of machine tools that will be released from war work. On the other hand, a great many of the leading men in the machine tool trade believe that at the end of the war there will be a continued brisk trade in machine tools for at least several years to come. The latter view seems to be the more rational. It is based not on assumption, but upon a careful study of the conditions and the factors that must be taken into account. The following paragraphs contain a review of these conditions and a brief analysis of the factors that will determine the status of the machine tool business in the United States when the world is again at peace. These conditions affect both the foreign and the domestic trade.

Demand for Machine Tools in Europe

Directly following the end of the war there will be a period of reconstruction in practically all European countries; this will be greater, of course, in those that have been devastated in the war than in others. For a period of anywhere from two to five years these countries will draw upon the United States for a great many of their necessities, including machine tools, because they will not be ready, themselves, to supply immediately more than a small part of the enormous demand for machine tools that will make itself felt at once. They must have their factories running at full blast, in order to be able to rehabilitate themselves economically; and to do this it will be necessary for them to obtain just as rapidly as possible the full quota of machine tools that will be required for fully employing their peoples.

Belgium offers, of course, the most striking example of what will be necessary for the rehabilitation period. We understand that practically all the machine tools have been removed from Belgium and those that have not been removed have probably been run day and night for years, until they are practically valueless. Hence, it is reasonable to assume that the complete machine tool equipment of the whole of Belgium will have to be immediately replaced. While Belgium is a comparatively small country, it was and will be, in proportion to its size and population, one of the most highly industrial of the countries in Europe, and the number of its factories is relatively great. The machine industry of Belgium was especially highly developed, and it is probable that the number of machine tools in proportion to the population was greater in Belgium than in any other country in the world. To supply that nation with the necessary tools, therefore, will in itself be no small task.

Belgian manufacturers who escaped from Belgium at the time of the occupation by Germany are now looking forward to this period of reconstruction, and some of them have already placed orders in the United States for machine tool equipment to be delivered immediately upon the signing of the peace declarations. The National Acme Co. has one such order on its books at this time. Conditions similar to those in Belgium exist in northern France, part of which is also highly industrial, but those countries which have not actually been devastated by the war will also place heavy demands upon the machine tool industry. The machine tools in France, England and Italy at the present time are being run at their maximum capacity, and at the end of the war they will be found to be practically worn out. The high efficiency that will be required during the reconstruction period, in order that the nations as soon as possible may again be able to return to normal industrial conditions, necessitates the best machine tools and equipment of all kinds. Hence, there will be a demand for new and efficient machine tools that can not be immediately filled by these nations themselves, but which must be met by the United States, where, because of our natural resources and the size of our population, we will be able to retain reasonably normal industrial conditions throughout the war, and we should, therefore, be able to supply other nations with their machine tool requirements almost immediately upon the termination of hostilities.

Second-hand Tools are Not a Big Factor

It has been believed by some men in the industries that after the war a great many machine tools will be thrown upon the second-hand tool market, and that this will materially affect the market for new machine tools. This, however, is not likely to be the case. The machine tools today in our munitions factories, as well as in our other machine building plants, do not receive the usual care and attention. They are in many cases run by untrained and careless operators and will be, generally speaking, in a bad condition when the war is over. They will have little or no value for first-class work, and while they may be used to supply some smaller and less important factories, the second-hand machine tools will probably not be a big factor in the machine tool trade. Hence, it is reasonable to assume that the domestic market for new tools will also be quite brisk, and it will be several years after the end of the war before there will be any material depression in the machine tool market.

Normal Demand Compared with War Demand

The normal demand for machine tools at the end of the war will not, of course, compare with the high-pressure demand during the war, and the curve indicating the amount of business done will, no doubt, drop slightly. It may now have reached its maximum, and we know that it always has its hills and valleys. It will not go below normal, however, for several years to come, on account of the conditions outlined above. Its return to normal is perhaps rather to be desired in many instances, because it has many advantages for the manufacturer which are absent when the demand is at its present height. A return to normal demands will stabilize the labor supply and wages. It will make it possible to conduct business in a more efficient and economical manner. It will stabilize prices and, in general, put the business on a firm foundation.

Conclusion

Summing up, therefore, what has been said, I believe that the machine tool trade will be fully, or above, normal, for several years after the war, because Europe will have to place itself on an efficient and highly productive industrial basis, and it will be necessary to replace the machine tools that have been either removed, as in Belgium and northern France, or that have been worn out like those used in the munitions factories all over Europe. The second-hand market will not materially affect the market for new machine tools, because most of the tools that will be available in the second-hand market will be practically worn out, out of alignment, and, generally speaking, unfit for use in the best classes of machine shops.

* * *

Large additions to the country's steel-making capacity were made in 1917. Ninety-seven new open-hearth furnaces, capable of an output of 4,326,500 tons of ingots per year, were completed. Of this total, 1,220,000 tons is furnished by the United States Steel Corporation. In 1916, previously the record year, the new capacity added was 4,205,000 tons. Fourteen new blast furnaces were blown in during 1917, with an annual capacity of 2,520,000 tons, against only five furnaces in 1916, with a capacity of 800,000 tons. Yet the pig iron production in 1917, estimating that of December at 3,000,000 tons, was 735,000 tons less than in 1916.

Ball Bearings for Machine Shop Equipment—1

By Edward K. Hammond[1]

MACHINE designers who have not given a great deal of consideration to the advantages secured through the use of ball bearings in mechanical equipment for the machine shop, are inclined to think that power saved through the elimination of friction is the chief advantage secured through the use of this type of bearings. As a matter of fact, they have many other equally important advantages among which are the reduction of wear, which overcomes the necessity of "taking up" bearings at specified intervals; the possibility of packing these bearings in a supply of lubricant which is sufficient to last for a considerable period of time, thus reducing the amount of attention required; and the fact that ball bearings operate with practically no wear, so that shafts or spindles supported by them are held in accurate alignment.

Some of the more conservative machine tool builders concede the possibility of saving power, but it is the opinion of these men that the ball bearings are relatively short-lived and so the saving of power is secured at the expense of having to make frequent machine repairs and replacements of ball bearings. The idea that ball bearings are incapable of giving prolonged service has doubtless been carried over from the days when bicycle riding was at its height. Ball bearings used in bicycles were the means of enabling these machines to run much more easily, but the bearings were often made of unsuitable grades of steel which had been poorly heat-treated; and to add to these undesirable conditions, the bearings themselves were improperly designed. It followed as a natural result, that they were unable to give satisfactory service. Everyone who has had experience with bicycle riding concedes that even these crude ball bearings were certainly the means of saving power.

Just criticism of ball bearings on the ground that they are short-lived has now been completely overcome. Bearings of this type were required for use in automobile construction, and here the incentive to develop efficient bearings was sufficiently great so that the requisite amount of money was forthcoming to have the problem studied by thoroughly capable engineers and designers. As a result, various types of ball bearings have been developed which are well suited for those classes of service in which they are used. Much thought has been given to the selection of suitable grades of steel for making parts of the bearings; and methods of machining and heat-treating these parts to give them the required accuracy and physical properties have been developed to such a degree of perfection that today the ball bearing represents one of the most perfect forms of mechanism which is manufactured on a commercial basis. Last, but far from least, as regards the successful application of ball bearings in machine shop equipment, a great deal of study has been given by competent engineers and machine designers to the requirements that must be fulfilled in mounting ball bearings and providing for their efficient lubrication. It is our purpose to present, as far as possible, information concerning the latest developments in the application of ball bearings in machine shop equipment.

Requirements of Efficient Ball Bearings

In the preceding paragraph a brief idea has been given of the degree of perfection which has been attained in ball bearing manufacture, but the reader will doubtless be interested in a specific, though brief, statement of the actual facts. First of all, it is of absolute importance to make the bearing parts of a suitable grade of steel of the required chemical analysis, and this steel must be heat-treated in such a way that the balls and races are hardened right to the center. If there is any lack of uniformity in the hardness of different parts of the bearing, this will manifest itself by a variation in the amount of compression of these parts under load, and such a condition would seriously impair the efficiency of operation of the bearing. The process of machining the balls and races must be carried on with the greatest care, because it is required to have the surface of the balls and the races in which they run ground to a remarkable degree of precision, and the dimensions must be held within exceptionally close limits.

It is an accepted fact among experienced ball bearing engineers that any roughness on the surface of the balls or races will result in the rapid destruction of the bearing; it is only where bearings with perfectly finished and properly heat-treated parts are used in shops where the necessary care is given to lubrication, etc., that the statement can be made that this type of bearing is practically free from wear. Last, but not least, it is necessary to have the races ground so that they do not depart from the true circular form, and to have a variation of not over 0.0001 inch in the diameter of balls used in any one bearing. The reason for this is that lack of uniformity in the size of the balls, or deviation from a true circular form in the races, would result in an uneven distribution of the load so that certain sections of the bearing would be subjected to excessive stresses which might be sufficient to start wear. Properly made balls and races will last for a long time before they start to show signs of wear, but experience has shown that when a ball bearing once begins to wear its complete destruction is rapidly accomplished. The finish secured in polishing the balls and race grooves should be so perfect that it is impossible to detect the slightest scratch when the surfaces are viewed through an ordinary pocket magnifying glass.

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[1] Associate Editor of MACHINERY.

Effect of Ball Diameter and Race Contour on Load-carrying Capacity

Assuming the steel used in making ball bearings to be the same in all cases, the load-carrying capacity of a ball bearing is determined by the size of the balls and the dimensions and form of the raceways. Other things being equal, the larger the ball, the greater will be its capacity to support a load. Similarly, the ability of a ball bearing raceway to carry the load imposed upon it by the balls will increase steadily as the curvature of the groove is made to conform more closely with the curvature of the balls running in that raceway. These statements of facts that are well known to men of experience in the design and use of ball bearings will naturally cause the machine tool designer who has not had a great deal of experience with bearings of this type to ask the reason for these variations in the load-carrying capacities of different bearings. Briefly stated, these reasons are as follows: In order for a steel ball to fail under a load imposed upon it, the ball must be broken by crushing. All materials are elastic to a certain extent, and in the case of a ball under load, this elasticity results in the points of contact between the ball and the surfaces pressing on it being flattened out somewhat, so that instead of the theoretical point contact there is actually a surface contact. When the load is great enough to distort the ball beyond the elastic limit of the steel, the ball is crushed. The area of the surface of contact between a ball and a flat surface, owing to the application of a specified pressure upon the ball, will increase steadily as the size of the ball increases. It will be apparent that this naturally gives the larger ball capacity for supporting a greater load because the load per unit area of contact will be less for a large ball than for one of smaller size. Now let us consider the case of variation in the curvature of the ball raceway. For races of the same size and subjected to the same load, the area of contact due to distortion of the ball and raceway by the load will increase steadily as the radius of curvature of the raceway becomes more nearly equal to the radius of the ball. For this reason, the pressure per unit area will decrease steadily as the curvature of the raceway approaches that of the ball, and so the load-carrying capacity will increase.

Relation of Race Contour to Frictional Resistance

Where other conditions are kept uniform, it is found that frictional resistance in a ball bearing—although very small under any conditions—increases from a minimum amount which is present when a ball is rolling in contact with a flat surface, up to a maximum amount that exists in the case of a ball running in raceways of the same curvature as the ball. Although a uniform increase in load-carrying capacity is accomplished by making the radius of curvature of grooves in the raceways approach that of the balls, it is considered good practice to design ball bearings in such a way that a mean curvature is provided, which represents a balance between the minimum amount of friction in the case of balls running on a flat surface and the maximum load-carrying capacity secured through having the balls run in contact with raceways of the same curvature as the balls. For instance, the Gurney Ball Bearing Co., of Jamestown, N. Y., has adopted the following standard curvatures for the raceways of bearings carrying different sizes of balls. For bearings provided with balls up to 15/16 inch in diameter, the curvature of the inner raceway is 4 per cent and the curvature of the outer raceway is 6 per cent greater than that of the balls. For bearings provided with balls ranging from 1 to 1 15/16 inch in diameter, the curvature of the inner raceway is 3 per cent and the curvature of the outer raceway 4 per cent greater than that of the balls. For bearings provided with balls 2 inches in diameter and larger, the curvature of the inner raceway is 2 per cent and the curvature of the outer raceway 3 per cent greater than that of the balls.

Load-carrying Capacity of Radial Ball Bearings

The load-carrying capacity of a ball bearing and its length of life is also dependent upon the number of balls in the bearing, the perfection of finish of the balls and the raceways in which they run, and the speed of rotation of the shaft carried by the bearing. These and other conditions affecting the load-carrying capacity to which reference has been made in preceding paragraphs are connected in the following formula for the load which may safely be put upon a radial ball bearing:

$$P = \frac{KZD^2}{5} \qquad (1)$$

where

P = safe working load in pounds;
K = constant depending upon shape of raceways and their condition;
Z = number of balls in bearing; and
D = ball diameter expressed in eighths of an inch.

Formula (1) applies to ball bearings operating under conditions of uniform load and speed, and in the accompanying table there are given values of constant K corresponding to different speeds of rotation. It will be apparent from this table that the speed of rotation is a highly important factor in determining the load-carrying capacity of a ball bearing. This is due to the fact that the steel must have an appreciable time to recover from a condition of distortion before it is once more subjected to a heavy load. In most cases, ball bearings are so mounted that the outer race remains practically stationary, this race being supported in such a way that it creeps slowly around in the housing in which the bearing is held. As a result, the load is concentrated on about one-fifth of the circumference of the outer raceway. Another feature of having the outer race free to move slightly in its housing is that this race can adjust itself longitudinally so that the ball tracks in the inner and outer races are in accurate alignment with each other. Movement of the inner race brings its entire circumference into contact with the balls at each revolution of the shaft. In selecting a suitable size of bearing to meet the requirements of given conditions of service, the load P is known and the constant K may be taken from the table, if the speed of rotation of the shaft is known. This leaves the number of balls Z in the bearing and their diameter D as the two factors to be determined, and these are selected in such a way that they satisfy the conditions of the equation.

VALUES OF CONSTANT K FOR VARIOUS SPEEDS OF ROTATION

R.P.M.		10	150	300	500	1000	1200
Constant	48.4	36.3	29.14	24.2	20.9	15.62	14.96
R.P.M.	1500	2000	2500	3000	4000	5000	10,000
Constant	13.6	12.1	10.56	9.68	8.58	7.70	5.06

Machinery

Load-carrying Capacity of Ball Thrust Bearings

As in the case of radial bearings, the selection of thrust bearings to meet the requirements of any known conditions depends upon the nature of the service required of them. Where there are only light loads of uniform intensity to be carried at low speed and at infrequent intervals, a bearing of small capacity will give the required service. Conversely, if heavy loads and severe shocks have to be carried by a ball thrust bearing, and if the shaft runs at high speed and for many hours each day, we have the most severe class of service. Of course, there are a great many cases where the service required of a bearing comes midway between these extreme conditions. The load-carrying capacity of a ball thrust bearing depends upon the shaft speed and the size and number of balls. The lower the shaft speed, the higher will be the load-carrying capacity, although this is not an exact inverse proportion. Conversely, the larger the size and the greater the number of balls in a bearing, the higher will be its load-carrying capacity. Formula (2) expresses the conditions governing the load-carrying capacity of a ball thrust bearing.

$$P = \frac{K_1 N D^2}{\sqrt[3]{S}} \qquad (2)$$

where

P = safe working load in pounds;
K_1 = constant ranging from 25 to 40 according to quality of steel;
N = number of balls in bearing;
D = ball diameter expressed in eighths of an inch; and
S = R.P.M. of shaft.

What has been said about the use of Formula (1) for determining the load-carrying capacity of radial ball bearings, applies equally to the use of Formula (2) for determining the load which may be safely carried by a ball thrust bearing.

Economy of Space through Use of Ball Bearings

Where ball bearings are substituted in place of plain bearings a considerable amount of space is often saved because of their more compact design. Rubbing friction in plain bearings must be kept down within reasonable limits by making the bearings of sufficient diameter and length so that the pressure per unit of projected bearing surface is not too high. With the ball bearing there is a true rolling action between the balls and races, so that the load can be carried by bearings of much more compact form. This saving in space is often a great advantage in cases where a compact design is a matter of importance. For instance, this is particularly true in the case of equipment built for use in exceptionally congested plants. In order to give a more concrete idea of the amount of space which may sometimes be saved through the substitution of ball bearings for plain bearings, attention is called to Fig. 1, which shows the mounting of S K F ball bearings in an electric motor. This mounting is shown above the center line of the shaft, while below the center line are shown the old plain bearings which were formerly used. In this case, it will be apparent that the saving in space amounts to approximately 50 per cent of that formerly occupied by the plain bearings.

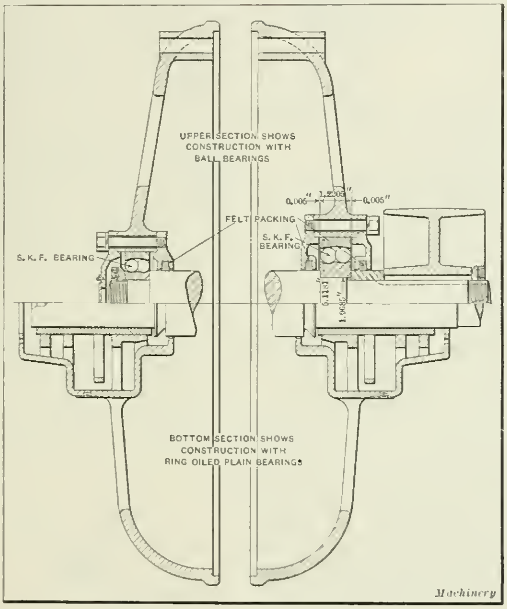
UPPER SECTION SHOWS CONSTRUCTION WITH BALL BEARINGS
S. K. F. BEARING
FELT PACKING
S. K. F. BEARING
0.005"
1.2205"
0.005"
5.1181"
1.9685"
BOTTOM SECTION SHOWS CONSTRUCTION WITH RING OILED PLAIN BEARINGS
Machinery

Fig. 1. Example of Space saved through Substitution of Ball Bearings for Plain Bearings

Precautions to Observe in Substituting Ball Bearings for Plain Bearings

It often happens that a builder of drilling machines or some other form of mechanical equipment may decide to substitute ball bearings for plain bearings at certain points on the machines. This action is often prompted by the fact that a competitor is selling a ball bearing equipment of somewhat similar design. In small shops which have inadequate engineering facilities—and sometimes in establishments which are better equipped—it happens that the substitution of a ball bearing for a plain bearing is carried out somewhat in this fashion. For the sake of discussion, we will consider that a decision has been reached to substitute a ball thrust bearing for a plain set of thrust collars. The drawings are scaled up and it is found that a certain amount of space is available for the ball bearing; then, after this amount of space has been ascertained, reference is made to the catalogues of ball bearing manufacturers to find out where a bearing can be obtained that will fit into this space. Satisfactory results cannot be expected from such haphazard methods of procedure, because it is a matter of absolute importance that a ball bearing be of the proper size to sustain the load that it is required to carry. If the effort is made simply to find a ball bearing that will fit into the available space on a machine which was formerly occupied by a plain bearing, the chances are that the bearing will not be the one best adapted for the peculiar conditions of service under which it is to be used. Probably the failure of ball bearings to give satisfactory results when selected by these slipshod unscientific methods has been one of the most fertile fields for failure, and has been one of the important reasons why some builders of machine shop equipment have reached the conclusion that it is difficult to obtain satisfactory results through the application of ball bearings in their products. It is therefore important that the prospective user submit his selection for approval to the ball bearing manufacturer.

Power Saved by Ball Bearings

Engineers and machine designers who have not had a wide experience with the use of ball bearings are inclined to think that saving of friction and consequent improvement of transmission efficiency are the main advantages secured through the use of bearings of this type. As a matter of fact, other equally important advantages are secured. Important among these are practical freedom of ball bearings from wear so that they require no adjustment, the possibility of mounting the bearings in such a way that they may be provided with a supply of lubricant sufficient to last for several months, and other allied advantages. The saving of friction is, however, a very important feature of ball bearings as compared with plain bearings, and the following examples are cited in order to show about what savings may be expected. In this connection it is very important to note that the reduction of friction and improvement of transmission efficiency, where ball bearings are substituted for plain bearings, may run anywhere from nothing up to nearly 100 per cent. The amount of saving will depend entirely upon the conditions of service.

Engineers of the S K F Ball Bearing Co., who have made a careful study of power losses resulting from frictional resistance in the bearings of transmission equipment and machinery used in industrial plants have estimated that 40 per cent of the total amount of power developed by the prime movers is wasted in overcoming friction. Regardless of whether power is generated in a plant maintained by a large industrial corporation or whether it is bought from an electrical generating station, it is obviously important to devise methods of reducing friction losses as far as possible, and the manufacturer cannot feel that he is running his plant under maximum conditions of economy until every precaution has been taken to reduce friction losses to an absolute minimum. One well-known expedient which has been adopted in order to overcome losses of power due to friction consists of the substitution of anti-friction bearings—either ball bearings or roller bearings are commonly employed—in order to substitute the practically frictionless rolling action of bearings of this type for the rubbing action of plain bearings, where there is sure to be a considerable amount of frictional resistance between the surfaces which are in contact with each other. Investigations conducted to ascertain the amount of power wasted in overcoming the frictional resistance of plain bearings, that could be saved through the substitution of ball bearings, have shown that under favorable circumstances 60 per cent of the lost power could be saved; that is to say, 24 per cent of the total energy developed by the prime mover or drawn from electric power circuits. Certainly this saving is great enough to warrant giving the matter careful consideration.

In order to show how important the saving of power effected through the use of anti-friction bearings may become under certain conditions, attention is called to the experience of a manufacturing plant which was so situated that space was at a great premium. This firm decided to add certain departments, which made it necessary to provide additional power capacity for driving the new equipment which was to be installed in the factory. After a great deal of planning, space was found for the new manufacturing departments, but the management spent a lot of time trying to figure out where the new power plant could be put without reaching a satisfactory conclusion in regard to the matter. Finally, the superintendent of this plant suggested that by substituting ball bearing shaft hangers in place of the plain bearing hangers which were then in use, a sufficient amount of power would be saved to enable the existing power plant to drive all of the equipment. The power load of the plant was 1200 amperes and under existing conditions of the transmission equipment in the factory, all of this power was required to drive the machines already in use. When the lineshaft hangers were equipped with ball bearings made by the Gurney Ball Bearing Co., of Jamestown, N. Y., it was found that 800 amperes was plenty to drive all of the equipment in the original plant, thus leaving 400 amperes to meet the power requirements made necessary by the extension of manufacturing facilities. This was more than ample to provide for driving all of the new machines that had to be installed and relieved the management of the embarrassing problem of furnishing space to install additional power plant equipment. These ball bearings were thus the means of saving the investment in a new power plant, and they are earning an income represented by the total of the interest on money which it would have been necessary to invest in the power plant, the cost of operating this plant, and the annual rental value of the space which the new power plant would have occupied.

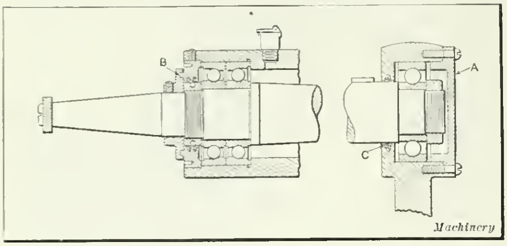

Fig. 2. Different Types of Sealing Devices for Ball Bearing Mountings, to provide for holding in Oil and excluding Dirt

The Transmission Ball Bearing Co., 1050 Military Road, Buffalo, N. Y., retained Roderick J. Parke, electrical engineer of Toronto, Canada, to conduct an exhaustive series of tests to determine the relative efficiency of shaft hangers equipped with "Chapman" type ball bearings of this firm's manufacture and with plain bearings, respectively. The results of this investigation led to the conclusion that when a shaft 2 15/16 inches in diameter is running under its maximum normal load, substitution of ball bearings for plain bearings is responsible for an annual saving of $19 per bearing, this estimate being based upon power at $30 per horsepower per year, which is a conservative estimate. The tests upon which this figure is based were conducted by Mr. Parke under laboratory conditions which gave him the opportunity of obtaining conditions of loading on the bearings that duplicated, as nearly as possible, the conditions imposed by belt pull, etc., when the bearings are actually at work in a factory.

Lubrication of Ball Bearings

Successful operation of ball bearings, and consequently of the machines in which they are used, depends to a considerable extent upon the observance of certain precautions in their lubrication, maintenance, and inspection. The fact that ball bearings need little attention often leads users to think that no attention whatever is required after the ball bearings are once installed. It is of paramount importance for the bearings to be properly lubricated for the following reasons: (1) To protect the polished steel surfaces against rust. (2) To facilitate the axial movement of the outer race and also to assist in the slow rotating movement of the outer race. Inasmuch as the friction in ball bearings is slight, the consumption of lubricant is very small; therefore, only lubricant of the best quality should be used.

It is often rather difficult to reach a decision in the selection of the correct type of lubricant for ball bearing installations, chiefly on account of local conditions. Experience has shown that a suitable lubricant can only be found by experiment. In most cases it is possible for ball bearing manufacturers to make tentative recommendations of lubricants that have proved satisfactory in similar installations. In addition to this, it is possible for the user of ball bearings to secure the cooperation of a number of prominent manufacturers of lubricants, who will be in a position to make definite recommendations for a suitable grade of lubricant, covering the various individual installations. Generally speaking, a heavy grade of mineral oil will be satisfactory in the majority of cases. In many cases, however, such operating conditions as inaccessibility of the bearings, the slow speed at which they run, etc., make it necessary to use grease, and experience in this connection has made it possible for engineers experienced in the design and operation of ball bearings, to recommend a suitable grade of grease for such conditions.

At high temperatures, the viscosity of the lubricant should be such that its retention in the bearing housing will not be a matter of difficulty. When at very low temperatures, the lubricant used should not congeal at the lowest temperature at which the machine is called upon to operate.

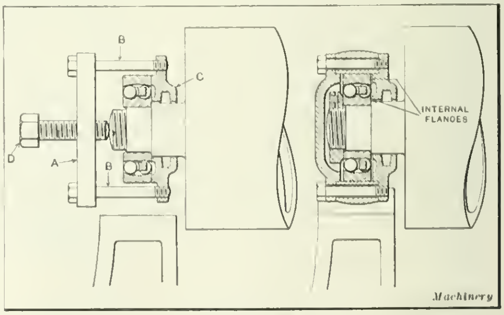

Fig. 3. Provision made in Ball Bearing Mounting for disassembling without Damage to Balls and Races

For high-speed applications, a light spindle oil will usually give the best results, although there have been cases in high-speed installations where the substitution of a heavy oil for a light oil has resulted in a much cooler running bearing. This may be explained by the fact that the inertia of a heavy oil is such that when the bearing is once up to speed, less resistance is offered to the rotation of the balls. In addition to this, there is an absence of frothing. Freedom from air pockets in the oil allows the heat to be transmitted to the outer casing more readily than if air pockets were present. In all high-speed installations, it is necessary to see that there is very little oil in the bearing housings. A large quantity of oil will cause churning and heating.

Chemical neutrality is the principal requisite of a ball bearing lubricant, that is, freedom from acid or alkali.

Most lubricants contain a small amount of acid due to the methods of refining, and to neutralize this acid, alkali is introduced into the lubricant. As the presence of either acid or alkali in a lubricant is highly injurious to the finely polished steel surfaces, it is necessary to use only those lubricants where the acid content is not greater than one-tenth of one per cent. As practically all lubricants will develop free acid with age, it is desirable to have the alkali content slightly greater than the acid content, but in no case should it be greater than one-tenth of one per cent. The excess of alkali over the acid will tend to neutralize any free acid which may later develop in the lubricant. There is a tendency for the acid content of a lubricant to increase when subjected to high temperatures. This is particularly true in the case of grease, and where ball bearings are operating under such conditions, it is advisable to test the lubricant after subjecting it to the actual operating temperatures under which it will be used, in order to ascertain whether there has been an abnormal increase in acidity.

Should it be impossible to obtain laboratory tests to determine the acid or alkali content, the following tests will determine whether or not the lubricant is suitable for use with ball bearings:

Litmus Test—Take a sample of the lubricant and wash it thoroughly with warm water. The water should then be tested with neutral litmus paper and should a faint reddish tinge show on the paper, the lubricant should be rejected as unsuitable.

Exposure to Atmosphere—Take a piece of highly polished steel and wrap it in cotton waste, which has been dipped in the lubricant to be tested. Place the steel wrapped in oil-soaked waste on a hot stove for a period of from eight to twelve hours or expose it to the sunlight for a few days. If, at the end of this time, the polished surfaces of the steel appear dull, the lubricant should be rejected as unsuitable.

Barium Chloride Test—Prepare a saturated solution of barium chloride in distilled water; dilute an ounce of the oil with one ounce of high gravity gasoline to thin it, then add six or seven drops of the barium chloride solution. If sulphuric acid is present, a white deposit or precipitate will be formed.

Copper Test—A simple test for acidity may be made by immersing a piece of highly polished copper in the lubricant for twenty-four hours. Should the surface of the copper appear dull at the end of this time, the lubricant contains acid and should be rejected as unsuitable for use with ball bearings.

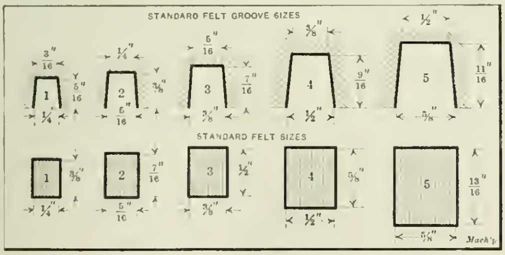

Fig. 4. Diagram showing Standard Sizes of Felt Packings and Grooves adopted by S K F Ball Bearing Co.

The renewal of lubricant in ball bearing mountings depends to a great extent upon the operating conditions of the machinery. In the ordinary type of installations, operating under normal conditions, renewal should be made about once every two months, although close observation for a short time after installation will enable a closer estimate of this period to be made. When renewing lubricant, the housing should be thoroughly washed out with gasoline. After the old lubricant has been removed, drain plugs should be again inserted and the housing filled with gasoline. If it is possible, the bearings should be rotated a few times so that each part of the bearing is brought under the cleansing influence of the gasoline. The drain plugs should then be removed and the housing carefully drained. The bearings should not be allowed to stand in gasoline because of their liability to rust and tarnish. If the machinery, after being lubricated again, should not be started immediately, it will be advisable to turn over the rotating parts at least once so that all parts of the bearings may become coated with the lubricant, thereby insuring protection against corrosion. The quantity of lubricant to be inserted depends on the size of the housing, the service conditions, and the speed.

When using grease as a lubricant for ball bearings, it is recommended that the first lubricant be applied by means of a grease gun through the lubricating openings and not by removing the end caps. This will reduce the chance of foreign matter entering the bearings and will also eliminate much of the possibility of injury to parts of the bearing. Care should be exercised to avoid putting too much grease into the housing, as this will result in its being forced out through the packings. An inspection of the machines during the early period of installation will enable the user to determine the proper amount of grease to be added. Lubricating plugs or caps of supply pipes must always be screwed up tight after the lubricant is inserted to avoid the entrance of dirt during the operation of the ball bearings; and the greatest care must be exerted to avoid dust, filings, and metal chips from getting into the bearings.

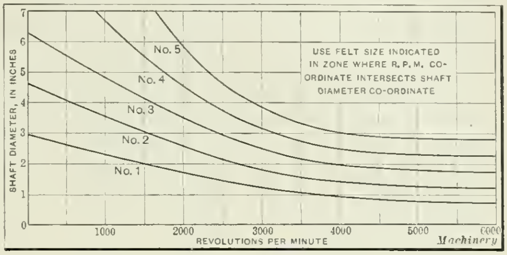

Fig. 5. Chart used for selecting Proper Size of Packing for a Given Ball Bearing Mounting

Designing Mountings for Ball Bearings

In designing mountings for radial ball bearings, it is the usual practice to provide for securing the inner race to the shaft or other rotating member, while the outer race is left free to rotate slowly inside the mounting. Two reasons for this procedure are that the outer race is allowed to revolve so that wear is uniformly distributed, and to enable this race to move very slightly in a longitudinal direction in order to align the inner and outer races accurately with each other. Mountings for ball bearings should be made in such a way that they will retain oil or grease in the bearing and exclude dirt and other foreign matter which would tend to accelerate the rate at which wear takes place. In Fig. 2 there are shown three methods commonly used for sealing ball bearing mountings. At *A* it will be seen that a cap is designed to be a tight fit over the end of the mounting, so that the joint produced is both oil-tight and dustproof. This is easily accomplished, because the cap is secured to a stationary machine member. At *B* is shown what is known as a "labyrinth" seal, consisting of a circular tongue on a stationary member which enters a corresponding groove cut in a rotating member. A clearance of from 0.001 to 0.003 inch is provided between the tongue and groove, and this space becomes filled with grease which constitutes an efficient seal. At *C* is shown a third method of sealing the joint between the mounting and the rotating shaft. This consists of machining a groove in the housing which may be filled with either grease or a felt packing to provide for the exclusion of dust.

Designing Mountings for Ball Bearings with Provision for Disassembling

In designing mountings for ball bearings, it is important to provide for having one raceway fixed and the other arranged so that it is free to creep around very slowly in its housing. When a shaft is the rotating member, the correct practice is to have the inner race secured to the shaft and the outer race free to move slowly around in its mounting.

Conversely, when a loose pulley rotates on a shaft, the outer race should be secured in the pulley and the inner race arranged so that it can creep around on the shaft.

In developing the mountings for ball bearings, it is common for the designer to produce a form that is satisfactory in other respects, but that is likely to give trouble due to failure to provide a means of disassembling the balls or races. In almost all cases the inner race of the bearing is made a light press fit on the shaft which is to be carried by the bearing. It will be apparent that if an attempt is made to pull the bearing off the shaft by applying pressure to the outer race, this will result in pulling the inner race off its press fit on the shaft through force applied on the inner and outer races by the balls, as a result of lateral movement of the outer race relative to the inner race. This pressure applied by the balls may become so great that slight checks or indentations will be produced in the races, and when such damage is done, a hammering action will be set up in the bearing when it is put back into service that will cause it to be rapidly destroyed. In Fig. 3 there is shown the design for a ball bearing mounting developed by the S K F Ball Bearing Co., which effectually overcomes damage to bearings through lack of suitable provision for disassembling. It will be seen that a cross-bar *A* and screws *B* are provided to fit into threaded holes in the cap *C* which seals the bearing mounting at one end. This cap *C* is so designed that when pulled against the bearing by tightening screw *D*, the inside of the cap engages both the inner and outer races of the bearing, and when the screw is tightened up still further, cap *C* applies a uniform pressure to the inner and outer races with the result that the inner race is pulled off its pressed fit on the shaft without any tendency for the outer race to move laterally in relation to the inner race. In this way, the bearing can be disassembled without any damage being done to the balls or races of the bearing.

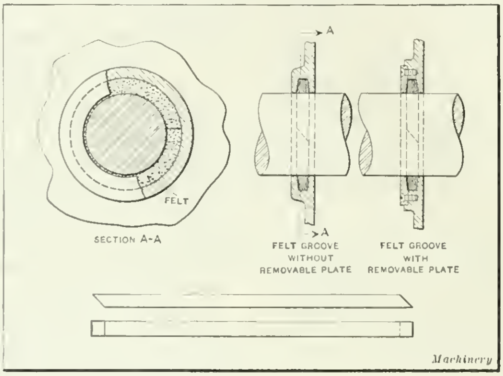

Fig. 6. Diagram illustrating Method of Procedure in making Felt Packing and fitting it into Grooves of Ball Bearing Mounting

Felt Packings for Ball Bearing Mountings

In studying the illustrations of mountings for ball bearings on different types of machine tools and other shop equipment, it will be noticed that in practically every case the caps which fit around the shaft at each end of the mounting are grooved to receive a packing which is used to exclude grit and other forms of dirt from the bearing. When a ball bearing is in operation, the rate at which the balls and races tend to wear is extremely slow until after an appreciable amount of wear has actually developed; but experience has shown conclusively that after the bearing has once started to wear, deterioration is likely to take place very rapidly. Obviously, the presence of grit or other forms of dirt in a bearing will accelerate the tendency for the bearing to wear, and it is on this account that particular care is taken to provide dustproof packings in ball bearing mountings.

When a shaft is rotating, the number of feet per minute at which a point on the surface of the shaft travels is governed by the diameter of the shaft and the number of revolutions per minute at which it runs. By holding either the angular speed or the diameter constant and changing the other variable it at once becomes apparent that an increase of the variable factor will result in increasing the linear speed of travel of the surface of the shaft. The size of felt packing used in mountings for ball bearings is governed by the linear speed of travel of the shaft, because the higher the speed, the larger must be the packing, in order to prevent its rapid destruction. In determining the required size of the felt packing consideration must be given to both the diameter of the shaft and the number of revolutions per minute. The S K F Ball Bearing Co., of Hartford, Conn., has made a careful investigation of this subject, as a result of which five standard sizes of felt packings have been adopted which are suitable for use in grooves of specified sizes.

In Fig. 4 are shown the standard groove and felt sizes which have been adopted, and a chart is presented in Fig. 5 which is used in determining the proper size for the groove and felt packing which are required for any given conditions of shaft diameter and speed of rotation for which a ball bearing mounting must be designed. In using this chart, the horizontal line corresponding to a given shaft diameter and the vertical line corresponding to the number of revolutions per minute at which this shaft is to run are located on the chart, and the intersection of these horizontal and vertical lines is then found. The size of the felt packing which is required is determined by the area on the chart in which this point of intersection lies. For instance, suppose it is required to have a shaft 2 inches in diameter rotate at 2100 revolutions per minute. The horizontal and vertical lines through 2 inches and 2100 revolutions per minute are located in the area which indicates that a No. 2 felt packing is necessary to fulfill the requirements of this service. The dimensions of the required felt packing and groove are found from the diagram reproduced in Fig. 4.

In making these packings, it is very important to use a suitable grade of felt, as the material must be of good quality and compact structure in order to stand up satisfactorily under the conditions of service to which it is subjected. It is also important to make each of the packings in the form of an endless ring in order to avoid possibility of dirt finding its way into the bearing at the point where the ends of the felt are joined. After cutting off a piece of the required length, the ends are cut off at an angle, so that they can be sewed together and form a close-fitting joint with the felt packing of uniform size at the joint. It is also important for the joint to be in a plane perpendicular to the axis of the shaft and not parallel to the axis. The reason for this is quite obvious, as with the joint in a plane parallel to the axis of the shaft, it would be easier for dirt to find its way through the joint and into the bearings. The method of splicing the ends of the felt packing, and the proper position for the packing in the housing are shown in Fig. 6.

Application of Ball Bearings in Machine Tools

The application of ball bearings in motor cars has demonstrated their ability to save power and to operate under severe conditions of service with very little wear. Machine tool builders were not slow to realize the possible advantages to be secured through the application of bearings of this type in the machines which they manufacture. One of the earliest applications was for supporting the thrust load on drilling machine spindles, but subsequently ball bearings have been used in many other types of machine tools. It is generally conceded that for supporting driving shafts in machinery, and for use in countershafts and lineshaft hangers, ball bearings are the means of effecting a substantial saving in power, and about the only reason why they are not generally used in these cases is that some machinery builders and shop superintendents still have to be convinced that the additional expense of ball bearings would be offset by the saving of power.

Conditions Required in Machine Tool Spindle Bearings

About the only point on machine tools where there is a considerable difference of opinion in regard to the desirability of using ball bearings is for supporting the main spindle. Designers of machine tools are faced with the necessity of fulfilling two sets of conditions in the spindle bearings, which at first sight appear to be diametrically opposed to each other. In order to maintain the desired degree of accuracy in the work, it is necessary for the fit of the bearings that carry the spindle to be as nearly free from vibration and lost motion as it is possible to make it, but to obtain a satisfactory degree of efficiency in the transmission of power, the bearings must also be a free running fit. The service required of these bearings is exceptionally severe, owing to the fact that the loads are subject to sudden changes of magnitude and of the direction in which they are applied. At first sight, it may appear that these two sets of conditions are entirely incompatible, but experience has shown that there are several ways in which the desired combination of conditions may be secured. One method which has been found to give satisfactory results is to use ball bearings for supporting shafts and spindles. Owing to the conditions under which these bearings operate, which have been described in an earlier paragraph, frictional resistance is practically eliminated, and in the case of properly made bearings, the amount of wear is a negligible quantity, so that lost motion will not result in inaccuracy of the work produced on machine tools equipped with ball bearings.

Use of Ball Bearings for Carrying Machine Tool Spindles

During recent years, there has been some controversy between different designers and builders of machine tools concerning the desirability of supporting machine tool spindles in ball bearings, if it is required to obtain accurate work from the machine. It is generally conceded that the use of ball bearings is the means of effecting a substantial increase in transmission efficiency with a corresponding reduction in consumption of power; but those who are not in favor of the use of ball bearings in place of the standard tapered bronze boxes with provision to compensate for wear claim that, after they have been in use for a short time, ball bearings develop a slight amount of lost motion. In order to substantiate the accuracy of this contention, the claim is made that even if the proper size of ball bearing is selected for the service required of it, and granting that this bearing is a perfectly tight fit at the time it leaves the ball bearing manufacturer's plant, lost motion will develop shortly after the bearing has been placed in service. Those who argue along this line state that it in no way contradicts the claim made by the manufacturers that bearings of this type will run for years without showing any sign of wear. The claim made is that, at the time the bearing is new, the surface of the balls and of the inner and outer races are covered with a multitude of very fine scratches left by the abrasives with which these surfaces were ground, and that, when the bearing is started to run under load, it results in these scratches being rolled down to produce a smooth bearing surface, which is highly efficient as regards its freedom from friction, although this improvement in the bearing surface is attained at the expense of a slight amount of lost motion in the bearing. To overcome this criticism, ball bearings used to carry machine tool spindles should be of a type which makes it possible to so design the mountings for the bearings that means are provided to compensate for the slight amount of lost motion which develops shortly after the bearing is placed in service. Some ball bearing manufacturers state that the slight roughness referred to above does not exist when the grinding is properly performed and is followed by polishing.

The use of ball bearings for carrying machine tool spindles is a relatively recent development, and, as in the case of practically all departures from well-established practices of machine design, it is quite natural to expect that many designers will claim that it is impossible to find a satisfactory substitute for the tapered bronze bearing box which is used in a great majority of bearings for machine tool spindles. Despite this fact, there are a number of machinery builders who are now mounting spindles in ball bearings and claim that perfectly satisfactory results are being obtained. It is the contention of these men that, to obtain satisfactory results from ball bearings in this class of service, certain precautions must be taken, the observances of which determine the success or failure of the design. Probably the best way of discussing this matter will be to show typical applications of ball bearings in machine tools and explain methods of mounting which different manufacturers have found to be satisfactory.

The preceding discussion has been concerned with outlining the basic principles which must be observed in the design of mountings for ball bearings, and the methods of lubricating the bearings in order to reduce frictional resistance and protect the balls and raceways from rust. The second installment of the article, which will be published in September, will describe the methods used by representative machine tool builders in applying ball bearings in their machines.

* * *

OBTAINING GOOD RESULTS IN TAPPING[1]

In order to obtain satisfactory results in tapping, it is first necessary to obtain good taps and dies that are properly designed for the work to be done, and that have been accurately machined, carefully hardened, inspected, and tested. In all cases great care should be taken to bring the tap into as nearly perfect alignment with the hole as possible. If the machine is out of alignment it should be corrected, and in no case should a floating holder be used simply to compensate for any error in alignment. Good results can be obtained by holding the tap in a telescopic holder, but the friction between its sliding surfaces should be kept as low as possible; also it should have a minimum amount of lateral float. The holes to be tapped should be large enough to prevent any binding or excess friction, and care should be taken to see that they are drilled deep enough to prevent the tap from coming into contact with the bottom, or with chips resting on the bottom of the hole. The cutting edges of taps should be kept sharp; as much attention should be given to them as to the cutting edges of any other tool. The proper lubricant should be used, and a good supply forced, or allowed to flow, over the tap while tapping. The kind of lubricant adapted to any particular work should be determined by experiment.

The most efficient speed should also be determined by experiment, and this speed should then be maintained. In many cases too low spindle speeds are responsible for inferior threads and a high percentage of tap breakage. Starting or reversing should be accomplished with as little shock as possible to the tap. The tap should be guided forward and back again as nearly as possible at the same speed as that with which the tap feeds forward or back in the work. A long bar of stock that is bent should not be put in a machine, as the shaking resulting from this practice causes breakage of taps, inferior threads, and rapid wearing of the machine bearings.

To obtain the highest efficiency, tapping should be accomplished by a separate operation. This avoids the necessity of delaying turning or boring operations while making repairs or adjustments for the tapping operation. In this way, more accurate threads can be produced and there will be a minimum of spoilt work and tap breakage.

* * *

Machinery may be badly damaged by being hauled from the railway depot to the plant by inexperienced teamsters, but as this damage may not be discovered until the plant is in operation, it will very likely be charged against the manufacturer as a defect in construction. Recently, some large air compressors were loaded upon the wagon in such a way that the stress of the shocks from the wheels was carried by bolts in the lining of the cylinder that separated the water jacket from the compressor chamber, with the result that the bolts were strained and a joint was opened. The cause of the leak, however, was known in this case, for an engineer had noticed the compressor on the dray and had called attention to the faulty loading, predicting the damage that was later found

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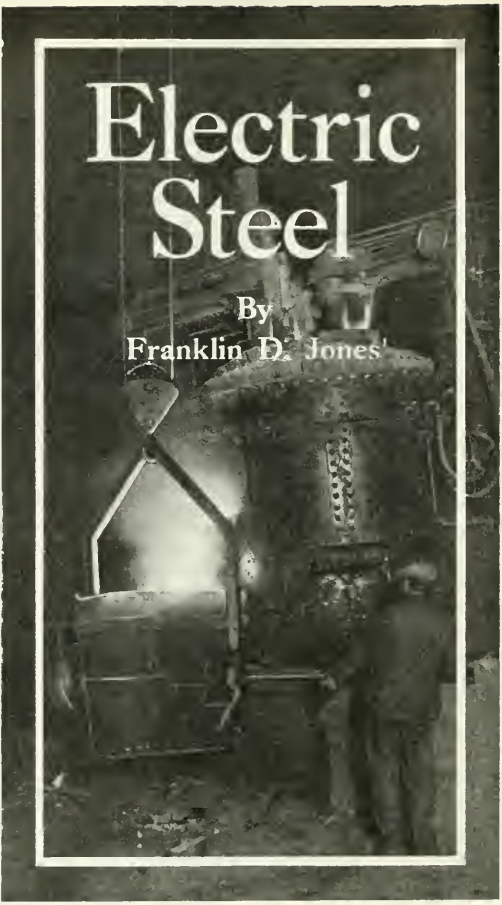
[1] Summary of a paper read by Harry E. Harris, president of the H. E. Harris Engineering Co., Bridgeport, Conn., before the Connecticut Section of the American Society of Mechanical Engineers at Bridgeport, Conn.

Electric Steel

By Franklin D. Jones[*]



WHILE electric steel or steel made in the electric furnace is not a new product, the expansion of this branch of the steel industry has been so rapid, especially since the beginning of the war, that users of steel as well as steel-makers are naturally interested in the reasons for this rapid growth and the trend of its development. In 1908 there was only one furnace in the United States producing electric steel and the output for the year was only about 55 tons. The number of electric furnaces installed in the United States on January 1, 1918, was 233 and many new installations have been made during the past six months. The estimated tonnage for electric steel during 1917 varies greatly and ranges from about 235,000 tons up to one million tons. Whatever the tonnage, it is certain that the electric steel industry, which a few years ago was in the experimental stage, is now on a firm commercial basis.

Early experiments in the production of electric steel were made by Sir William Siemens, who constructed a small arc furnace in 1878. Twenty years elapsed, however, before the Stassano furnace, which was the first to operate commercially, was introduced. The use of electric furnaces would doubtless have increased more rapidly after the introduction of this process had it not been for the relatively high cost of generating electrical energy at that time. The wonderful advancement made in both the generation and distribution of electricity during recent years, combined with the advantages of the electric furnace for certain melting and refining processes, has resulted in the rapid development of this method of producing steel.

Application of Electric Furnaces in Steel Industry

Electric furnaces are adapted primarily for melting and refining processes, and they probably will never be able to compete with the blast furnace for smelting ore except under certain favorable conditions. What might be defined as "an electric blast furnace," was developed in Sweden in 1910. This furnace is similar in principle to an ordinary blast furnace, except that it is provided with three electrodes which take the place of the tuyeres. The furnace operates without an air blast, and either charcoal or coke is used for melting the charge of iron ore. The charge is fed into the top of the furnace in the usual way. The use of the electric furnace for smelting iron ores is evidently limited to localities where hydro-electric installations and cheap electrical power are available. One electric furnace which has been installed in the United States and is used for smelting has a rectangular steel shell lined with a refractory material and a sloping bottom to facilitate the flow of the molten metal. Five stacks which extend above the roof of the furnace are used for charging and graphite electrodes are located between these stacks. The furnace is charged at regular intervals and its operation is continuous.

The important applications of electric furnaces in the steel industry are for making special alloy steels, tool steel (including ordinary carbon steel and high-speed steel), for melting the steel used in making steel castings, and for melting the ferro-alloys which are added to "special steels" to secure different chemical and physical properties. Most of the ferro-alloys used in the United States prior to the war were imported, but, at the present time, large quantities of the alloys used in producing high-speed and special steels are manufactured in this country. These alloys include ferro-silicon, ferro-chrome, ferro-nickel, ferro-tungsten, ferro-manganese, ferro-vanadium, etc. The electric furnace has also been used to some extent for refining cast iron in the foundry instead of using a cupola, and also low-phosphorus pig iron and "washed metal." "Washed metal" is pig iron from which most of the silicon and phosphorus have been removed, and it is used for making special low-phosphorus steel.

Most of the electric steel produced is used either for making special alloy steels or tool steel, although the electric furnace is used extensively in steel foundries. No accurate data are available as to the amount of tool steel made electrically compared with the output of the crucible process. Some steel-makers and metallurgists contend that the electric furnace not only produces much more tool steel at the present time than the crucible process, but that ultimately it will be used almost exclusively for tool steel production. Others connected with the steel industry believe that there will continue to be a field for both the electric and crucible processes and that the electric furnace is adapted more especially for the production of special alloy steels for use in the construction of automobiles, airplanes, ordnance, etc. Steel may be produced in the electric furnace which is undoubtedly equal to crucible steel in quality, if not superior, and it is claimed that the electric process is

In view of the fact that the use of electric furnaces in steel foundries and for producing special alloy and carbon tool steels has increased very rapidly since the beginning of the war, the general application of the electrical process and its advantages, dealt with in this article, are of timely interest. The article also describes the various types of furnaces in common use and the methods of operating them either independently or in conjunction with the more common refining processes.

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[*] Associate Editor of Machinery

more economical, especially at the present time, on account of the cost of crucibles.

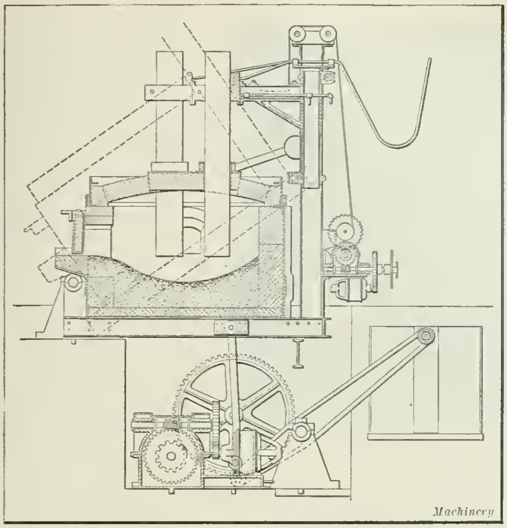


Fig. 1. Small Heroult Furnace and its Electrically Operated Tilting Mechanism

There is a decided difference of opinion regarding the present and future use of the electric furnace in preference to the open-hearth furnace. Even though the cost of electric steel is higher than open-hearth steel, the greater degree of refinement and closer regulation that is possible with the electric furnace offset this difference of cost for the finer grades of steel. In steel foundry practice, it is claimed that an equivalent tonnage of high-grade electric steel can be produced at an average lower cost than the ordinary commercial grades of open-hearth steel, since the charge of the electric furnace may consist entirely of old scrap which is cheaper than the combined scrap and pig iron required with the other process. One of the striking features of the electric furnace development is the size of the installations. A great many plants are now equipped with furnaces having a capacity of five or six tons, but ten, fifteen, and twenty-five ton sizes are in use. The United States leads at present in the number of electric furnaces in operation and Great Britain occupies second place. The world's largest single center of electric steel production, however, is in Sheffield, England.

General Classes of Electric Furnaces

Electric furnaces are used either for melting and refining metals, or for heating them to some temperature below the melting point, as in connection with the heat-treatment of steel. The three general types in use may be classified electrically as arc furnaces, resistance furnaces, and induction furnaces. With each type, the heat is derived from electrical resistance, but the nature or form of the resistance varies in the different general classes of furnaces mentioned. The arc furnace, which is the most important type in the steel industry, is equipped with electrodes, the current passing from one electrode to another. These furnaces differ in regard to the arrangement and number of the electrodes, as explained later. The arc furnace is used almost exclusively in the production of electric steel.

While all electrical furnaces depend upon electrical resistance, the general type in which heat is generated by the passage of a current either through the charge or through a resistor forming part of the furnace is classified as a resistance type to distinguish it from the others. Some of these resistance furnaces are so arranged that electrodes come into contact with the charge and the latter forms the resistance. This is the direct resistance class. Another type has a resistor which surrounds the furnace crucible and heats it by direct radiation, and there is a third class in which the heat generated in the graphitic or other resistor is radiated to the walls of the furnace and is then reflected onto the charge. Resistance furnaces in general are used principally for heat-treating, annealing, and for melting non-ferrous metals.

With the induction type of furnace, the heat is generated in the metallic charge by means of induced currents. This type is similar in principle to a static transformer, the material heated corresponding to the low tension winding. Thus, the induction furnace may be defined as an electrical apparatus which contains within itself the transformer that induces the heat in the charge, whereas the arc furnace is practically a hearth which holds the charge, and the arc is the source of heat, serving the same purpose as the flame in an open-hearth furnace. The first induction furnace for steel melting was developed by Kjellin, in Sweden, about 1900. The primary winding of a Kjellin type surrounds the core and is within a cylinder made of refractory material and cooled either by circulating water or a forced draft. The annular shaped hearth containing molten metal is beyond the windings and acts as a single turn of the secondary winding; consequently, when current flows through the primary winding, a current is induced in the bath of metal which is thereby heated, practically all of the electrical energy being converted into heat. Induction furnaces are used very little in steel plants, but are applied principally in melting non-ferrous metals.

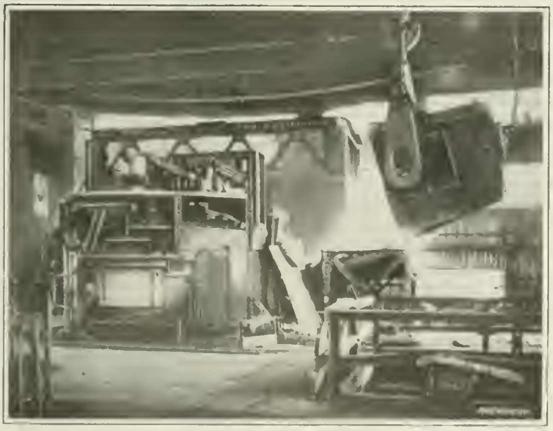


Fig. 2. Twenty-five-ton Heroult Furnace receiving Charge of Molten Metal

Methods of Operating Electric Furnaces

Electric furnaces may either melt a cold charge or they may receive the metal in a molten condition. Most of the electric furnaces now in use are for cold melting, but the larger sizes are commonly arranged to use molten charges. After the introduction of the electric furnace, steel manufacturers soon recognized that it might be used to advantage in conjunction with the Bessemer converter and open-hearth furnace, following the plan of the well-known "duplex process" by which the metal is partly purified in a Bessemer converter and is then further refined in the open-hearth furnace. In fact, the first electric furnace installation in the United States consisted of an open-hearth furnace for preliminary melting and refining, and an electric furnace which received the molten metal for deoxidizing and desulphurizing it and for making whatever additions or changes might be necessary to secure the desired analysis. This is often called the "hot metal process." Both Bessemer converters and open-hearth furnaces are also used in conjunction with the electric furnace. The Bessemer converter is used for decarbonizing and desiliconizing the metal; the open-hearth furnace is then used for dephospherizing it, and the refining process

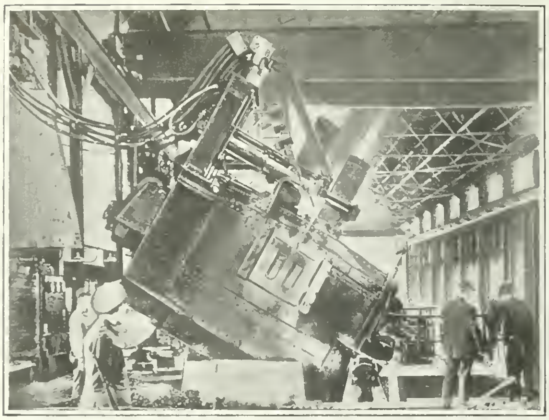


Fig. 3. Twenty-five-ton Heroult Furnace in Pouring Position

is then completed by deoxidizing and desulphurizing in the electric furnace. One installation operating on the triplex system consists of ten electric furnaces having a nominal capacity of 25 tons each, two 25-ton open-hearth furnaces, and two 25-ton Bessemer converters, the three processes being used in tandem. The metal is first "blown" in the Bessemer converter. Then it is transferred to the open-hearth furnaces and finally to the electric furnaces. The estimated capacity of this plant is 50,000 tons of electric furnace steel per month.

Electric furnaces may either be basic or acid, but a large percentage are lined for basic operation. The basic furnace permits the use of a basic slag which serves to remove impurities from the metal, just as in the basic open-hearth furnace. Thus phosphorus, sulphur, and oxygen may be removed, which permits using relatively cheap raw materials. With the acid process, no phosphorus or sulphur is removed, and if these elements are to be held within narrow limits, the materials composing the charge must be carefully selected.

Advantages of Electric Process

The steel produced in the electric furnace may be chemically purer than that made by any other process, although it does not necessarily follow that electric steel has superior physical qualities simply because it is pure chemically. Inferior grades of steel may be produced in the electric furnace, and the extremely high temperatures obtained from the electric arc are often referred to as the principal cause of poor electric steel. The fact remains, however, that the electric furnace when properly designed and used is capable of producing steel which chemically or physically is unexcelled. One advantage of the electric furnaces is that they permit of closer control of the composition of steel than any other process, which accounts for their use, for instance, in preference to the open-hearth furnace in the production of special alloy steels. In the electric furnace, since the heat is obtained from the electric current and no fuel is burned, there are no impurities introduced from the gases of combustion; in fact, fusion may be effected in a neutral or reducing atmosphere. Less excess alloy needs to be added to the heat in an electric furnace to insure the proper amount in the finished steel. Some steel makers claim that it is necessary to use only one-half the amount of ferro-manganese that would be required with the best open-hearth practice. Another point in favor of the electric furnace is that the alloy additions for making alloy steels may be made in the furnace itself, rather than in the ladle, thus insuring thorough assimilation, diffusion, and a more homogeneous product.

Accurate control of the composition of electric steel tends to make the results of heat-treatment more certain, and it may be subjected to a higher degree of heat without injury in forging or in connection with heat-treatment than is the case with other steels. The electric furnace also has an advantage in that it may be used in recovering alloy scrap, which, in some cases, is not desirable to include in the charge of an open-hearth furnace. Furthermore, when alloy scrap is used in an open-hearth furnace, a large proportion of the alloy metal is lost in the slag. It is practicable to use relatively cheap raw materials in the electric furnace and to convert them into high-grade steel, which can be deoxidized and desulphurized almost completely. The phosphorus and sulphur may not exceed 0.010 per cent, and in carbon steel the average sulphur content is lower, whereas, in alloy steels, the sulphur barely exceeds 0.015 per cent.

Tests of electric and open-hearth steels each having a carbon content of 0.12 per cent showed the following physical properties: Ultimate strength of open-hearth steel, 56,500 pounds per square inch; elongation in two inches, 29.82 per cent; ultimate strength of electric steel, 65,200 pounds per square inch; elongation in two inches, 26.05 per cent. When the carbon content was increased in each case to 0.20 per cent, the ultimate strength of the open-hearth steel was 58,320 pounds per square inch; and the elongation in two inches, 28.35 per cent. The ultimate strength of the electric steel was 73,150 pounds per square inch, and the elongation in two inches, 22.75 per cent.

Types of Arc Furnaces Used in Steel Industry

Since the arc furnace is used almost exclusively in the steel industry, only this general type will be considered. All arc furnaces may be divided into two classes, first, the arc-radiation class and, second, the arc-resistance or arc-conduction class. Furnaces of the second class may belong either to the short-arc type or the long-arc type. The Stassano furnace, which was the first commercial design, heated the metal almost entirely by radiation from the electric arc and belongs to the arc-radiation class. The arc-resistance type is so arranged that heat is generated by the arc and by the passage of current through the charge. The current may either pass along the surface of the charge to the other electrodes or through the body of the charge.

The arc furnace may use either direct or alternating current, the latter being used largely, since this is the current supplied by most power companies. The three-phase current is employed more than the two-phase or single-phase. The voltage depends upon the length of the arc, as the latter is a form of electrical resistance. Whatever voltage is required for melting or heating is obtained by transformers at the

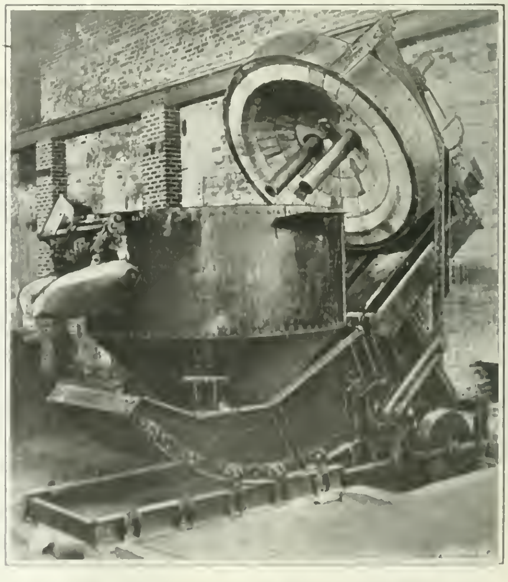


Fig. 4. Five-ton Snyder Furnace with Roof tilted back for Charging

furnace, so that the transmission voltage may be of any value. The usual potential between electrodes is about 100 volts.

Heroult Electric Furnace

The Heroult furnace, which is now used more than any other type, belongs to the arc-resistance class. The electrodes are placed above the bath and the current passes from one electrode to the metal and from the metal to the next electrode. In this way, the bath is heated both by the heat radiated from the arc and by the heat produced by the resistance of the steel and the slag to the passage of the current through them. Fig. 1 shows a sectional view of a three-phase Heroult furnace and its electrically operated tilting mechanism. The three electrodes extend down through the roof of the furnace and are so located that lines joining their centers form a triangle. The steel shell of the furnace is lined with a refractory material, the exact nature of which depends upon whether the furnace is to be basic or acid in its operation. The three electrodes are connected with the transformers by flexible cables which permit the furnace to be tilted while pouring the charge. The furnace shown in Fig. 1 is so arranged that it tilts about a hinge located just below the spout so that the latter remains nearly stationary while pouring. The dotted lines indicate the pouring position. Power for tilting the furnace is derived from a motor which transmits motion to a large gear wheel through a combination of spur and worm gearing. This gear wheel is connected directly with the furnace by means of rods, as the illustration shows. One advantage of this arrangement is that, if the operator fails to stop the motor, the furnace will simply descend to its original position; moreover, when the furnace is either at the upper or lower positions of the stroke, it will move in the desired direction, no matter which way the controller is operated. The weight of the furnace is balanced by a counterweight which connects by means of levers.

The 25-ton Heroult furnace illustrated in Figs. 2 and 3 is the largest size in use at the present time. Fig. 2 shows a charge of molten metal being poured from the ladle into the furnace, and Fig. 3 shows the furnace tilted and the refined charge being poured.

Snyder Electric Furnace

The Snyder electric furnace belongs to the arc-resistance class and is a long-arc type. The electric current may be either single-phase, two- or three-phase, or direct-current, but the latter is not commonly used. The single-phase or direct-current furnaces have two electrical connections, whereas the two- or three-phase furnaces have three or more, according to the type. The three-phase furnace has two of the phases connected to the movable carbon electrodes at the top, while the third is connected to a metal contact at the bottom of the furnace. The Snyder furnace is doorless, and the entire roof of the furnace is tilted back for charging, as shown in Fig. 4. After the charge has been dropped into the furnace, the roof is pulled forward by a motor and sealed with a dry fireclay gasket. The electrodes may be either hand or motor-operated, an automatic regulator being applied in the case of motor operation. An advantage claimed for the long arc is that it minimizes the necessity of moving the electrodes. The opening roof feature also reduces the time for charging, since machinery can be used instead of shovels. These furnaces are arranged in three different ways to meet the pouring requirements under different conditions. With the rocking type illustrated in Fig. 4, which is the most common, the end of the spout moves forward and down as the furnace is tilted to the pouring position. This type is recommended when it is relatively easy to move the ladle to correspond with the movement of the spout. The second or "heaving" type has a circular shaped rocker underneath the furnace which is so located that the spout remains practically stationary as the furnace is tilted. This arrangement is especially adapted for hand ladle work. With the third or "dumping" type, the spout moves down and backward. This type is ordinarily preferred for small installations in which it is easy to follow the spout with hand ladles.

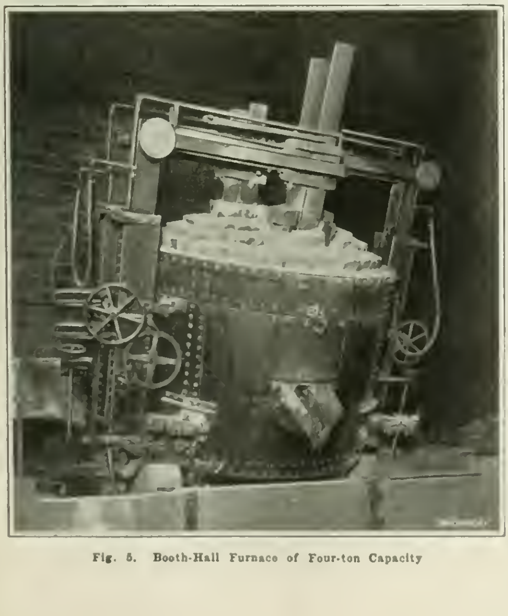


Fig. 5. Booth-Hall Furnace of Four-ton Capacity

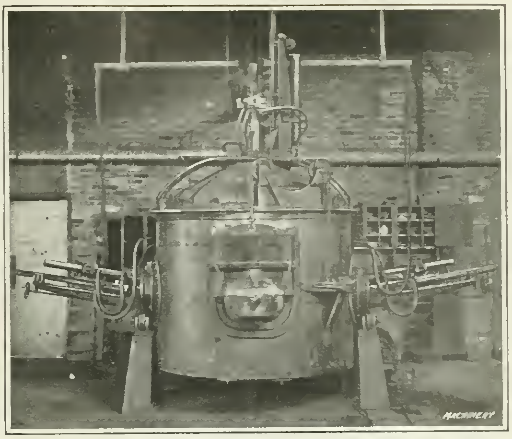


Fig. 6. Front View of One-ton Rennerfelt Furnace

Rennerfelt Electric Furnace

The Rennerfelt electric furnace operates with a free-burning arc like the Stassano furnace, but differs from the latter in the way the arc is formed. A cross-sectional view of a three gross-ton size is shown in Fig. 7. There are three electrodes, a vertical electrode being placed between two which are shown in a horizontal position but may be tilted, as explained later.

The vertical electrode carries about 40 per cent more current than the others, so that the arc is thrown downward toward the bath and away from the roof of the furnace. The three-phase current, which may be of any voltage and frequency, is transformed to a two-phase three-wire system. The two side electrodes are connected to the terminal of each phase, and the top one is connected to the middle conductor. The power input is regulated by moving the side electrodes in or out, thus changing the length of the arc. This adjustment may be effected by hand or by electric motors controlled either automatically or by means of push-buttons. The top electrode has to be moved downward perhaps once an hour, depending upon its consumption. When charging the furnace, the side electrodes are tilted upward, thus leaving sufficient space beneath for inserting the whole charge at one time. As the charge melts, the electrode ends are continually lowered, thus keeping the flame about two or three inches over the bath. A one-ton Rennerfelt furnace is shown in Fig. 6. The

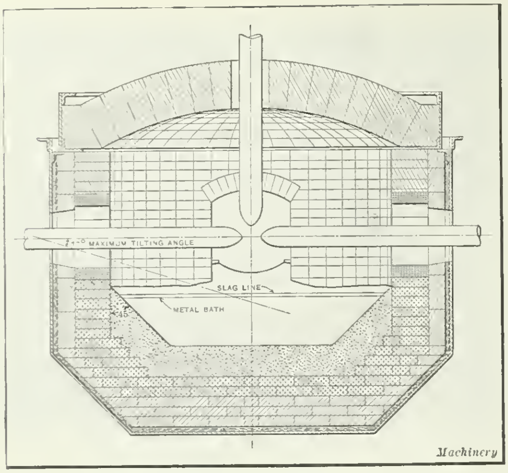


Fig. 7. Sectional View illustrating Arrangement of Electrodes on Rennerfelt Furnace

electrodes at the sides and their holders, and the upper vertical electrode, may be seen in this illustration. These furnaces are provided with trunnions resting on roller bearings supported by frames at the sides and they are tilted either by hand or by motor, depending upon the size. The furnaces with a capacity up to one ton have only one working door which is used both for charging and pouring; the larger furnaces have one charging and one pouring door.

Booth-Hall Electric Furnace

The Booth-Hall furnace, shown in Fig. 5, is so arranged that power is introduced through one, two, or three main vertical electrodes, the number depending upon whether the furnace is to operate single-phase, two-phase, or three-phase. The furnace also has an auxiliary electrode and wrought-iron grids which are imbedded in a hearth with a refractory facing. The auxiliary electrode is inserted vertically through the roof, except in small furnaces, in which case it is inserted obliquely through the door opening. The two-phase furnace is considered preferable for the usual power supply and steel refining conditions, and the following description applies particularly to this class.

When starting a heat in a two-phase furnace with a cold charge, a pawl on the auxiliary electrode holder is released, permitting the electrode to rest upon the scrap charge. Arcs are then drawn with the two main electrodes and the metal begins to melt under these arcs. The auxiliary electrode acts as a common neutral or return, no arc being drawn, and consequently no melting occurs under the auxiliary electrode. When enough molten metal has accumulated on the hearth to make the latter a conductor of electricity, the current begins to flow through the wrought-iron grids. The auxiliary electrode is then withdrawn from the furnace entirely, and the opening for it is closed. The furnace then continues to operate, the current passing through the main vertical electrodes, the bath, and the hearth, and out through the grids. The transformer connections are so arranged that each of the two phases has an independent circuit. The arcs are governed by automatic electrode regulators for maintaining a uniform power input into the furnace and a balanced load on the lines.

Since there are only two electrodes entering the roof of a two-phase furnace except at the beginning of a heat, it is claimed that the furnace has a relatively low radiation loss, less electrode breakage and electrode consumption, as well as a lower initial cost for the furnace equipment, as compared with types having three or four main electrodes. The possibility of failure to secure contact when starting a heat is said to be eliminated by the use of the auxiliary electrode. The two main electrodes and the auxiliary electrode acting as a common neutral make it possible to use the arcs for sintering in the hearth of the furnace layer by layer, thus forming a monolithic mass that is durable. All the tilting and electrode regulating mechanism is below the floor and is completely covered. Furnaces ranging from 2½ to 6 tons capacity are built two-phase, since in practically all localities a single-phase load for such furnaces would not be acceptable to power companies. For refining steel, the two-phase furnace is recommended, except in 8- and 10-ton sizes, in which case the three-phase type is regarded as more practicable. Furnaces up to 1½ ton holding capacity intended for the straight melting of scrap are made single-phase, unless power conditions are such that a single-phase load is not acceptable.

Ludlum Electric Furnace

The Ludlum electric furnace is of ellipsoidal form, and it has three electrodes which extend down through the roof. These electrodes instead of being located in triangular formation are in a straight line corresponding to the center line of the furnace, as may be seen in Fig. 8, which shows a ten-ton furnace in the pouring position. The electrodes are held by bronze arms projecting from beams attached to the furnace structure. These arms may be raised and lowered by automatic control or by handwheels. There are no bottom connections. The shape of the furnace is such that there are no straight side walls nor overhanging walls with the furnace in any working position. There is a door at each end but no spout. The furnace can be charged from both ends at once, and it is tilted by an electric motor to pour through one of the doors.

The furnace is filled with the charge of scrap to be melted, and at first the electrodes rest on the charge so that soon after the current is turned on the electrodes melt their way through nearly to the bottom. By this time, a pool of molten metal has formed beneath the electrodes because the deepest part of the hearth is directly below them. The charge is melted from the bottom up, the arcs remaining covered by the scrap until the latter is completely melted, so that the roof is not exposed to the high temperature radiating from an open arc. The roof of this furnace is in the form of a low arch and, in practice, an extra roof is built on a separate frame, so that the old one can readily be replaced at any time. For basic operation, the hearth is lined with magnesite brick to a thickness of nine inches or more.

Greaves-Etchells Electric Furnace

The Greaves-Etchells furnace, shown in Figs. 9 and 10, has two of the phases connected to the two electrodes above the bath while the third phase is connected to a copper plate which extends over the bottom of the furnace. The cur-

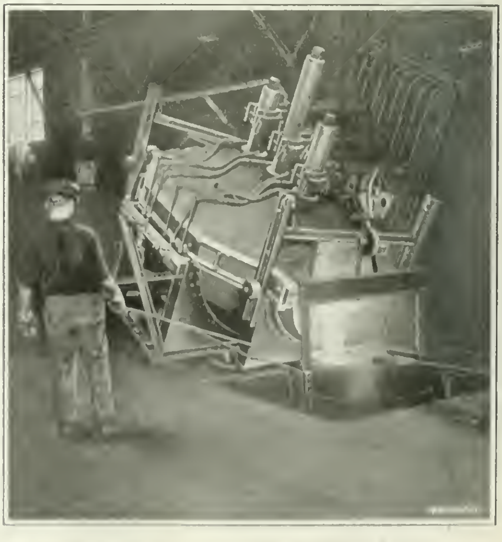


Fig. 8. Ten-ton Ludlum Furnace in Pouring Position

rent flowing through the hearth generates considerable heat below the bath and the electric arcs above the charge maintain the slag and surface at the desired temperature. Convexion currents in the metal resulting from the bottom heating cause a continuous circulation of the metal and uniform heating. The hearth lining, which is at least 20 inches thick, is made of dolomite, magnesite, and other materials, in such a way that the electrical resistance is high at the inside of the bath in proximity to the charge and decreases rapidly to a negligible quantity at the outside. The system of transformer ratios is arranged to give a balanced condition when the upper electrodes are in equal adjustment. The equipment has been designed to withstand any short-circuiting of the electrodes which may occur during the melting process when pieces of scrap fall against the electrodes. The transformer connections are such that the short-circuit current of one electrode must traverse two transformers in series and in different phase, which automatically lowers the power factor momentarily and also has a strong buffer effect; the permanent resistance in the path of the current through the hearth also limits the effect of short circuits. The raising or lowering of the electrodes for regulating the energy supplied by the furnace may be effected by automatic regulators or by hand control. The voltages across the arcs may also be varied in all except the smallest size of furnace, and the ratio of heat generated above and below the bath may be regulated over a wide range. The tilting mechanism is so arranged that the spout travels downward in a vertical line when pouring.

Girod Electric Furnace

The Girod electric furnace is an arc-conduction type of the class having bottom connections. The current is supplied by one or more carbon electrodes *A*, Fig. 11, which extend vertically through the furnace roof. The lower ends of these electrodes are near the level of the slag as in other furnaces. In the bottom of the furnace and as far as possible from the upper carbon electrodes, there are six or more steel electrodes *B* which pass through the refractory bottom and are in direct connection with the furnace shell and the low-tension side of the power plant. With this arrangement, the current is forced to pass through the charge, the object being to obtain a more uniform heat than when the arc is formed above the charge or passes through the upper surface. Another advantage claimed for the Girod furnace is that the current passing through the bath produces an electromagnetic field which gives the bath a rotary movement and accelerates chemical reaction.

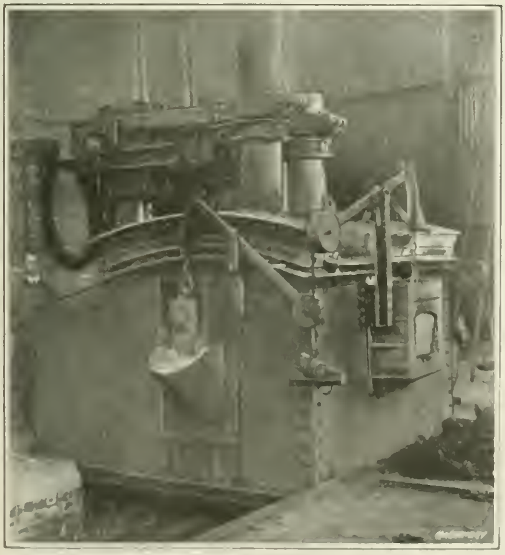


Fig. 9. Three-ton Greaves-Etchells Furnace

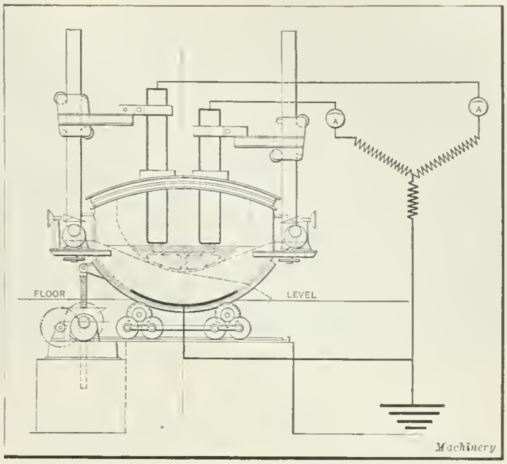


Fig. 10. Diagram illustrating Arrangement of Twelve-ton Greaves-Etchells Furnace

The Girod furnace may be adapted to any system of current, and the usual tension is 65 volts for small furnaces and 70 volts for large ones. The use of single-phase alternating current is considered preferable for furnaces of small capacity. Furnaces up to four tons in capacity are generally single-phase and have one carbon electrode, whereas larger sizes are three-phase and have three carbon electrodes. The use of a single-phase furnace involves, in a three-phase distribution system, the installation of rotary converters or motor generators with transformation losses of about 14 per cent. The three-phase furnace simply requires step-down transformers with energy losses of only 3 or 4 per cent. The connections of a three-phase furnace are arranged to give an equal load on each phase. The furnace is fitted with a sliding door through which the charge is inserted and the slag removed. Opposite the door is the tap hole.

Electrodes for Electric Furnaces and Their Regulation

The electrodes used in electric furnaces for steel melting and refining are made either of amorphous or graphitic carbon. The graphite electrodes are generally used on the long-arc type of furnace, but many short-arc furnaces are provided with amorphous carbon electrodes, because of the "umbrella" effect, since they are twice as large in diameter as the graphite electrodes and afford better protection for the roof against the intense heat radiated directly from the arc. While the electric conductivity of graphite is much higher than that of amorphous carbon, the former is more expensive. The number of electrodes depends upon the kind of current used and whether or not there are electrical connections through the bottom of the furnace. With bottom connections, a single-phase furnace requires one electrode; a two-phase furnace, two electrodes; and a three-phase furnace, three electrodes. If there are no bottom connections and the current either passes from one electrode to the other through the bath or if the electrodes are arranged to maintain the arc above and clear of the bath, then a single-phase furnace requires two electrodes; a two-phase furnace, four electrodes; and a three-phase furnace, three electrodes.

The adjustment of the electrodes to regulate the length of arc and the flow of the current may be effected by hand, but an automatic regulating device is generally employed. Hand regulation involves constant attention on the part of the operator, and is laborious on the large furnaces so that automatic regulation is preferable. The Thury system of regulation as applied to a three-phase furnace, has three regulators, there being one for each electrode. The electrodes are maintained in the desired positions by means of these regulators, in conjunction with the motor-driven electrode adjusting mechanism. The regulators are connected to a motor-driven countershaft, and each regulator is in the form of a double-

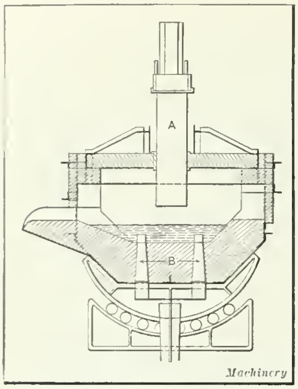


Fig. 11. Diagram showing Arrangement of Electrodes in Girod Furnace

throw switch for rotating the motor in either direction. The operation of this switch is controlled by a solenoid which is energized by current from a series transformer in the main circuit on the high-tension side. The regulating mechanism controlling the switch is held in equilibrium when the flow of the current is normal. Any decided variation in the flow causes the regulator switch to be thrown in whatever direction is required to restore the normal current flow by adjusting the electrodes. The electrode holders should be water-cooled in order to prevent arcing at the connections, although this may not be necessary on very small furnaces.

The automatic electrode control made by the General Electric Co. has a control panel consisting of three sections. On the upper section are located three electrode groups, each consisting of one contactor group and one shunt relay. The shunt relay is connected across the alternating-current circuit, and if the latter is broken or the power fails for any reason, the relay opens the control circuits, thus preventing damage to the furnace and loss of heat. The contactor group consists of one raising contactor, one lowering contactor, and one dynamic breaking contactor, all mechanically interlocked. On the middle section of the panel there is a glass case containing three contact-making ammeters, each controlling one contactor. Below each ammeter there is a dial switch for varying the number of effective turns in the ammeter coil and in this way the amount of power fed to the furnace. (A more recent design is equipped with a rheostat in shunt with the ammeter coil.) On the bottom section of the panel, there are four double-pole single-throw switches. One of these is a totalizing switch for the electrode motors, each motor being controlled by one of the three additional switches. On the back of the panel, three contactors are located for varying the resistance in series with the electrode motors when changing from normal to the emergency conditions, and vice versa.

Electric Furnace Linings

Magnesite and silica are the chief materials used for electric furnace linings. In a basic furnace, the lining of the hearth up to a point a little above the slag line is usually of magnesite, although dolomite may also be used. The furnace wall above the slag line may be lined with silica, magnesia, or chrome brick, the material being selected according to conditions. Silica is used for the roof lining of a basic furnace, and an acid furnace is lined with silica throughout.

The Rennerfelt furnace illustrated in Fig. 7 is lined for basic operation. Firebrick is placed next to the shell, as indicated by the single section lines. The next layer, which extends slightly above the slag line, consists of magnesite bricks (indicated by cross-hatching or double section lines) and an inner fused lining of dead burned magnesite. The side walls from the point where the magnesite bricks end, up to the roof, are lined with silica bricks which are also used for the roof. For acid operation, the bottom of the furnace would be made up of silica bricks with a fused lining of ganister on top, and the walls and roof would be lined with silica brick.

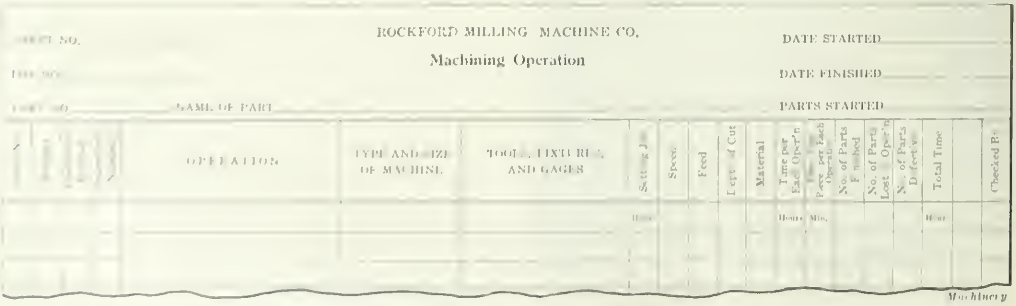
Electric Furnace Current Consumption

The current consumed by an electric furnace per ton of metal refined or melted depends somewhat upon the kind of steel, the degree of refining, the size of the furnace, and the general operating conditions. A furnace melting and refining plain carbon steel may have a current consumption as low as 450 kilowatt-hours per net ton, whereas, in the case of alloy steels, the consumption may vary from 600 to 800 kilowatt-hours. The current consumption is usually larger for the smaller installations and may be 800 or 900 kilowatt-hours for a furnace operating on special steels. When the sulphur and phosphorus contents with a given grade of scrap must be reduced to very low limits, more power is required, because more slag, made principally of lime, must be melted. Electric furnaces melting cold scrap and converting it into tool or alloy steels (using two slags) ordinarily have a current consumption varying from 700 to 800 kilowatt-hours per net ton, whereas, when producing a merchant grade of carbon steel (using one slag), the consumption may not exceed from 500 to 650 kilowatt-hours per ton, the amount depending upon the size of the furnace, the rapidity of the melting, and the grade of the scrap, rusty deoxidized scrap requiring more power. When the charge is not melted in the electric furnace and the latter is used in conjunction with either the Bessemer converter or the open-hearth furnace, the current consumption is relatively low. For instance, furnaces operating on the triplex system have required only 110 kilowatt-hours per ton.

* * *

CONVENIENT SHOP OPERATION SHEET

The accompanying illustration shows a shop operation sheet used by the Rockford Milling Machine Co., which makes it possible to keep a convenient record of all the information required in connection with the manufacture of parts. It will be noted that on this sheet the operation, type and size of machine, tools, fixtures, and gages used, speeds, feeds, depth of cut, material to be used, estimated time for setting up the job and for machining, as well as the total time for doing the work, are given. In addition, columns are provided for recording the number of parts finished, number of parts lost in operation, and number of parts found defective. A column giving the operator's number identifies the work with the man doing it. This operation sheet has been found convenient and meets the requirements very well. In the column headed "Time Per Each Operation" is recorded the time on a certain quantity of pieces for each setting. In the next column is recorded the time on one piece for each setting.



SHEET NO.

ROCKFORD MILLING MACHINE CO.

Machining Operation

DATE STARTED

[illegible]

DATE FINISHED

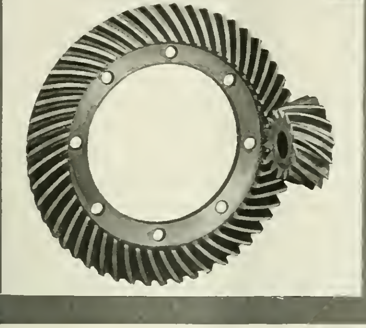
PART NO. NAME OF PART

PARTS STARTED

[illegible]	OPERATION	TYPE AND SIZE OF MACHINE	TOOLS, FIXTURES, AND GAGES	Setting Up	Speed	Feed	Depth of Cut	Material	Time per Each Oper'n	Piece per Each Operation	No. of Parts Finished	No. of Parts Lost in Oper'n	No. of Parts Defective	Total Time		Checked By
				Hours					Hours	Min.				Hours		

Machinery

Convenient Shop Operation Sheet used by Rockford Milling Machine Co.



Strength of Spiral-Type Bevel Gears

Formulas for Determining Strength of Spiral-type Bevel Gears and Principles upon which they Depend—By Reginald Trautschold[1]

AUTOMOBILE manufacturers who have adopted the spiral type of bevel gears in their transmissions have discovered that such gears, when accurately formed by generating machines, are appreciably stronger than similar bevel gears with straight teeth. With the present-day tendency to lighten car construction as much as possible, so as to reduce the dead weight propelled by the engine, the gearing unquestionably offers a field in which a certain saving in weight can be profitably made. Any reduction in the weight of gearing can only be considered, however, if there is no sacrifice in safety; that is, the gearing must be proportioned for strength according to the accepted Lewis formula for the strength of gear teeth. Departure from the proved practice of years would be detrimental to the interests of any manufacturer reckless enough to disregard past experience. The spiral type of bevel gear is quite unlike the plain spur gear, so that neither the Lewis formula nor the modified form suggested by Carl G. Barth, in which the speed factor ratio is introduced, can be used without considerable modification.

Before considering these modifications, a peculiar feature of the spiral type of bevel gear construction should be investigated, as it materially affects the strength of such gears. The cutter angle of the rotary generating tool employed to form the convex side of the teeth is slightly greater than the cutter angle used for forming the concave side. The variation is slight, but it is sufficient to give to each side of the tooth a slightly different, although similarly curved, profile. The effect of this construction on forward rotation is similar to that produced if the driving member in a gear combination has a greater pressure angle than the driven gear; the contact will commence on the pitch line of the teeth, not at the top of the teeth, as when the pressure angles of both gears are similar.

In Fig. 1 is shown the outline of a 14.5-degree driven tooth superimposed on a tooth having a 20-degree pressure angle, but which is otherwise of the same pitch proportions. The illustration shows only the outline of the teeth, but, as the tooth spaces must be conjugates of the teeth, it is evident that contact between addendum tooth profiles cannot take place between advancing tooth profiles in such an arrangement. As the addendum section of the driving tooth rolls into contact with the dedendum section of the driven tooth, a slight acceleration will be given to the driven gear. This, however, will not load the receding tooth profiles if the variation in their respective pressure angles is reversed, as it is in the spiral type bevel gear construction, for then the more obtuse pressure angle of the advancing driven-gear profile makes that profile slightly flatter than the receding profile of the driving-gear tooth. An exactly similar action takes place when spiral-type bevel gears are run together in forward rotation: The advancing profile of the driving gear has a slightly more obtuse pressure angle than the contact profile of the driven gear, while the pressure angles of the opposite profiles are reversed. The variation in the pressure angle of the convex and the concave tooth profiles is so slight in spiral-type bevel gears, however, that there is no appreciable acceleration as the gears roll into mesh, but there can be no stress on the teeth until they are in full mesh. This peculiarity, as well as the fact that more than one set of teeth is always partly in full mesh, has much to do with the silent properties of spiral-type bevel gears, and explains why they may be considerably stronger than similarly proportioned straight-tooth bevels.

Fig. 2 illustrates, diagrammatically, the stress to which gear teeth of the same pitch and size of gear, but differing in proportions, are subject at the instant of the first contact. At *A* is shown an ordinary involute tooth of standard proportions; at *B*, an involute tooth with an addendum equal to three-tenths the working depth of the tooth, but of the same total depth; and at *C*, the stress to which a spiral-type bevel gear tooth proportioned similarly to the tooth shown at *B* will be subject.

Investigation of a number of ordinary involute teeth of standard proportions that have been broken through excessive stress shows that fracture invariably occurs just within the dedendum circle, at a point approximately 7 per cent of the circular pitch from the dedendum circle. The line of fracture for teeth with an addendum equal to three-tenths the working depth probably occurs somewhat nearer the pitch circle, so that the line of fracture for the average tooth may safely be taken as on the dedendum circle, even in the case of a tooth that is appreciably under-cut. The breaking-moment arm *M* is, then, the length of a normal from the center of the fracture line to the pressure plane through the point of first contact. The force exerted on the tooth at the instant of first contact is, obviously, the same in amount for the three tooth constructions illustrated, so that the strength of the respective teeth is governed simply by the length of the breaking-moment arm *M* and the square of the chordal root thickness of the tooth at its weakest section, or just above the fillets.

Proportioning the teeth with a short addendum and a long dedendum, as shown at *B*, Fig. 2, increases the breaking-moment arm *M* slightly, and at the same time decreases the chordal thickness at the root of the tooth, so that the resulting tooth is considerably weaker than one of the same pitch, etc., and of standard proportions. Conversely, a tooth with a long addendum and a short dedendum is stronger than a tooth of standard proportions. If the proportions of the tooth shown at *B* are retained, but the loading of the tooth delayed until the pressure is first applied at the pitch line, as in the case of the driven gear in a set of spiral type (which is usually the weaker member of the combination on account of its short addendum and long dedendum) or as illustrated at *C*, Fig. 2, the breaking-moment arm *M* is considerably reduced, although the chordal thickness of the tooth remains the same. The result is a stronger tooth than the tooth of standard proportions.

Breaking-moment Arm Factor

In the case of the teeth shown at *A* and *B*, Fig. 2, the length of the breaking-moment arm, assuming the probable line of fracture to be tangent to the dedendum circle, is dependent, for all practical purposes, upon the whole depth *W* of the tooth and the pressure angle at the instant of contact. Actually, the governing length of the tooth is equal to the distance between a plane tangent to the dedendum circle at the neutral axis of the tooth and the point of first contact; this dimension is but slightly less than the whole depth of the tooth. The decrease is equal to the height of the arc forming the top of the tooth, or, in the case of the tooth shown at *C*, to the height of the semicircular pitch arc. As the whole depth of the tooth will be used only for comparative ratios, any error arising in the calculation of the breaking-moment arm *M* may be safely overlooked. The ratio of the breaking-moment arm to the whole depth *W* of the tooth will then equal the ratio of the diameter of the base circle of the gear to the diameter of the circle on which tooth contact first occurs, so that the breaking-moment arm is equal to the whole depth of the tooth multiplied by the quotient of the base circle diameter divided by the diameter of the circle of first tooth contact.

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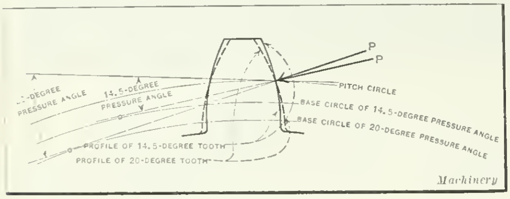

P
P
PITCH CIRCLE
-DEGREE PRESSURE ANGLE
14.5-DEGREE PRESSURE ANGLE
BASE CIRCLE OF 14.5-DEGREE PRESSURE ANGLE
BASE CIRCLE OF 20-DEGREE PRESSURE ANGLE
PROFILE OF 14.5-DEGREE TOOTH
PROFILE OF 20-DEGREE TOOTH
Machinery

Fig. 1. Tooth Profiles with Different Pressure Angles

In the case of gears on which tooth contact commences at the top of the teeth (all gears with similar pressure angle for either tooth profile), the breaking-moment arm is equal to the product of the whole depth of tooth multiplied by the diameter of the base circle divided by the outer diameter of the gear. In the case of gears on which tooth contact does not occur until they are in full mesh (gears on which the first tooth contact occurs on the pitch line), as with spiral-type bevel gears, the breaking-moment arm is equal to the product of the dedendum multiplied by the diameter of the base circle divided by the pitch diameter. The dedendum dimension is used in this case instead of the whole depth of the tooth, as contact between meshing teeth does not occur over the addendum section of the short-addendum gear. (See Fig. 2 and derivation of breaking-moment arm formulas.)

The influence of the altered breaking-moment arms on the strength of the teeth is found by dividing the breaking-moment arm for teeth with standard addendum (1) by the breaking-moment arm for teeth with short addendum, and (2) by the breaking-moment arm for teeth of the spiral-type bevel gear variety with short addendum. For standard gears with the addendum equal to three-tenths the working depth of the tooth, the modified breaking-moment arm factors are equal to the strength factor of gear teeth with standard addendum multiplied by the ratio of the number of teeth plus 1.2 to the number of teeth plus 2. For spiral-type bevel gears with short addendum, the modified breaking-moment arm factors are equal to the strength factor of gear teeth with standard addendum multiplied by the quotient of 1.385 times the number of teeth divided by the number of teeth plus 2. In the first instance, the breaking moment arm factor is somewhat increased, and in the second, it is appreciably reduced.

For gears in which the addendum is made seven-tenths the working depth of the tooth (mating pinions for gears with short addendum teeth), the breaking moment arm factor is considerably reduced, whether the load is first applied at the top of the teeth or on the pitch line, as in the case of spiral-type bevel gears. For such long addendum, short-dedendum pinions, the factors controlling the strength of the teeth due to the decreased dedendum dimensions are derived in a manner similar to that employed for ascertaining the corresponding factors for short addendum teeth. For standard pinions with long addendum teeth, the modified breaking moment arm factors are equal to the strength factor of gear teeth with standard addendum multiplied by the ratio of the number of teeth plus 2.8 to the number of teeth plus 2. For spiral-type bevel gears with long addendum, these factors are equal to the strength factor of gear teeth with standard addendum multiplied by the quotient of 2.85 times the number of teeth divided by the number of teeth plus 2.

Root Thickness Factor

Reducing the addendum and correspondingly increasing the dedendum dimensions of gear teeth results, if the gear has twelve or more teeth, in reducing the root thickness of the teeth—under-cutting the teeth—so that such practice is limited to gears with a considerable number of teeth. In gears with less than twelve teeth, the comparatively large angle included, subtended on the dedendum circle, is greater than the pressure angle, so that there is a slight increase in the root thickness of the teeth. In any case, the circular thickness *C* of gear teeth on an arc just clearing the fillets is proportional to the distance between the tops of similar adjacent involute rack teeth. The chordal thickness *T* of the teeth just above the fillets, the thickness of the teeth on the probable line of fracture, is equal to the dedendum diameter of the gear plus twice the clearance multiplied by the sine of the angle measured on the pitch circle by one-half the circular thickness of the teeth just above the fillets.

Dividing the chordal thickness of teeth with standard addendum by that of teeth with short or long addendum, measures the proportional root thickness resulting from increasing or decreasing the dedendum. In the instance of making the addendum three-tenths the working depth of the tooth, the reduction in root thickness increases with the number of teeth above twelve, but for gears with less than twelve teeth, the root thickness is slightly increased. On the other hand, when the addendum is made equal to seven-tenths the working depth of the tooth, the root thickness is increased for gears with ten or more teeth, the increase becoming larger and larger as the gear approaches the rack form. The root thickness of pinions with long-addendum teeth numbering less than ten is slightly reduced when the addendum is made seven-tenths the working depth of the teeth, but, owing to the reduced breaking-arm moment, the teeth are likely to be slightly stronger than the teeth of similar gears with standard addendum

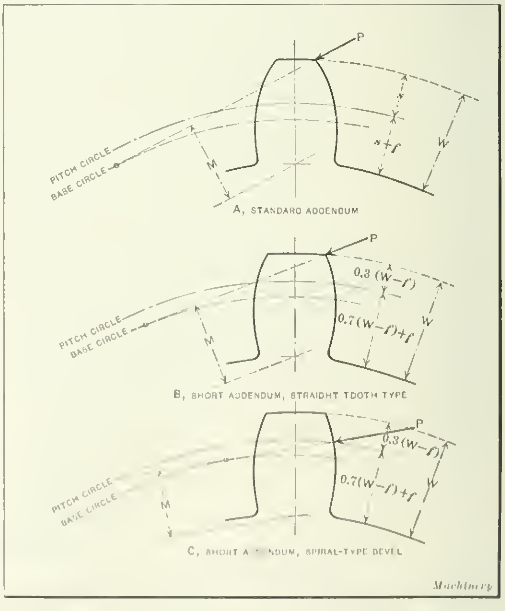


Fig. 2. Strength of Gear Tooth of Different Proportions

Comparative Strength of Teeth with Short and Long Addenda

The y factor in the Lewis formula for the strength of gear teeth is proportional to the strength of the teeth, and, if this is multiplied by $\frac{N + 1.2}{N + 2}$ and the product is again multiplied by the square of the comparative root thickness just above the fillets, a similar factor Y_1 will be obtained for gears with an addendum equal to three-tenths the working depth of the tooth. Similarly, the Lewis y factor multiplied by $\frac{1.385 \times N}{N + 2}$ and then by the square of the comparative root thickness just above the fillets will give a similar factor Y_2 applicable for calculations for the strength of spiral-type bevel gears with short addendum. For pinions with long addendum, the Lewis y factor multiplied by $\frac{N + 2.8}{N + 2}$ and then by the square of the comparative root thickness just above the fillets gives a similar factor y_1, for pinions with an addendum equal to seven-tenths the working depth of the teeth; and the Lewis y factor multiplied by $\frac{2.85 \times N}{N + 2}$ and the product by the square of the comparative root thickness gives a factor y_2, which is applicable for the calculation of the strength of spiral-type bevel pinions with long addendum.

Notation of Breaking-moment Arm Formulas

D = pitch diameter;
B = base circle diameter;
f = clearance;
N = number of teeth;
O = outside diameter;
W = whole depth of tooth;
a = pressure angle;
M = breaking-moment arm;
Arrangement A = straight-tooth gears with standard addendum;
Arrangement B = straight-tooth gears with short addendum;
Arrangement C = spiral-type bevel gears with short addendum.

Breaking-moment Arm Formulas

$$B = D \cos a \qquad W - f = \frac{2D}{N}$$

$$W = \frac{2.157D}{N} \qquad f = \frac{0.157D}{N}$$

Arrangement A:

$$M = \frac{WB}{O} = \frac{WD \cos a}{D + (W - f)} = \frac{\dfrac{2.157D \times D \cos a}{N}}{\dfrac{DN + 2D}{N}} = \frac{2.157D \cos a}{N + 2}$$

Arrangement B:

$$M = \frac{WB}{O} = \frac{WD \cos a}{D + 0.6\,(W - f)} = \frac{\dfrac{2.157D \times D \cos a}{N}}{\dfrac{DN + 1.2D}{N}} = \frac{2.157D \cos a}{N + 1.2}$$

Arrangement C:

$$M = \frac{[0.7(W - f) + f]\,B}{D} = \frac{\dfrac{(1.4D + 0.157D)\,D \cos a}{N}}{D} = \frac{1.557D \cos a}{N}$$

$$\frac{M \text{ for Arrangement } A}{M \text{ for Arrangement } B} = \frac{2.157D \cos a}{N + 2} \times \frac{N + 1.2}{2.157D \cos a} = \frac{N + 1.2}{N + 2}$$

$$\frac{M \text{ for Arrangement } A}{M \text{ for Arrangement } C} = \frac{2.157D \cos a}{N + 2} \times \frac{N}{1.557D \cos a} = \frac{1.385N}{N + 2}$$

Notation of Root Thickness Formulas

D = pitch diameter;
P = diametral pitch;
N = number of teeth;
T = chordal thickness of tooth above fillets;
C = circular thickness of tooth above fillets;
D_1 = dedendum diameter plus twice the clearance;
a = pressure angle;
β = angle measured by half of circular root thickness above fillets;
Arrangement A = straight-tooth gears with standard addendum;
Arrangement B = straight-tooth gears with short addendum;
Arrangement C = spiral-type bevel gears with short addendum;
Arrangement D = straight-tooth gears with long addendum;
Arrangement E = spiral-type bevel gears with long addendum.

Root Thickness Formulas

Arrangement A:

$$D_1 = D - \frac{2D}{N} = \frac{N}{P} - \frac{2}{P} = \frac{N - 2}{P}$$

STRENGTH FACTORS FOR MODIFIED LEWIS FORMULAS FOR GEARS WITH LONG- AND SHORT-ADDENDUM TEETH

Number of Teeth	Standard Factor y	Factor for Gears with Short Addendum Y_1	Factor for Spiral-type Gears with Short Addendum Y_2	Factor for Pinions with Long Addendum y_1	Factor for Spiral-type Bevel Pinions with Long Addendum y_2
8	0.051	0.052	0.062	0.053	0.111
9	0.055	0.054	0.066	0.058	0.127
10	0.059	0.056	0.070	0.064	0.142
11	0.063	0.059	0.074	0.069	0.157
12	0.067	0.062	0.078	0.076	0.172
13	0.070	0.063	0.081	0.079	0.185
14	0.072	0.065	0.083	0.082	0.195
15	0.075	0.067	0.086	0.086	0.208
16	0.077	0.069	0.089	0.089	0.216
17	0.080	0.071	0.092	0.093	0.227
18	0.083	0.073	0.095	0.097	0.238
19	0.087	0.076	0.099	0.101	0.251
20	0.090	0.079	0.103	0.105	0.263
21	0.092	0.080	0.105	0.108	0.272
23	0.094	0.082	0.108	0.111	0.282
25	0.097	0.084	0.111	0.115	0.294
27	0.100	0.086	0.114	....	....
30	0.102	0.088	0.117	....	....
34	0.104	0.089	0.120	....	....
38	0.107	0.091	0.122	....	....
43	0.110	0.093	0.126	....	....
50	0.112	0.095	0.128	....	....
60	0.114	0.096	0.130	....	....
75	0.116	0.097	0.132	....	....
100	0.118	0.099	0.134	....	....

Machinery

$$\frac{C}{2} = \frac{0.7854 + \tan a}{P}$$

$$\beta = \frac{\dfrac{360\,(0.7854 + \tan a)}{P}}{\dfrac{3.1416N}{P}}$$

$$\beta = \frac{119.63}{N}, \text{ for 14.5-degree involute teeth}$$

$$T = D_1 \sin \beta = \frac{(N - 2) \sin \beta}{P}$$

Arrangements B and C:

$$D_1 = \frac{N}{P} - \frac{2.8}{P} = \frac{N - 2.8}{P}$$

$$\frac{C}{2} = \frac{0.7854 + 1.4 \tan a}{P}$$

$$\beta_1 = \frac{\dfrac{360\,(0.7854 + 1.4 \tan a)}{P}}{\dfrac{3.1416N}{P}}$$

$$\beta_1 = \frac{131.49}{N}, \text{ for 14.5-degree involute teeth}$$

$$T = D_1 \sin \beta = \frac{(N - 2.8) \sin \beta_1}{P}$$

Arrangements D and E:

$$D_1 = \frac{N - 1.2}{P} \qquad \frac{C}{2} = \frac{0.7854 + 0.6 \tan a}{P}$$

$$\beta_2 = \frac{107.78}{N}, \text{ for 14.5-degree involute teeth}$$

$$T = D_1 \sin \beta_2 = \frac{(N - 1.2) \sin \beta_2}{P}$$

$$\frac{T \text{ for Arrangement } A}{T \text{ for Arrangements } B \text{ and } C} = \frac{(N - 2) \sin \beta}{(N - 2.8) \sin \beta_1} = T_1$$

$$\frac{T \text{ for Arrangement } A}{T \text{ for Arrangements } D \text{ and } E} = \frac{(N - 2) \sin \beta}{(N - 1.2) \sin \beta_2} = T_2$$

Notation of Formulas for Finding Strength Factors for Modified Lewis Formula

y = standard factor;
Y_1 = factor for gears with short addendum, 0.3 times working depth of tooth;
Y_2 = factor for spiral-type bevel gears with short addendum;
y_1 = factor for pinions with long addendum, 0.7 times working depth of tooth;
y_2 = factor for spiral-type bevel pinions with long addendum;
N = number of teeth in gear;
T_1 and T_2 = chordal thickness of teeth above fillets.

Formulas for Finding Strength Factors for Modified Lewis Formulas for Gears with Long and Short Addendum Teeth

$$Y_1 = \frac{T_1^2\, y\, (N + 1.2)}{N + 2} \qquad y_1 = \frac{T_2^2\, y\, (N + 2.8)}{N + 2}$$

$$Y_2 = \frac{1.385NyT_1^2}{N + 2} \qquad y_2 = \frac{2.85NyT_2^2}{N + 2}$$

Notation of Formulas for Strength and Power Capacity of Spiral-type Bevel Gears

S = safe working stress, in pounds per square inch;
P = diametral pitch;
P_1 = circular pitch, outer end of teeth;
P_2 = average circular pitch;
O = pitch diameter, outer;
D = average pitch diameter;
N = number of teeth;
F = face width;
E = distance from apex to outer end of tooth;
δ = center angle;
θ = spiral angle;
R = revolutions per minute;
V = average velocity in feet per minute.

Formulas for Strength and Power Capacity of Spiral-type Bevel Gears

$$E = \frac{O}{2 \sin \delta} \quad (1) \qquad P_2 = \frac{P_1\,(E - 0.5F)}{E} \quad (3)$$

$$P_1 = \frac{3.1416}{P} \quad (2) \qquad D = 0.3183P_2N \quad (4)$$

$$V = 0.2618DR \quad (5)$$

Total load on spiral-type bevel gear teeth = transmitted load × sec θ (6)

Transmitted load = total load × cos θ (7)

Straight-tooth bevel gears with standard addendum:

$$\text{Safe load} = SP_2Fy\left(\frac{600}{600 + V}\right) \qquad (8)$$

Straight-tooth bevel gears with short addendum, 0.3 times working depth of tooth:

$$\text{Safe load} = SP_2FY_1\left(\frac{600}{600 + V}\right) \qquad (9)$$

Spiral-type bevel gears with short addendum:

$$\text{Safe load} = SP_2FY_2 \cos \theta \left(\frac{1200}{1200 + V}\right) \qquad (10)$$

Straight-tooth bevel pinions with long addendum, 0.7 times working depth of tooth:

$$\text{Safe load} = SP_2Fy_1\left(\frac{600}{600 + V}\right) \qquad (11)$$

Spiral-type bevel pinions with long addendum:

$$\text{Safe load} = SP_2Fy_2 \cos \theta \left(\frac{1200}{1200 + V}\right) \qquad (12)$$

Power capacity of bevel gears:

$$\text{Horsepower} = \frac{\text{safe load} \times V}{33{,}000} \qquad (13)$$

Notes on Formulas for Strength of Bevel Gears

The Lewis formula, as modified for straight-tooth bevel gears, is not directly applicable to spiral-type bevel gears by the simple substitution of new y values, as two other peculiarities of that type of gear materially affect its strength and power-transmitting capacity. In the first place, there is an entire absence of shock, as spiral-type bevel gears roll into mesh. In this respect, they are similar to gears of the herringbone type and the same modification of the strength formula should be made as has been found necessary for herringbone gears. W. C. Bates found that the transference of load from tooth to tooth without shock in herringbone gearing modified the speed-factor ratio added to the Lewis formula by Carl G. Barth by changing the constant 600 to 1200. This modification, which has been necessary in the case of herringbone gears, should also be made in the case of spiral-type bevel gears, as the two types are similar as far as elimination of shock is concerned. The second modification is caused by the thrust produced by the obliquity of the spiral teeth and is dependent upon the spiral angle of the gear. The total load on a spiral-type bevel gear tooth—the resultant of the transmitted load and the thrust—is equal to the transmitted load multiplied by the secant of the spiral angle. Then the safe load that can be put on the spiral-type bevel gear is the load that it could carry were it not for the thrust multiplied by the cosine of the spiral angle. The safe load for spiral-type bevel gear teeth, therefore, takes the form given in Formula (10).

Example—Required the horsepower and safe load, when run at 600 revolutions per minute and having a safe working stress S of 15,000 pounds per square inch, 25 teeth, 5 diametral pitch, and a 1.75-inch face: (a) of a 90-degree spiral-type bevel gear having a 30-degree spiral angle and a short addendum; (b) of a 90-degree straight-tooth bevel gear with a standard addendum; and (c) of a straight-tooth bevel gear with a short addendum; that is, 0.3 addendum and 0.7 dedendum.

Applying Formula (2), the circular pitch P_1 measured at the outer end of the teeth is $3.1416 \div 5 = 0.6283$ inch. As the outer pitch diameter O is $25 \div 5 = 5$ inches and the center angle δ is 45 degrees, by Formula (1), the apex distance E is $\dfrac{5}{2 \times 0.70711} = 3.535$ inches. The average circular pitch P_2, therefore, by Formula (3), is

$$\frac{0.6283\,(3.535 - 0.875)}{3.535} = 0.4728 \text{ inch}$$

Then, by applying Formula (4), the average pitch diameter D is $0.3183 \times 0.4728 \times 25 = 3.7623$ inches, and, by Formula (5), the average velocity V is $0.2618 \times 3.7623 \times 600 = 590.982$, say 590 feet per minute.

For (a), then, applying Formula (10), the safe load is

$$\frac{15{,}000 \times 0.4728 \times 1.75 \times 0.111 \times 0.866 \times 1200}{1200 + 590} = 800 \text{ pounds,}$$

very nearly, and the power capacity, by Formula (13), is

$$\frac{800 \times 590}{33{,}000} = 14.3 \text{ horsepower.}$$

For (b), by Formula (8), the safe load is

$$\frac{15{,}000 \times 0.4728 \times 1.75 \times 0.097 \times 600}{600 + 590} = 606.99 \text{ pounds,}$$

and the power capacity, by Formula (13), is

$$\frac{606.99 \times 590}{33{,}000} = 10.85, \text{ say } 10.9, \text{ horsepower.}$$

For (c), by Formula (9), the safe load is

$$\frac{15{,}000 \times 0.4728 \times 1.75 \times 0.084 \times 600}{600 + 590} = 525.64 \text{ pounds,}$$

and the power capacity, by Formula (13), is

$$\frac{525.64 \times 590}{33{,}000} = 9.397, \text{ say } 9.4, \text{ horsepower.}$$

If the power capacity of gear (c), which is 9.4 horsepower, is taken as 1, the comparative strength of gear (b) is $\frac{10.9}{9.4} = 1.16 \times$ gear (c); the comparative strength of gear (a) is $\frac{14.3}{9.4} = 1.52 \times$ gear (c); and $\frac{14.3}{10.9} = 1.31 \times$ gear (b).

This example shows that a 25-tooth, 5 diametral pitch, 1.75-inch face, 90-degree spiral-type bevel gear with a 30-degree spiral angle, the customary obliquity, and constructed of steel having a safe working stress of 5000 pounds per square inch can transmit 14.3 horsepower at 600 revolutions per minute. A similar straight-tooth bevel gear with standard addendum will be safe to transmit less than 11 horsepower at the same speed; while a straight-tooth bevel gear with an addendum equal to three-tenths of the working depth of the tooth, in order not to under-cut the mating pinion, will only be good for 9 1/3 horsepower. The possible saving in the weight of bevel gearing through the use of spiral-type bevel gears is apparent, as the spiral-type bevel gear is 35 per cent stronger than the similar straight-tooth bevel gear with standard addendum, and 56 per cent stronger than the similar straight-tooth bevel gear with short addendum.

* * *

DELAYS CAUSED BY EXACTING GOVERNMENT SPECIFICATIONS

BY A. M. M.

The government specifications that accompanied all contracts for machinery or raw materials previous to the war were so exacting that manufacturers were obliged to make higher bids and specify more time on government contracts than on ordinary commercial work. In many cases manufacturers found that only by producing machinery or materials that were greatly superior to the generally accepted first-class commercial product could they meet the government requirements. Now that the war has brought a demand for maximum production to all our manufacturing concerns, it has been found that these over-exacting specifications have, in many cases, seriously affected production. It has also been found that in many cases these specifications can be made less exacting without affecting the material value of the product. If the war serves to eliminate these exacting specifications that experience and careful testing prove to be unnecessary, a great economic work will have been accomplished. If specifications are substituted that more nearly conform to those that have been found suitable by the leading manufacturers of high-class machinery, the manufacturing concerns will not be obliged to bid higher and specify more time on government contracts in order to protect themselves from the delays and expense they have often experienced in attempting to meet the government requirements.

An instance of how the extremely exacting government specifications affect production may be cited in the manufacture of condenser tubes. One of the leading manufacturers of brass tubes for condensers was given a government contract for large quantities of condenser tubes with instructions to rush deliveries. The specifications included a compression test of the material which caused the ordinary brass that had previously been found satisfactory for condensers to be rejected. The test was apparently based on the hardest piece which could be found among all the commercial stock. In order that the tubes might pass inspection, it was necessary to make the average much harder than the ordinary stock; for in manufacturing such tubes there is quite a wide variation in the hardness, and in order that a large percentage should not fall below the requirements, it was necessary to make them all unusually hard. After delays incident to such manufacture, the tubes were delivered. They were purposely specified "Extra hard," and yet they were assembled without annealing the ends before expanding. As a result, 5 or 10 per cent of them cracked during the expanding process. All were then removed and the entire lot rejected. After a serious delay, the government specifications for hardness were made less exacting and the tubes were made over.

This whole difficulty was the result of the government policy of having something made a little better than the regular commercial product. An extra load was thus thrown on the brass company, which was already working 100 per cent on government orders. After a few experiences of this kind, almost any company will bid higher and specify more time on government contracts in order to protect themselves against such conditions.

Millions of extra costs and months of delay may result from over-exacting specifications. In the past, these unduly severe specifications have been considered as a matter of course, and no one has been censured for making them; but if a government official should write a specification which seemed good enough, according to general practice, but which later for any reason permitted some inferior material to be accepted, the mistake would be held to outweigh all the gains he may have previously realized from his common-sense practice. For this reason there is a tendency to make specifications unduly exacting, thus throwing the burden on the manufacturers. Before this state of things can be changed, some way will have to be found to relieve government officials from adverse criticisms when they make specifications according to their best judgment, which later allow some unsuitable material to pass inspection.

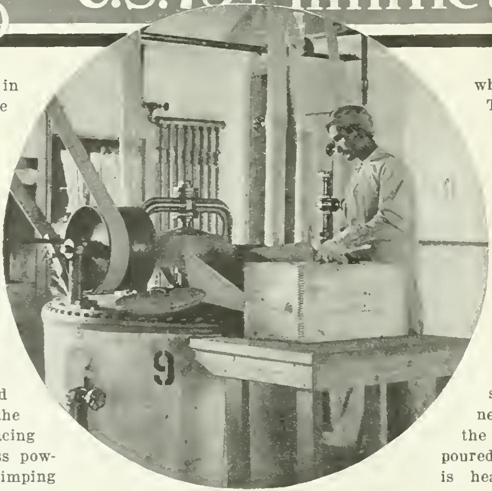
Another cause of delay in filling government orders is the custom of refusing to pass an invoice for payment if some trifling item is omitted in the shipment. About half a year ago one of the well-known dealers of mechanical equipment delivered goods on a government order amounting to about $15,000. Several small collets were missing. These articles were not an integral part of the machines, but were specified as equipment. For some reason the dealer has not yet been able to obtain these items, and without them he has been unable to obtain any part of the $15,000. This dealer now has on his books government orders for much needed equipment, each order calling for certain machines, and a large list of special equipment. The machines with regular commercial equipment might be shipped almost immediately, but the dealer feels that he cannot make any shipments until the last item mentioned in the order is ready, as he would be tying up large amounts of money for an indefinite period. Consequently, a few spare parts which may never be needed cause delays of two or three months in shipping these machines.

* * *

A complete report on the Australian customs tariff as it stands today has been made public in a bulletin issued by the Bureau of Foreign and Domestic Commerce, Department of Commerce. The purpose of the report is to post American manufacturers and exporters on points in the new tariff that are not generally understood in this country. The preferential provisions, by which goods made in England and South Africa enjoy advantages over all others, are treated in great detail. The bulletin is entitled "Customs Tariff of Australia," Tariff Series No. 37. Copies can be obtained at ten cents each from the Superintendent of Documents, Government Printing Office, Washington, D. C., or from any of the district or cooperative offices of the Bureau of Foreign and Domestic Commerce.

Loading *the* U.S. 75-Millimeter Shell

Fifth of a Series of Articles Describing the Methods Employed by the T. A. Gillespie Co. in Making the U. S. 75-millimeter Shell—By Erik Oberg[1]



IN the four preceding articles in this series, published in the March, April, May, and June numbers of MACHINERY, the forging, machining, and inspection of the U. S. 75-millimeter shell were described in detail. In the present article, which is the last one in this series, the loading of the shell will be dealt with. Briefly described, the loading consists in filling the shells with a high explosive, which is poured into the shells in a molten condition and sets into a solid form within the shell, inserting the primer in the cartridge case, placing the required charge of smokeless powder in the cartridge case, and crimping the cartridge case onto the end of the shell. After painting and marking, the shells are ready to be shipped to France, the fuses being inserted on the field when the shells are ready to be used.

Preliminary Operations

In the preceding articles in this series, the shell was followed through the machining operations and inspection to the point where it was placed in cartons ready for shipment. The shells are received at the loading plant in this condition, and the first operation is to remove them from the cartons. They are then placed upon a belt conveyor which takes them to a shellacking machine in which the shell is rotated while a shellacking "gun" is inserted by the operator into the shell cavity for coating the inside with a rosin shellac. The shell is then put back on the conveyor and passes to a drying table on which it is left a few hours to dry. A piece of paper is then wrapped around the shell, the two ends of the paper being pasted together. The object of this wrapper is to prevent the molten high explosive, that may be spilled, from adhering to the outside of the shell when poured into it; it will adhere to the paper instead, which can be torn off.

Fig. 1 shows a number of these shells provided with a paper wrapping and stored on the tables in the storage rooms ready to be passed to the room where the shells are loaded. A conveyor takes the shells from this room to the loading room. This conveyor is a double-track roller conveyor on which wooden boxes are placed having holes or compartments in them in which the shells are placed on end. These boxes are generally made to hold eight shells each. Between the shellacking and storage room and the room where the high-explosive charge is poured into the shells is a preheating oven about 175 feet long, through which the conveyor tracks pass. In this oven, the shells are preheated to a temperature of about 40 degrees C. (104 degrees F.), the object of this preheating being to take the chill off the shells so that they will be more nearly of the same temperature as the molten high explosive that is poured into them. The preheating oven is heated by air previously passed around steam coils and forced through the oven duct by a fan. The duct has a capacity for 2500 shells at a time.

Pouring High Explosive

From the preheating oven, the boxes containing the shells pass into the pouring room, still moving along the conveyor as indicated in Fig. 2. A shee-iron funnel is placed in the opening of each shell, as indicated in the illustration, which shows a number of shells ready for pouring.

The high explosive used for the 75-millimeter shells is trinitrotoluol, generally known as T.N.T. This explosive is obtained by the loading factory from the high explosives manufacturers in the form of a yellow powder, somewhat similar to powdered brown sugar. The melting kettles for melting this powder, so that it can be poured into the shells in a liquid form, are placed on the second floor of the building, and piping extends from the kettles down to the first floor, so that the liquid can be drawn into "tubs" on the lower or pouring floor. The melting kettles are steam-jacketed, and as the melting point of T.N.T. is about 80 degrees C. (176 degrees F.), it is easily melted by steam at a comparatively low pressure. The general appearance of one of these melting kettles is shown in Fig. 3. The belt and pulley shown drive, by means of bevel gearing, a shaft which passes down through the kettle, onto which are attached paddles for stirring the mixture while melting.

The molten mixture is now drawn from the bottom of the kettles on the lower floor into tubs or containers such as shown

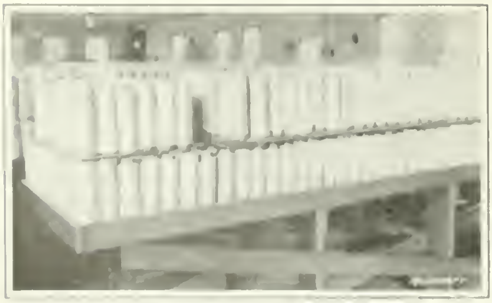


Fig. 1. High-explosive Shells with Paper Wrapping Ready to be passed on to Loading Room

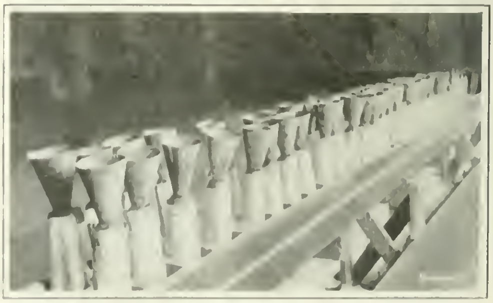


Fig. 2. Shells placed in Boxes on Roller Conveyor with Funnels Ready for pouring T.N.T.

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[1] Editor of MACHINERY.

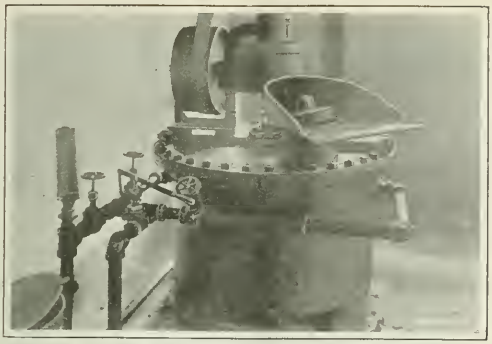

Fig. 3. Steam-jacketed Kettle for melting T.N.T. so that it can be poured into Shells in a Liquid Form

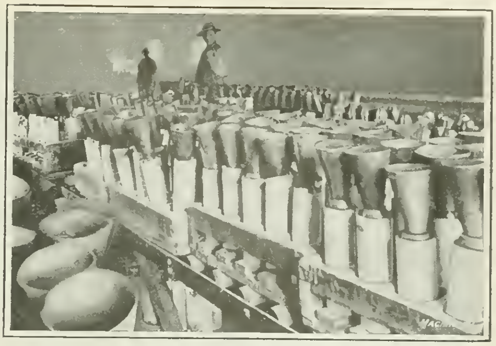

Fig. 4. Shells after High Explosive has been poured into them, and before Funnels have been knocked off

at *A*, Fig. 5. These tubs are placed on trucks so that, after having been filled by the molten high explosive, they may be easily removed to the cooling machines, one of which is shown in Fig. 5. In these machines, the liquid is mechanically stirred by a paddle until of just the right temperature for pouring into the shells. One of the two ducts shown at the top of the machine forces the cool air into the hood above the tub, while the other duct carries off the hot air and fumes from the liquid. The pourer determines when the liquid has reached the right temperature by dipping the end of a knife into the tub and judging by the appearance of the crystals when the liquid cools on the end of the blade.

The cooling tubs are provided with connections for steam pipes, as indicated at *B*, so that any explosive charge that solidifies in the bottom of the tub can be melted by merely passing steam through the jacket which surrounds the inner tub. In this way, the tubs can always be kept clean.

After the molten liquid has reached the right temperature, which varies somewhat according to the atmospheric conditions, but is generally between 77 and 80 degrees F., it is withdrawn from the cooling machine, pulled up close to the conveyor upon which the shells are placed ready for pouring, and the liquid is poured from the tubs into pails from which the workmen pour it into the funnels placed in the shells. The liquid is poured into the shell until it has not only filled the shell completely, but also stands about half way up in the funnel. The object of this is to provide enough liquid so that when it contracts in the shell, upon cooling, there will be enough material to be drawn upon from the funnel to insure that the shell is completely filled. The funnel is permitted to remain in the shell opening for about an hour, until the liquid has solidified, at which time it is removed by simply pulling it off by hand, after which the part of the charge remaining in the funnel is knocked out of it with a copper hammer, and remelted. The object of using a copper hammer is to prevent any spark that might form in case a steel hammer was used against the sheet iron, which might explode the T.N.T. The paper wrapping around the shell is then removed, and the charge in the shells permitted to set for two hours more, after which the shells are cleaned off on the outside from any T.N.T. that might have been spilled upon them. Fig. 4 shows a view in the room where the funnels are removed from the filled shells and the shells cleaned.

Boring for Booster and Cleaning Threads

The shells now pass to the boring room in which the cavity in the high explosive for the booster is bored out. Part of the machine in which the boring is performed is shown in Fig. 6. The machine works automatically after the shell has been placed in it, and bores a hole in the T.N.T. charge by means of a steel drill. To provide against any possible explosion, these machines are each set in a circular enclosure consisting of 5/8-inch armor-plate surrounded by an 8-inch thick wall of concrete, this enclosure being partly open on one side only for the insertion of the shells to be bored, the opening facing a wall. Hence, the operators do not need to stand in front of these machines while they are operating. The dust from the boring is carried away by a duct so as to prevent the air around the machines from being charged with this dust. After the boring, the cavity for the booster is inspected.

The shells next pass to the thread-cleaning room where the

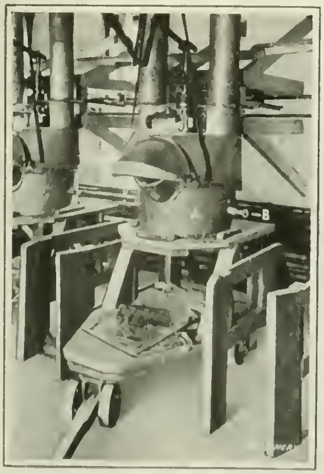

Fig. 5. Device for cooling Molten High-explosive Charge to Right Temperature for Pouring

Fig. 6. Machine used for boring out Cavity in High-explosive Charge in Shell for Booster

Fig. 7. Cleaning out Threads in Shell. Compressed Air is blown into Cavity to remove Dust

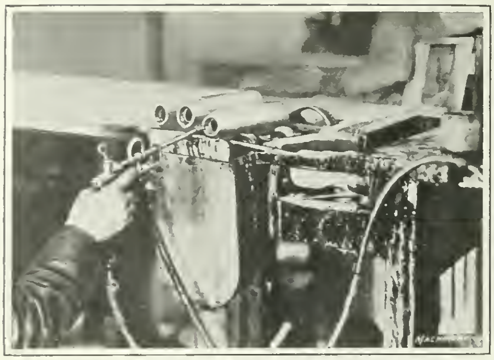

Fig. 8. Varnishing Inside of Cavity for Booster

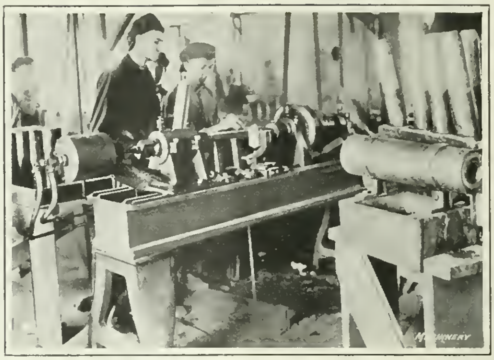

Fig. 9. Crimping Cartridge Case onto Shell

threads are cleaned out, as indicated in Fig. 7, by the shell being placed on rollers and rotated by hand, while a sharp pointed tool bent at the end similar to a thread boring tool is inserted into the threads to remove the T.N.T. that has been lodged in them. After the threads are cleaned, the operator moves the open end of the shell up into the duct shown to the left. The small piping indicated in the center of the duct blows compressed air into the cavity of the shell, while suction is provided through the large duct, so that all the dust is removed. After the booster cavity has been bored and the threads cleaned, the inside of the cavity is shellacked, the shell being placed on rollers, as indicated in Fig. 8. These rollers are mechanically rotated while a spraying gun coats the inside of the cavity with shellac. The shell is pushed off the rollers by means of an ejector operated by a foot-treadle, and a new shell rolls into place on the rollers without the operator's aid.

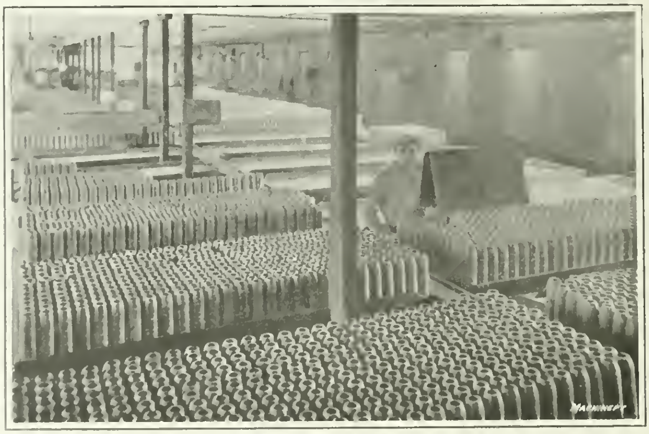

Fig. 10. Shells sorted according to Weight

Weighing and Sorting Shells

The shells are now weighed in order that they may be sorted into different classes according to the weight of the shell and the explosive charge. Fig. 10 shows the sorting tables upon which the shells are placed after having been weighed. In the middle of the room is a belt conveyor, as shown, upon which the shells pass from the scale, and from which they are picked up by the sorters and placed upon the tables. Every lot of shells sent out from the factory must belong to one single weight group, in order to meet the requirements of the gunners on the firing line.

Assembling Shell and Case

From the storage tables, the shells pass to the assembling room. Here they are first placed into a simple vise having semicircular jaws for holding the shell while the booster is put in place. They are then put onto a conveyor which carries them to the assembling machines where the brass cartridge case is crimped onto the end. The cartridge cases with the proper charge of smokeless powder come to this machine by a conveyor from another part of the factory. Before being placed in the assembling machine shown in Fig. 9, the end of the shell below the copper band is greased, the grease being kept in a molten condition and put on with a brush. The object of this grease is to provide a waterproof joint between the case and the shell.

For the assembling, the shell is placed with its nosed-in

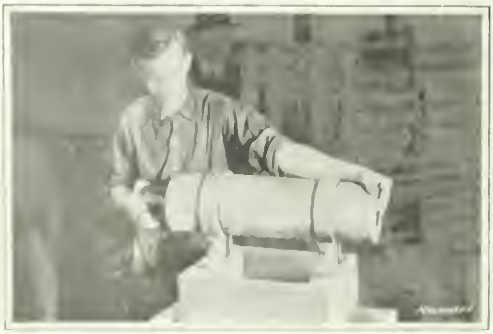

Fig. 11. Gaging Shell and Cartridge Case in a Gage which is an Exact Reproduction of Chamber of Gun from which Shell is fired

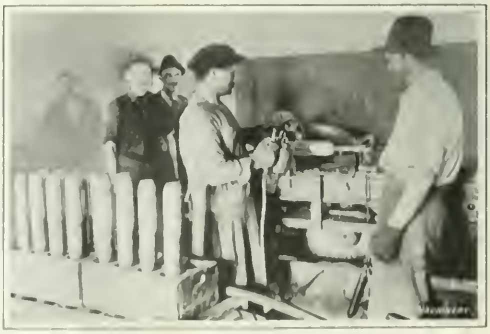

Fig. 12. Painting Shell with Spray Gun to protect it against Weather Conditions and to form a Background for Stenciling

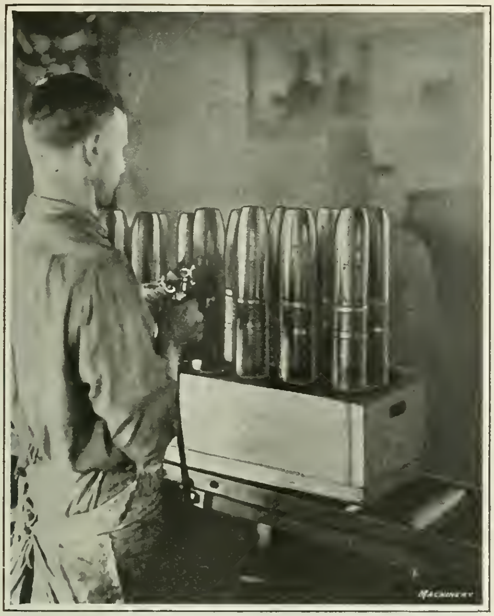

Fig. 13. Marking Shells with Stencil and Spray Gun

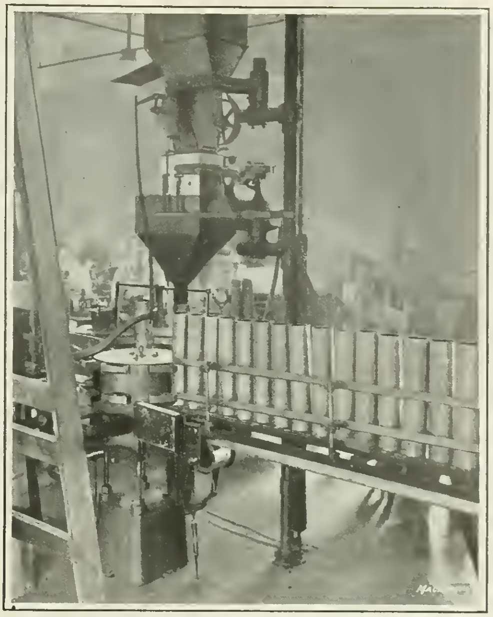

Fig. 14. Automatic Smokeless Powder Weighing Machine

end in a conical recess in a chuck at the headstock end of the machine, while the end of the brass case fits into a small cavity in the tailstock. Pressure is then applied by means of air on a piston in a cylinder at the outer end of the tailstock, as indicated in the illustration; this forces the tailstock forward and with it the cartridge case onto the end of the shell. At the same time, rollers operated by a foot-lever are brought to bear upon the end of the cartridge case for producing the required pressure for crimping the case onto the shell. The grease pressed out at this time is cleaned off by the operator with a small wooden knife. The completed shell with its case immediately upon being removed from the assembling machine is passed to the inspector, who places it in a chamber gage as shown in Fig. 11. This gage is provided with a bore which is identical with that of the chamber bore in the gun from which the shell will be fired, and gages the copper band, bourrelet, and the rear end of the brass case. If the shell will pass into this gage, it is also sure to fit the gun.

Painting and Finishing

The shells are now placed on end in wooden boxes, eight shells to a box, and passed on conveyors to the painting and finishing room. They are there placed in a machine similar to a small lathe and painted by a spraying gun, the projectile end only being painted in this way, as shown in Fig. 12. A suction draft is provided for carrying off the paint fumes. From the painting machine the shells pass to the stenciling operator who marks them with the mark and number as indicated in Fig. 13. The marks are black on a yellow background. The marking is done very rapidly by means of a stencil and a spraying gun. After this, a small felt plug is put into the booster at the place where the fuse will later be inserted, and then the shells are placed in heavy paper tubes provided with a sheet-iron bottom. The shells are put into these tubes nose first, and a cap is placed on the other end, this cap being crimped onto the paper tube. The cap is provided with an inside washer having a cavity over the primer in the shell in order to protect the primer from accidental shocks or blows. The top of the paper tube with the cap in place is then dipped in tar for waterproofing.

The shells are then packed in boxes, nine shells to a box, and the boxes are carried by a conveyor to the finished storehouse, ready for shipment. Fig. 18 shows the type of boxes in which the shells are packed ready for shipment. These boxes are now ready to go to France.

Loading Cartridge Cases

The cartridge cases are supplied to the factory completely drawn and finished, but the primers are not in position. The latter are also supplied to the factory complete, ready to be inserted in the cartridge cases. Fig. 15 shows the use of an arbor press for pushing the primer into position in the cartridge case, after which it is stamped on the base with a lot number, as indicated to the right in the same illustration. Two men are engaged in the work of inserting the primer, one putting it into position and the other operating the press. After having been stamped, the cartridge cases pass in an upright position on a conveyor into the room where they are loaded with the smokeless powder. The conveyor and the manner in which the cartridge cases pass

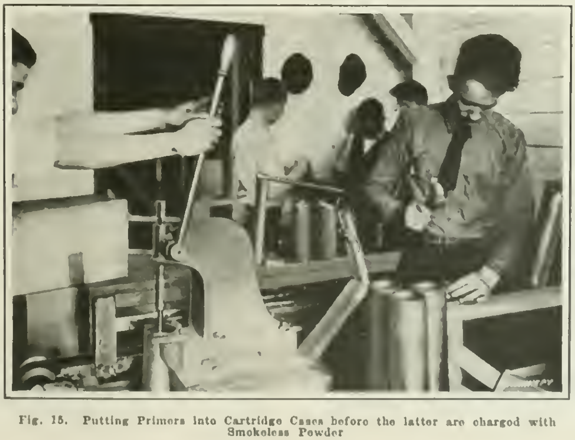

Fig. 15. Putting Primers into Cartridge Cases before the latter are charged with Smokeless Powder

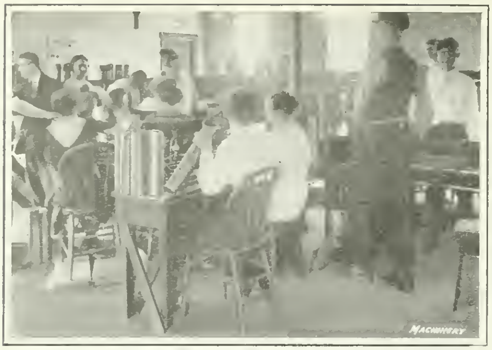

Fig. 16. General View of Room in which Charge in Cartridge Case is Twice weighed for Checking Purposes

into this room are shown in Fig. 14. They then pass underneath the automatic weighing machine shown in the center of this illustration, where a predetermined amount of smokeless powder is discharged into the cartridge case from a hopper above. The cartridge cases pass automatically onto the weighing machine, which has a revolving table, as indicated. This table is indexed so that each cartridge case is held directly underneath the spout of the hopper for the period required for depositing the smokeless powder. It then indexes around and brings a new case underneath the spout of the hopper. The cases are then automatically removed from the revolving table or turret of the weighing machine and pass along a conveyor, from which they are taken and placed upon a large revolving wooden table, indicated in the center of Fig. 16, the post shown being the shaft about which this table revolves. Around this circular table are stationed the inspectors who weigh the charge of smokeless powder to see that it is exactly right. These inspectors are girls who work in pairs. The girl next to the table is the company's inspector and the outside girl is the government inspector. Each of these girls empties the charge from the case onto the scoop of an accurate scale and weighs the charge. The company's inspector adds or removes one or more pellets of powder in case this is required, and then puts the charge back again into the cartridge case. The government inspector pours out the charge again into the scoop of her scale and check-weighs it. At this time, it must be found correct within the limits allowed, which are very narrow. A near view of the two inspectors is shown in Fig. 17. The company's inspector to the left is adding a few pellets in order to make up the correct weight. The government inspector to the right is putting back a charge into the case after it has been found correct.

The cases are now put into the boxes on the conveyor shown in the background of Fig. 17. A sheet-iron cap is placed over the open end of the shell in order to prevent spilling the powder. The shells then pass on a conveyor to the assembling department.

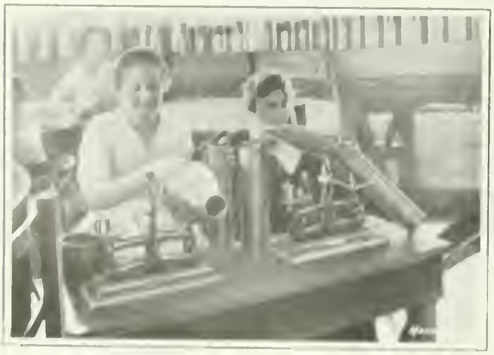

Fig 17 Girls engaged in Check-weighing Charges in Cartridge Cases

ESSENTIAL INDUSTRIES

An inquiry directed to the War Industries Board in Washington has brought forth the following reply with regard to the definition of "essential industries" at the present time:

Plants engaged exclusively in manufacturing aircraft or supplies, ammunition for the United States and the Allies, large guns, small arms for the United States Government and the Allies, chemicals and coke.

Plants manufacturing electrical equipment, electrodes, explosives, agricultural implements, farm operating equipment, feed, ferro-alloys, fertilizers, and firebrick.

Plants manufacturing, milling, preparing, refining, preserving and wholesaling food for human consumption; and those manufacturing tin and glass containers and other food containers.

Gas-producing plants and those manufacturing exclusively gas-producing machinery, hemp, jute and cotton bags, insecticides, and fungicides.

Iron and steel blast furnaces and foundries; steel plants; rolling mills; plants making machine tools; mines and plants engaged exclusively in manufacturing mining tools and equipment; refineries of mineral and vegetable oils; plants making exclusively oil-well equipment.

Public institutions and buildings; public utilities; railways; plants manufacturing locomotives, freight cars, rails, and railway supplies; food refrigeration and exclusively ice producing plants; laundries; producers or wholesalers of seeds (except flower seeds).

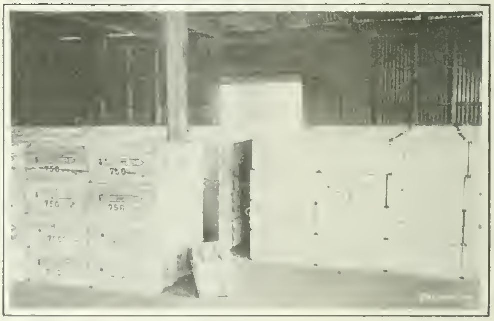

Fig. 18. Shells packed in Boxes Ready for Shipment; Nine Shells to a Box

Ships (bunker coal), not including pleasure craft; plants engaged exclusively in building ships (not including pleasure craft) or in manufacturing exclusively supplies and equipment therefor; manufacturers of soap.

Tanning plants, save those for patent leather, and those manufacturing tanning extracts; manufacturers of tin plate; plants producing exclusively binder twine and rope and those making wire rope and rope wire.

* * *

INCREASING POWER PLANT EFFICIENCY

The United States Fuel Administration has appointed Henderson W. Knott to manage the field force of engineers and inspectors that is at work among the power plants of the country. Mr. Knott has been the general manager of the Morgan Crucible Co. of New York City and his appointment is a part of the plan, originated by David Moffat Myers, advisory fuel engineer of the Fuel Administration, to have each of the 250,000 steam plants in the United States visited by a competent man who can make suggestions and report in connection with the questionnaire originated by Mr. Myers. This field force will be organized by states in order to give it greater efficiency.

* * *

Dipping steel springs in molten tin prevents their becoming brittle when electroplated. Uncoated springs become brittle during the electroplating process. Sulphuric acid pickling baths also greatly decrease the flexibility and the elasticity of iron wire and steel springs.

FACTORY INVESTIGATIONS

REASONS FOR EMPLOYING OUTSIDE EXPERTS AND METHODS OF CONDUCTING INVESTIGATION

BY ALBERT A. DOWD[1]

If the superintendent of a factory feels indisposed and does not know just what is the matter with him, he seeks the advice of a physician in order to determine what is wrong and obtain suitable remedies. Many manufacturing firms are finding that their factories are not producing the work as rapidly or as accurately as they should; but instead of consulting one who, like a physician, has made a special study of such cases, these firms seek to determine the reasons for this condition themselves. It is difficult for them to do this for the same reason that a sick man cannot diagnose his own case. In the first place, the superintendent is too close to the work to view it broadly; besides, he cannot look into all the details connected with the product of his factory. Undoubtedly an investigation would show him where some of the trouble lies, but he has not the time to study these matters and at the same time keep in touch with the thousand and one things that must be attended to by a man in his position.

Factory superintendents usually assume a hostile attitude toward any outside investigation by a specialist for the following reasons: the cost of the investigation, due to the high compensation demanded; the possibility of causing labor troubles in the factory, due to the interference and suggestions of an outside party; the interruption of production; the cost of changing methods, tooling, and the like in order to increase production; the unfortunate experiences of many firms with so-called "efficiency engineers"; and the belief of the average factory superintendent that he knows more about his own production and the best way to manufacture it than any outside man can tell him.

The main question, however, is: Can a mechanical expert go into a factory, with the product of which he is unfamiliar, and after making a thorough investigation show the manufacturer ways in which he can improve the production and save money? The writer has been engaged in this work for various factories and has found that with proper coöperation by the management, and a receptive attitude on the part of the foremen, many improvements can be made to stimulate production. In many cases the changes necessary are not costly and can be instituted without interfering with the production in any way.

Place for Beginning Investigation

The investigator must enter a factory with an open mind and must consider the entire factory as a problem to be solved. He should start the investigation in the assembling department. In this way he will become familiar with the product in its finished state, and will see why certain parts must be made more accurately than others in order to facilitate the assembling. Besides, various points can be noted in connection with the assembling and fitting that will aid in locating inaccuracies during the machining processes. These points can then be traced to their origin and notation made as to improvements needed. For example, if it is noted that certain parts will not fit together properly and so must be taken off and dressed with a file or otherwise fitted, it is evident that there is something wrong with the method of machining or that the inspection department is at fault. The methods used in the assembling department vary greatly and in some cases manufacturers are lax in providing suitable assembling stands and fixtures, so that a man must take a great many unnecessary steps. The engineer can make notations of all these matters, and study them in detail later.

When the engineer has studied the assembling and fitting departments, his next step should be to take up the points noted, one at a time, in the various departments where the machining operations are accomplished. When tracing the operations, from the time the product leaves the rough stock room to the time it reaches the assembling department, he may find that considerable time is lost by frequent handling and that some pieces of work take a certain routing while other parts are routed in an entirely different manner without any apparent reason. A case of this kind was found in a factory using flat and round stock. The flat stock was cut to size by a shear in the rough stock room; but the round bar stock was placed on a hand truck and taken into another part of the main factory to be cut. Not only was the round bar stock difficult to handle on a truck, but, during the cutting operation, the truck obstructed a passageway. Yet, there was no reason why the shear for the round stock could not be moved into the stock-room and the bars cut up in this department, the same as the flat pieces.

Faults Found in an Automatic Screw Machine Department

Another case recently noted was in an automatic screw machine department, which was exceedingly well equipped with machines capable of turning out work to good advantage; but though the machines were working continuously the production was nowhere nearly what it should be. An investigation showed that the camming of some of the machines was very bad; in one case, the idle time on a machine producing one piece of work every sixty-five seconds was found to be twenty-five seconds when it should not have been more than five or six seconds. It was also found that the machines were not speeded up to their greatest efficiency and that the drills were ground at an angle that did not permit the best results to be obtained. Furthermore, the operator did his own drill grinding for six machines, and had no set of duplicate tools nor any method but a makeshift sort of gage by means of which he could set the tool, after it had been ground, to the proper position. The job was a very simple one, requiring only a drilling, facing, forming, and cutting-off operation on a piece of cold-rolled stock. By improving the camming of the machines, providing duplicate tools and simple sheet-metal gages by means of which the tools could be set, and increasing the speeds of the machines slightly, the production was increased over 40 per cent without any appreciable cost.

There seems to be a tendency on the part of those using cutting tools, especially automatic screw machine operators, to keep the frequency of tool grinding down to the minimum. In the case cited, the cutting tools were ground about twice a week, and the operator seemed to think that he was obtaining very good production and that the efficiency of the machine was shown by the fact that the tools did not need to be ground oftener. As a matter of fact, if a tool that is put to hard service requires grinding only once in three days it is evident that that particular tool is not doing its utmost work. Naturally the operator does not wish to grind tools oftener than he is obliged to, on account of the difficulty of resetting them so as to produce the work correctly. However, if a set of simple sheet-metal gages is made up and a duplicate set of sharp tools is kept in a convenient place, the matter of grinding becomes a much less serious proposition and the machines can be run to maximum efficiency and produce the work properly.

Matters of this kind are very likely to be overlooked by the superintendent, and as long as the machines themselves are running steadily and producing a certain quantity of work that is commercially acceptable, he is not likely to think much about this department. As a matter of fact, in the case cited, if an investigator had been engaged a few months sooner it might have been unnecessary to buy two new machines, because the production would have been sufficiently increased without them.

Increasing Production by Overhauling Machines

About a year ago the writer was investigating conditions in a factory in New England, producing a press that had a platen varying in size from 20 by 30 inches to 36 by 48 inches. The investigation started, as usual, in the assembling department, where it was found that from three days to a week was consumed by the man in scraping and otherwise fitting some of the parts. Frequently the scraping of the platen consumed several days before it was in suitable shape. Tracing this piece back, it was found that the planing machines used were in very bad shape. There were twelve planers in the factory, so these were torn down one at a time, and the various working parts and the table were refitted so that the machine produced the work within reasonable accuracy. Of course, this refitting of the machines cost considerable money and held up the work on that particular machine during the process, but the time required to assemble the machine and do the necessary fitting on the platen was greatly reduced.

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[1] Address: Care of Service Engineering Co., 25 Church St., New York City.

The examples noted are typical of things that may be found by an investigator, but which would not otherwise be noted, and a factory may be operated for months with a considerable loss in production before the actual causes of the loss are discovered. It must be remembered, however, that any engineer who undertakes an investigation must be a man of wide experience, who is able to analyze the various conditions in the factory as he finds them and suggest suitable remedies. The prevailing opinion among manufacturers is that if an outside investigator were to visit their factory he would be likely to do more harm than good. It is unfortunate that this attitude has become prevalent and the engineer investigator must live down this reputation. He has come to stay, and conditions in the manufacturing field at present confirm the belief that more and more of these men will be required as their value becomes appreciated. Some manufacturers prefer to do their own investigating and have a man for this purpose in their organization; but this system does not work satisfactorily for the reason that the viewpoint of this man is too narrow, and he does not obtain the desired results because he is too closely in touch with the work.

* * *

CONVERTING MOTOR ARMY TRUCK INTO LATHE FOR TURNING WOODEN SHELLS

At Camp Lee there developed recently an urgent demand for three hundred 3-inch "wooden shells." These shells, which were to be used in maneuver work and had to be completed in two days, were to represent a 3-inch shell and cartridge case. As there was no lathe or tool equipment of any kind at the camp adapted to wood turning, it was considered an impossibility to produce the shells at the camp, until Sergeant Carlson, who is a very resourceful mechanic, undertook the construction of a special "wooden shell" turning lathe.

The only available supply of material that could be used for constructing this lathe was a partially dismantled automobile army truck, from which parts had been removed to repair similar trucks. Fortunately, the motor and the transmission case had been left intact and were in serviceable condition. With parts taken from the motor truck and by the aid of a few crude tools from the blacksmith shop, the lathe shown in Fig. 1 was built and put into operation. The lathe bed is constructed from wooden plank supported between two wooden posts. The transmission case of the motor truck is mounted on this base and made to serve as the headstock.

The transmission case shaft equipped with a flange coupling for connection with the universal joint of the motor driving shaft is used as the spindle, and the flange coupling is made to serve as a faceplate. The emergency brake drum on the transmission shaft serves as a pulley and is driven by a belt from the fan-belt pulley on the motor truck engine. The tailstock center is made from a piece of threaded round iron, obtained from the blacksmith shop. This rod is screwed in the post in line with the improvised faceplate and the end is bent to form a crank, so that it can be turned in or out, the same as the ordinary tailstock center. The tools for turning were made from old files at the blacksmith shop.

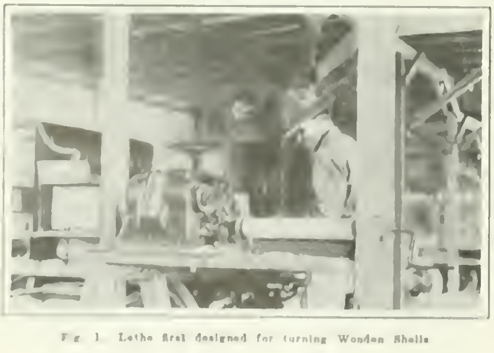


Fig. 1. Lathe first designed for turning Wooden Shells

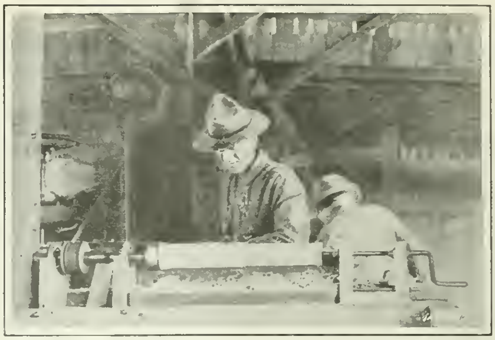


Fig. 2. Improved Type of Lathe for turning Wooden Shells

This lathe was not entirely satisfactory, however, and the inventor proceeded to improve upon the original design. The lathe which was finally evolved is shown in Fig. 2. This improved type was found entirely satisfactory, and evidence of this fact is clearly shown by the expression on the face of the operator. The main spindle is equipped with ball bearings and was removed from the transmission case of the dismantled car. The tailstock center is the one employed in the original lathe, but is provided with a new type of holder, as shown. The main spindle, which is equipped with a wooden pulley, is belt-driven from the fan-belt pulley on the truck motor.

One of the interesting facts in connection with the development of this lathe is that the time required in designing and constructing was only one day, and the rate of production of wooden shells on this lathe made the delivery of the 300 shells possible within two days' time.

* * *

AMERICANIZATION—A VITAL PROBLEM IN THE INDUSTRIES

The Chamber of Commerce of the United States has published a booklet entitled "What You can do for Americanization," which is being widely distributed among the industries. In this booklet, manufacturers are requested to take steps to imbue foreign-born men and women thoroughly with the American spirit and assist them in becoming American citizens. Among the suggestions given are the following: See that the safety, sanitation, and housing of your men are such as to keep them fit during the war. Every man or woman who does not speak English should be learning it. Insist upon their learning it in school or in your shop, and designate one of your employes to see that it is done. Urge the public educational authorities to start language classes in the factory for those who do not understand English and are unable to attend school. Efficiency increases with knowledge of English and citizenship. Give it recognition by increased wages and promotion. Stop anti-American propaganda and agitation in your plant, by providing information and cooperation on true Americanism. Invite naturalization officers to explain citizenship to your aliens and encourage them to make America their home. Give them time off with pay to attend to their naturalization examinations. Develop incentives through wages, bonuses, insurance pensions, and profit-sharing. The employer who keeps his men at work contentedly today is America's most practical patriot

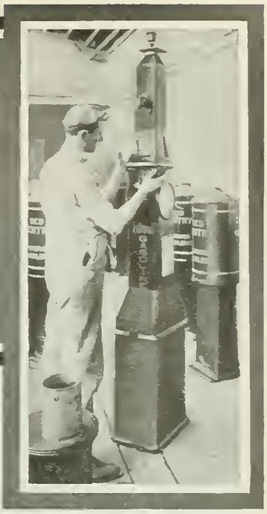
* * *

An alloy that is very ductile, resistant, and flexible is formed by combining tantalum with small proportions of gold and copper. After the metals are reduced to a fine powder and mixed, the mixture is subjected to pressure and the compact mass thus formed is fused in an electric furnace. The alloy is as non-oxidizable as pure tantalum, and can be produced at a reasonable price.

Methods of Trademarking Your Product

By Edward K. Hammond[1]

Functions of Trademarks and How to Apply Those Possessing the Maximum Durability and Publicity Value



IT can be said without fear of contradiction that a trademark which is placed on any metal product in such a way that the marking will not become obliterated or invisible from wear, discoloration, etc., constitutes a perpetual advertisement for the manufacturer during the entire working life of the machine, tool, or other product upon which the trademark is applied. Any manufacturer makes a great mistake in not placing a trademark on his product, together with his name and address, for such a marking is frequently the means of securing repeat orders. It is quite a common matter for shop men to be asked by the purchasing department of a plant to give their opinion of the relative merits of two competing products between which the purchasing agent is anxious to make a decision in issuing subsequent orders.

In order to illustrate this point, let us suppose that the foreman of the grinding department in the factory has been asked by the purchasing agent to give his opinion of the relative merits of two different types of grinding-wheel truing tools in use in the shop. At the time each of these tools is received, the usual form of invoice doubtless comes with it, but after the details of payment have been settled, it will often happen that the wheel-truing tools go from the receiving room to a supply room and thence to the shop, where they will simply be identified as wheel-truing tools without any connection to the manufacturer's name. If the tools are clearly trademarked, the shop foreman will have no difficulty in identifying the particular tool which his experience has shown to possess the most points of merit under actual conditions of service, and so he will be able to make a definite recommendation to the purchasing department, which will assure more of these good tools being purchased for his use. But if the tool carries no trademark, or if it is marked in such a way that the design will be obliterated shortly after the tool has been placed in use, it is very difficult for the man in the shop to state definitely which tool he has in mind, as a result of which mistakes are likely to be made in identifying the tool that the foreman referred to, which results in the loss of repeat orders by the manufacturer who has actually made the tool that should have been given preference.

In order to possess the maximum publicity value that is available, a trademark should have some peculiar significance in connection with the product to which it is applied, in order to connect the trademark with the product and cause the marking to be readily remembered. For instance, the Simmons Hardware Co., of St. Louis, Mo., has adopted the trademark of "Keen Kutter" for various types of edged tools which are produced in its factory. Obviously, this name will very easily be associated with cutting tools, and so, if a foreman in any factory where these tools are used wishes to suggest their purchase for use by men employed in his department, it will be very easy for him to tell the purchasing agent that these "Keen Kutter" tools have given exceptionally satisfactory service.

Use of Trademarks in Advertising Literature

After he has been successful in developing a trademark which is properly linked with the product on which it is used, the manufacturer should follow the scheme to its logical conclusion by making free use of his trademark on letter heads, advertising literature, etc. The idea of a trademark is to advertise the product on which this mark is placed, and maximum results are only obtained by persistently endeavoring to make the trademark synonymous with the product on which it is placed, so that a prospective customer who is in the market for the product in question will immediately connect the well-advertised trademark with the particular type of tool or equipment which he wishes to buy. It is a matter of general knowledge that trademarks can be registered in the United States Patent Office, so that the manufacturer who is the maker of well-known trademarked products is protected against the use of his trademark by competitors. It costs very little to apply trademarks on most manufactured products, and they may become very important factors in conducting the work of the sales department.

Importance of Durability of Trademarks

Reference has already been made to the importance of having a trademark applied in such a way that it will possess the necessary durability to be plainly visible during the entire working life of the tool. Unless care is taken to obtain this result, nothing approaching the maximum publicity value which is available can be expected from the trademark. For instance, consider the case of a manufacturer of wooden-handled tools who adopts the practice of marking them with a colored paper label pasted on the handle. Such a method of marking constitutes a highly efficient advertisement for a short length of time, because the label can be printed in bright colors, which naturally attract attention. It is fairly obvious, however, that these labels can only last for a very short length of time, because if they are not torn or worn off the product on which they are applied, discoloration will soon make them unreadable. On the other hand, if the trademark, maker's name, etc., is impressed in the metal surface or applied by some process which leaves the required design and maker's name, etc., raised above the surface of the metal surrounding the marking, each trademark will last for the entire working life of the tool, thus giving continuous service as an advertisement of this particular type of tool.

In deciding upon the best method to use for trademarking a given product, several factors must be considered. First of all, it is necessary to obtain a design which is as characteristic as possible of the particular product on which the trademark is to be applied, and next in order is the importance of selecting a method of applying this marking to give a neat and workmanlike appearance. In connection with the selection of a method of applying the trademark, consideration must be given to the conditions under which the product is used on which this trademark is to be applied. In any case, the ultimate object which is desired is to keep the trademark in a condition which makes it plainly visible during the entire working life of the tool. Such being the case, it would obviously be unsuitable to stamp a trademark into the surface of a machine tool frame which will become coated with oil and dirt. A trademark applied by such a method would very soon be obliterated, with the result that the manufacturer of the machine would fail to secure his full quota of publicity from the trademark. This is one reason for adopting the almost universal practice of making the mold in which the frame casting is produced in such a way that the trademark, manufacturer's name, etc., are cast in letters which are raised sufficiently above the surface of the metal so that they are not likely to become invisible.

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[1] Associate Editor of MACHINERY

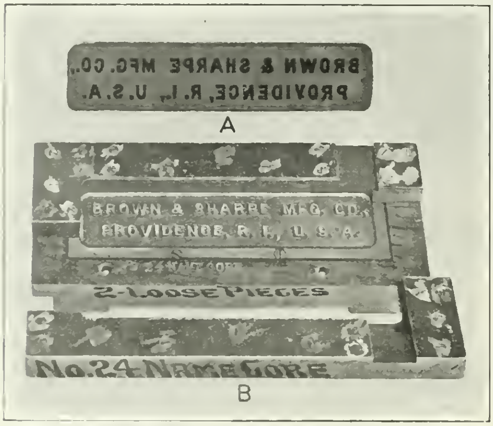

Fig. 1. (A) Core for casting Marking on Machine Tool Frame and (B) Core-box in which Core is made

Various Methods of Trademarking

The manufacturer who is about to make a selection of the method of applying a trademark to his product will naturally be interested in reading the following brief description of the different methods by which trademarks are applied to a variety of metal products. For marking machine tools with the builder's name and address and any special name or legend which has been adopted to identify the tools of his manufacture, it is almost universal practice to cast the required marking directly upon the machine bed. For this purpose, a core on which the necessary lettering, etc., is produced is set in the mold in which the casting is to be poured and left protruding sufficiently to cause an indenture upon which the raised letters appear. This indenture brings the surface of the letters flush with the surface of the machine bed, thus avoiding any tendency for the letters to be worn or broken off. Fig. 1 shows at *A* one of the cores used for casting the required marking on the frames of machine tools built by the Brown & Sharpe Mfg. Co., of Providence, R. I., and at *B* there is shown the core-box which is required for use in making these trademarking cores. Fig. 2 shows a machine frame marked in this way.

A substitute for the method of casting a name right on a machine bed is to apply a nameplate made of brass or some similar metal. A nameplate has one important advantage over the name cast onto the machine bed in that it is made of a different colored metal, and so perhaps attracts more attention. However, the nameplate is a trifle more expensive to apply, and there is also the risk of its becoming detached from the machine. In any case, where a nameplate is to be applied to a machine or other product of considerable size, the design of the product to be marked should be studied with the view of selecting a position for the nameplate which will combine the advantages of having it protected from unnecessary wear and still having it so placed that it is readily seen by those who operate the machine or pass by it. Nameplates may be of various forms, but in all cases the metal from which they are made should be sufficiently hard so that the lettering will not be bruised or worn smooth, and to further assure against the production of such an undesirable condition, the letters should have plenty of relief.

Nameplates are made in a number of different ways, among which mention may be made of the processes of casting the plate in a mold, or of producing the required legend and design by etching, lithographing, or embossing. Nameplates made by each of these methods have certain points to commend them. The chief claim made for the cast nameplate is that almost any desired amount of relief can be provided for the letters and other elements of design. Cast nameplates are likely to be rather expensive, owing to the necessity of making patterns and molds, but this limitation has been considerably reduced through a method developed by the Federal Nameplate & Novelty Co., of Chicago, Ill. This firm has developed a process for making die-cast nameplates in sectional molds, which are built up by assembling the necessary combination of letters, spaces, border lines, etc., each letter, spacing block, or section of border being carried on an individual steel block which is carefully machined on all sides so that any required number of these blocks can be assembled together and form a tight fit. The great advantage of this method of making nameplates is that standard die sections may be carried in stock by the nameplate manufacturer, in the same way that a printing plant carries different standard type faces in stock. Then when an order is received for, say, two hundred nampelates of a given design, the necessary die sections can be taken from the racks and assembled to form the die required for casting these nameplates. After a given order has been completed, the die is broken up and the die sections replaced in their respective positions in the racks, so that the only die charge which need be made against a given job is the average wear and tear on the die sections used in handling the work. This method is naturally the means of making a great saving in the cost of production, because to make a special die for die-casting, a small number of nameplates must of necessity add greatly to the expense, as the whole cost of the die has to be distributed over a small number of plates.

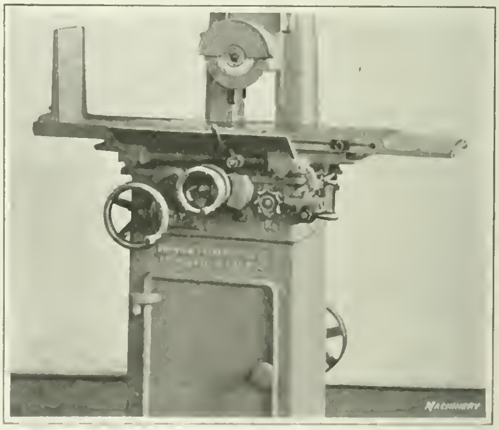

Fig. 2. Marking on Machine Frame produced by Use of Core shown in Fig. 1

Making Etched Nameplates

A great many nameplates used on different types of small machines and metal products are made by etching the legend and design on the metal plate. For this purpose, the method of procedure used in manufacturing nameplates is as follows: A drawing of the required design is made to an enlarged size in order to enable the artist to work more easily. A zinc etching of the required size is then made from this drawing by the photo-engraving process. The etching is set up in a special form of printing press and the design of the required nameplate is printed on the surface of sheet-brass blanks from which the nameplates are to be made. While the printed surface is still wet, a specially prepared acid-resisting chemical powder is shaken over the surface of the sheet brass, and this powder sticks to the wet parts of the blank, while it may be easily brushed off those sections of the brass surface which are left clean. The work is now ready to be etched, for which purpose it is treated with acid that eats its way into the exposed surfaces of the brass but will not "cut" the portion of the surface which is provided with the specially prepared "resist" that was applied by the printing operation. The amount that the design is left in relief will be governed by the length of time that the brass is exposed to the etching acid, but after the desired result has been obtained, the acid is washed off with clear water.

Fig. 3 shows a variety of etched nameplates made by the Crowe Nameplate Co., of Chicago, Ill. This firm has specialized in the making of etched nameplates and has developed processes for obtaining a variety of different color combinations. For instance, plates may be made of white metal, brass, copper, etc., with the combination of bright letters and a frosted background, or vice versa; also, colored plates may be made with the background in various colors and the letters in the natural color of the metal, etc. Such color schemes add greatly to the effectiveness of the nameplate from a publicity standpoint. Other colored nameplates are made by a process of lithographing on sheet metal which enables any required combination of colors to be obtained. One serious limitation of the lithographed nameplates is that they do not stand up very well under severe conditions of service. Two examples of nameplates made by the lithographic process are shown at *A* and *B* in Fig. 4, and at *C* there is shown a plate on which the letters were raised on the sheet metal by an embossing die.

Etching a Trademark upon the Product[1]

There are various metal products, of which cutlery is an example, that may be effectively trademarked by etching directly upon the surface of the metal. In the case of steel or iron products, nitric acid may be used as the etching medium, and this acid oxidizes the iron, leaving the etched surface black, so that it stands out in distinct contrast with the light colored surface of the surrounding metal. As in the case of making etched nameplates, the principle governing the process of etching directly upon the surface of the metal product is to apply a resist in which the required design is cut in order to expose the metal to the action of the etching fluid, while the surface of the metal surrounding the marking it is desired to etch is protected by means of the resist. The method of procedure in handling the work is somewhat different, however.

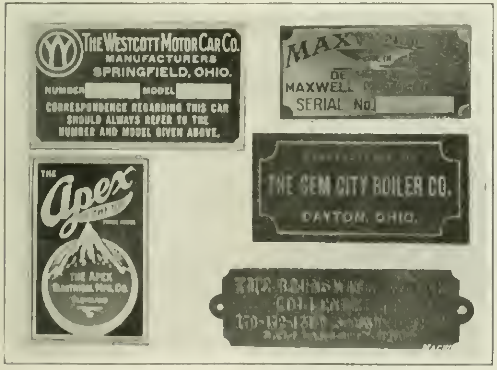
THE WESTCOTT MOTOR CAR CO.
MANUFACTURERS
SPRINGFIELD, OHIO.
NUMBER
MODEL
CORRESPONDENCE REGARDING THIS CAR SHOULD ALWAYS REFER TO THE NUMBER AND MODEL GIVEN ABOVE.
MAXWELL
SERIAL No.
THE Apex
THE APEX ELECTRICAL MFG. CO.
THE GEM CITY BOILER CO.
DAYTON, OHIO.

Fig. 3. Examples of Different Combinations of Letters and Backgrounds on Etched Nameplates made by the Crowe Nameplate Co.

One way of etching trademarks on cutlery which has been found to give satisfactory results is to apply a light coat of shellac on the surface in which the trademark is to be etched. A rubber printing stamp is made with the required trademark, and this stamp is first applied to a pad saturated with caustic soda and then pressed on the shellac, which has been given time to dry on the metal surface to which it was applied. The result is that the caustic soda applied by the rubber stamp "cuts" the shellac, so that it can be removed by lightly brushing the surface with water. When 20-per-cent nitric acid is applied, it will etch that part of the steel surface which has been exposed by cutting the trademark in the shellac, while the remainder of the surface is protected from the acid by the shellac. The acid is left on the work for about eight minutes, although the exact time varies considerably, according to the composition of the metal. After giving the acid time to etch the trademark on the work, the entire surface is rinsed in cold water in order to wash away the excess acid and prevent further action. Various other methods of applying a resist and cutting the required design in the resist to expose the surface of the metal for etching may be employed, but the method of using a rubber stamp and caustic potash to expose the metal under a shellac resist is perhaps one of the most rapid and effective that can be employed.

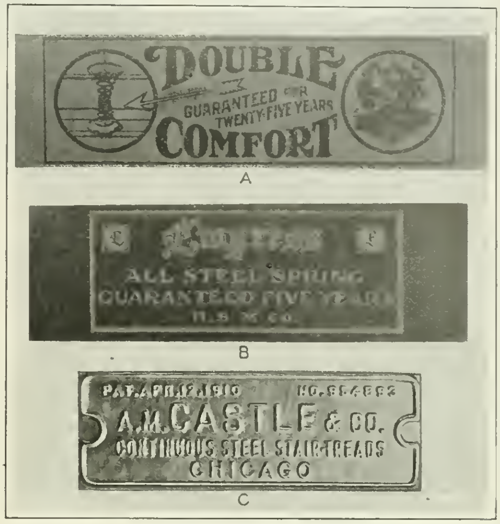

Fig. 4. (A and B) Nameplates made by the Lithographic Process and (C) Nameplate with Letters embossed on Sheet Metal

Etching Trademarks on Tools

At the plant of the Nelson Tool Co., 781-783 E. 142nd St., New York City, a practice is made of etching the company's name on dies and other tools made in the shop. For this purpose, the method of procedure involves the use of the usual combination of a resist and etching fluid, but the way in which the work is done has certain interesting modifications. Beeswax is used as a resist, and the wax is applied to the metal by heating an iron bar about ½ inch in diameter in the flame of a Bunsen burner and rubbing this bar over the surface of a cake of wax about 2 by 4 inches in size. Application of the hot iron bar warms the wax so that it approaches a melted condition; the warmed side of the wax is then rubbed over the surface of the tool which is to be etched. This leaves a film of wax on the surface of the tool which is impervious to the action of the acid used for etching. After the wax has been given sufficient time to cool and harden, a steel scriber with a

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[1] In the September, 1917, number of MACHINERY there was published an article entitled "Graduating, Engraving, and Etching." This article gave detailed information concerning various resists and etching fluids suitable for use on steel, iron, brass, etc.

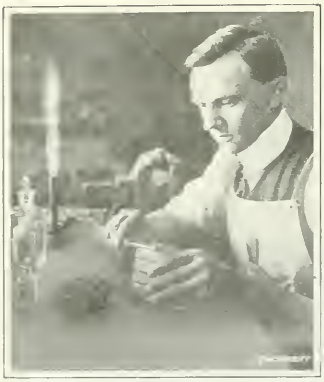


Fig. 5. Method of applying Wax for etching Trademark

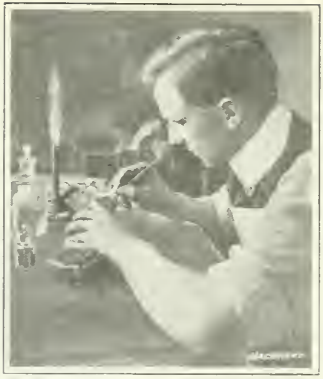


Fig. 6. Method of engraving Marking for Trademark in Wax

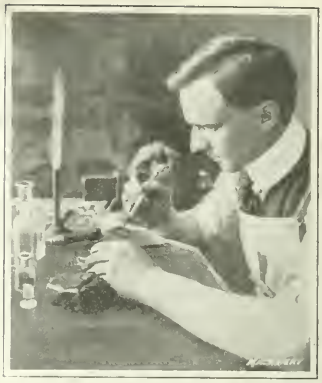


Fig. 7. Method of applying Acid for etching Trademark

sharp point is used to make the desired marking, with the result that the wax is cleared away from the surface of the steel, leaving the metal under the marking exposed but the surrounding surface of the steel covered with wax.

An etching fluid consisting of four parts of hydrochloric acid to one part of nitric acid is then applied to the steel. The exact length of time which the acid stands on the work will vary according to the composition of the steel and certain other conditions, so that it is necessary to experiment in order to determine the exact length of time which gives the desired depth of etching. Usually, the time required will be from five to ten minutes. It varies according to the composition of the steel and whether it is hard or annealed. After the acid has been left on the work for the required time, it is washed off with water, after which the wax resist can be removed. The marking produced on steel by an etching fluid containing nitric acid is of a dark brown or black color, which shows up distinctly on the light colored surface of the steel. The reason for the etched marking being black is that nitric acid is an oxidizing agent, the etching process consisting of the conversion of light colored metallic iron into iron oxide which is nearly black. Figs. 5, 6, and 7 show successive steps in etching trademarks on tools as done by the Nelson Tool Co.

Robinson's Etching Solution

The following formula for an etching solution for etching lettering on carbon or high-speed steel was developed by J. B. Robinson, of the Rochester Ball Bearing Co., while employed at the Bausch & Lomb Optical Co., Rochester, N. Y., and has been termed the "Robinson formula." It consists of 2 parts of acetic acid, 8 parts of nitric acid, and 5 parts of hydrochloric acid. Beeswax is used as a resist, the wax coating being rubbed onto the object to be etched very thinly and smoothly, preferably by using the edge of a scale or similar object. The acid is permitted to act for about two or three minutes, with a fresh mixture, and produces a black deposit in the etched lines. It is claimed that this solution gives very satisfactory results, and those who have used it recommend it highly.

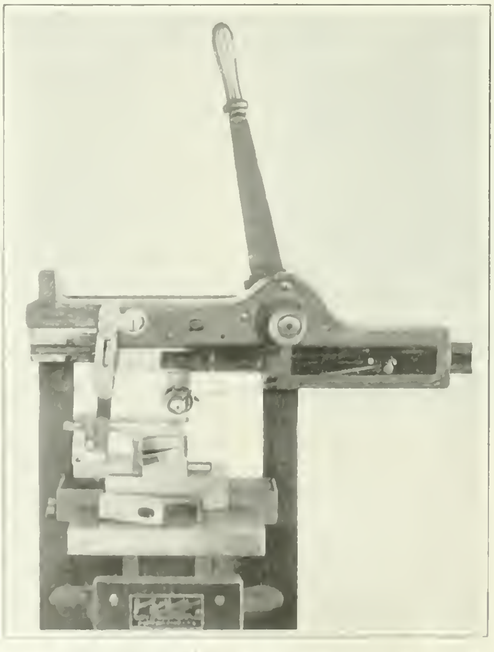


Fig. 8. Dwight Slate Marking Machine equipped for impressing Trademark in Flat Work

Decalcomania Transfer Method of Etching

For etching trademarks on metal products, use is often made of decalcomania transfers, which are perforated so that they form a background for the trademark, thus constituting a resist which protects the metal surface while the desired marking is left exposed so that it may be etched by the fluid which is applied for that purpose. There are various methods of applying decalcomania transfers for etching, but the following is one that has been found to give satisfactory results: The face of the transfer is given a thin coat of quick-drying varnish and allowed to stand until the varnish becomes very sticky or "tacky," as it is called. The varnished side of the transfer is then applied to the work to be trademarked and the transfer is rolled with a rubber roller to expel air bubbles and get the transfer firmly in contact with the work.

After allowing the varnish a few minutes to set, the paper backing of the transfer is soaked with water, so that it may be peeled off, and the transfer is once more rolled down with a wet felt roller. Between the transfer and the paper backing there is a layer of starch, which is softened by the water to facilitate removing the paper. The transfer is finally tapped with a dry piece of chamois leather. Varnish is able to resist the action of an etching acid, and as the varnish is likely to spread out from under the transfer to surrounding surfaces of the metal, it must be removed before the etching process is started. This can best be done with benzine or some other non-greasing detergent with which the varnish is washed off the metal surfaces. One good way of accomplishing this result is to dampen the whole surface where the transfer has been applied with diluted turpentine or ammonia and then rub the surface lightly with a dry soft rag. This removes any varnish that has run out from under the transfer onto the surface of the metal which must be exposed for etching. Where extremely fine etching is required, it may be a good plan to apply one or two coats of varnish over the transfer and allow it to stand for a day before proceeding with the etching.

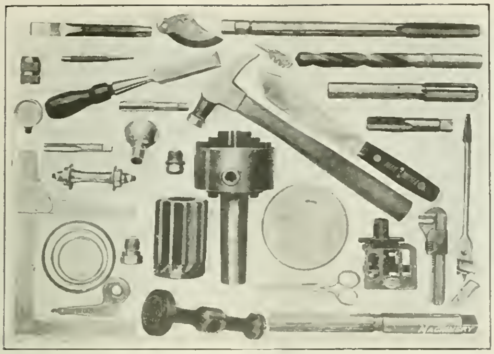


Fig. 9. Examples of Work with Trademarks impressed with Dwight Slate Marking Machines

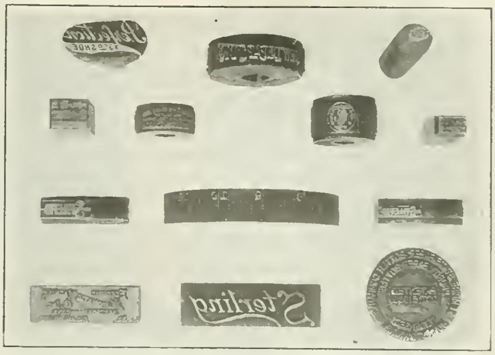


Fig. 10. Examples of Dies made for Use on Dwight Slate Marking Machines

After the preparation of the work for etching has progressed to this point, the following steps in the process will vary according to the depth to which it is required to etch the trademark. If a deep marking is required, it will be found necessary to paint over the decalcomania transfer with asphaltum varnish, and also all exposed surfaces of the metal, except where the etching is to be done. Then after this varnish has had time to dry, the work can be immersed in an etching bath for the required length of time to produce a marking of the desired depth. When it is only required to etch lightly, a small amount of acid can be placed over the design, and if the surface is flat and level, there will be no danger of the acid running, and so it is unnecessary to apply asphaltum paint around the edge of the transfer. After the resist has been prepared in this way, the etching process is accomplished by the use of acid or any other suitable fluid in exactly the same way as if the resist had been prepared by the application of wax or some other material which would not be affected by the etching fluid. When applying transfers, it is important to have the work thoroughly cleaned to remove all traces of grease from the metal. In the factory of Henry Disston & Sons, Inc., Philadelphia, Pa., this method is used for applying trademarks to various types of saws. About sixty saws are laid out along a bench and, after the transfers have been put on, the etching acid is applied with a small sponge. The workman walks all down the line, moistening the sponge with acid and applying it to each saw blade. Then he starts again at the top of the line and rinses off the acid with a large sponge soaked with water. This means that the acid is left on the work for about five minutes.

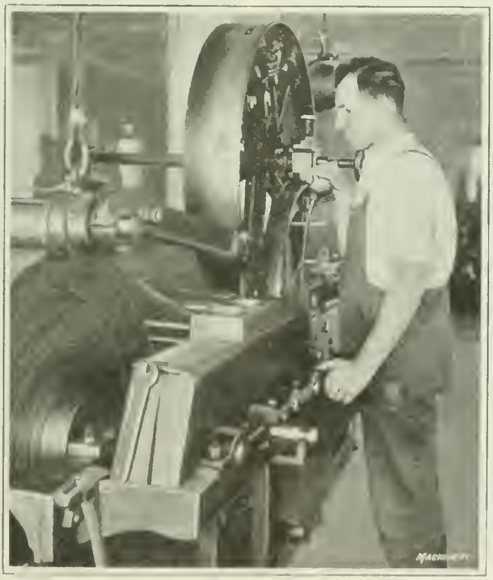


Fig. 11. Combination Trademarking and Measuring Machine used for Impressing "Duxbak" Trademark into Schieren Leather Belting

Impressing a Trademark into a Metal Surface

Another commonly used method of trademarking is to employ a stamp to impress a trademark into the surface of a metal product. In some cases, a single stamp can be made to include all of the marking that is required, while in other cases individual stamps are made, each of which has one letter or figure, so that these stamps may be used successively to produce the required marking. Where the latter method is employed, trouble is likely to be experienced through irregularity in the depth of impressions secured with different stamps. A little thought will suffice to show that for figures of a given height it will require more pressure to sink a figure 3 to a specified depth in the work than to sink a figure 1 to the same depth. Some plants have conducted very careful investigations of the relative amounts of pressure which are required and have arranged each stamp with a weight that slides on a bar attached to the top of the stamp. Each of these bars is arranged with a limit stop, so that the height from which the weight falls onto the stamp to provide for impressing the stamp into the work may be varied according to conditions. By determining the relative height from which each weight should fall in order to impress the letter or figure to the desired uniform depth, provision is made for producing a trademark of satisfactory appearance.

Such a method of providing for the production of uniform marking in the work is obviously a tedious process and one which involves considerable loss of time. A much more satisfactory method is to use one of the Dwight Slate marking machines built by the Noble & Westbrook Mfg. Co., of Hartford, Conn. These machines are furnished with a die on which the desired marking is left in relief by cutting away the surrounding metal. The machine is operated by having the die carried on a slide so that this die may be moved over the surface of the work in which it is desired to impress the trademark. The work is carried on a table supported by a vertical slide, and this table is raised to bring the work into contact with the die by pushing down a foot-lever.

An adjustable stop is set so that the foot-lever brings the table to a uniform position each time, in order that the marking may be of the same depth in all pieces of work, and the operation of the machine itself insures a uniform depth of marking on each individual piece. Either flat or cylindrical shaped pieces may be marked on the machine. In the case of cylindrical work, a flat die is used and the work is rolled on the table under this die. Where it is desired to mark flat work, a cylindrical shaped marking die is used which is rolled over the surface of the work. In addition, provision may be made for marking on tapered pieces of work, special fixtures being provided for handling such operations. Figs. 8 and 12 show machines set up for marking flat and cylindrical shaped work, respectively. A good idea of the range of trademarking which may be handled on the Dwight Slate marking machine will be apparent by referring to Fig. 9, which shows a number of examples of work; and in Fig. 10 there are shown different types of marking dies made for use on the machine. In using a round die for marking flat work or a flat die for marking round work, it will be apparent that there is only one point of contact between the die and the work at any one time. This greatly reduces the amount of pressure required to impress a given marking, and as a result many kinds of material that would otherwise be distorted can be readily marked by this process. For instance, it is found practicable to impress markings into hollow tubes. Adjustments are provided on the machine for use in connection with flat or round dies, so that the proper character on the die comes into contact with the work at a specified point, this adjustment being obtained by screw stops. Movement of the slide which carries the die across the work is effected by a hand-lever which actuates the slide by means of a rack and pinion.

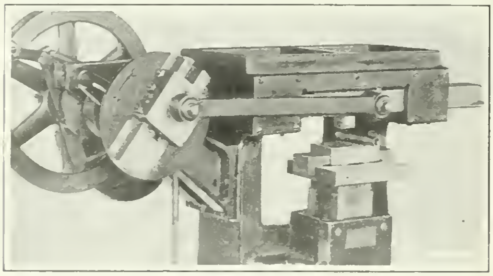


Fig. 12. Dwight Slate Marking Machine equipped for impressing Trademark in Cylindrical Work

A somewhat similar method is employed by manufacturers of leather belting for impressing a trademark into the surface of this product, but in the case of belting care must be taken to make the marking die with the edges of the raised design carefully rounded, instead of having these edges sharp. The reason for taking this precaution is that in making belting it is the practice to impress the trademark into the belting by compressing the leather under the raised portion of the die without actually cutting the fibers of the leather. If these fibers were cut, it would naturally result in weakening the belting. In Fig. 11 there is shown a combination trademarking and measuring machine used in the plant of Charles A. Schieren Co., 73 Ferry St., New York City. It will be seen that this machine is equipped with a wheel and that the belting to be marked runs under it so that the stamp may impress the Schieren trademark of "Duxbak Belting" together with the registered design in the surface of the leather at each interval of ten feet. This machine also stamps the length of belting, which greatly facilitates the work of measuring up any specified length of belt that is required for a given drive. The trademarking machine is equipped with a mechanism which automatically adjusts the marking punches to bring up the required tens digit in 10, 20, 30, etc., while the units digits are placed around the circumference of the wheel so that they mark from 1 to 10 in each successive interval of ten feet of belting. On this machine, belting up to 14 inches in width may be marked, and for marking larger widths of belting a hand stamp and hammer are employed, as shown in Fig. 13.

Method of Marking Steel Barrels and Boxes

Barrels and boxes made of sheet steel are naturally more expensive than similar wooden containers, but when made of steel they can be used repeatedly, so that the price paid for service rendered by steel barrels is often less than when they are made of wood. Wooden barrels are quite commonly marked by either pasting a label on the barrel or painting the desired marking on it, but either of these methods produces a mark which is likely to be obliterated. With expensive steel barrels which are to be used repeatedly, the owner does not like to run the risk of losing his property, and so it is highly desirable to adopt some more permanent form of marking than that produced by pasting on a label or painting the name on the surface of the steel. One excellent method, which is quite commonly used by manufacturers of steel barrels, is to employ sectional embossing dies of the form shown in Figs. 14, 15, and 16. The dies shown in these illustrations are made by James H. Matthews & Co., 3946 Forbes Field, Pittsburg, Pa. The particular advantage of these dies is that they may be assembled in any way to provide for producing the desired marking on the head of a barrel, and firms engaged in making barrels for a number of customers are able to rearrange these sectional dies for applying the desired marking to work that is being done for different customers, instead of having to go to the expense of having a special solid die made for each customer's work.

In marking the head of a barrel with these dies, provision is made for assembling the upper and lower die members into the faces of the dies used for drawing up the barrel head, so that the drawing and embossing operations may be performed at a single stroke of the press. Those who anticipate using dies of this kind to mark their work will naturally be interested in learning of the amount of pressure which is required for performing the embossing operation, and in answer to this question it may be stated that each one-inch letter requires a pressure of 10,000 pounds for embossing ten-gage steel. In Figs. 14 to 16, it will be seen that the equipment consists of an upper and a lower holder in which the upper and lower embossing die sections are assembled. The illustrations show holders made to accommodate three lines of letters and one line of figures, but holders are made to carry different combinations of letters and figures. The available standard holders have the following combinations: one line of letters, one line of letters and one line of figures, two lines of letters, two lines of letters and one line of figures, three lines of letters, three lines of letters and one line of figures, four lines of letters, and four lines of letters and one line of figures.

An advantage arising from the use of these sectional dies is that they are always available for use, thus saving time which might otherwise be lost through the necessity of waiting for a solid die to be made. The use of these sectional dies, which constitute a standard feature of equipment in a plant engaged in the manufacture of work which can be marked by such dies, saves the expense of making a special die, and thus often enables one manufacturer to underbid his competitor whose figure is based upon the necessity of making a solid die for marking the work. Experience in the performance of embossing operations with dies of this type has shown that certain combinations of letters of the alphabet will provide a sufficient supply to enable the user to set up practically any name and address or other marking which his customer desires

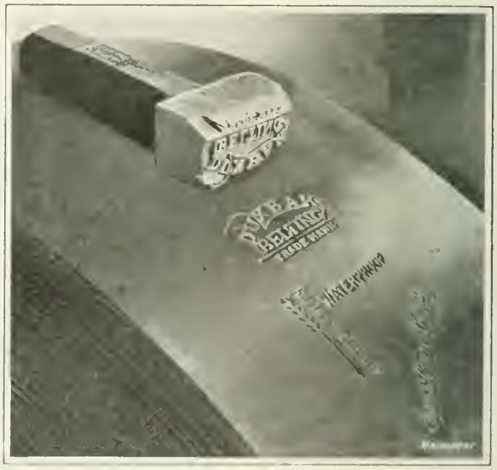
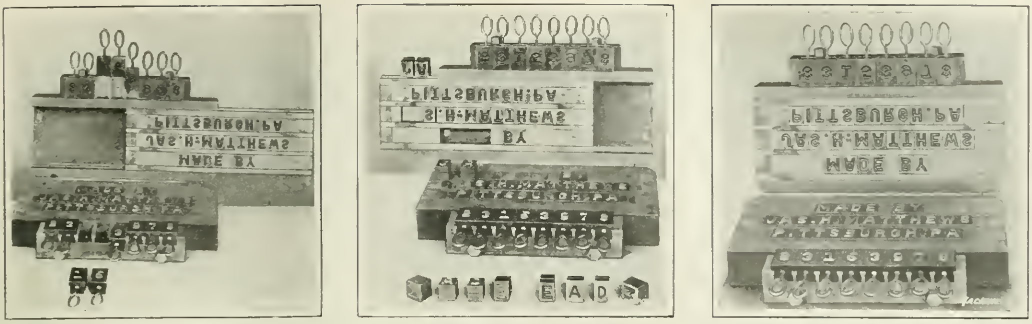


Fig. 13. Form of Hand Stamp used for impressing "Duxbak" Trademark on Wide Leather Belting



Figs. 14, 15, and 16. Sectional Embossing Dies made by James H. Matthews & Co. which can be assembled in Holder like Type to provide for embossing Required Marking on Heads of Steel Barrels and Other Sheet-metal Products

to have placed on the head of a steel barrel. This is a modification of the printer's font system, and for a barrel head embossing outfit, what is known as a "Five A" font of dies is usually supplied, which consists of the following sets of letters: Five A's, three B's, four C's, four D's, six E's, three F's, three G's, four H's, five I's, three J's, two K's, six L's, four M's, five N's, five O's, three P's, two Q's, five R's, six S's, five T's, four U's, three V's, three W's, two X's, three Y's, two Z's, two &'s, and two periods. In each case the figures given refer to a set of dies, and each set comprises one male and one female letter, with sufficient clearance between them to accommodate the metal which is being embossed. The dies are made of a suitable grade of carbon tool steel, which gives them a high degree of durability.

Whenever a line of the figure or letter holder is not employed to its full capacity, it is necessary to fill up the remaining spaces with blanks or "spaces," as they are commonly called. These spaces can be correctly set up with the letters in any line, the following being a case in point: Suppose the number of letters in the holder is quite small. It is necessary to place blanks evenly on each side of the letters in order to produce a neat looking arrangement. Spaces are also necessary, because it is imperative for the holder to be completely filled with either letters or spaces while the embossing operation is being performed. For any set of holders from two lines up, the following spaces are needed: Eight sets of 2-inch spaces, eight sets of 1-inch spaces, ten sets of 5/8-inch spaces, four sets of 1/4-inch spaces, and six sets of 1/8-inch spaces. To provide for holding figures, letters, and spaces when not in use, James H. Matthews & Co. make a special cabinet equipped with a hinged lid. The use of such a cabinet not only protects the die sections from damage, but also provides a definite place for them, so that the danger of loss is greatly reduced.

The term "fool-proof" is applied to these embossing die sections because it is impossible to assemble them in the holders in any other than the correct position. It will be apparent that considerable damage could easily be done if one or more die sections were placed in the holder upside down. The upper holder for the sectional lettering and figuring dies is made of tool steel, and the lines for the letters work on a slide, as clearly shown in Fig. 15, thus making it unnecessary to remove the upper holder from the head of the press in order to change any of the die sections. The lower holder is fastened to the bedplate of the press, and this holder carries the male dies. The die sections for embossing figures are furnished with wire handles, as shown in Figs. 14 to 16, and the dieholders are placed on the press with these handles facing

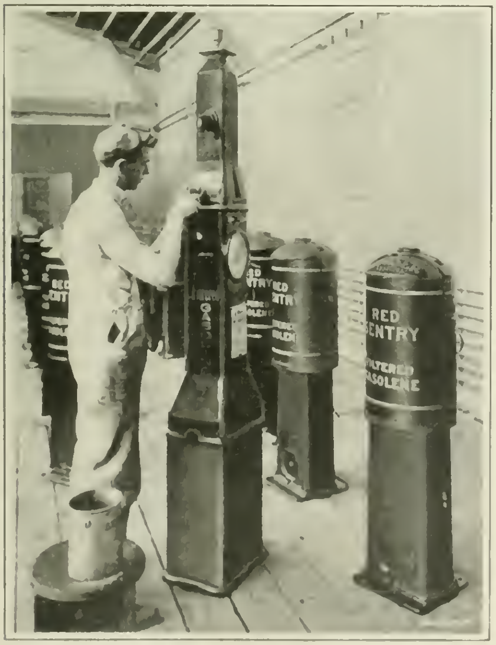


Fig. 17. Method of applying Decalcomania Transfer Trademark to Gasoline Pumps built by S. F. Bowser & Co.

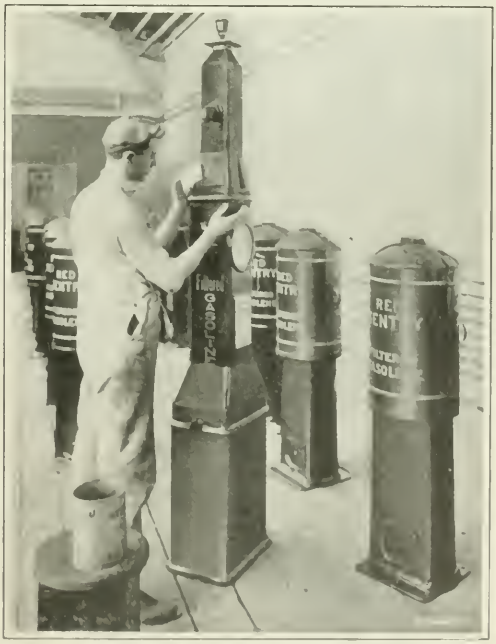


Fig. 18. Stripping Paper Backing off Transfer after Paper has been loosened with Water

toward the front. Both the upper and lower holders for figures are equipped with spring pin locks which engage the die sections when they are pushed into place in the holder. When it is desired to change a die section in the holder, a slight pull on the wire handle pushes this pin lock down into the holder so that the die section can be withdrawn.

Attention has already been called to the slide arrangement for holding the lettering die sections. The upper die sections have to be assembled in the holder face down, and to facilitate the work of assembling these sections, without danger of mounting them in the wrong position, a practice is made of marking the letter on the back of the die-block to correspond with the letter which is actually cut in the front of the block. The slides in which letter sections are mounted are provided with means of securely locking them in position when the die has been completely assembled ready to start performing the embossing operations. In conclusion, attention is called to the fact that this equipment can be used for embossing names, numbers, etc., on curved surfaces. There are, however, many limitations in the application of these sectional embossing dies on anything but flat work. This is due to the fact that when curved holders and curved dies are made, each section of the holder and each die section is curved to a different radius, as a result of which considerable time is required to properly assemble the dies ready for use.

Decalcomania Transfer Method of Trademarking

Where the frames of typewriters, gasoline pumps, and a great variety of similar metal products are to be painted and then given a final finish by applying lacquer or varnish to the painted surface, a very effective method of trademarking is to make use of the decalcomania transfer. These transfers are made in any desired form and in practically any color, and they may be very easily applied to the work after the painting has been done, but before the final coat of lacquer or varnish has been applied. The varnish covers the transfer, and not only gives it a good appearance, but also protects it from becoming discolored or worn off. The transfer consists of a design lithographed on aluminum foil. This material would be very easily torn, and so to afford it the desired protection, the lithographed foil is mounted on a sheet of paper for shipment to the customer. In applying the trademark, the surface on which the marking is to be applied is first given a coat of varnish, which is allowed to stand until it becomes decidedly "tacky." The transfer is then applied to this varnished surface and rolled down so that the aluminum foil is held by the varnish at all points, after which sufficient time is allowed for the varnish to dry completely. When this result has been obtained, a wet sponge is applied to the paper on which the aluminum foil is mounted, and after the paper has been thoroughly soaked with water in this way, it can be readily stripped off, leaving the transfer exposed ready to be given a final coat of lacquer or varnish. To facilitate the stripping off of the paper, a layer of starch is placed between the paper and the aluminum foil which is mounted on it, so that when water is applied with the sponge this starch is dissolved and causes the paper to be loosened from the foil so that it can be readily removed. It is not only a very easy matter to apply a trademark by this method, but the result is of good appearance, and quite durable after it has been protected by one or more coats of lacquer or varnish. Figs. 17 and 18 show steps in the process of applying decalcomania trademarks to automatic gasoline pumps built by S. F. Bowser & Co., of Fort Wayne, Ind.

Branding Trademark with a Hot Iron

An effective method of trademarking the wooden handles of files, chisels, and similar tools is to burn the trademark into the wood with a hot iron. To facilitate handling this work, the Simmonds Hardware Co., of St. Louis, Mo., has electrically heated stamps made with the desired trademarking. These stamps are placed on a table with the surface of the stamp at a sufficient height above the table, so that when the work is rolled over the hot stamp, the trademark is burned into the wood to the required depth. By this method, trademarking may be done very rapidly, because the practice is to roll the wooden tool handles across the surface of the hot stamp or "branding iron" as it might be more properly called, and when a workman knows how to perform this operation efficiently, almost a continuous stream of tools can be kept going across the trademarking table. In order to make this possible, it is, of course, necessary to have helpers who bring the tools to the man who applies the trademark, and other laborers who carry away the trademarked tools. This is, of course, an economy, because very cheap labor can be employed for this transfer work, leaving the experienced mechanic free to devote all of his time to work where his experience makes him especially valuable.

* * *

WAGES AND THE WAR

BY F. R. DANIELS

One argument advanced by certain manufacturing concerns not engaged in war work against paying increased wages is that by doing so they would be deliberately competing with the Government in its effort to secure help, thus tending to hamper war work and the production of the necessities of war. In the case of the small manufacturers, no such argument is made, as it is quite evident that the lack of help caused by the steady exodus of machinists and tradesmen in general seriously affects their production, and the replacing of these men necessitates the paying of higher wages; often, even then, only inexperienced men can be secured. The output may be of such a nature that the demand for these products will not warrant the payment of increased wages, and under the existing conditions, such a shop, though small, but well organized, may become idle and the business ruined.

War conditions have made it necessary for the Government to enlist the services of a vast force of industrial workers, particularly mechanics, yet the fact that so many shops have, as a result, been greatly depleted, seems rather unjust to the manufacturer of non-war products, and especially to the small manufacturer. This state of affairs may be justified by some who take the attitude that this should be the contribution of such employers as a token of their patriotism, and that they should not hesitate to sacrifice their own financial welfare. If such a stand is just, then it would seem unfair that the manufacturer who is prospering at the expense of the small manufacturers should receive all the profits. Something should be done, it seems, to relieve the existing conditions in this respect. The selective draft is proving a success, and is the only impartial and practical plan for securing a great army of fighters. Would not a selective conscription of labor be a fair and expedient manner of alleviating the present strain and of maintaining an efficient industrial army? Under such a scheme, all war contracts should stipulate the payment of standardized wages, based on experience, education, or efficiency tests, for each of the various classes of work required. Maximum and minimum wages should be fixed which would not be out of proportion to the recognized standards for the particular kind of work to be performed. Every employer should be required to furnish the Government, at stated times, a list of names of men of suitable ability, age, and domestic responsibilities, who would be valuable to the Government and not indispensable to the organization of the various shops. If these lists were based on the percentage of men employed, all would be equally affected and probably none would be disorganized. The Department of Labor could classify these names and hold them in reserve, subject to distribution throughout the various government shops and other manufacturing plants engaged in war work.

Wherever possible, men conscripted in this manner should be merely lent to the Government, and their former positions held open until such time as their services would no longer be required by the demands of the war. Under this plan, the shifting of labor from civil pursuits to war work could be accomplished with fairness to the employer and the employe. Also, the small manufacturer and the manufacturers of non-war products would be properly safeguarded, and every business prevented from stagnation and possible ruin. On the whole, it seems that this plan is about as feasible as any of the many proposals made.

SPECIAL SHELL DRILLING MACHINES

BY DONALD A. BAKER[1]

As shown at *A*, Fig. 1, the fuse socket of the U. S. three-inch shrapnel shell has a small hole drilled through it at an angle. This hole is later tapped to take a set-screw. By means of the jig shown in Fig. 2, this drilling is done on a double-spindle drilling machine, so that two sockets are drilled at one time. The fixture consists of a cast-iron body *A*, to the two angular faces of which are screwed the locating nose-pieces *B* on which the work is placed. The plate *D* that carries the drill bushings *C* is supported by a stud *E* and is held in position by two pins *F;* these are a drive fit in the plate *D* and a sliding fit in the body *A*. The plate *D* is held under tension by a coil spring *G* that acts on the head of stud *E*.

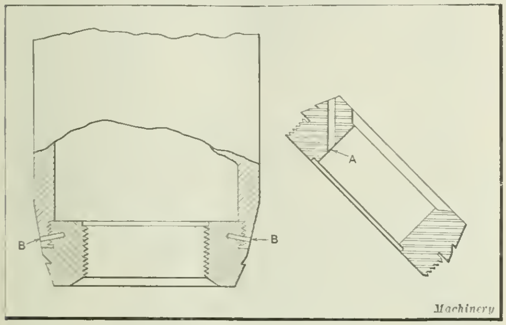


Fig. 1. Fuse Socket of Shrapnel Shell

The operation of the jig is as follows: The operator presses the treadle *H*, operating a lever *J*, which, acting through the stud *E*, raises the bushing plate *D;* this allows two fuse sockets to be placed on the locating nose-pieces *B*. When the foot is removed from the treadle, the bushing plate *D* is carried down onto the work by the action of the spring *G*, which holds the work securely while it is being drilled. Drilling is done in the usual way, except that the pinions operating the sleeves that carry the drill spindles are connected to each other so that both are operated by a common hand-lever.

Dowel-pin Hole Drill Jig

At first, the dowel-pin holes *B*, Fig. 1, through the shell and fuse socket were drilled one at a time by using the fixture shown in Fig. 4. But when both holes are drilled simultaneously, by means of the machine shown in Fig. 3, the work

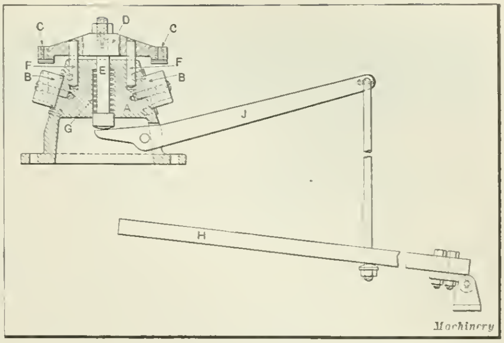


Fig. 2. Jig for drilling Fuse Sockets on Two-spindle Drilling Machine

is done more than three times as fast. This double-spindle drilling machine consists of two ordinary drill spindles *A;* only the left-hand one is shown, as they are identical with the exception mentioned later. These spindles were borrowed from existing equipment. The spindles are placed in suitable bearings *B*, which, in turn, are bolted to the frame of the machine; the latter is of angle-plate construction, as shown at *C*. The shell is located in the proper position by means of a locating plug *D*, made to fit the inner threaded portion of the fuse socket, which is held to close dimensions. This locating plug is carried by the angle-plate *E*, which is fastened to the frame of the machine as shown. The butt end of the shell is held in the proper position by means of a V-groove in the top of the bracket *F*, while the clamping is accomplished by means of the over-arm *G*, which is held under tension by the coil spring *H* and is operated by a foot-treadle, as shown. The feeding of the drills is controlled through an arrangement of the pinion *I* and the two bevel gears *J*, which are operated through the shaft *K* and the hand-lever *L*.

One of the unique features of the machine is the means of adjusting the drills to the work, irrespective of their length or the distance they project from their chucks, for to be used at their maximum efficiency it is necessary for both to start cutting at the same time. This is accomplished by arranging one of the bevel gears attached to the pinion shafts so that it can be either run free or locked fast on its shaft, as desired. This was done by boring a hole lengthwise through the center of the pinion shaft and then boring a taper in the end to which the gear was to be attached; this end was then split like an expansion mandrel type of chuck, and the taper draw-bolt *M* inserted and fastened by a knurled-head nut *N*.

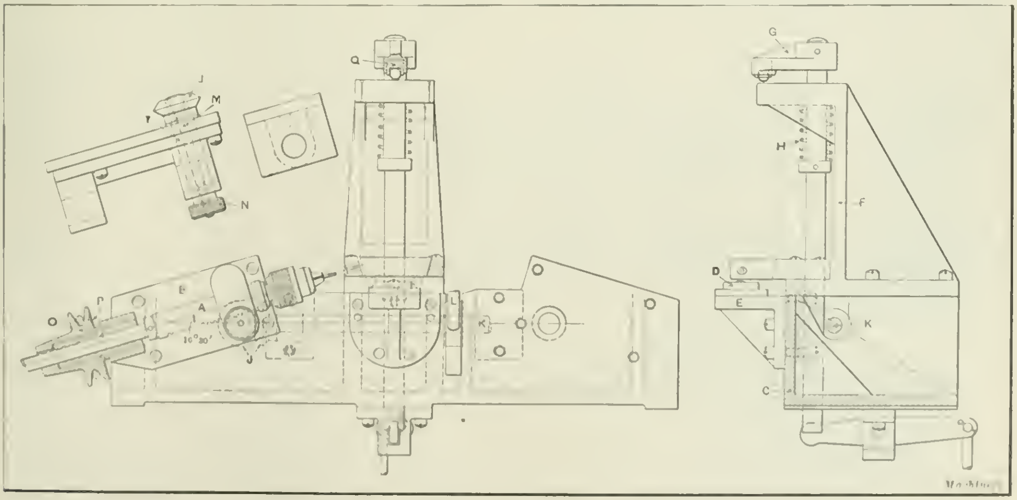


Fig. 3. Jig for drilling Two Dowel-pin Holes at a Time

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[1] Address: Core of Service Engineering Co., 25 Church St., New York City.

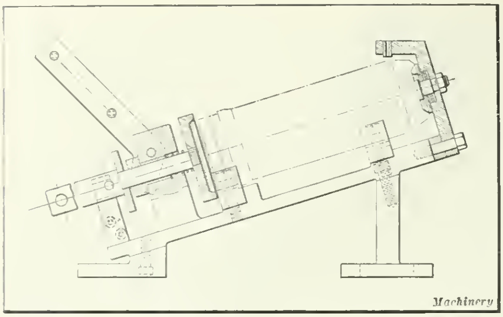

Fig. 4. Jig for drilling Dowel-pin Holes One at a Time

To set up the machine, the shorter drill is placed in the left-hand chuck and the hand-lever *L* is depressed until the right-hand drill is brought up against a set block, which is placed over the locating plug *D* and determines the depth to which the work is to be drilled, as these holes do not go quite through the work. In this position the stop-collar on the right-hand spindle is tightened; then the bevel gear *J* is loosened, and the left-hand spindle is brought forward by hand until its drill is against the set block. The gear is then locked by means of the draw-bolt *M* and the knurled nut *N*, and the machine is ready to produce. Only one stop-collar for controlling the depth of the drilling is needed, as one spindle is controlled by the other.

The driving is done by means of round leather belts over the grooved pulley *O*. On the upright machine from which these spindles were taken the pulleys retained their position by their own weight, but here they must be fastened in place. This is done by means of the thin split collars *P*, the two halves of which are held to the pulleys by means of small flat-head screws; the split collar runs in a groove cut in the bearing bushing.

The over-arm which holds the shell in place has a hardened steel ball, which is retained by a hardened cup *Q*, the outer end of which was drawn sufficiently so that it could be swaged in around the ball enough to keep it from dropping out, but not enough to prevent its turning freely. As its point of contact with the base of the shell is placed some distance back of the center line, if a careless operator does not place the shell in the proper position, the forces operating upon it when the foot-lever is released will automatically bring the shell into its correct position, seat it firmly on the locating plug, and back against the V-groove at the top. Running at a speed of 1500 revolutions per minute, this machine has a capacity of between 120 and 150 shells an hour.

USE OF BOX JIGS

Where there are a number of holes to be drilled in different sides of a piece of work, a great deal of time would be lost if separate jigs and work-holding fixtures were provided for drilling each hole, or even for drilling the holes in each different face of the work. It is well known by experienced drilling machine operators that the setting-up time is often considerably in excess of the actual drilling time, and so the loss resulting from the necessity of changing the work several times in order to employ different jigs and fixtures for various operations would be a very serious matter.

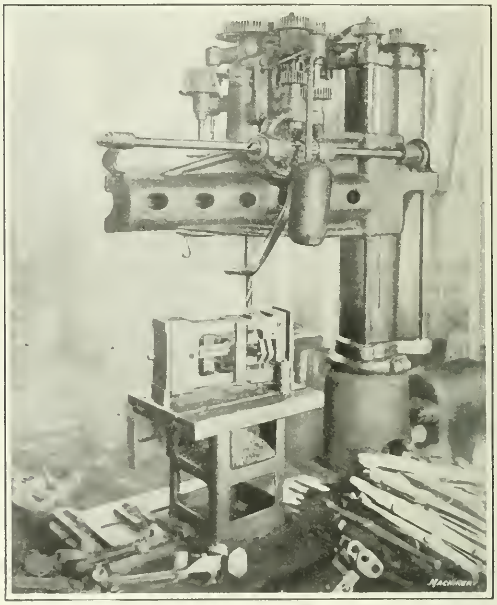

Fig. 1. Box Jig designed for drilling Holes in Shiftor Bracket

To overcome the difficulty, it is common practice to use what are known as box jigs, in which the piece to be drilled is supported; these jigs are furnished with feet on different sides, which provide for supporting the work with the different surfaces in which holes must be drilled held ready for the performance of such drilling operations. In this way, the work is set up once and the box jig may be turned over to bring different sides of the work into the drilling position, enabling all holes to be drilled without loss of time in resetting. In Fig. 1 is shown a radial drilling machine engaged in drilling the holes in the shifter bracket for one of the No. 216 drilling machines built by Baker Bros., of Toledo, Ohio. With this box jig, provision is made for drilling holes in three sides of the work through the finished faces *A*, *B*, and *C*, Fig. 2, on the jig.

The way in which the work is located in this jig is as follows: Work *D* is dropped into the jig and pushed up into contact with three locating stops *E*, *F*, and *G*, after which bolts *H*, *I*, and *J* are tightened to hold the work in contact with locating stops *E*, *F*, and *G*, respectively. After this has been done, straps *K*, *L*, and *M* are placed over the work and secured by bolts, the provision of C washers enabling these straps to be put in place or removed quite rapidly. Straps *K* and *M* both carry guide bushings, and bolt *N* in strap *L* holds the work down in the jig. The use of box jigs for work of this kind will be found to increase production rates considerably. E. K. H.

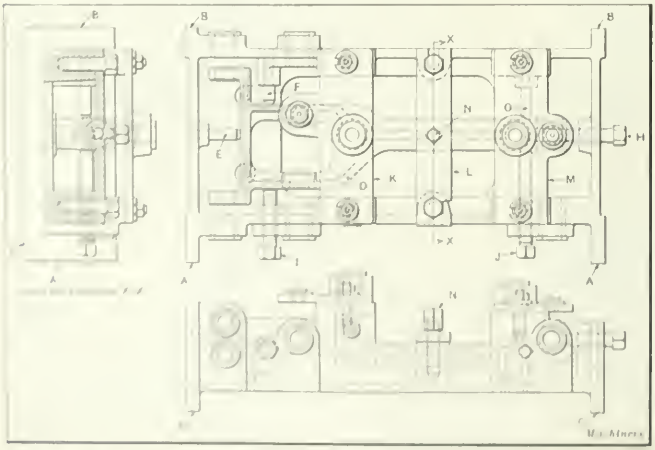

Fig. 2. Three Views of Box Jig showing Arrangement of Bushings and Method of Holding Work

LETTERS ON PRACTICAL SUBJECTS

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AN ECONOMICAL METHOD OF PRODUCING MECHANICAL DRAWINGS

The effort that is being made at the present time to increase the production of mechanical drawings brings up the important question as to what type of drawing is best adapted to the requirements of both purchaser and manufacturer. Drawings that are used by workmen in the shop necessarily contain many notes and dimensions that are of no use to the purchaser and they are too complicated and confusing for the purchaser's needs. On the other hand, a drawing that is suited to the purchaser's needs does not necessarily contain the dimensions and notes necessary in producing the machine. Thus it will be seen that to meet the demands of both purchaser and manufacturer it is necessary in most cases to produce two different sets of drawings. In making pencil drawings and tracings, such as are in general use, a great deal of unnecessary detail is likely to creep into their makeup, which naturally delays production. The scarcity of draftsmen has also made it difficult to obtain the required drawings in many cases.

As the drawings required by both manufacturer and purchaser usually differ only in the dimensions and notes they contain, it seems a useless waste of time to make two sets of drawings that are so nearly alike. But this practice is necessary when using ordinary pencil drawings and ink tracings. However, there is a method of making mechanical drawings that eliminates the necessity of making two sets of drawings to meet the requirements of both purchaser and manufacturer. This method, known as the "Van Dyke" method of producing mechanical drawings, has not received much attention in the technical publications, but it is being used with great success by some of our largest manufacturing concerns, and the writer, who has used hundreds of these prints and who is familiar with the method of producing them, believes that many manufacturers will realize a great saving in time and expense by using this system of producing mechanical drawings.

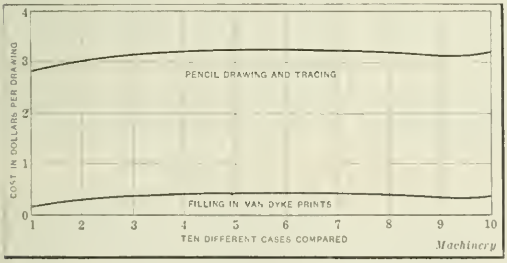


Fig. 1. Comparative Costs in making Mechanical Drawings

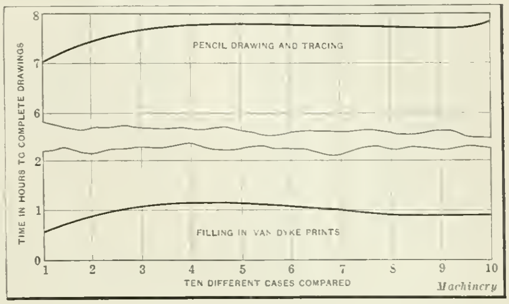


Fig. 2. Comparative Time required to complete Drawings

The Van Dyke method may be described as follows: A regular detail tracing of each machine is prepared, fully dimensioned, and properly filled in with notes necessary to complete the machine. When these tracings are completed, each dimension and note is obliterated by blocking out all dimensions and notes with ink. The tracings then become what are termed "master drawings." In blocking out, an outline is first drawn around each dimension and note with a ruling pen. These enclosed spaces are then filled in with a lead pencil which fills the pores of the cloth, after which the spaces are filled in with ink. The pencil lead prevents the ink from penetrating the cloth and causing wrinkles where large spaces are blocked out. Van Dyke prints are then made in the usual way from the master drawings. A supply of these prints should be kept on hand so that they may be filled out at short notice. Tables are prepared which contain the dimensions required in the shop when building each standard machine and also dimensions that are necessary in the drafting-room.

When a print is needed in the shop, the drafting-room, or by a purchaser, the dimensions required are filled in from these tables and all unnecessary dimensions and notes are omitted. In this way a drawing that is free from unnecessary detail is quickly and easily prepared. In Fig. 1 is shown the comparative cost of pencil drawings and Van Dyke prints. These data were obtained from records of tests covering a period of two years, which were made by a well-known manufacturing concern. Fig. 2 shows the relative time required in making the two types of drawings.

The ink tracing or "master drawing" should be kept in indexed files in the drafting-room, but the Van Dyke print with its paper of bond-like quality, tends to tear when filed in an ordinary filing cabinet. Therefore some other method of filing should be adopted. One company that uses these drawings in contract work makes a practice of folding them after use and placing them with the contract data. This method proved very satisfactory, as the contract file was located in the drafting-room.

Buffalo, N. Y. LAWRENCE H. GEORGER

AIR-RIFLE LOCK-KNOB HOLDER

The accompanying illustrations show a lock-knob holder of an air rifle and the dies for making it. In Fig. 1, *A* shows the finished piece, which is made in two operations, and *B* the piece after the first operation. Fig. 2 shows the die for the first operation. This pierces three holes and rounds the end of the blank in the first stage, and cuts it off and gives it the form shown at *B*, Fig. 1, in the second stage. The finished piece is pushed out of the die by the spring pad *A*, Fig. 2, and is carried by the forming punch *B* to the top of the stroke, where it is pushed off by the pin *C*. As the press is inclined, the piece drops into a box at the back of the die. Fig. 3 shows the die for the second and last operation. This die finishes the form and drifts the hole in the top ready for it to be tapped. The forming die *A* is carried on a spring, and has

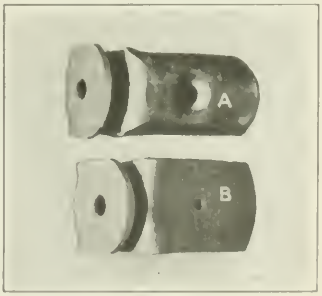


Fig. 1. Lock-knob Holder in partly made and Finished Form

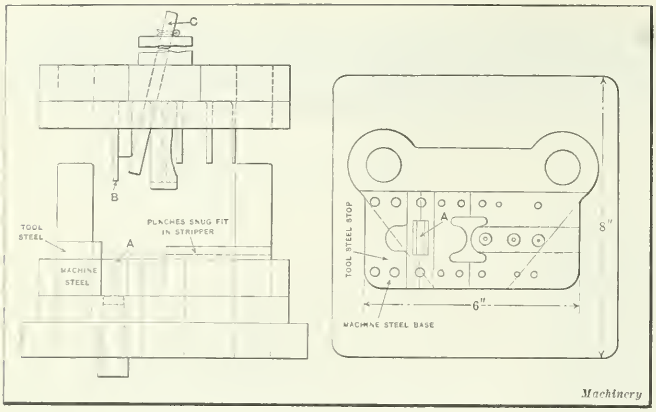


Fig. 2. Die for making First Form of Lock-knob Holder

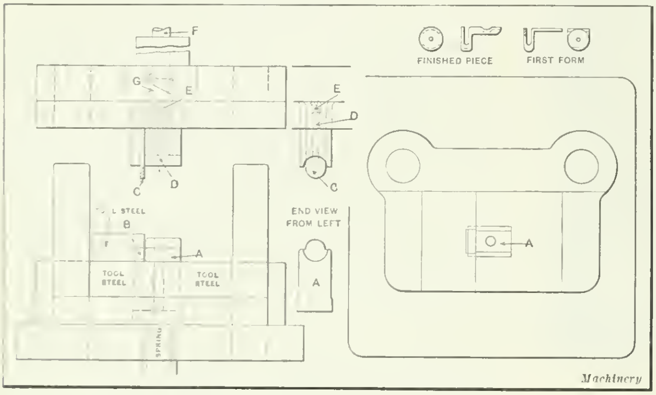


Fig. 3. Die for finishing Lock-knob Holder

enough travel for the piece to be placed in position with the double end loose in the upper part of a tapered pocket *B*. When the punch descends, this double end is carried down with the die and is formed into a circle between the forming die *A* and the upper part of the punch, while the blade *C* holds it to shape inside. At the same time the flat top is made half round to correspond with the end. The drift punch *D* is backed by a set-screw *E*, as the punch-holder is drilled out at this point for the knock-out *F*, which operates the two pins *G* that push off the finished piece at the top of the stroke.

De Kalb, Ill. W. B. Greenleaf

OBTAINING RESULTS IN SPECIAL MACHINERY DESIGNING

What is meant by results? Evidently that a machine built from certain plans will have a satisfactory output and will give reasonable service without troubles of various kinds. It should also be without faults that will necessitate the expenditure of additional capital for experimenting to realize the results desired. To attain these ends requires cooperative procedure. The designer should profit not only from his own experience, but should utilize the experience of others. He should also have a systematic method of attacking his work and not allow any haphazard methods to prevail.

The first cost of a special machine is always high, so the chances of failure should be reduced to a minimum to avoid costs for experimenting, and also to avoid delays before getting the machine into successful operation. A designer, therefore, should get all the ideas on the problem obtainable before doing any drafting work. When he takes up the work of making the drawings he should have a clear conception of what is to be done. A good method of procedure is as follows:

First, obtain complete data as to the present methods of handling the work the special machine is to do and the costs, in order to determine how profitable an investment the special machine will be. This should be done before the project is carried too far.

Second, make a preliminary design for the contemplated machine to such a reduced scale as is considered necessary; this design should consist of only enough lines to convey the general idea of the machine. Feeds, speeds, and the output of work should be figured and a rough estimate of the cost of the machine should be made.

Third, submit this design, together with all data, to those who are concerned, for criticism or approval; the various ideas or changes suggested should be noted. The work should not be carried beyond the preliminary design stage until a general agreement has been reached as to what kind of machine will be required; the principles of construction should be right.

Fourth, make a final preliminary design from which it will be possible to develop the various units of which the machine will consist.

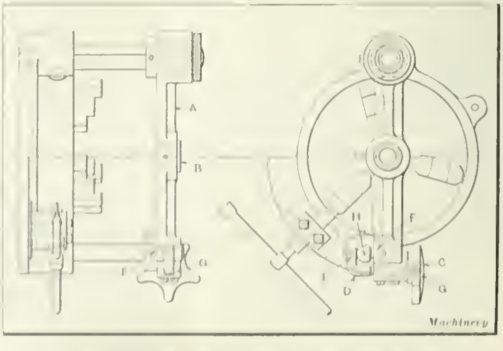
The designer may now employ others to aid him in developing and detailing the units. When a unit is completed, the blueprints may be sent to the machine shop and the work of building the machine carried along with the designing. A competent designer who has a job well in hand can carry out this idea to the extent that the machine he is designing may be well along in the shop by the time he is putting out his final drawings.

One great advantage of building a machine on the unit principle is that it is possible to note, when a unit is completed, if it will perform the functions required of it. A unit, the performance of which may be in doubt, may be built before the others, so that it will not be necessary to build a complete machine in order to experiment with an idea.

Newark, N. J. F. E. Johnson

UNIVERSAL DRILLING AND REAMING JIG

The accompanying illustration shows a drilling and reaming jig having two distinct advantages, namely, an adjustable drill-bushing holder to suit all heights of work, and a quick-action clamping device. In operation, the bridge casting *A*, which holds the drill bushing *B*, is moved into position, and the knob *C* turned to the right, causing the clamping bolt *D* to move with the knob until stopped by the pin *E*. The knob is then tightened in the usual manner, bringing the clamp



Jig for drilling and reaming Gears, Pulleys, Sprockets, etc.

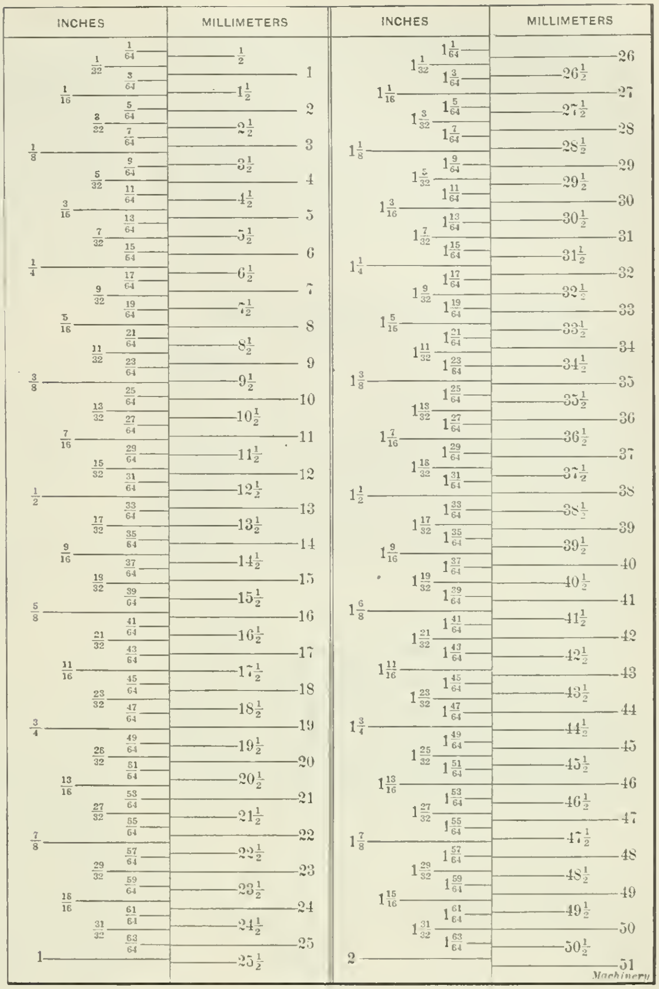
against the stud *H*, which bears against the hardened end of the pin *F*. To unclamp, the knob is turned to the left until stopped by the washer *G* on the threaded end of the clamping bolt which acts as a lock-nut, thus causing the bolt to turn sidewise with the knob so that the bridge casting may be moved to one side, allowing removal and substitution of the work. The bore of the bridge casting should be made to a standard size, so that bushings for different classes of work will be interchangeable. For holding the work, a universal lathe chuck is used, and by providing false jaws, such work as small pulleys, sprockets, gears, bushings, etc., may be machined with this type of jig. After the jig is once placed on the drilling machine, it is only necessary to change the bushing and jaws to adapt it for different classes of work.

Seneca Falls, N. Y. E. L. Robenolt

VALUES OF FRACTIONS OF INCH IN MILLIMETERS

With the increased use of the metric system in this country in the past few years, various methods have been devised for obtaining the equivalent values when either the English or the metric system is given. The accompanying chart will be found especially useful when only approximate results are desired, as it gives the relative value in millimeters of each sixty-fourth of an inch up to two inches. Thus it shows that 29/32 inch is equal to 23 millimeters; carried to three decimal places, the correct value would be 23.019 millimeters. It also shows that 13½ millimeters is equal to 17/32 inch; carried to three decimal places, the correct value of 17/32 inch is 13.493 millimeters.

Detroit, Mich. C. H. Whipple



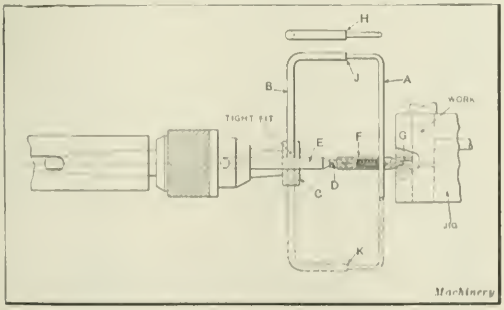
Relative Value of Fractions of an Inch in Millimeters

DEVICE FOR LINING UP SMALL DRILLS WITH DRILL BUSHINGS

It is often the practice, when setting up a drilling machine job for small holes, to spring the drill enough to enter the bushing, instead of bringing the bushing into alignment with the drill. This results in broken drills.

The writer finds by using the device shown in the illustration when setting up automatic drilling machines for drilling small holes, such as 0.093 inch diameter in 5/8-inch pins, that it is possible to save about 75 per cent of the drills which would have been broken if such precaution had not been taken. The collar *C* should turn on center *E* so that it will be possible to swing the rods *A* and *B* from position *J* to position *K*. Rod *B* should be a tight fit in collar *C*, and rod *A* should be free to turn in the center *F*. There should be just enough spring tension back of the plunger *D* to hold the centers in place. If the bushing *G* is in line with the drill spindle, the centers *E* and *F* will be in perfect alignment, and the rods *A* and *B* will be in contact at point *J* as shown, and also at point *K* when in the position shown by the dotted lines. To determine readily if contact is made at each position, rod *A* is turned in center *F* as shown at *H*. If rods *A* and *B* do not come in contact at both positions *J* and *K*, the jig should be adjusted until they do, thus bringing the drill and drill bushing into alignment.

South Manchester, Conn. Alfred Pilling



Device for lining up Small Drills with Drill Bushings

PUTTING RUBBER ON BAND-SAW WHEELS

The rubber on band-saw wheels should be in the form of endless bands and of pure gum if long and satisfactory service is to be obtained. After the old bands are removed, the rims should be thoroughly cleaned, if of iron; if of wood, they should be turned true. Then both the band and the wheel should be given a coat of thick shellac and allowed to set for a half hour, after which they should be given another coat and the bands stretched on the wheel. Care must be taken not to have them stretch more at one point than at another, as that will leave thick and thin spots in the band. A good way to even the tension is to put a thin piece of wood between the band and the wheel, long enough so that each end may be grasped and drawn around the wheel between the band and the wheel. After equalizing the tension of the band, the wheel should be allowed to stand for at least twenty-four hours. Even with the best of care, there will be high spots and the wheel will not be true. The writer has always found it possible to use a stick clamped to the frame of the machine for a rest on which a turning tool, ground to a point and very sharp, could be used to make the wheel perfectly true. It is then finished with sand or garnet paper. A perfectly true wheel reduces the breakage of saws to a minimum. Another common cause of saw breakage is too high tension; saws should not be so tight that they will vibrate to any tone.

Denver, Col. J. L. Gard

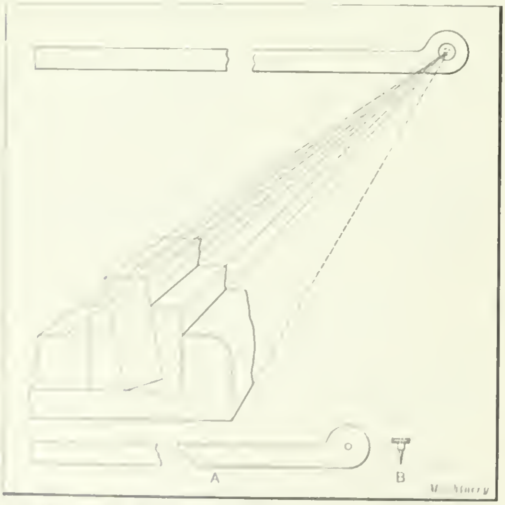
HORSEPOWER OF EXPLOSIVES

Many people seeing the powerful effects of explosives, have attempted to harness this power for driving automobiles, airplanes, etc., and numerous applications for patents on engines for this purpose have reached the Patent Office. If the inventors were better informed upon the subject, they would be saved danger, expense, and work; for there is much more power confined in a pound of gasoline than in a pound of dynamite. If they could see the half-dozen horsepower hours caged in a pound of gasoline expended in a fraction of a second, as is the case with the high explosive, they would waste no more time trying to tame a wild cat to do the work of a horse.

Jersey City, N. J. Harry E. Dey

PROTRACTOR FOR MAKING LINEAR PERSPECTIVE DRAWINGS

In making drawings, it is sometimes necessary to represent objects as they appear to the eye at a given angle of vision. A good example of this type of drawing is shown in the accompanying illustration of a diemaker's parallels. In making drawings of this kind it is often necessary to draw a great many converging lines that terminate at what is known as the "vanishing point." The protractor shown at *A* will be found convenient for drawing these lines in cases where the vanishing point may be placed inside the edge of the drawing board. The protractor has a hole at one end to receive the special thumb-tack *B*. When it is decided what angle of vision is required, the thumb-tack is pressed into the drawing-board at the predetermined vanishing point. The converging lines can then be drawn along the top edge of the protractor.

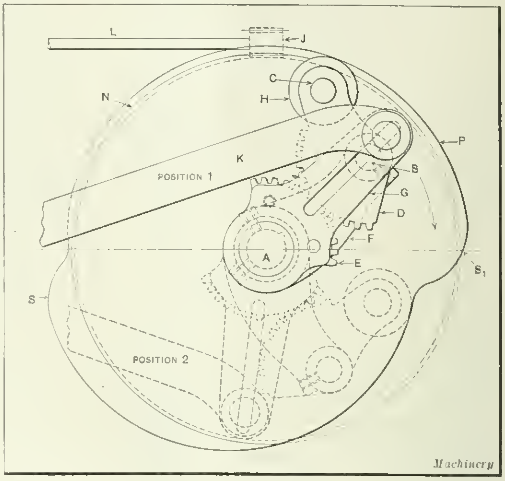


Method of using Protractor in making Drawing of Diemaker's Parallels

New York City E. J. Higgins

TRAVERSE MOTION FOR GRINDER CARRIAGE

An interesting and unique mechanism for controlling the traverse motion of the carriage on a grinding machine is shown in the accompanying illustration. This mechanism is designed to feed the carriage by means of a crank motion. The accelerated motion given to the crank at the ends of the stroke is the principal feature of the device. This acceleration gives the carriage a uniform rate of travel the full length of the stroke which prevents under-grinding at each end of the spindles. The illustration shows a plan view and two positions of the mechanism.



Mechanism for obtaining Uniform Rate of Traverse of Grinder Carriage, with Crank Motion

In Position 1, the parts are shown as they slide the carriage toward the end of the first traverse, while in Position 2 the return traverse has started. The driving rod, which is not shown, is connected to the connecting arm *K*, by an adjusting screw and nut. Worm-shaft *L*, which receives its motion from the main drive of the machine by means of bevel gears, carries worm *J*, which drives the upright shaft *A* through the worm-wheel *N* in the direction shown by the arrow. Driving arm *F*, is keyed and fastened by set-screws to *A*, as shown, and carries, at its outer end, a stud which is fastened by set-screws in hole *B*. Segment *D* has a forked or clevised end, in which the roll *H* is carried, revolving freely on stud *C*. The segment and roll are capable of pivoting on the stud at *B*. Segment *E* is loose on shaft *A*, and carries crank-arm *G* fastened to it by means of a screw and dowel-pin. The segment is prevented from lifting off by a head on the upper end of the shaft.

The grinding starts with roll *H* at point *S*, one full traverse being from *S* to S_1, where the return motion starts, ending automatically at *S*, after the necessary number of traverses has been completed. As the arm *F* swings around on *A*, segment *D*, which meshes with segment *E*, forces roll *H* against cam *P*.

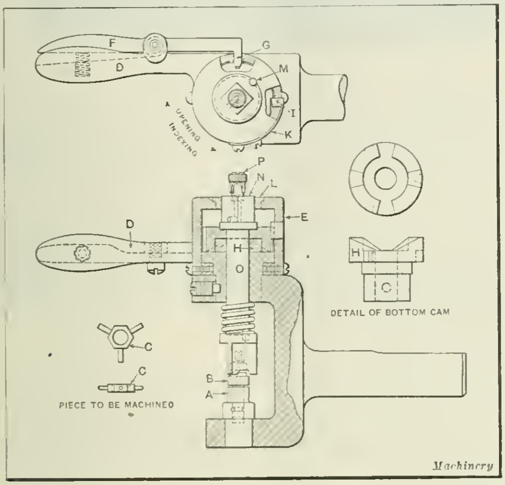
When *H* reaches point S_1, and one traverse has been completed, the heel of cam *P* throws *H* toward the center, forcing the segment *E*, which is free to turn clockwise on *A*, to suddenly revolve about five teeth. This action throws arms *G* and *K* forward quickly, and incidentally the carriage as well, preventing a dwell at the end of the spindle. The resulting relation of the parts is shown in Position 2. Arm *G* has a T-slot, in which the connection of *K* may be adjusted, in or out, to obtain the desired throw, that is, the proper length of the traverse.

The feed of the carriage being constant, the same amount of time is consumed on either long or short traverses. Since the speed of *A* is always the same, as the length of the spindles increase, the number of traverses required is also increased, by means of a knock-off device. It is obvious that the depth of the cut on short spindles is greater than that on long spindles, and that fewer traverses are required to grind short spindles to the desired size, and vice versa.

F. R. Daniels

INDEXING FIXTURE FOR USE IN TURRET

The fixture here illustrated was designed by the writer to hold a small, hollow, hexagon spider while finishing the projecting spindles, with a box-tool held in the spindle of the lathe. The lower fork carries a projecting bushing *A*, which holds a swiveling member *B*, the upper end of which is turned to fit the hole in the center of the work *C*. The shoulder of member *B* is milled square to present as small a surface as possible for the lodgement of chips, which will throw the work out of center.



Indexing Fixture for Use in Turret

The end of the handle *D*, used for indexing and raising the spindle, is enlarged to form an inverted cup *E*, which acts as a dirtproof cap for the operating mechanism that it contains. This handle is furnished with a spring-loaded lever *F*, the end of which forms a taper pin *G*, which fits the indexing slots in the lower cam *H*. When handle *D* is turned in one direction with indexing pin *G* withdrawn, the catch *I*, held by the flat spring *K*, will slip out of the slot which it engages in the upper cam, allowing the spindle to be indexed to the next position. But if the handle is turned in the opposite direction, the catch will engage the straight side of one of the two slots, revolve the upper cam, and raise the spindle, thus permitting the work to be removed. In the top of cap *E* is a steel bushing *L*, held by a pin *M* that acts as a key, and through the center of the bushing is a square hole that fits a corresponding square *N* on the top of the spindle *O*. This bushing allows spindle *O* to slide up or down, but makes it turn positively with the handle. The oil-cup *P* and the hole through the spindle permit oil to be applied where lubrication is most needed. The enlarged lower end of the spindle is shaped to fit the work and is fastened to the spindle by a screw and key, as shown in the illustration to make it possible to assemble the fixture.

The fixture may be designed so that the flats on the upper and lower cams will engage when the spindle is raised, thus holding the spindle up and making it unnecessary for the operator to hold the handle, but probably this will not be necessary for most work, as the leverage and cam action will easily compress the large spring. The general principle shown may be adapted to similar tools for holding work to be drilled, faced, etc. This fixture may be used on a drilling machine table as well as on the turret lathe.

Dubuque, Iowa CHESTER W. HATHAWAY

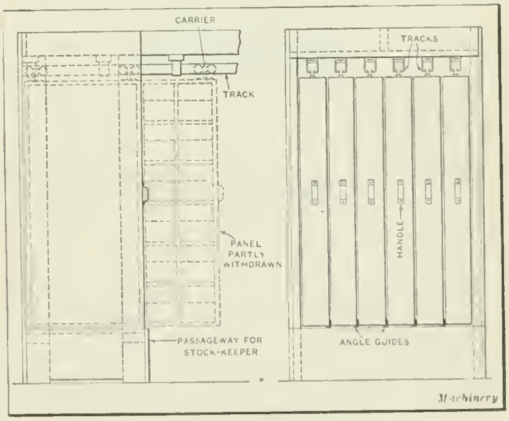
FIGURING IN THE METRIC SYSTEM

With reference to the article entitled "Figuring in the Metric System" on page 939 of the June number of MACHINERY, the writer would add a few words of warning to those employed on government work. On the Ordnance Department drawings, the dimensions are often expressed in both inches and millimeters, the latter being placed in parentheses; for instance, (5) 0.1968 ± 0.005. The inches are usually carried to four decimal places, but in many cases they are carried only to three. Dropping a few ten-thousandths of an inch here and there may make no difference in many cases, but when we consider special forms of threads, one must be sure to find out which figures are governing. On the pitch this difference is likely to cause an error that is by no means small. In view of this fact, when reading a drawing one may have to work half in the English system and half in the metric.

Hartford, Conn. THOMAS A. REILLY

TOOL AND STOCK STORAGE CABINETS

The storage cabinet here illustrated is unique and at the same time perfectly practical. This system of construction makes it possible to keep a large assortment of stock or tools in a small, compact space, and yet allows easy access to any article. The material is as well cared for as when placed in closed cabinets or shelving. It is especially adapted to use in tool distributing rooms where such small tools as drills, reamers, taps, threading dies, milling cutters, arbors, etc., are kept but is equally well suited for keeping the stock of screws, bolts, nuts, washers, or other small parts generally kept in small quantities in toolmaking and diemaking departments. Where larger quantities of material are stored, other systems, such as stationary bins, are better suited to the requirements on account of the excessive weight. Each cabinet contains one or more panels, each of which is suspended from the top by two ball bearing rollers or carriers operating in rectangular hollow metal tracks. The bottom of the track should not be less than 6 feet 6 inches from the floor to allow head room for the keeper to walk beneath. The cabinet illustrated contains six panels, but the number is limited only by the requirements. The lower end of each panel is guided between two steel angles. Small bins or sections are built into the panels when required to accommodate the material to be stored, but such tools as milling cutters or circular forming tools are generally hung on pins fastened to the upright members of the panels. Drills, reamers, etc., are best accommodated when kept on inclined shelves with small raised partitions.



Tool and Stock Storage Cabinet

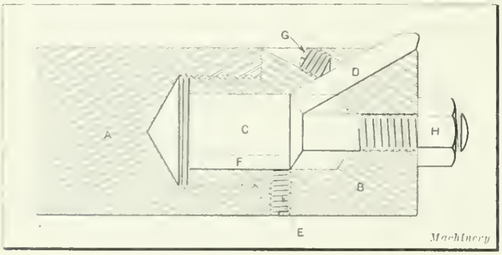
When stock is to be withdrawn, the panel containing the articles desired is drawn forward from its normal position in the cabinet, as shown by the dotted lines. A substantial bow-shaped handle attached to the front of the panel will be found convenient in moving it. The contents should be plainly marked on the front of each panel. The depth of the panels can be varied to meet requirements, but a depth exceeding three feet would be rather inconvenient to handle, on account of the long arm movement necessary in drawing them forward. The entire cabinet may be made of wood or metal, the wood construction being less expensive. On account of the simple design, it can be built in any shop. It is a good plan to arrange a double row of cabinets with an equal number of panels on each side, all opening toward the center passageway. This permits the stock-keeper to draw material from either row of cabinets.

One particularly valuable feature of this system of storage is the very small space required, without interfering with the easy access to the material. Another important feature is the ease with which the equipment can be extended to enlarge its capacity, it only being necessary to provide additional panels as required.

Aurora, Ill. ELLIS J. G. PHILLIPS

ADJUSTABLE CUTTER-HEAD

A boring-bar or cutter-head that is easily made is shown in the accompanying illustration. It consists simply of a bar *A* into which the cutter-head *B* is screwed. The head is recessed for the center bolt *C*, the bevel seat of which is in contact with the heel of the cutting tool *D*. A pilot-point set-screw *E*, which works in a groove *F*, prevents the center bolt from turning, while set-screw *G* holds cutter *D* firmly in position. The position of the cutter is adjusted by means of the nut *H* on the end of the center bolt.



Construction of an Adjustable Cutter-head

Detroit, Mich. C. C. SPREEN

FIXTURE FOR MILLING CYLINDER HEADS ON ENGINE LATHE

The fixture shown in the accompanying illustrations is designed for milling gasoline motor cylinder heads on an engine lathe. The depth of the cut required in finishing the milled surface of the casting is 5/32 inch, and the surface milled is 26 inches long by 8 inches wide. The milling cutter is held in the lathe spindle and the work brought into contact with the end of the cutter, as shown in Fig. 1. The fixture for holding the work is bolted to the top of the lathe carriage. This fixture allows the work to be fed across the end of the milling cutter at right angles to the spindle, and it is so designed that a uniform rate of feed can be easily maintained by means of a heavy balanced handwheel attached to the end of the fixture lead-screw. The depth of the cut is controlled by moving the carriage of the lathe.

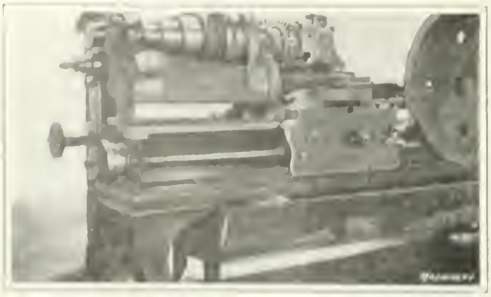


Fig. 1. Front View of Engine Lathe with Fixture and Work in Place

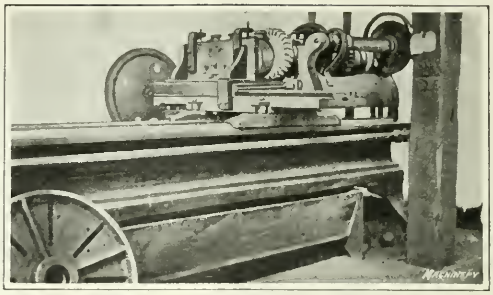


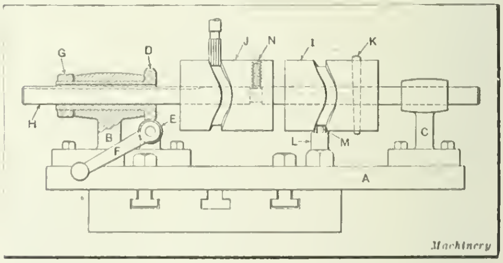
Fig. 2. Rear View of Lathe showing Method of holding Work

Fig. 1 shows the front of the lathe with the fixture and work in place, and Fig. 2 shows the back of the lathe. The latter illustration shows clearly the angle-plate on which the work is mounted, and also the method of holding the work firmly in place. From thirty-five to forty-five castings are finished in ten hours by this method, and the surface milled is true within the limits of accuracy required.

Milwaukee, Wis. FRED FRUHNER

CAM CUTTING ON A DRILLING MACHINE

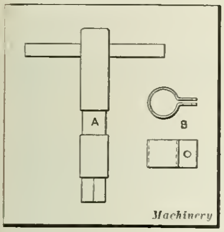
The accompanying illustration shows a method employed for cutting barrel cams on a drilling machine in a shop not equipped with a milling machine. Plate *A* is fastened to the table of the drilling machine, and supports the two stands *B* and *C*. Stand *B* forms a bearing in which the sleeve of worm-wheel *D* rotates when driven by worm-shaft *E*. Worm-shaft *E* has its bearing in a bracket that is part of stand *B*. Crank *F* provides for a hand feed, but this was replaced by a grooved wheel driven by a round belt from an overhead shaft after the operator became more familiar with the work. Worm-wheel *D* is held in its bearing by collar *G*. Shaft *H* carries the work *J* and the master cam *I*. The shaft turns freely in bearing *C*, and is allowed to slide in the sleeve of worm-wheel *D*. The sleeve of worm wheel *D* has a key which fits into a keyway in shaft *H*; this allows shaft *H* to turn only when worm-wheel *D* is turned by worm *E*. The work *J* is fastened to shaft *H* with a set screw *N*, as shown; the shaft is turned down slightly smaller where the set-screw is located, so that the burr caused by the set-screw will not prevent the removal of the shaft. Master cam *I* is pinned to the shaft by a taper pin *K*. The stud *L* is fitted with a roller *M* that fits in the groove of the master cam. When shaft *H* is turned by means of worm *E*, the groove in the master cam, coming in contact with roller *M*, imparts a sliding movement to shaft *H*, so that, when the end-mill is fed down on the blank cam *J*, it forms a groove which is a reproduction of the groove in the master cam. The finished cam is removed by knocking out taper pin *K*, loosening set screw *N*, and withdrawing the shaft.



Cam Cutting Attachment for Drilling Machine

Camden, N. J. THOMAS JAMES

SHOP AND DRAFTING-ROOM KINKS



Device for securing Wrench to Lathe to prevent it from being lost

TO PREVENT CHUCK WRENCH FROM BEING LOST

As a means of preventing the chuck wrench of a lathe from becoming lost, the wrench may be turned down, as shown at *A* in the illustration, and strap *B* securely fastened in the reduced portion. A chain is attached to *B*, the other end of which may be secured to the lathe.

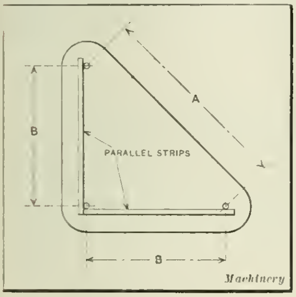
New York E. J. Higgins

SQUARE TEST GAGE

The illustration shows a gage that is useful in checking the squares of toolmakers and inspectors. Three hardened and ground plugs are set in a well-ribbed and seasoned cast-iron base. These plugs are placed by the button method and checked by either a micrometer or Johansson gage. The distances from center to center may be varied to accommodate different sizes of squares, or an accurate parallel strip may be used over the plugs. The dimension

$$A = \frac{B}{\sin 45 \text{ degrees}} = \frac{B}{0.70711}.$$

The variation or error of the squares may be checked either by Johansson blocks or tissue paper feelers.

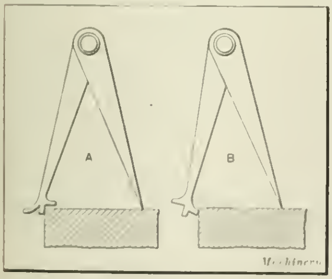


Gage for testing Squares

Watertown, N. Y. H. V. Coulston

HERMAPHRODITE CALIPERS

The hermaphrodite calipers shown in the illustration have one leg so shaped that it can be used for internal or external work. When the leg is in the position shown at *A* it is useful for scribing lines on thin work. Ordinary hermaphrodite calipers have a tendency to slip over the side of the stock when used for this purpose, but the cut-out on this type keeps the leg against the stock and an accurate line may be scribed.



Hermaphrodite Calipers that are Useful for scribing Lines

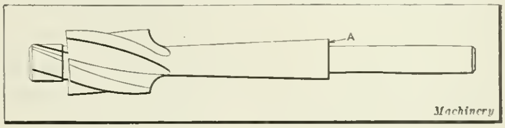
Newark, N. J. George Werner, Jr.

TO DISTINGUISH HIGH-SPEED STEEL FROM CARBON STEEL

The spark test cannot always be relied upon to distinguish high-speed steel from carbon steel, as steel containing very little tungsten will spark the same as high-speed steel. The nitric-acid test is a good test to use. Nitric acid will "eat" carbon steel immediately, but will not attack at once high-speed steel that contains even a very small amount of tungsten. The surface of the steel tested should be absolutely clean. L.

STRAIGHT-SHANK COUNTERBORE

On small work, where straight-shank drills are used, because they are more easily changed than the taper-shank drills, which must be removed by using a drift, a counterbore like that here shown is very useful. It cannot slip upward in the chuck, for the shoulder *A* is against the chuck jaws. By using the stop on the drilling machine, a uniform depth of counterbore is assured.

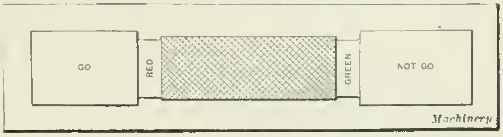


Straight-shank Counterbores that cannot Slip upward

New York City E. J. Higgins

DISTINGUISHING MARKS FOR ENDS OF PLUG GAGES

If the necks of plug gages are marked with bands of strong contrasting colors, the ends will be distinguishable at a glance. This plan will permit a much more rapid use of the gage, for no time need be spent in looking for the figures stamped on each end or for the words "Go" and "Not Go." There will also be much less chance of error due to using the wrong end.



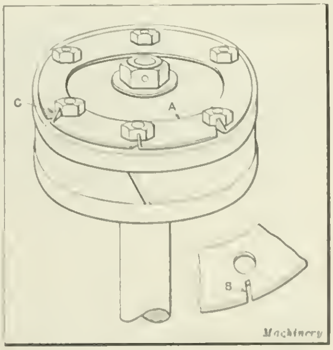
Plug Gages marked so that Ends are easily distinguished

Detroit, Mich. C. C. Spreen

NUT-LOCK PLATE

While on an engine repair job the writer saw a kink that seemed worth passing on to the job shop machinist and others. The illustration shows a lock plate used to hold on the follower plate nuts of a steam engine piston. The circular ring, or plate *A*, was 3/32-inch plate steel; the holes were drilled for the studs or bolts and a slot was cut on the outside edge to within 1/4 inch of each hole, as shown at *B*. The lock plate was put on and the nuts all set up tight; then with a cold chisel the tab was bent up against the flat of the nut side, as shown at *C*.

C. H. Willey
Concord, N. H.



Nuts held in Place by Lock Plate

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

A GEOMETRICAL PROBLEM

I. E. S.—Referring to the illustration, please show how to find the distances x, y, and r from the dimensions given.

Answered by J. J. Clark, Scranton, Pa.

A.—There appear to be three unknowns, but there are only two in reality, since y can be found immediately as soon as r is known. Draw the vertical line AC and the horizontal lines BC and DE; join A and B and A and D. In the right triangles ACB and AED, $BC = x$, $AC = y - 0.256$, $AB = r + 0.256$, $DE = 0.973 - x$, $AE = y - 0.261$, and $AD = r + 0.015$. But $y = r + 0.204$; hence, $AC = r + 0.204 - 0.256 = r - 0.052$, and $AE = r + 0.204 - 0.261 = r - 0.057$. Since $BC^2 + AC^2 = AB^2$, $x^2 + (r - 0.052)^2 = (r + 0.256)^2$; whence, $x^2 + r^2 - 0.104r + 0.002704 = r^2 + 0.512r + 0.065536$, and

$$x^2 - 0.616r = 0.062832 \qquad (1)$$

Also, since $DE^2 + AE^2 = AD^2$, $(0.973 - x)^2 + (r - 0.057)^2 = (r + 0.015)^2$; whence, $0.946729 - 1.946x + x^2 + r^2 - 0.114r + 0.003249 = r^2 + 0.03r + 0.000225$, and

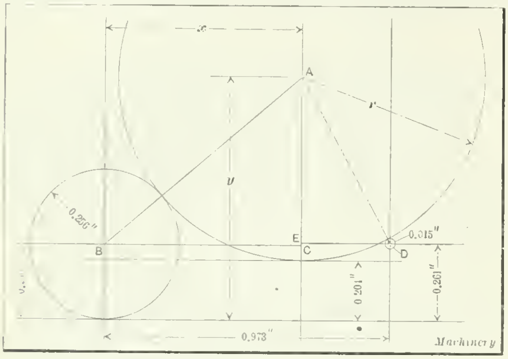
$$x^2 - 1.946x - 0.144r = -0.949753 \qquad (2)$$

Multiplying Equation (2) by 77 and Equation (1) by 18, we have:

$$77x^2 - 149.842x - 11.088r = -73.130981 \qquad (3)$$

$$18x^2 - 11.088r = 1.130976 \qquad (4)$$

Subtracting Equation (4) from Equation (3), $59x^2 - 149.842x = -74.261957$, from which $x = 0.675001$ inch, or 1.86469 inch. Evidently, the smaller value is the one desired in this case. Substituting this value of x in Equation (1), $0.675001^2 - 0.616r = 0.062832$; from which $r = 0.63766$ inch. Finally, $y = 0.63766 + 0.204 = 0.84166$ inch.



A Geometrical Problem

FORMATION OF BLOW-HOLES IN BABBITTED BEARINGS

F. T.—We have had difficulty in babbitting the bearings required for the turbines of torpedo boat destroyers. These bearings vary in diameter from 5 to 14 inches and in length from 5 to 18 inches. The babbitt metal, which is very hard, is heated to 500 degrees C. (932 degrees F.), but blow-holes and very small pin holes form in the lining.

A.—The formation of blow-holes in babbitted bearings is not always due to the same cause, and several sources of trouble will be mentioned. To begin with, the ladle from which the babbitt is poured should preferably have a rounded spout, rather than one which is sharp or broad, because a broad, thin stream of metal tends to produce porous areas or blow-holes. Before the babbitt is poured, it should also be stirred thoroughly to insure a lining of uniform composition. Oil on the surface of a babbitted mandrel tends to cause the babbitt to blister. It is the practice of a prominent electrical concern to cover the mandrel with a thin coating of clay wash by plunging the mandrel while heated into a pail containing a solution of one or two pounds of Jersey red clay. When the mandrel is dry, it is covered with a thin clay coating, which prevents the formation of blow-holes and gives the babbitt lining a smooth surface.

When heating the babbitt metal, the temperature should be increased slowly, especially when melting new babbitt or when old babbitt is being remelted. The metal should be stirred at frequent intervals, and it is advisable to cover the surface of the molten babbitt with powdered charcoal or graphite to reduce oxidation. The mandrel temperature is right when water evaporates rapidly from its surface without spluttering. Babbitt metal, as a rule, should be kept at a constant temperature of about 870 degrees F., although the exact temperature depends somewhat upon the composition. If the babbitt is poured at too low a temperature, the lining will have a coarse granular formation, and if the shell or casting and the mandrel are too cold, blow-holes and other defects will result. On the other hand, if the temperature of the metal is too high, it will cool too slowly and the heavier elements will have time to settle, thus producing a bearing which is soft at one place and brittle at another.

The iron shell to be lined with babbitt should be preheated to a temperature of from 200 to 300 degrees F. before pouring, the higher temperature being preferable unless the shell is very heavy. The preheating should be done in an oven, although a gas or coke fire may be used, in which case the surface to be babbitted should be turned upward away from the fire, as otherwise a deposit may be formed which will prevent the babbitt from adhering properly. The best results are obtained by pouring the babbitt with the bearing in a vertical position.

A DRAFTSMAN'S PROBLEM

J. F.—Referring to the illustration, please show me how to find the distances a, b, c, and d; I should like a method that will cover all similar cases.

Answered by J. J. Clark, Scranton, Pa.

A.—Draw NB parallel to GA; join N and O; draw OC and OD perpendicular to NB and NM, respectively; draw MA perpendicular to GA. Angle $DOC = MNB$, and sin $MNB = \frac{MB}{MN} = \frac{\frac{3}{8} - \frac{1}{4}}{2} = 1/16 = 0.0625$; therefore angle $MNB = 3$ degrees 35 minutes. In the right triangle NOC, cos $NOC = \frac{OC}{ON} = \frac{\frac{1}{4} + \frac{1}{8}}{\frac{3}{8} + \frac{1}{8}} = \frac{3}{4} = 0.75$; therefore angle $NOC = 41$ degrees 24 minutes 35 seconds. $ONC = 90$ degrees $-$ 41 degrees 24 minutes 35 seconds $=$ 48 degrees 35 minutes 25 seconds. $OND = ONC + CND =$ 48 degrees 35 minutes 25 seconds + 3 degrees 35 minutes = 52 degrees 10 minutes 25 seconds. $OD = \frac{1}{2} \times$ sin $OND = \frac{1}{2} \times$ sin 52 degrees 10 minutes 25 seconds =

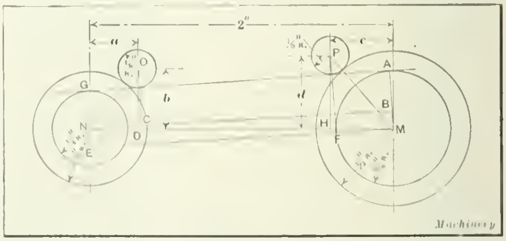


Diagram Illustrating a Draftsman's Problem

½ × 0.78988 = 0.39494 inch = b. ND = ½ × cos OND = ½ × cos 52 degrees 10 minutes 25 seconds = ½ × 0.61327 = 0.30664 inch = a. Draw ME parallel to GA; draw PF and PH perpendicular to ME and MN, respectively. Angle $FPH = EMN = MNB$. Cos $FPM = \dfrac{⅛ + ¼ + ⅛}{½ + ⅛} = 4/5 = 0.8$; therefore angle FPM = 36 degrees 52 minutes 11 seconds. Angle $HPM = FPM + FPH$ = 36 degrees 52 minutes 11 seconds + 3 degrees 35 minutes = 40 degrees 27 minutes 11 seconds. HM = ⅝ × sin HPM = ⅝ × sin 40 degrees 27 minutes 11 seconds = ⅝ × 0.64882 = 0.40551 inch = c. HP = ⅝ × cos HPM = ⅝ × cos 40 degrees 27 minutes 11 seconds = ⅝ × 0.76094 = 0.47559 inch = d.

Formulas expressing the values of a, b, c, and d are rather awkward, but may be written as tollows: let R and r be the radii of the larger and smaller of the two circles at the left; let R_1 and r_1 be the radii of the larger and smaller of the circles at the right; let r_2 be the radius of the fillet circles, and s the distance between the centers; then

$$a = (R + r_2) \cos \left(\cos^{-1} \frac{r + r_2}{R + r_2} + \sin^{-1} \frac{r_1 - r}{s} \right)$$

$$b = (R + r_2) \sin \left(\cos^{-1} \frac{r + r_2}{R + r_2} + \sin^{-1} \frac{r_1 - r}{s} \right)$$

$$c = (R_1 + r_2) \sin \left(\cos^{-1} \frac{r_1 + r_2}{R_1 + r_2} + \sin^{-1} \frac{r_1 - r}{s} \right)$$

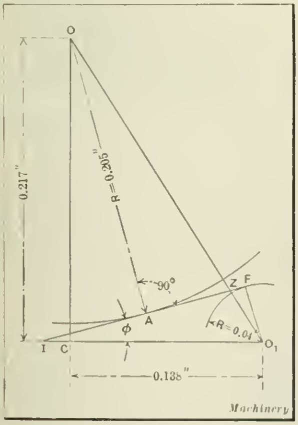
$$d = (R_1 + r_2) \cos \left(\cos^{-1} \frac{r_1 + r_2}{R_1 + r_2} + \sin^{-1} \frac{r_1 - r}{s} \right)$$

PROBLEM IN TRIGONOMETRY

C. E. M.—Referring to the accompanying illustration, please show how to find the angle ϕ. I should like to have the method explained in detail.

Anewered by G. H. MacCulloughb, Worcester, Mass.

The following is a simple solution of the "Problem in Trigonometry" appearing in the July number of MACHINERY, page 1042. By omitting two unnecessary construction lines, and connecting O and O_1, the figure here shown is obtained. In the right triangle OCO_1 the hypotenuse $OO_1 = \sqrt{OC^2 + O_1C^2} = \sqrt{0.217^2 + 0.138^2} = 0.25716$. By construction, it is evident that triangles OAZ and O_1ZF are similar. The proportion $\dfrac{O_1Z}{OZ} = \dfrac{O_1F}{OA}$ is therefore obtained. Adding 1 to both sides, $\dfrac{O_1Z}{OZ} + 1 = \dfrac{O_1F}{OA} + 1$. Changing to fractions, $\dfrac{O_1Z + OZ}{OZ} = \dfrac{O_1F + OA}{OA}$. Substituting the values given, $\dfrac{0.25716}{OZ} = \dfrac{0.040 + 0.205}{0.205}$. Solving, $OZ = 0.21518$. Cos angle $AOZ = \dfrac{AO}{OZ} = \dfrac{0.205}{0.21518} = 0.95270$. Angle AOZ = 17 degrees 41 minutes 33 seconds. The tangent of angle $O_1OC = \dfrac{O_1C}{OC} = \dfrac{0.138}{0.217} = 0.63594$. Angle O_1OC = 32 degrees 27 minutes 15 seconds. Angle AOC = angle O_1OC - angle AOZ = 32 degrees 27 minutes 15 seconds - 17 degrees 41 minutes 33 seconds = 14 degrees 45 minutes 42 seconds. Now the angles AOC and FIO_1, or angle ϕ, are equal, since their corresponding sides are perpendicular. Therefore, angle ϕ = 14 degrees 45 minutes 42 seconds.



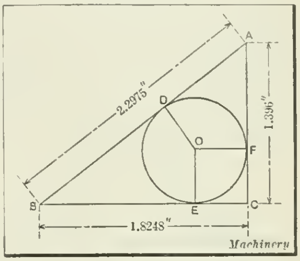
Problem in Trigonomotry

TO FIND RADIUS OF CIRCLE INSCRIBED IN TRIANGLE

A. S.—In a right triangle having the dimensions shown in the accompanying illustration, a circle is inscribed; please show how to find the radius of the circle.

Anewered by Guy H. Gardner, New London, N. H.

Another solution of the problem given in the July number of MACHINERY, page 1042, is given in the following; it is remarkably simple and easily understood. In the accompanying illustration, $BD = BE$ and $AD = AF$, because "Tangents drawn to a circle from the same point are equal." $EC = CF$, and EC = radius OF. Then let R = radius of inscribed circle. $AC - R = AD$ and $BC - R = DB$. Adding, $AC + BC - 2R = AD + DB$. $AD + DB = AB$; hence, $AC + BC - AB = 2R$. Stated as a rule, "The diameter of a circle inscribed in a right triangle is equal to the difference between the hypotenuse and the sum of the other sides." Substituting the given dimensions, we have 1.8248 + 1.3959 - 2.2975 = 0.9232 = $2R$, and R = 0.4616.



To find Radius of Circle inscribed in Triangle

This solution was also submitted by A. B. Subia, Hyland Park, Mich.

TO FIND RADIUS OF CIRCLE

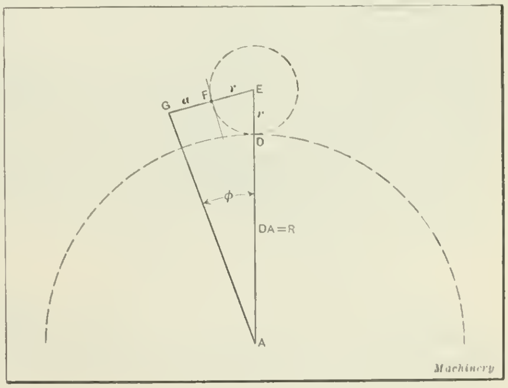
Answered by G. H. MacCullough, Worceeter, Mass

The formula for finding the radius of a circle as given in the July number of MACHINERY can also be derived as follows: Given EG perpendicular to AG, segment $FG = a$, $AD = R$, and the angle ϕ; to find r. $GE = a + r$, and $AE = R + r$. Then the triangle AEG is a right triangle, and $GE = EA \sin \phi$. Substituting the values for GE and AE found above:

$$a + r = (R + r) \sin \phi = R \sin \phi + r \sin \phi$$

$$r (1 - \sin \phi) = R \sin \phi - a$$

$$r = \frac{R \sin \phi - a}{1 - \sin \phi}$$



Finding Radius of Circle

BASIS OF EMPLOYES' COMPENSATION PAYMENTS

BY CHESLA C. SHERLOCK[1]

The amount of compensation that an injured workman may recover is generally based upon the average weekly wages he has earned for the full year next preceding the date of injury. Just what is meant by this expression of the statute has caused a wide difference of opinion among the authorities. The California commission has decided that tips or gratuities received in addition to the regular salary should not be considered a part of the workman's earnings when determining the basis of a compensation award. It was argued that such were earnings, that they were reasonably certain, and that the average amount earned in a given time could easily be ascertained. But the opinion was handed down on the ground that if the court took the contrary view it would present too great an opportunity for fraudulent claims being presented to the commission from time to time, there being no way of proving earnings from tips, other than by taking the injured man's word for it. The court in Texas took a contrary view and allowed compensation to a porter of a hotel whose sole income consisted of tips. The same conclusion was reached by the Massachusetts court, allowance being made by the court for the amount of earnings over and above the regular salary received from the employer.

Computing Compensation of Seven-day Worker

In cases where the injured man is a seven-day worker, the question arises as to whether or not he can be allowed compensation computed on a seven-day or a six-day basis. There is a considerable difference in the amount of compensation paid, and it is a fruitful source of dispute among employers and injured workmen. This is especially the case in industrial occupations. The California commission refused to permit seven-day workers to receive compensation on a computation on a six-day basis; it fixed 332 days as the average number of working days in the year and based computation upon that figure rather than 300, as is the case of a six-day worker.

Compensation when Injured at Other than Usual Occupation

Workmen are often injured at a time when they are engaged in work apart from their usual occupation. If there is a difference in the wages allowed for the different kinds of work, the question naturally arises as to whether the wage of the usual occupation should govern or whether the wage of the occupation engaged in at the time of the injury should govern. An example of such a case is where a carpenter was temporarily engaged in washing windows. As a carpenter, he would receive $5 a day, while as a window washer he would be entitled to only $1.50 a day. The California and Connecticut courts have said that the wage of the work being done at the time of injury will govern—not the wage of the usual occupation. In a California case, a lineman who customarily earned $4.50 a day was injured while in the National Guard, where he received only 70 cents a day and board. The commission made the award on the basis of employment in the National Guard and not as a lineman.

In a Wisconsin case, a citizen was killed while obeying a summons to aid an officer in making an arrest. The Supreme Court of that state made the award, not upon the basis of occupational earnings, but upon the basis of the usual pay for police services in the locality. The Massachusetts court, however, does not take kindly to this construction of the acts, and has held that if a workman capable of earning a higher wage is injured while temporarily employed, he is entitled to an average of his earning power. It is necessary, however, to prove that he is able to earn the higher wage

Part Service for Several Employers

The Maryland commission has said that where an employe is rendering part-time services for one employer, with the privilege of serving other employers, the basis of a compensation award will be the average weekly earnings that he receives from all sources, and not merely the amount received from the employer in whose services he is at the time of the injury. In a California case it was shown that a watchman was employed by several steel mills and industrial concerns to work for them jointly. He was killed by a burglar while on the premises of one employer. The commission held that his dependents were entitled to an award based upon the combined earnings from all employers, and not merely from the amount of earnings received from the employer upon whose premises he happened to be at the time of his death. The payment of compensation, however, was to be made by the employer upon whose premises the workman was killed.

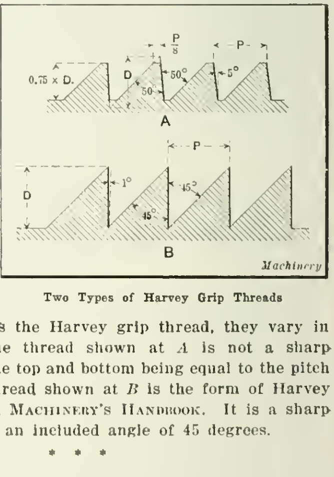
Over-time Earnings and Intent of Law

The question of whether over-time earnings should be considered in arriving at the average weekly earnings of the injured workman has caused a great deal of litigation before the courts and commissions. It seems to be the consensus of opinion, however, that over-time earnings should not be considered in arriving at the average weekly wages. The intent of the law is to be entirely fair to both parties concerned, although it is sometimes hard to make them understand this. It is desired to ascertain, if possible, the average income of the workman from his employment and then divide the loss equally between the workman and the employer. That, in a nutshell, is the whole purpose of the compensation acts.

* * *

HARVEY GRIP THREADS

The Harvey grip thread has an included angle of 45 or 50 degrees, but the thread section is not symmetrical about a line at right angles to the axis of the bolt or threaded body. Apparently there is no standard slope to which the sides of the thread should be cut in reference to a line at right angles to the axis, as indicated by the accompanying illustration. At *A* is shown one form used, in which one side of the thread forms an angle of 5 degrees with a line at right angles to the axis, while in the form shown at *B* the corresponding side forms an angle of only 1 degree. While both threads are known as the Harvey grip thread, they vary in several respects. The thread shown at *A* is not a sharp V-thread, the flat at the top and bottom being equal to the pitch divided by 8. The thread shown at *B* is the form of Harvey grip thread shown in MACHINERY'S HANDBOOK. It is a sharp V-type thread having an included angle of 45 degrees.



Two Types of Harvey Grip Threads

* * *

Nearly 300,000 men had been transferred, about the end of June, from one unit to another in army camps in this country as a result of occupational qualifications ascertained through the Committee on Classification of Personnel of the Adjutant General's office. About 40,000 transfers have taken place each week recently. In some of the camps, where as many as 2500 men are received daily, a force of 200 trained interviewers is employed to ascertain full information regarding the men's occupations, education, experience, and special qualifications. It is necessary for enlisted men leaving this country to make out an occupational card, which enables officers on the other side to place them where they can be most useful. Among men now being transferred because of occupational qualifications are mechanics, chauffeurs, chemists for gas defense work, physicists and meteorologists for aviation purposes, surgical-instrument repairers, bacteriologists, map draftsmen, refrigeration experts, crane operators, foresters, railroad builders, railway shop workmen, accountants, gunsmiths, and other ordnance specialists and workmen for engineer regiments.

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[1] Address: Box 601, Des Moines, Iowa

Machining an Automobile Differential Cross

By Albert A. Dowd[1]

WHEN alloy steels are used in automobile construction and when parts made from this material are hardened and ground after the machining operations have taken place, the possibility of distortion during hardening must be given consideration. In certain kinds of work, such as the large ring gear in the rear axle construction, the greatest pains are taken in the hardening process to obviate any chance of distortion. This is attended to by placing the gear in a kind of clamp the function of which is to prevent any alteration taking place due to the heat-treatment. On some of the other parts, however, a clamp is not used, and the pieces therefore become more or less distorted in the hardening process. The allowance for grinding is usually sufficient to take care of a small amount of change, but there are some instances where trouble is likely to be caused unless due preparation is made to counteract the changes caused by hardening.

An excellent example of this kind is the differential cross used to support the pinions in the differential case of an automobile, shown in Fig. 1. Reference to this illustration will show that there are four arms *A* arranged radially at 90 degrees from each other and equidistant from the center hole *B*. These arms are used to support the pinions in the differential and it is necessary that they should be in the proper relation to one another. The center hole is not of great importance, but it is machined rather accurately in order to assist in obtaining the correct relation of the arms. The shoulders *C* must also be equidistant from the center. Now it will be noted that the work is hardened and ground after machining, and as the arms of the cross are turned on centers it might be assumed that these would be in the correct relation to one another after hardening, provided they were located properly in the first place. As a matter of fact, however, there would be more or less change in their relation so that it would be unsafe to use the centers in the final grinding operation. In order then to make sure that the arms will be correctly ground the various operations must be carefully planned. In the case of this particular piece, the operations given in the following were decided upon.

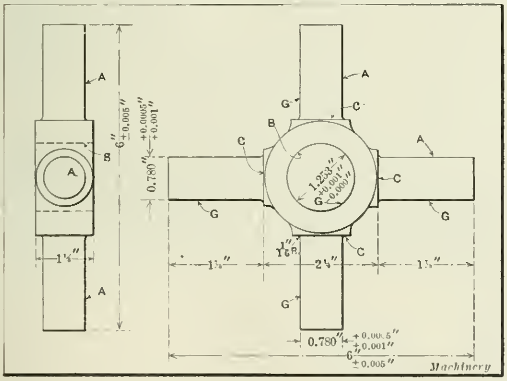

Fig. 1. Cross for supporting Pinions of Automobile Differential Case

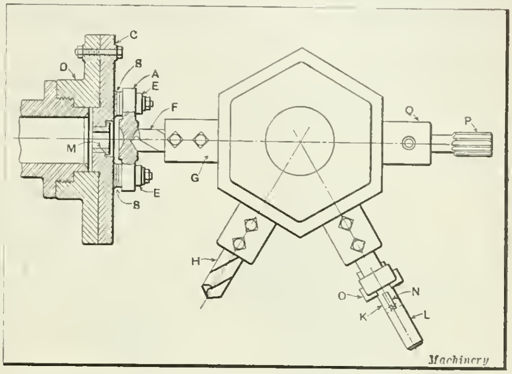

Fig. 2. Set-up for drilling, boring, reaming, and facing Hub

Sequence of Operations

The sequence of operations on the work is as follows: (1) drop-forge and trim; (2) anneal and pickle; (3) spot, drill, bore, and ream 1.253-inch hole, and face hub; (4) face other side of hub; (5) straddle-mill ends of arms; (6) center arms; (7) turn arms, cut fillet, and face ends; (8) harden; (9) grind two opposite arms; (10) grind 1.253-inch hole; (11) grind one other arm, working from hole to centers in previously ground arms; (12) grind arm opposite last one ground; (13) inspect. This sequence of operations simply indicates the work which is done in each operation, but does not take up the matter in detail. This will be taken care of in the following description.

Turret Lathe Operations

Referring to Figs. 2 and 4, the setting up of the turret lathe for the third operation on the work is clearly indicated, as is also the presentation of the various tools to the work. In Fig. 2, the work *A* is located in V-blocks *B* on a

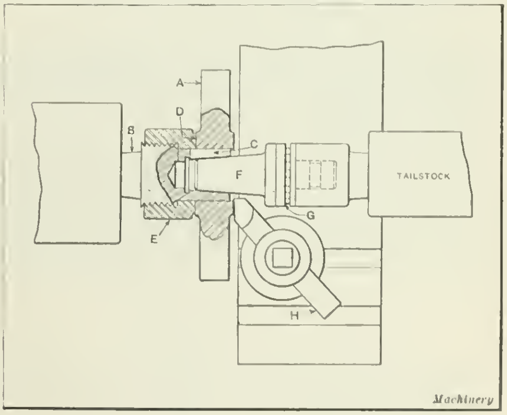

Fig. 3. Expansion Arbor for Facing Operation

faceplate fixture *C* which is mounted on an adapter *D*, screwed to the spindle of the machine. The work is clamped by means of a strap *E*. The first tool used is a spotting drill *F* in a standard holder *G*. This tool is followed by a drill *H* and a boring and facing bar *K* having a pilot which enters the bushing *M* in the faceplate fixture. The boring and facing bar is provided with cutters *N* and *O* for boring and facing, respectively. The reamer *P* is of the floating type held in a special holder *Q*. The reaming of the piece completes this operation, but it will be noted that only one side of the large hub has been faced.

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Facing Other Side of Hub

Having machined the hole and faced one side of the hub, the other side must now be faced off square with the first side. A 14-inch engine lathe is used for this operation with a special arbor as indicated in Fig. 3. This arbor is of the expanding type and is held in the spindle by a tapered shank *B* in the usual manner. The work *A* is slipped onto the portion *C* of the arbor until the finished face *D* comes to rest against the collar *E*. This collar is threaded on the arbor and simply acts as a longitudinal stop, although it is also intended to be used as a knock-off in case the work should stick. The end of the arbor *C* is split in three places longitudinally to allow for expansion. The inside is tapered to fit a plug *F* mounted in the tailstock and having a ball thrust bearing *G* behind it as indicated.

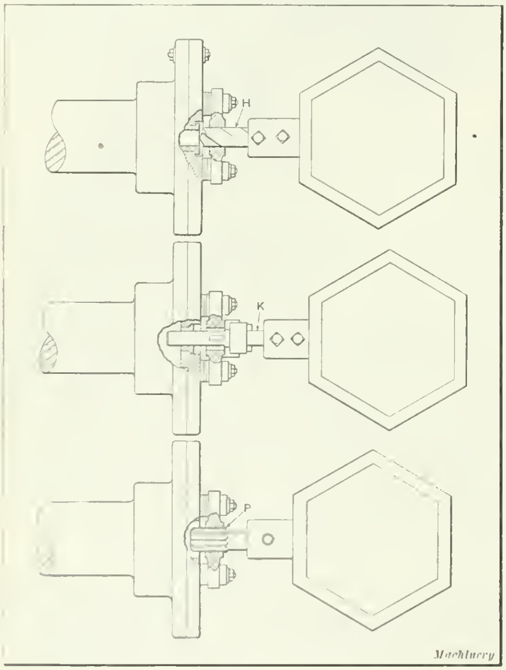


Fig. 4. Drilling, boring, reaming, and facing Hub

After the work is placed on the arbor, the tailstock is brought up quickly until the tapered plug *F* enters the hole and expands the arbor in the work, thus holding it squarely. The tool *H* is used for facing the end of the hub. It will be seen that the method indicated is very rapid, and while it is not new in its application, it will be found useful for certain classes of work.

Index Fixture for Straddle-milling

The next operation on the work consists in straddle-milling the ends of the arms *B* and *C*, Fig. 5. For this purpose the work is placed on a fixture *E*, being located on a central stud *A* with the arms *B* and *C* resting in V-blocks. The upper half of this fixture is made so that it can be readily indexed by means of the lever *F*. The straddle-milling cutters *D* face across the ends of the arms when in the position shown. The hardened pins *H* and *K* give the correct radial location, and the clamping of the fixture at a given point is accomplished by means of the nut at *N*. After the two arms *C* are milled, the lock-nut *N* is loosened and the lever moved around until the hardened pin *O* strikes against another pin *P*. This gives the correct position for the second milling of the arm *B*. After this work has been done, the arms should be uniform in length about the center hole.

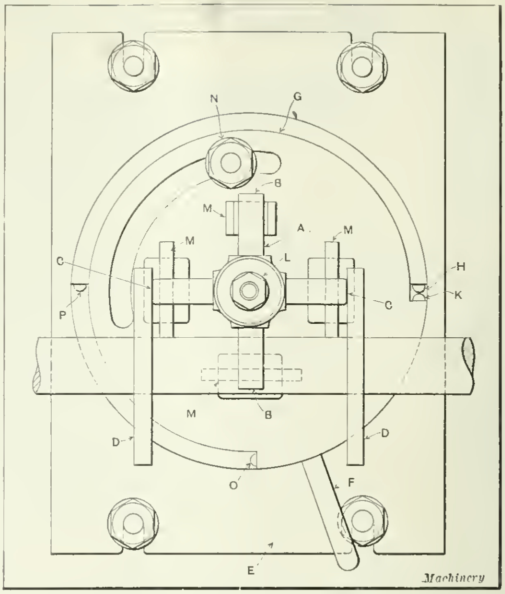


Fig. 5. Fixture for straddle-milling Ends of Cross

Box Jig for Centering the Arms

In order to take no chances with an indexing fixture for putting the center hole in the arms, a box jig, shown in Fig. 6, was used. The work is placed on a central stud *A* in the four-sided box jig *B*, and it is held firmly against a finished surface by means of the wedge *C*. A combination center

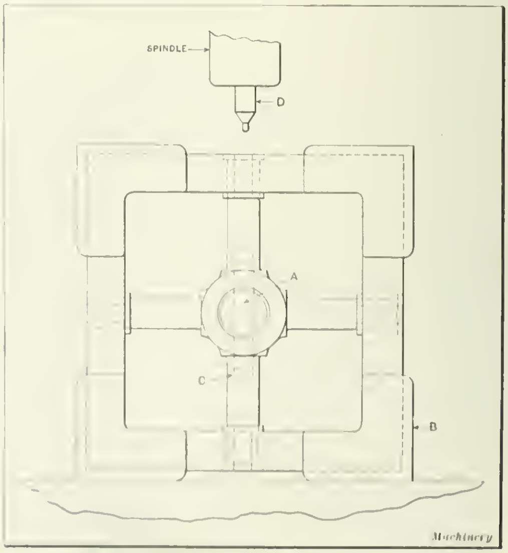


Fig. 6. Box Jig for drilling Center Holes in Arms of Cross

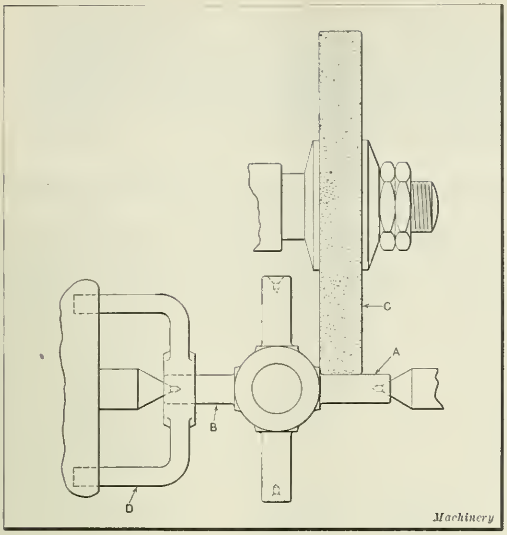


Fig. 7. Method of grinding Two Arms

drill and reamer *D* acts through bushings on each of the four arms consecutively. A fixture of this kind is much to be preferred to an indexing fixture for this operation, because the accuracy can be maintained much more easily. The four holes for centers in the arms are now in their correct relation to one another, and to the center of the work, and it will be understood that these points are determined carefully in order to prevent trouble in the subsequent machining operations.

Rough-turning the Four Arms

The next operation on the work consists in rough-turning the four arms on centers in an engine lathe as indicated in Fig. 10. There is nothing particularly out of the ordinary in this operation except that a special form of driving dog is used as indicated at *B*. This dog is so arranged that there is no screw to tighten, and it can be slipped onto the end of the arm and the lathe started immediately. As pressure is applied to the cutting tools the cam arm on the dog tightens firmly on the work and prevents slippage. The more pressure that is applied, the tighter the dog holds, and yet it can be released in a moment. The work *A* in this operation is held on centers, and the tools *C* and *D* turn the arms and cut the fillet. Immediately after this operation the work is hardened.

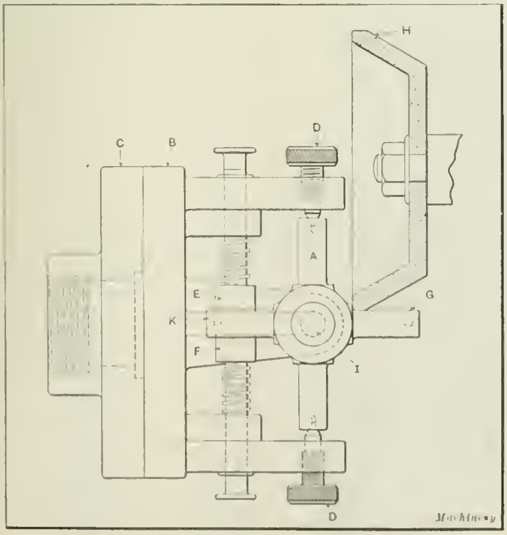


Fig. 8. Fixture for grinding Two Remaining Arms True

Operation after Hardening

Now it will be seen that after a piece of this kind has been hardened, the carefully put in centers may not be in the correct relation to each other. It is also possible that they will not be in alignment with the center hole. For this reason the two arms *A* and *B*, Fig. 7, are first ground on their own centers, reversing the work end for end and grinding with a wheel *C* in the usual manner. The wheel is dressed so as to produce the fillet at the junction of the arms with the center hub. The work is dogged with a two-tailed dog *D*, as indicated, during this operation. Now after grinding these two arms it may be found that they are true with each other but possibly slightly out of alignment with the center hole in the hub. The possibility of inaccuracies between these portions of the piece will be counteracted in the next operation.

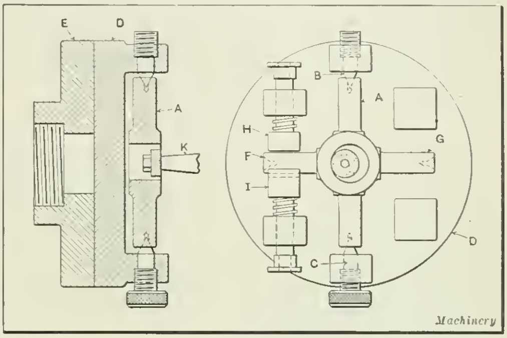


Fig. 9. Fixture for grinding Center Hole in Line with Ground Arms

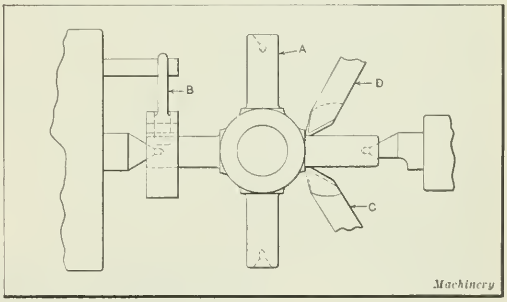


Fig. 10. Special Dog and Tools used in turning Arms of Cross

First Grinding Fixture

The hole in the center hub is now ground so that it will be in perfect alignment with the two arms ground in the last operation. The work *A*, as shown in Fig. 9, is set up on the two centers at *B* and *C* in a faceplate fixture *D* mounted on an adapter *E* on the live spindle of a cylindrical grinder. Now in order to make sure that the hole will be in the correct relation to the two arms *F* and *G* which have not yet been ground, the arm *F* is located in a spring V-block *I* as indicated. A button, which is also of the spring variety, holds the arm in position in the V-block as shown at *H*. The internal grinding spindle *K* of the machine is utilized for grinding this hole. When this operation is completed, the centers *B* and *C* and the center hole in the hub are in the correct relation to one another.

Final Grinding Operation

The alignment of the two previously ground arms with the center hole in the hub was accomplished by the last operation, but it is not known how the other two arms stand either in relation to the center hole or to each other on account of possible distortion in hardening. Assuming that they are not true, the work must set up in such a way that location will be obtained by means of the previously ground hole in the hub and the two arms which have also been ground. Fig. 8 shows the final grinding operation on the work. A special faceplate fixture *B* is mounted on an adapter *C* on the live spindle of the machine in the usual manner. The work *A* is set up on a central plug *I* and also on the screw centers *D*, the latter being used in the arms ground in a previous operation. In this setting no other centers can be used on account of the possibility of distortion in hardening. In order to steady the work, however, the spring buttons *E* and *F* are used. The work is entirely unsupported at *G*. A special cup-wheel *H* is used for grinding the outside of the arm and it is formed slightly to produce the fillet at the shoulder. After this work has been done the piece is reversed and the other arm *K* is finished in like manner. After this operation it will be seen that although the hardening process may have caused some distortion in the work, the method of handling after hardening eliminates any inaccuracies and produces work that is correct in every particular. These methods may be successfully applied to other work of a similar nature.

* * *

STANDARDS FOR STEEL ROLLER CHAINS

At the spring meeting of the American Society of Mechanical Engineers, in Worcester, Mass., a joint report of the standards committees of the American Society of Mechanical Engineers and the Society of Automotive Engineers was presented. This report has been approved by the following manufacturers of steel roller chains: Baldwin Chain & Mfg. Co., Worcester, Mass.; Culver-Taylor Chain Works, Detroit, Mich.; Diamond Chain & Mfg. Co., Indianapolis, Ind.; Duckworth Chain & Mfg. Co., Springfield, Mass.; Link-Belt Co., Indianapolis, Ind.; and Whitney Mfg. Co., Hartford, Conn. The report states that, as existing conditions should be disturbed as little as possible during the period of the present war, no new pitches, roller diameters, or widths of chains will be recommended. It also says that it is desirable to reduce the number of chain models in general use to the smallest possible number, and to select from those now made a series of sizes to be known as "Manufacturer's Standard," which will be designated by special numbers that will be used by all manufacturers. The series of pitches recommended are ½, ⅝, ¾, 1, 1¼, 1½, 1¾, 2, and 2½ inches; and the roller diameters and the widths are to be those most nearly approaching five-eighths of the pitch; the trade number should indicate the number of quarter inches in the pitch. The recommended sizes are given in the accompanying table. While models now catalogued will not be discontinued those mentioned in the table will be recommended to the trade as the best proportioned chains for general use, and as those most likely to be kept in stock.

DIMENSIONS OF STANDARD STEEL ROLLER CHAINS

Manufacturer's Standard Number	Pitch, Inches	Roll Diameter, Inches	Width, Inches	Manufacturer's Standard Number	Pitch, Inches	Roll Diameter, Inches	Width, Inches
2	½	0.306	¼	6	1½	⅞	1
2½	⅝	0.400	⅜	7	1¾	1	1
3	¾	15/32	½	8	2	1⅛	1¼
4	1	⅝	⅝	10	2½	1 9/16	1½
5	1¼	¾	¾	..	..	...	..

Machinery

The bottom diameter of sprockets should never be over size, and chain lengths should never be under size. The proper meaning of chain width is the exact distance between the inside plates and not the actual length of the roller. Hence, sprockets should always be made sufficiently narrow to allow clearance for chains made in accordance with this definition.

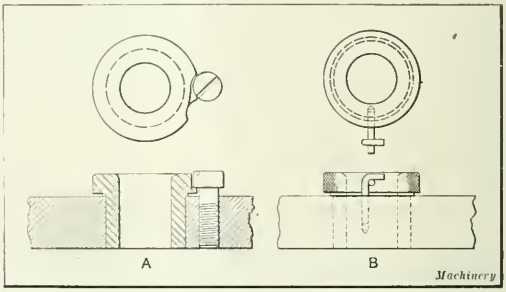
The following names for chain parts should be adopted: pin, instead of rivet or stud; bushing, the part in which the pin turns, roller, the part that turns over the bushing, side plate, instead of inside link or bushing side bar; pin link plate, instead of outside link or rivet side bar, roller link, instead of center block; pin link, consisting of one pin-link plate assembled with two pins; connecting-link plate, the detachable pin link belonging to a connecting link; connecting link, a pin link and a connecting-link plate assembled; offset link, instead of cranked link, consisting of two offset side-plates assembled with a bushing and a roller at one end and an offset link pin at the other.

* * *

SLIP BUSHING WITH RETAINING DEVICE

BY HUGH H. LEE[1]

The lock for a drilling and reaming bushing shown at *A* in the accompanying illustration has been found by the writer to give general satisfaction among shop men. It is on the same principle as the one described in the March number of MACHINERY, with the exception of the key. The bushing is machined in the same way, but a flat fillister-head cap-screw is used instead of the key and countersunk cap-screw, thus making it less complicated.



Retaining Devices for Slip Bushings

The lock shown at *B* consists of two pieces of 1/8- or 3/16-inch drill rod, as may be required. One of these pieces is left straight and is pressed into the side of the bushing; the other piece is bent at right angles and is pressed into the bushing plate, the bent part pointing in the opposite direction to that in which the drill or reamer will turn. The bushing is slipped into the hole and is given a twist toward the hook, the bend coming just high enough to catch the pin in the bushing. This holds the bushing from rotating or drawing out of the plate with the drill or reamer.

* * *

DEFINITION OF COMPRESSED-AIR TERMS

Upon the recommendation of its technical committee, the Compressed Air Society, 30 Church St., New York City, has adopted the following definitions of certain compressed-air terms and the society recommends that the use of other expressions of efficiency be discontinued:

Displacement—The displacement of an air compressor is the volume displaced by the net area of the compressor piston.

Capacity—The capacity is the actual amount of air compressed and delivered, expressed in free air at intake temperature and at the pressure of dry air at the suction; it should be expressed in cubic feet per minute.

Volumetric Efficiency—Volumetric efficiency is the ratio of the capacity to the displacement of the compressor.

Compression Efficiency—Compression efficiency is the ratio of the work required to compress isothermally all the air delivered by an air compressor to the work actually done within the compressor cylinder, as shown by the indicator cards, and may be expressed as the product of the volumetric efficiency, the intake pressure, and the hyperbolic logarithm of the ratio of compression, all divided by the indicated mean effective pressure within the air cylinder or cylinders.

Mechanical Efficiency—Mechanical efficiency is the ratio of the air indicated horsepower to the steam indicated horsepower in the case of a steam-driven machine, and to the brake horsepower in the case of a power-driven machine.

Over-all Efficiency—Over-all efficiency is the product of the compression efficiency and the mechanical efficiency.

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[1] Address: 8110 St. Clair Ave., Detroit, Mich.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

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Leeds & Northrup Double Recorder for Heating Furnaces. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. 1157
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Thompson Universal Cutter and Tool Grinder. Thompson Grinder Co., Springfield, Ohio 1158
Elyria Heavy-duty Lathe. Elyria Machine Co., Elyria, Ohio.. 1158

CLEVELAND MILLING MACHINE

The important features of this machine are a square over-arm, a feed-box in the knee—thus eliminating a universally jointed feed-shaft—a column cast solid with the base, a single-pulley, constant-speed drive with sixteen changes of speed, exclusive use of sliding gears, hardened and ground gears and shafts, bronze bearings throughout, and a supporting post for the knee with a one-piece elevating screw.

A MILLING machine embodying several unusual and interesting features, and one which differs somewhat in its general appearance from the more conventional designs, has been brought out by the Cleveland Milling Machine Co., Cleveland, Ohio. This machine has a single-pulley, constant-speed type of drive, with sixteen changes of spindle speed and sixteen changes of feed. These speeds and feeds are controlled by two levers of the ball joint type, similar to the levers of automobile gear shifts. These levers may be seen projecting from the side of the column in Fig. 1. All changes of speed and feed are obtained through sliding gears, and they are in geometrical ratio. The feed-box is in the knee, so that a universally jointed feed-shaft is not required.

The power transmission is so arranged that no loose gears are required on the spindle. All the shifting of gears is done on secondary shafts below the spindle. Tumbler gearing has been eliminated entirely both in the main drive and in the feed mechanism. The spindle reverse is contained within the machine, so that right- or left-hand cutters may be used. All of the speed, feed, and other driving mechanism is self-contained within the machine, none of the driving mechanism being bolted on the outside of the column or knee. All the gears and shafts in the driving and feeding mechanism are of hardened steel, are automatically lubricated, and run in bronze bearings.

The machine column is a complete box section of very rigid construction. The base and column are cast in one piece. This is a semi-steel casting, heavily ribbed, and tied together with heavy vertical and horizontal walls. The only openings in the column are those necessary for the change-gear levers on the front, the pulley drive housing in the rear, and the cutter lubricant tank on the left side of the machine. Access to the inside of the column is not necessary, as all interior parts are automatically lubricated and all bearing adjustments are made from the outside. Horizontal and vertical walls separate the lubricating oil for the machine from the cooling compound used on the cutter, and also serve to make the column more rigid. The base of the machine is finished on the under side so that it will stand evenly and solidly on its foundation. The base is pan shaped and has enough depth to catch oil and chips. The dovetail knee slide extends up to the over-arm, thus providing ample surface for clamping attachments. This dovetail slide is so arranged that the heaviest pressure is not taken at the thinnest section of the wall.

The knee, as well as the column, has an improved dovetail slide. The bearing of the saddle is not on the thinnest section of the slide, but on the wide, flat surface, the narrow slide acting as a guide only. There is no bearing in the center of the dovetail slide, which eliminates the chances of its being marred by wrenches or other tools which may be laid on top of the knee. The bearing of the knee on the column is extended well above the top of the saddle slide, thus giving the knee a longer bearing on the column and reducing the bearing pressure to a minimum. The feed-box, as well as the knee, is entirely enclosed, thus excluding any chips from getting into the feed mechanism. The elevating screw is large in diameter and in one piece. The knee is supported on a post which acts both as a support to the elevating nut and as a guide in the knee. The hand feed and power feed for the knee are independent of each other.

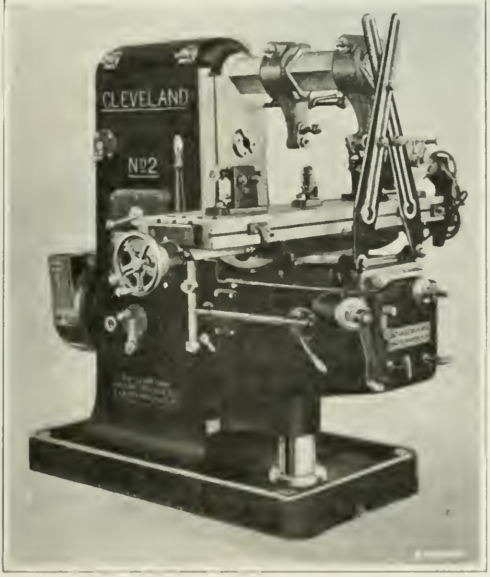


Fig. 1. Cleveland No. 2 Milling Machine

The table of the machine is finished all over, so that it will not be likely to warp on account of internal strains. Th

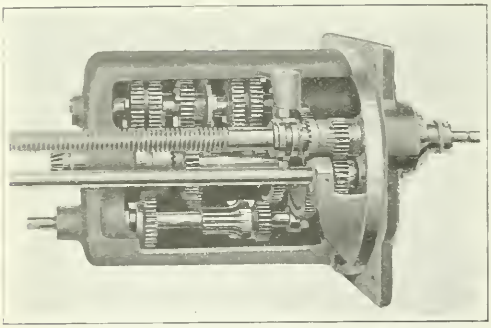


Fig. 2. Detail View of Feed Mechanism which is enclosed in Knee

bearings on the table are at the top of the saddle, instead of at the bottom of the dovetail. This method secures a large bearing surface and locates the bearings at greater distances apart. These bearings are automatically lubricated by rollers in the saddle. The bearing on the saddle is also at its widest portion, and both the saddle and table bearings are provided with long taper gibs and adjusting screws to compensate for wear.

One of the unusual features of this machine is the square over-arm. This form was adopted to provide a positive alignment of the arbors and a maximum rigidity of the arm pendants. If the arbor is not true and the arm pendant or support is adjusted by the operator to accommodate the arbor, the latter, under these conditions, will work in a cramped position, which tends to produce crystallization and breakage. With the square over-arm, it is impossible for the operator to place the arbor supports on the over-arm and arbor in any other way than exactly in line.

The spindle is flanged, which eliminates the overhang on the end of the spindle and the trouble caused by cutters screwing fast on the spindle. The flanged spindle has a face keyway into which are inserted hardened steel jaws for driving arbors or face mills. It is not necessary to remove these jaws when changing from a face mill to an arbor. The spindle is provided with a positive lock that enables the operator to loosen the arbor nuts readily. A handwheel is also provided for revolving the spindle which is convenient for the operator. The spindle lock cannot be operated while the machine is running, nor can the main driving clutch be engaged while the spindle lock is in the locking position. The bearings at the front and rear ends of the spindle are adjusted with a nut on the outside at the rear end of the spindle.

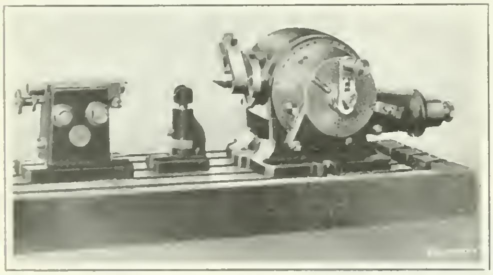
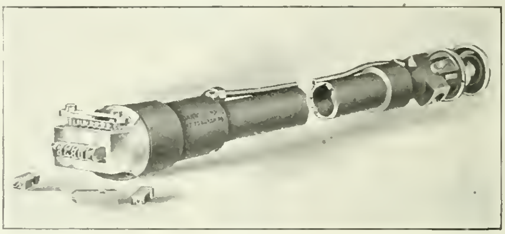


Fig. 3. Dividing Head of Cleveland Milling Machine

All bearings and gears in the column and knee are flooded with lubricant, so that oil holes in these members are unnecessary, and the operator does not need to oil the important parts of the machine. The reservoir containing the oil requires filling only once in several months. A sight glass on the side of the column shows the condition of the oil supply at all times. The machine has a centrifugal pump for supplying cooling compound to the cutters. This pump operates only when the spindle is revolving, so that it is not necessary to shut off the cooling compound when changing the work or measuring it, the control being entirely automatic.

PANNIER SINGLE-STROKE PNEUMATIC HAMMER

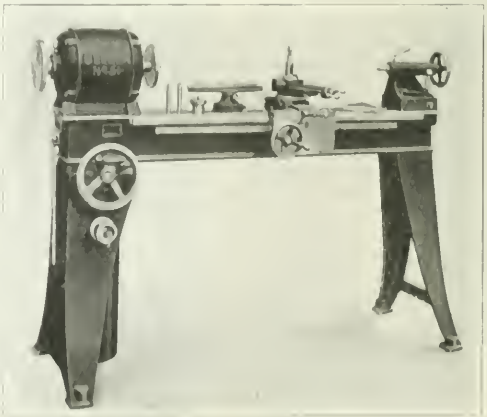
A single-stroke pneumatic hammer intended especially for stamping purposes is now being manufactured by Pannier Bros. Stamp Co., Inc., 207-209 Sandusky St., Pittsburg, Pa. This hammer may be used for either hot or cold stamping. The head used for hot stamping contains a series of wheels on which the figures are engraved, so that by turning the wheels any desired combination of figures can be obtained. For cold stamping, a head holding single numeral stamps is used. The hammer is connected by hose to any air line, and it is used by simply placing the stamping head against the part to be marked and opening the valve in the handle. The plunger is then driven against the stamping head, which produces a clear impression on the work. The hammer weighs about 18 pounds and requires about 80 pounds air pressure. This hammer is the result of a suggestion made by a prominent superintendent of one of the big Pittsburg steel mills, who required a device of this kind. The hammer is intended for stamping heat, slab, or serial numbers on steel billets, rods, bars, flats, and other heavy metal products.



Pannier Single-stroke Pneumatic Hammer made especially for Stamping Purposes

OLIVER SPEED LATHE

The No. 51 speed lathe now being manufactured by the Oliver Machinery Co., Grand Rapids, Mich., is driven by a motor designed for three-phase alternating current of 60 cycles and 220 volts. The illustration shows a machine equipped with a hand-feeding carriage and a compound swivel rest, but the lathe may be provided with a plain bed in 4- or 5-foot lengths, with capacities between the centers of 24 and 36 inches, respectively. The swing of this lathe is 12 inches. The motor, headstock, and ball bearings are entirely enclosed, thus excluding dust and dirt. The rear end of the motor is fitted with a combined handwheel and faceplate. This is a new feature for which a patent has been applied. The periphery of the faceplate is rounded the same as a handwheel and the inside face is curved inward, thus forming a rim which

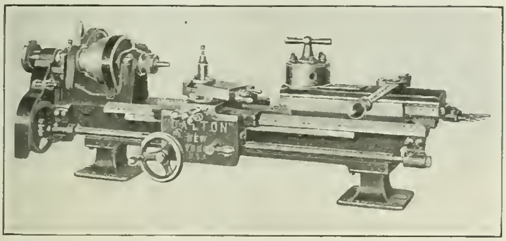


Oliver No. 51 Speed Lathe driven by Three-phase Alternating-current Motor can readily be gripped. The outer surface, however, is straight or flat and forms a faceplate for rear end turning.

The controller of the motor is dustproof and similar to a street car controller, although very much smaller. It is mounted inside of the left-hand leg and is operated by the handwheel seen at the front. The rim of this handwheel is marked to indicate the "off position" and the different speeds which are 570, 1140, 1725, and 3450 revolutions per minute. The mark at the top indicates the motor speed and the mechanism is such that the handwheel cannot be turned in the wrong direction. All parts of the lathe are interchangeable.

TURRET FOR DALTON SIX-INCH LATHES

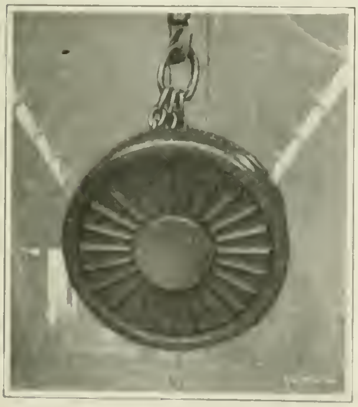
A turret designed for application to the six-inch bench lathes of the Dalton Mfg. Corporation, 1915 Park Ave., New York City, is shown on the lathe here illustrated. This turret has six holes or tool positions, and its slide is operated by the horizontal hand-lever seen in the illustration. Individual stops are provided for each turret hole. When the turret-slide is being turned, the turret automatically indexes for locating the next successive tool in the working position. This turret attachment is especially adapted for manufacturing operations on duplicate parts which must be held in the chuck.

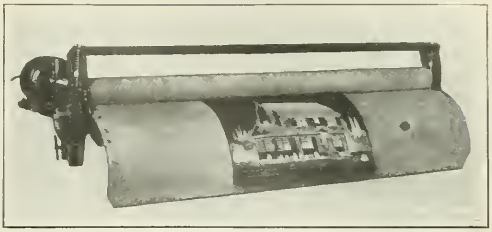


Dalton Six-inch Lathe equipped with Turret

OHIO MILL TYPE LIFTING MAGNET

The Ohio Electric & Controller Co., 5900 Maurice Ave., Cleveland, Ohio, is the manufacturer of the 50-inch, or No. 5, mill type lifting magnet shown in the illustration which is a view of the bottom surface. The design of this magnet conforms in general to accepted standards which have proved to be most efficient and it possesses several detail features designed to eliminate the most common causes or sources of operating trouble. Possibly the most serious and expensive troubles have been due to grounds and to open ends and short circuits resulting from the loosening of the internal screw and nut connections by the severe vibration and jolts to which magnets are subjected. In order to avoid difficulties of this kind, welded connections and asbestos insulation are used exclusively in the Ohio magnets. To prevent the breakage of the bolts and the outer rings, the magnet, which is over eight inches high, is secured by heavy chrome-vanadium steel studs having nuts on the top of the case protected by ribs. Other improvements are: minimum of head room, ample copper in the coil, heat radiating ribs at top and bottom, and flexible armored leads welded directly to coil.


Ohio Fifty-inch Mill Type Lifting Magnet

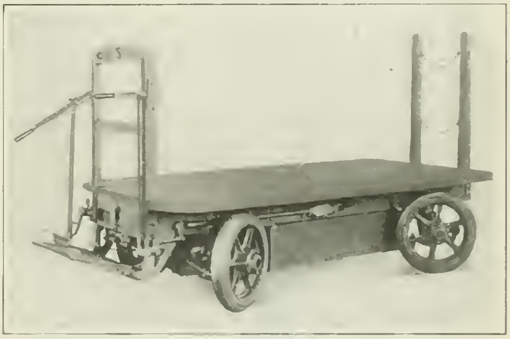

Shaw Blueprint Wringer

SHAW BLUEPRINT WRINGER

The blueprint wringer which has just been brought out by the Shaw Blueprint Machine Co., 9-11 Campbell St., Newark, N. J., is driven by an electric motor through worm-gearing and handles blueprints at the rate of ten linear feet per minute. This wringer is fastened directly to the washing tank, and the prints may be fed through it without lifting them from the bath. It is claimed that this wringer will remove over 90 per cent of the water, and as the prints emerge from it they are dry enough to trim and use within four minutes. The prints after passing through the wringer are also free from wrinkles. This wringer is designed to take the place of expensive drying machines.

CRESCENT ELECTRICAL INDUSTRIAL TRUCK

The electrically driven industrial truck made by the Crescent Truck Co., 347-349 First Ave., Elizabeth, N. J., and designated as the Type F, has a rated capacity of 4000 pounds and will run without recharging at a speed of from five to seven miles per hour during a ten-hour day and with the full working load. One of the interesting features of this truck is the method of steering. The steering lever, which is operated vertically, is directly connected to all four wheels. By turning all four wheels for steering, a very short turning radius is obtained. In fact, this truck has a turning radius of six feet, measured from the center line, so that it will enter the side door of a standard box car and run toward either end. The truck wheels are driven through a worm-gear type of differential and the whole driving mechanism is enclosed in a housing, as shown in the illustration, and continually runs in oil.



Crescent Four-wheel Steer Electric Industrial Truck

The truck platform is 23 inches above the floor and is 48 inches wide and 7 feet 6 inches long. This platform is hinged to allow access to the driving mechanism and battery. The controller is of the drum type, there being three speeds forward and three reverses, with a positive stop between. The frame is made up of 4-inch channel steel. The wheels are cast steel and have solid rubber tires 20 inches in diameter. These wheels are provided with Timken roller bearings. The wheel-base of the truck is 4 feet 10 inches, and the tread 36 inches. The length over-all is 9 feet 3 inches.

COATS LEAD TESTING MACHINE

For use in testing the lead of thread gages and other work where it is required to make measurements to 0.0001 inch, the Coats Machine Tool Co., Inc., 30 Church St., New York City, has recently placed on the market a machine on which the necessary mechanism is furnished to operate a Prestwich fluid gage, by means of which readings of the magnitude of error in lead are obtained. Reference to the accompanying illustrations, which show front and rear views of the machine, in connection with the following description, will make its operation quite clear. The thread gage to be tested is supported between centers and a stylus *A* is entered into the thread. This stylus is supported on a bellcrank pivoted at *B*, and six different sized points are furnished with each machine to provide for measuring threaded work of various pitches. The arms of this bellcrank are of equal length.

Any lateral movement of the stylus which enters the thread on the work, due to an inaccuracy in the lead of the thread, results in transmitting a vertical movement of equal magnitude to the horizontal arm of the bellcrank which engages the contact point on the Prestwich fluid gage diaphragm. In this way a reading is obtained of the magnitude of error in the lead. This will be clearly understood after reading the following description of the machine and the way in which it is used. It will be seen that the brackets which support centers on which the work is carried are mounted on the bed of the machine in such a way that their position may be adjusted to provide for handling work of various lengths. The remainder of the mechanism is supported on a vertical column, which is pivoted on a bar *C* at the back of the machine so that the point of stylus *A* is always held in contact with the work by gravity. Bar *C* is a sliding fit in brackets *D* and *E*, so that spring *F* may hold the ball point at the opposite end of bar *C* in contact with a fixed stop carried by bracket *G*.

In using the machine the thread gage is set up as shown, and the stylus point is entered into one of the threads, after which a careful reading is taken of the position where the fluid column in the Prestwich gage comes to rest. After this has been done, a Johansson block, having a thickness corresponding to any even multiple of the lead of the thread, is placed between the ball point at the end of bar *C* and the fixed stop carried by bracket *G*, and the stylus is again allowed to drop into place in the thread groove. If the lead is exactly uniform, the stylus will come to rest at the bottom of the thread groove or if a stylus with a ball point is used, this point will bear uniformly on both sides of the groove—so that the reading of the Prestwich fluid gage will be the same as it was for the original setting.

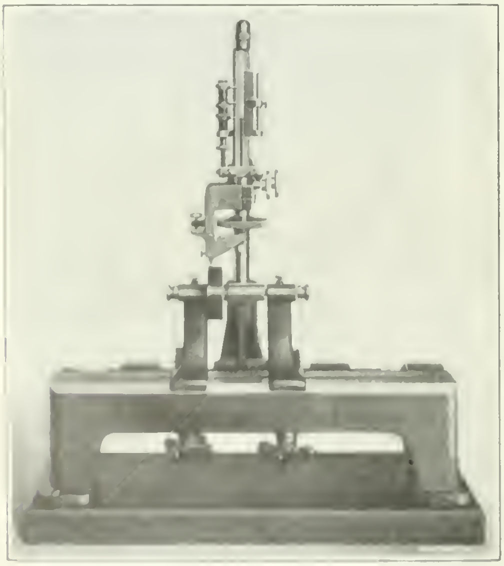


Fig. 1. Machine developed by the Coats Machine Tool Co., Inc., for testing Lead of Threads on Thread Gages, etc., to 0.0001 Inch

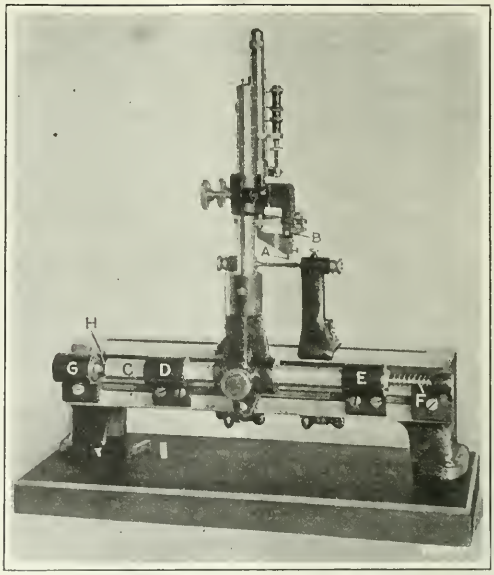
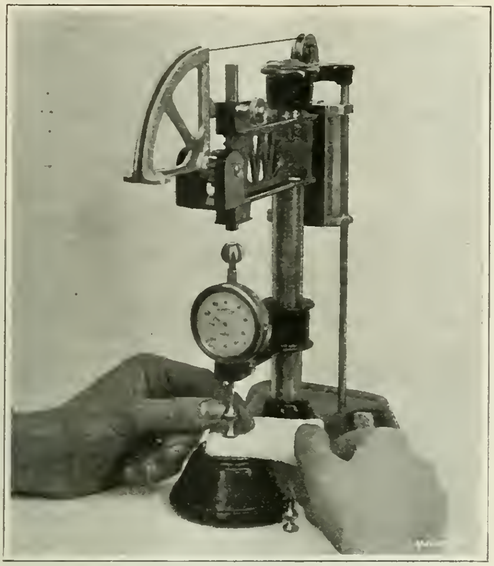


Fig. 2. Opposite Side of Coats Thread Lead Testing Machine, showing how Johansson Gage-blocks are used

Should it happen that the lead is short, the stylus will first engage the thread at the right-hand side, and in sliding to a position at the bottom of the thread groove, it will cause the lower arm of the bellcrank to swing slightly toward the left. This means that the horizontal arm of the bellcrank will be raised an equal amount and cause the level of the column of liquid in the fluid gage to rise, the error in lead being read on the scale as the difference between the reading for the original setting and the reading after the Johansson block has been inserted. Conversely, if the lead is long, the stylus will engage the thread at the left-hand side and cause the lower end of the bellcrank to be pushed to the right, thus lowering the horizontal arm and allowing the column of liquid in the fluid gage to fall. The error in lead under such conditions is, of course, the difference between the readings of the fluid gage for the original and final settings, as in the case of a thread with a short lead. It is considered good practice to use a thin Johansson block between the ball point and stop, as shown at *H* in Fig. 2, before making the original setting, and for the second setting this block and a Johansson block representing some multiple of the lead are both inserted. This is felt to be the means of securing more absolute uniformity in results, although it has no theoretical significance in the operation of the machine.

WIDNEY RESILIOMETER

The "resiliometer" is an instrument for testing the thickness, hardness, and resiliency or "life" of any resilient materials such as are used for washers, packing, gaskets, shock absorbers, etc. The tests made with this instrument may be used as a guide in the purchase of mechanical felt, rubber, and similar materials. The accompanying illustration shows the instrument being used to ascertain the thickness of material. The thickness of this particular sample is 0.283 inch, which is the normal or natural thickness. The large dial of the gage is graduated to thousandths of an inch, and one revolution of the large pointer is equivalent to one-tenth inch. If the material is more than one-tenth inch thick, thus causing the indicator hand to make more than one complete revolution around the dial, the reading is indicated by first noting the position of the indicating hand of the small dial, which is inside the face of the larger one.



"Resiliometer" for testing Thickness, Hardness, and Resiliency or "Life" of All Resilient Materials

In order to ascertain the degree of hardness of the material, a spring catch is released which holds the weight suspended at the rear of the instrument, thus allowing the quadrant to which the weight is attached by a wire to swing back until the presser-foot of the dial gage is subjected to pressure due to the weight. This presser-foot then sinks into the material, thus reducing the thickness at this point as indicated by a backward movement of the indicating hand of the dial gage. This reading is then compared with the normal or original reading. For instance, if the normal thickness were 0.283 inch and the thickness under pressure 0.111 inch, this would indicate that the material was 39.2 per cent hard, according to the Widney standard. If the material were not compressed at all, this hardness would be 100 per cent—an impossibility with any resilient material.

The resiliency of any compressible material, such as felt, rubber, etc., is indicated by its capacity to recover from compression. To make the resiliency test, the quadrant is pulled back, thus releasing the pressure on the presser-foot. As soon as the weight and pressure are released, the hand of the dial gage again moves forward and the reading should be taken immediately in order to ascertain the "instant resiliency" and not the gradual return to the normal thickness. If the reading under pressure were 0.111, as previously mentioned, and the thickness reading 0.200 as soon as the pressure was released, the rebound or resiliency would be equivalent to 0.089 inch (0.200 — 0.111 = 0.089 inch), which is 51.7 per cent of the possible rebound.

The hardness and resiliency readings vary with the thickness of the material; the greater the thickness, the greater the resistance to penetration, so that a higher hardness reading is obtained. The resiliency reading also increases at a ratio of approximately one-half the increase in the hardness reading. The resiliometer is manufactured by the Advance Felt Specialty & Cutting Co., 320 S. Jefferson St., Chicago, Ill.

LEWIS AUTOMATIC HOIST FOR FURNACE DOORS

The operation of the heavy doors of open-hearth furnaces and of certain other large furnaces used for the heat-treatment of metal products is usually effected by some form of hydraulically operated mechanism. The hoisting mechanism shown in the illustration, which is manufactured by the Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill., is an electrically driven automatic-releasing type. This hoisting mechanism was designed at the plant of the Alan Wood, Iron & Steel Co., Conshohocken, Pa., where it has been used continuously for over a year without repairs, attention, or maintenance expense.

Three of the hoists are shown in the illustration. Each one is provided with a pair of chain sheaves, mounted loose on a worm-wheel shaft between two flanges which are pinned to the shaft and supplied with fiber friction surfaces on the sides toward the sheaves. The worm-wheel is driven by a worm mounted on the shaft of a reversible motor, the worm and wheel being enclosed in a suitable housing. To the left-hand sheave is attached a chain which leads up to the tackle for raising the furnace door, and to the right-hand sheave is fastened a chain from which is suspended a heavy counterweight (down behind the mechanism shown). The wrap of the chains around the sheaves is in opposite directions. The contact surfaces between the sheaves have a beveled or spiral shape, with the result that when both chains are under tension, the sheaves are squeezed tightly against the friction flanges at the sides, and thus compelled to rotate in the direction of motion of the worm-wheel shaft.

To raise the furnace door, the motor is started in the direction which will pull down on the left-hand chain. As long as the counterweight continues its pull, the sheaves squeeze out against the flanges, and are thereby driven in the direction which will wind up the left-hand chain, and thus lift the door. The right-hand sheave has a fixed stop on its periphery, so located that it will come in contact with a stop on the bottom casting when the furnace door has reached its proper height. With the motion of the right-hand sheave arrested by this stop, the shaft cannot rotate the left-hand sheave further, because the squeeze between the sheaves and friction flanges is relieved. There is no opportunity, therefore, for over-winding, and if through carelessness the current is not shut off promptly, the shaft with its flanges will simply continue to revolve in sliding frictional contact with the sheaves, but without power to grip and rotate them further.

For lowering the doors, the direction of the motor is reversed, and practically the same process repeated, except that in this case the power of the motor is used to lift the counterweight, while the pull from the weight of the door serves to keep the sheaves squeezed apart against the friction flanges, until a stop on the left-hand sheave engages with a stop on the bottom casting, and prevents over-winding of the counterweight chain in the same manner as described for the other sheave. In other words, the door always goes up to the proper position, and always comes down to the proper position, no matter what its weight may be. Even if the door were considerably heavier than the counterweight, there would be no danger of its descending and pulling the counterweight up when the motor is stopped, for the instant the counterweight sheave is started toward reversal, the pull of its chain would squeeze the sheaves apart against the friction flanges.

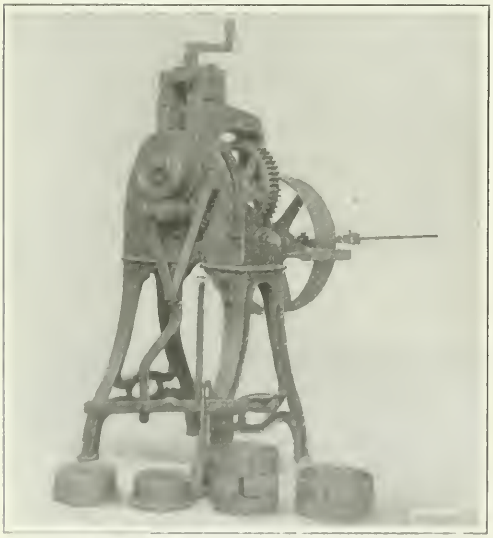
Lewis Motor-driven Automatic-releasing Hoists for Heavy Furnace Doors and the two sheaves would thus be put completely under control of the worm-wheel shaft again, and the worm-wheel is, of course, locked in position by the worm. The motor is started, stopped, or reversed by simple push-button mechanism. In the case of skip hoists, the sheaves are replaced by drums.

KANE & ROACH CIRCULAR BENDING MACHINE

The bending machine to be described is designed to bend material to a true circle without leaving flat or straight sections at the adjoining ends. In order to obtain this result, the upper roll around which the stock is bent (see accompanying illustration) is adjustable vertically and is also changeable so that the machine may be equipped with a roll corresponding to the diameter of the parts to be bent. The material that requires bending must be tightly gripped between this upper roll and the two lower rolls so that the stock is rolled tightly around the upper roll, thus forming a true circle.

The shaft which carries the upper roll is mounted in a sliding head, and vertical adjustment is obtained by a screw connecting with a crank at the upper part of the machine. The two lower rolls are mounted in an eccentric sleeve which provides vertical adjustment for tightening or releasing these rolls with respect to the band being bent. When the foot of the operator is removed from the lever, the arms of the eccentric sleeve rise and the corrugated rolls move down away from the work and release it. The work can then readily be removed while the machine is running. The two lower rolls are made of steel and are hardened. The corrugations on these rolls serve to pull the material through without slipping, but they do not mar or injure the material.

In order to obtain a true circle, free from any flat or straight sections on the ends, the upper roll should be about 1/4 inch smaller in diameter than the inside diameter of the work. If it is necessary to have extra stock in order to allow for welding the ends together, the roll should either be the same diameter as required for the work or from 1/8 to 3/16 inch larger to allow for the lap without having the ends overlap on the roll itself. The diameter of the upper roll may be varied as required by the work, so long as it is within the range of the machine.

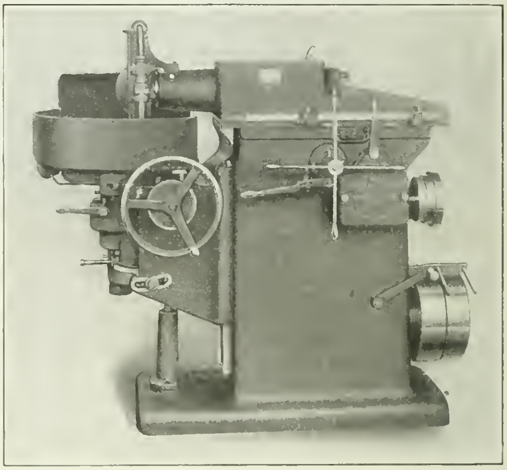


Kane & Roach Machine designed to bend to a True Circle without leaving Flats or Straight Sections at Ends

In operating this machine, the foot lever is depressed, thus moving the corrugated rolls up to the working position, as determined by a suitable stop. The space between these rolls and the upper one should be so regulated that the material is gripped tightly as it passes between the rolls during the bending operation. As soon as the bend is completed, the foot-lever is released, as previously mentioned, and the work removed. The work can be inserted, finished, and removed rapidly and while the machine is in operation. The gears are machine-cut, and a clutch pulley is provided for starting and stopping the machine. Machines of this general type are made in different sizes, depending upon the nature of the work. They are manufactured by Kane & Roach, Niagara and Shonnard Sts., Syracuse, N. Y.

PERSONS-ARTER ROTARY SURFACE GRINDER

The rotary surface grinder shown in the illustration is a 16-inch size now being manufactured by the Persons-Arter Machine Co., Worcester, Mass. This machine is designed along the same general lines as the 8- and 12-inch sizes made by this company, but it is of heavier construction and has some new features, including a different oiling system, different clutches, increased grinding angle capacity, and a special design of water pan and brackets. While the 16-inch model is equipped with a magnetic chuck 16 inches in diameter, it has a capacity for work up to 17½ inches in diameter and can swing work 21 inches in diameter with the wet equipment and 24 inches in diameter with the dry grinding equipment. Rectangular work up to a limit of 8 or 16 inches may be ground.



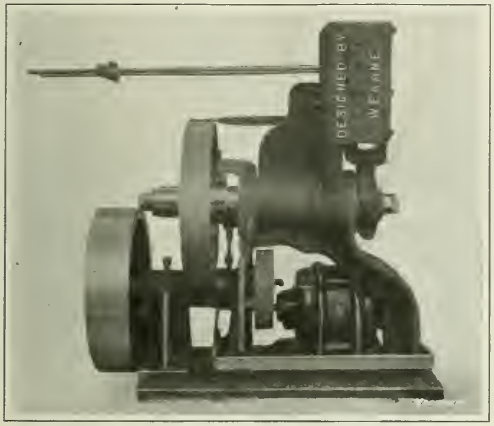
Persons-Arter 16-inch Rotary Surface Grinder

The vertical capacity of the work-table is 10 inches when using a full diameter grinding wheel. The entire chuck spindle bracket is pivoted on a taper pin, so that it can be tilted forward or backward for grinding beveled surfaces up to an angle of 16½ degrees. The bracket is adjusted by a screw which indicates the angle of the adjustment. Special attention has been given to the design of the water pan and also to the protection of the chuck and its electrical connections. All wiring is contained in the water pan, and the magnetizing of the chuck is controlled by an extra-heavy, double-pole switch which has a quick-action demagnetizing feature. These rotary surface grinders are used for grinding piston rings, cutters, circular saws, bearing races, valves, disks, dies, gages, etc.

KANE & ROACH DRILL ROD SHEARS

Kane & Roach, Niagara and Shonnard Sts., Syracuse, N. Y., are now manufacturing shears designed especially for cutting off high-speed steel drill rods or any small round bars that need to be cut accurately, particularly if it is essential to obtain a clean, square cut without marring or distorting the bar of stock. These special machines are made in two sizes. The No. 2 size is capable of shearing material varying from about needle size up to and including 1/2 inch. The dies are made so that a separate hole for each size may be provided. These holes in the dies fit each size rod or bar very closely. One set of dies may have from twelve to fifteen holes, the number depending upon the size stock to be cut. The stationary and sliding shear blades are duplicates. The holes in each blade are in alignment and provision is made for vertical or lengthwise adjustment to maintain the alignment. There is an eccentric in the connecting-rod on the crank end, so that adjustment may be obtained without interfering with the travel or stroke.

The bearings in both ends of the connecting-rod are bronze and all the gears are machine cut. The bearings for the balance wheel and pinion shaft are also of bronze, and the motor is mounted directly on the base, as the illustration shows. The starting or stopping of the machine is controlled by the foot-treadle which extends around the bottom of the machine. An adjustable stop-gage is provided to regulate the lengths cut off. These machines are usually placed beneath a table and are enclosed or covered, with the exception of the top or shearing part and the sliding gage. The machine is thus protected from dust and the operator is safeguarded.



Kane & Roach Shears designed especially for cutting Steel Rods

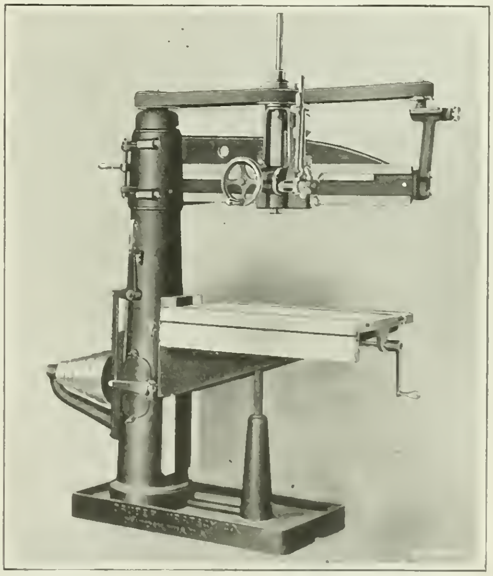
The No. 3 size is designed for diameters up to and including 3/4-inch round stock. While it can be used for very small stock, it is usually employed for sizes down to about 1/2 inch, which represents approximately the maximum capacity of the No. 2 machine. The No. 3 machine is arranged for a separate set of dies for each size of stock. The design and construction of the No. 3 machine are practically the same as the No. 2, except that it is much larger and designed for heavier work. These machines are especially adapted for use in tool steel plants, particularly where carbon or high-speed steel drill rods are manufactured. They are also useful for cutting round bars for other purposes, especially if the material is tool steel. These shears may also be used for cutting cold-rolled stock or other material when an accurate square end is desirable. A motor drive is recommended, but the machines can be arranged for a belt drive if desired.

WISCONSIN SENSITIVE RADIAL DRILLING MACHINE

The high-speed sensitive radial drilling machine recently put on the market by the Dauber-Kratsch Co., Oshkosh, Wis., is shown in the illustration. This machine has a rigid hollow column bolted to the base casting. The table is carried on wide vees, giving a substantial bearing on the column to which the table is gibbed. Additional support is obtained from the screw beneath the table, and vertical adjustments are made by turning the crank handle seen at the front of the machine. This crank operates the elevating screw through a pair of beveled gears. The load of the table and work is taken by a ball thrust bearing, so that vertical adjustments may easily be made. The radial arm is a hollow section and ribbed to take care of both torsional and bending stresses. This arm may be locked in position by means of one clamping screw, which locks both the top and bottom of the arm by operating eccentric clamps. The drill head is adjusted along the arm by the handwheel at the left of the spindle in conjunction with a rack and pinion. A single locking lever is used for locking the head in position.

The distance from the face of the arm to the center of the spindle is only 1⅝ inch, so that torsional stresses in the arm are relatively small. A hand-lever is used for feeding the spindle. This feed-lever is connected to the spindle through a ratchet, which is disengaged when the lever is thrown back to a vertical position, so that the spindle may be moved downward by the handwheel located at the right of the spindle. This handwheel may also be used for feeding very small drills. The drive for the machine is through a pair of rawhide and steel bevel gears to a central shaft inside the column. The pulley mounted on the upper end of this shaft drives the drill spindle by the belt shown in the illustration. The outer end of the arm carries a belt tightener to maintain the proper tension at all times. The tapping attachment is located in the column and is operated by the hand-lever at the front of the column, which controls a friction clutch and may be used for starting or stopping the machine as well as for reversing the drill spindle. All the principal bearings have double-row self-aligning S K F ball bearings. These machines may be provided with a T-slotted base and a table that may easily be swung out of the way. They are also made with either belt or motor drive.

The spindle speeds vary from 250 to 1200 revolutions per minute; ¾-inch high-speed drills may be used, and the machine drills to the center of a 72-inch circle; the working surface of the table top is 20 by 33 inches; the working surface of the table at the side is 5 by 33 inches; the vertical movement of the table is 16½ inches; the vertical movement of the spindle is 8 inches; the traverse of the head on the arm is 34 inches; and the weight is 1825 pounds.



Wisconsin High-speed Sensitive Radial Drilling Machine

HINDMAN SHELL TURNING AND BORING LATHES

The Duff Mfg. Co., Pittsburg, Pa., has recently brought out two high-duty lathes especially designed for turning and boring shells. The turning lathe is illustrated in Fig. 1 and the boring lathe in Fig. 2. These lathes are particularly adapted for machining 155-millimeter and 6-inch shells. Both the turn-

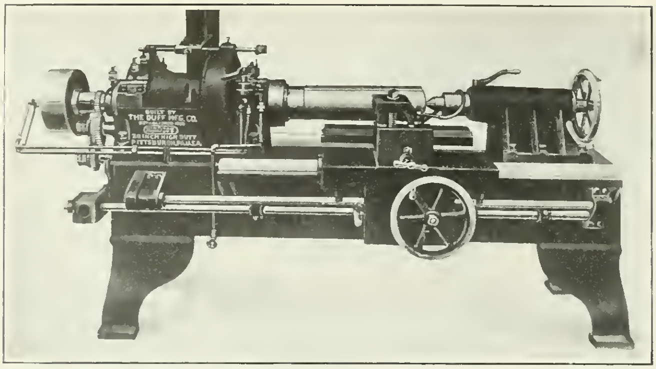


Fig. 1. Hindman Shell Turning Lathe

ing and boring lathes swing 20 inches over the ways. The drive is from a 5-inch belt. The loose pulley to which the belt is shifted when the machine is idle is mounted on roller bearings and is slightly smaller in diameter than the tight pulley to relieve the strain on the shaft. The thrust of the headstock spindle is taken at the rear by means of large self-aligning ball bearings. As these are "single-purpose" machines, one spindle speed of any ratio desired is provided. The speed ratios available are 11 to 1, 14¼ to 1, 18¼ to 1, and 25.3 to 1.

The apron of the lathe is of very simple construction and contains only two gears which control the hand operation of the carriage in both directions. Quick-return of the carriage is obtained by throwing the operating lever (located at the extreme left of the apron) into reverse after shifting the belt from the tight to the loose pulley by means of the lever located at the top of the headstock. With this arrangement, the main spindle is at rest while the quick-return is operating. Automatic stops are provided on the control rod on each side of the apron. The feeding movement is derived through a center screw drive instead of the rack and pinion type, thus increasing the power and evenness of the pull. The feed regularly furnished is 0.125 inch, although any other feed desired can be substituted if ordered. The ways are of the round bar type, and when worn can easily be replaced. The machine illustrated in Fig. 1 is equipped with a pneumatically operated chuck.

The spindle of the shell boring lathe shown in Fig. 2 has a 7½-inch hole 25 7/16 inches deep, thus permitting 155-millimeter and 6-inch shell forgings in the rough to be inserted for practically their full length. This construction makes it possible to use a shorter bed, eliminates the use of "pot chucks" and permits the rough-boring operation to be performed before the rough-turning operation if desired. The front of the spindle is so designed that large set-screws can be used to hold the shell instead of a chuck. This machine has a six way turret which is equipped with a powerful clamp extending over the entire surface of the turret base in order to hold the turret against play under the heaviest cuts. A rapid forward and backward traversing movement is provided. This lathe can be modified to take a saddle arranged for a single boring-bar controlled by a former or it can be equipped with a tailstock boring-bar and a power feed to the tailstock.

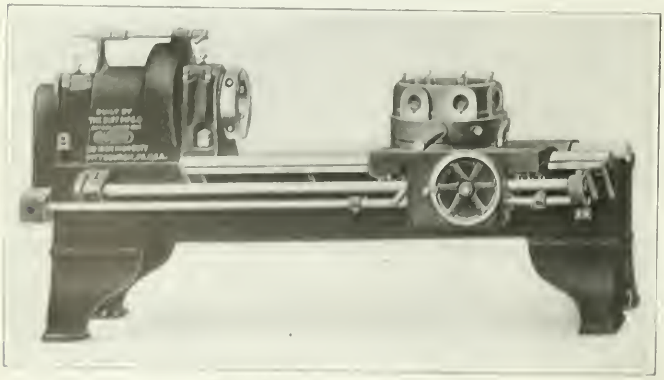
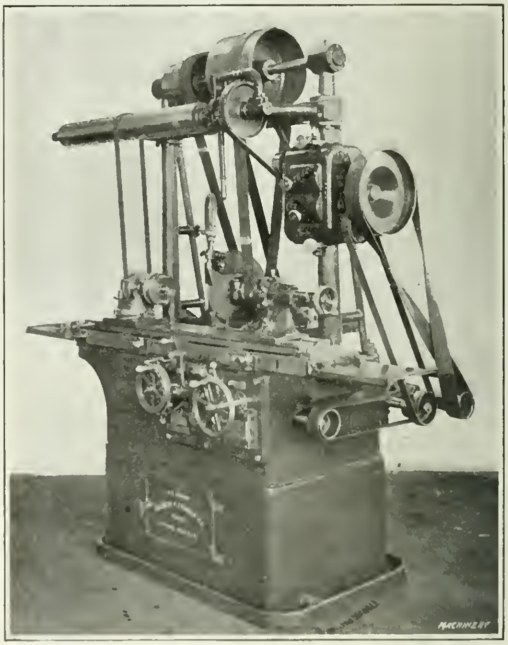


Fig. 2 Hindman Shell Boring Lathe

FRASER SELF-CONTAINED UNIVERSAL GRINDER

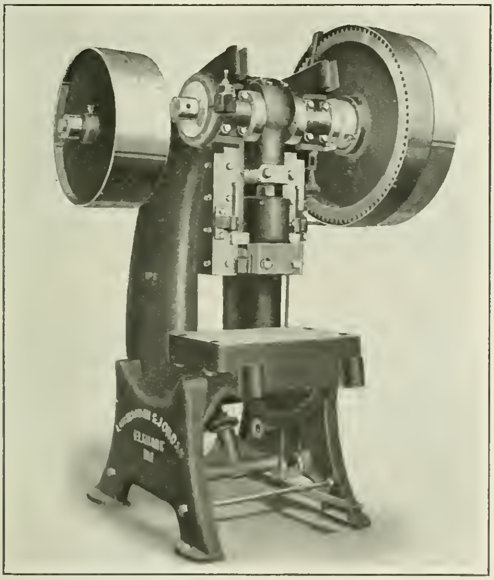
The high-power self-contained universal grinding machine manufactured by Warren F. Fraser Co., Westboro, Mass., which is shown in the accompanying illustration, is built in the four following sizes: 10- by 30-inch; 12- by 30-inch; 10- by 42-inch; and 12- by 42-inch. This machine has twelve changes of table speed, ranging from 12 to 235 inches per minute. There are also twelve spindle or work rotation speeds, varying from 14 to 279 revolutions per minute. These speed changes are obtained by means of a quick-change gear-box. Three grinding wheel speeds are provided. The countershaft is equipped with roller bearings and runs at 900 revolutions per minute. The machine is adapted for a direct drive from the lineshaft or motor. The Fraser automatic reversing movement, for which patents have been allowed, is used. This movement gives a slow traverse to the table at the end of the stroke, and brings the table to rest before the clutch is shifted for driving in the reverse direction. This reverse movement is employed to make the grinder operate smoothly and permit employing the highest rates of table traverse without shock or jar. These features are of particular value in a machine of this kind, and enable the machine to meet the requirements for which it has been designed.



Fraser Self-contained Universal Grinder

LOSHBOUGH - JORDAN COMBINATION-GEARED INCLINABLE PRESS

The No. 5 combination-geared, open-backed, inclinable press shown in the accompanying illustration is a recent design added to the line of power presses manufactured by Loshbough-Jordan Tool & Machine Co., Elkhart, Ind. While the design illustrated has the combination gear drive, either a back-geared or a plain flywheel type of drive may be applied to the No. 4 and No. 5 sizes. The flywheel of the press has a solid web, thus eliminating accidents which might result from an open-spoke wheel. The flywheel is provided with a revolvable bushing, and there is a three-point contact in the wheel for the clutch pin with tool-steel striking pins. A large grease cavity in the hub of the wheel provides for self-lubrication. The trip latch has a toggle control, so that it is positively locked until tripped by the foot. The clutch pin may be locked by a safety stop while setting the dies. The press is equipped with an upper knock-out bar in the slide, and there are screw stops for the upper knock-out. A square hole in the slide provides for clamping tightly punch shanks which may be slightly over or under size. The slide is adjusted by a one-piece ball and screw connection, and there is an adjusting nut to compensate for wear on the ball connection. The slide may be adjusted from either side. Provision is made for removable tie-rods.



Loshbough-Jordan Combination-geared Open-back Inclinable Press

SHEFFIELD LEAD-TESTING MACHINE

The lead-testing machine shown in Figs. 1 and 2 was designed by the Sheffield Machine & Tool Co., Dayton, Ohio, to provide a rapid, simple, and accurate method of determining lead errors in screw thread gages. The cast-iron bed of this machine has two parallel dovetail bearings on the top. Upon the rear and larger bearing are mounted the centers for holding the gage to be tested, and upon the front bearing is fitted the sliding block which carries the indicator slide. The indicator is held in place by a small hardened stud, which is clamped in position with a headless set-screw. By mounting the indicator in the proper bushing, the operator is assured of a full bearing of the slide in the block when testing a gage thread. The indicator slide has a knurled stop-screw and lock-nut to insure that the indicator ball point will make contact with the angle of the thread at corresponding points after being set in contact with the first thread.

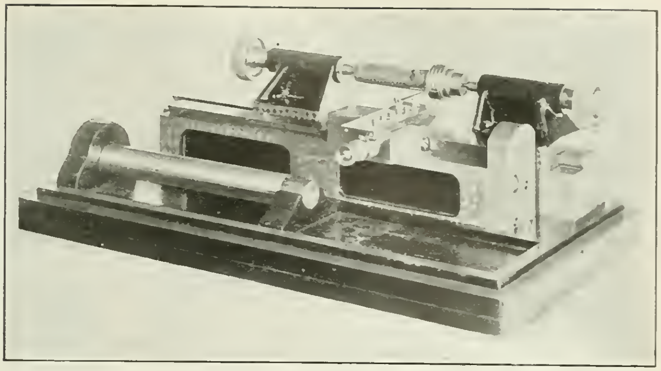


Fig. 1. Sheffield Lead Testing Machine

A better idea of the machine may doubtless be obtained by considering how it is actually used. The gage to be tested is mounted between the centers as shown, the heads being clamped in the required positions by means of knurled binding screws at the rear. A Johansson block is next inserted between suitable contact points to obtain a zero reading. One contact point is on the sliding block and there are two others in the steel plate seen projecting up from the end of the bed. The indicator slide is now moved toward the gage until the ball point of the indicator comes into proper contact with the side of the thread; the stop-screw is then set and locked. The gage is next turned slightly, or is adjusted longitudinally by releasing one center and advancing the other. The adjustment of the centers is obtained by means of the threaded center spindles which have knurled heads. This turning or lengthwise adjusting movement of the gage is continued until the indicator needle is in the zero position. We shall assume, by way of illustration, that the gage has eight threads per inch, and that another Johansson block measuring 0.125 inch is added to the one between the gage points. Then if the lead of the gage thread between these points is perfect, the indicator needle should stand at zero when the ball end is again brought into contact with the thread. If there is even a slight error, the change in the position of the indicator needle will make this apparent. By using other combinations of gage-blocks, the thread may be tested at various points.

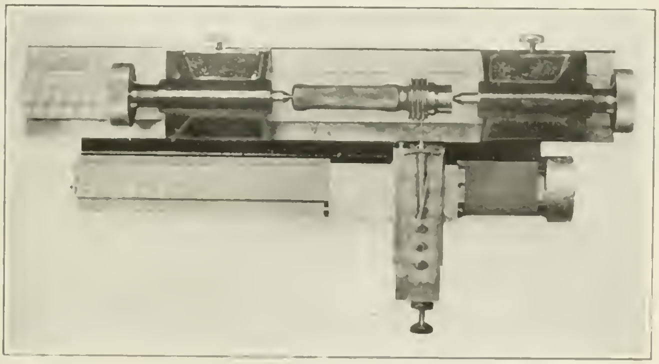


Fig. 2. Plan View of Lead Testing Machine

The Deming indicator, which is also a product of this company, is used and it is graduated to read to 0.0001 inch with standard length ball points and 0.00005 inch with short points. Several sizes of ball points are provided in both lengths; smaller points being used for the finer pitches. This testing device may be applied to either straight or taper gages and with the aid of a chart furnished, the form of the thread may be accurately measured. The hardened and ground test-bar seen at the front of the machine in Fig. 1 is provided for checking the alignment of the two parallel dovetail bearings to detect any wear which might affect the accuracy of the tests.

STUEBING MODEL K LIFTING TRUCK

To meet the requirements of handling loads greater than those ordinarily carried on industrial trucks, the Stuebing Truck Co., of Cincinnati, Ohio, has added to its line a Model K truck, which is illustrated and described herewith. The capacity is for handling loads ranging from 8000 to 14,000 pounds, and to provide the necessary strength and durability for this severe class of service, all parts of the Model K truck are made of steel castings, forgings, or bars. Provision is made for building trucks of any practical width or length to meet the customer's requirements. In working out the design, provision has been made for this variation in size by using a central chassis of standard width and then carrying the side bars or "wings" out sufficiently to handle any specific size of platform on which the load is placed preparatory to transporting it on the elevating truck. These trucks are made with wheels ranging from 6 to 12 inches in diameter by 4 to 6 inches face width. The illustrations show a truck built with especially low wheels for use in transferring heavy machinery from the assembling floor to freight cars in which the machines are to be shipped. Normally, the frame of the truck will be at a greater distance from the floor. The wheels are mounted on Hyatt heavy-duty roller bearings, so that heavy loads may be moved with a minimum amount of manual effort. The maximum load that can be carried by the truck—14,000 pounds—can be pulled by three men with the truck running on an average floor.

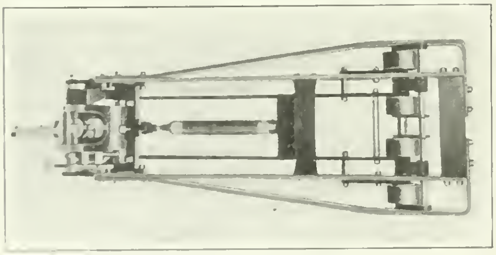


Fig. 1. Top View of Stuebing Model K Lifting Truck

In the operation of this truck, provision has been made for elevating the load by a system of multiplying levers, which greatly reduces the amount of effort required. To further carry out this idea, the design has been worked out in such a way that the majority of the work of elevating the load is accomplished by the up-stroke of the handle by which the truck is pulled. The complete process of elevating is accomplished by one downward, one upward, and a final downward stroke of the handle. On the downward stroke of the handle, pin *A* is in engagement with a hook, as shown in Fig. 2. The trunnion about which the handle swings is located between pins *A* and *B*, and during the downward stroke pin *B* swings into engagement with hook *C*. Then, during the upward stroke of the handle, pin *A* swings into engagement with hook *D*, ready for the second downward stroke of the handle, which is the final step in raising the load.

It will be apparent from the preceding description that during each movement of the truck handle, the pin which is in engagement with one of the hooks causes this hook to be pulled forward. The hooks are connected to the elevating platform on the truck, so that a forward movement of the hooks also results in pulling the platform forward. This platform is connected to the truck body by means of two short links or levers *E* at the front of the truck and six corresponding levers *F* at the rear. Hence, it will be apparent that a forward movement of the elevating platform results in raising the platform by swinging it up on levers *E* and *F*. Because of their multiplying effect, these levers enable the maximum load to be lifted with a relatively small manual effort by one man. There is a dashpot *G* on the truck which provides for lowering the load without shock or danger of damaging any parts of the mechanism. In this connection it is important to note that the dashpot allows the truck platform to be lowered, regardless of whether or not there is a load on the truck. The truck itself weighs approximately 1100 pounds, so that this weight facilitates lowering of the platform when unloaded, and the lowering action is further facilitated by a compression spring, which can be brought into action when it is desired to lower the truck rapidly.

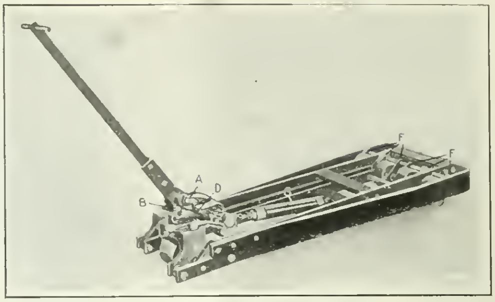


Fig. 2. Front View of Stuebing Truck

KOCH & SANDIDGE ADJUSTABLE CUTTER FOR CUTTING HOLES IN PLATES

A simple and compact form of tool for cutting holes in metal plates is shown in Fig. 1 and the method of using it is illustrated in Fig. 2. This tool is known as the "Jiffy" adjustable cutter, and is made by Koch & Sandidge, 19 S. Wells St., Chicago, Ill. It is designed to cut holes varying from 1¼ to 6 inches in diameter. The standard knives will cut through 3/16-inch steel. Special knives can be supplied for cutting through 1/2-inch steel, and also knives for cutting holes in 1-inch material, such as slate, marble, fiber, etc.

The tool consists of a swing chuck with two knives adjustable to various centers. The swing chuck is a steel casting. Pressure is put on the knives by means of a heavy spring. Rotation of knives is secured by applying to the swing chuck a special ratchet wrench which is furnished. A 3/8-inch pilot hole is drilled first, and, in the case of thin material, a flange nut is put on the opposite side of the sheet so that the stud may be placed through the pilot hole and screwed

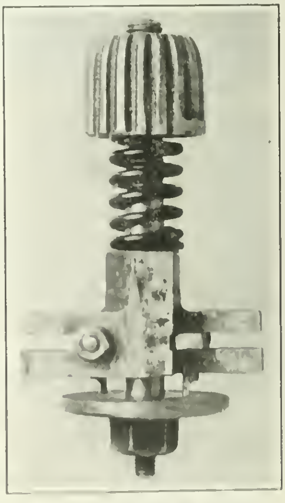


Fig. 1. Koch & Sandidge Adjustable Cutter for cutting Holes in Metal Plates

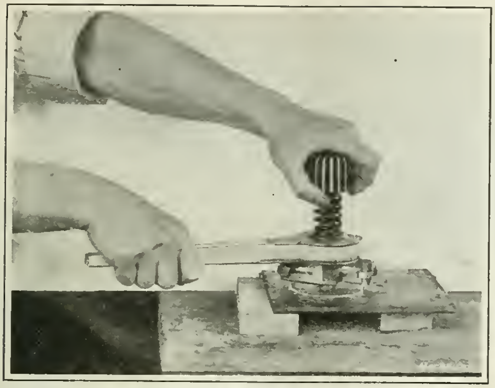


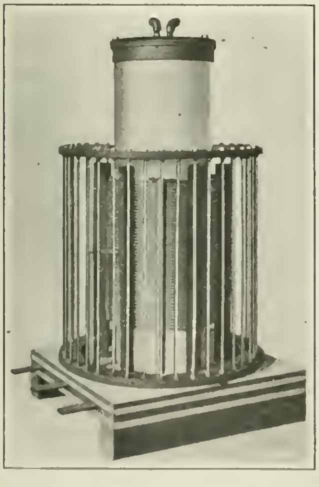
Fig. 2. Method of using Adjustable Cutter

into the flange nut. For cutting heavy material, the pilot hole could be tapped with a standard thread for receiving the stud, thus eliminating the use of the flange nut where it might be difficult to get back of the material to place the flange nut in position. The ratchet wrench is made of malleable iron.

Outside of the many ordinary applications—such as cutting holes in distribution cabinets, boiler tanks, automobile dashboards, etc.—there are many special applications, such as cutting holes in heavy structural steel members and where awkward shaped castings which cannot readily be drilled by machine process are encountered. This tool should prove of value in ship construction and in cutting through plates where it is not practicable to set up gas-flame cutting outfits. Special washers can be quickly cut by setting one of the knives at the inner diameter of the washer and the other at the outer diameter.

NORTHRUP-AJAX HIGH-FREQUENCY INDUCTION FURNACE

The Northrup-Ajax high-frequency induction furnace operates on a new principle in which oscillating currents are used for the generation of heat in the furnace. With this furnace, currents can be set up in the containing crucible, in the case of a non-conducting "melt," or in the melt itself if it has sufficient conductance to permit the flow of currents. No iron is employed for the concentration of magnetic lines of force. This furnace is made by the Pyrolectric Instrument Co., 636-640 E. State St., Trenton, N. J. It is adapted for such work as heat-treatment of metals, the making of special alloys, the melting of glass and non-conducting materials, and for producing temperatures above 1400 degrees C. (2552 degrees F.) without the presence of carbon being essentially associated with the operation of the furnace. This furnace may also be used for producing higher temperatures under controllable conditions of vacuum or pressure and the nature of the atmosphere.

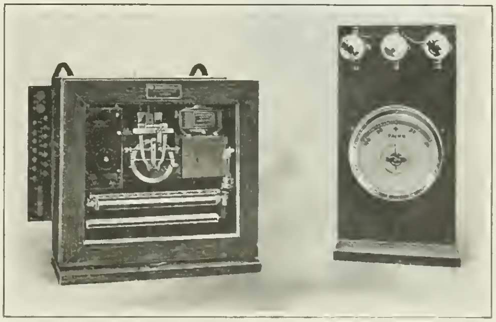


Northrup-Ajax Standard Vacuum Type of High-frequency Induction Furnace

The standard vacuum type of furnace is shown in the illustration. The small units manufactured by the Pyrolectric Instrument Co. are designed for single-phase operation. The oscillatory current system operates at about 8000 volts. This voltage is obtained from a 110- or 220-volt, 60-cycle circuit, by means of a single step-up transformer. The operator is protected when working around the furnace by a grounded metal cage enclosing the inductor coil, and the crucible itself may be grounded. Reliance is placed upon grounding a conducting enclosure rather than upon the strength of insulation. With a "Size E" furnace, using sixteen condenser units, a temperature of not less than 1600 degrees C. (2912 degrees F.) may be obtained in any gas or in vacuum, throughout the volume of a graphite crucible which has an internal diameter of 5 inches and a depth of 12 inches. This temperature may be obtained in less than fifty minutes, starting cold, the power input being under twenty kilowatts. By operating a longer time, a somewhat higher temperature may be obtained. A chrome-alloy crucible can be provided which may be heated to the melting temperature of the alloy. The entire furnace equipment is not subject to wear or depreciation. It is claimed that this type of furnace never burns out and, barring accidents, there is nothing to waste away other than the crucibles. The thermal efficiency of the furnace ranges from 40 to 60 per cent or more of the power input on the switch terminals.

LEEDS & NORTHRUP DOUBLE RECORDER FOR HEATING FURNACES

A modern development in the control of temperatures in heat-treating plants consists of power-operated pyrometers which are not only able to make records but also to control signals for furnace operators and the furnaces themselves. This control is made possible by a mechanism which, although regulated by a very small amount of power available from a thermo-couple, is at the same time able to apply whatever power is necessary for operating electrical switches or controlling valves and dampers. The accompanying illustration shows an automatic controlling recorder at the left and a furnace indicator with lamps at the right, the lamps being used to show by their color if the temperature is correct.



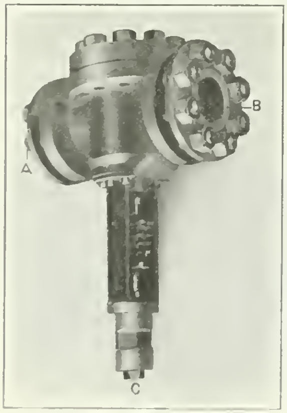
Leeds & Northrup Recorder with Signal Lamp and Indicating Ammeter

Where it is preferred to have the signaling at the furnace done automatically, a "single-point" or curve-drawing recorder is provided with contacts on the moving element by means of which the signal lamps will be lit, accordingly as the temperatures in the furnace are too high, too low, or correct. An interesting extension of this plan is to use two thermo-couples in different parts of the furnace and to provide the recorder with a commutator by means of which it reads first on one and then on the other. The chart produced is a single line running alternately back and forth between the two temperatures and indicating the temperature difference graphically. At the same time the commutator controls a fourth signal lamp at the furnace to show which thermo-couple is being measured.

The double recorder is thus suitable for demonstrating uniformity of furnace temperatures or the lack of it. It shows graphically the effects of empty furnace, full furnace, or part full furnace, and how distribution of heat is affected by rates of firing, location of load, door and other losses, cold hearth, etc. It is a convenient means for investigating furnaces and showing how errors may be overcome by moving burners, baffles, or arches, or changing the method of introducing heat, as by the use of side burners, underfiring, overfiring, number of burners, position of doors, etc. It also shows definitely the effects of the location of thermo-couples, how the readings vary according to their placing with respect to the work and the burners, and also the number of couples to be used.

The use of this double recorder has demonstrated that it is practically impossible to bring many kinds of loads up uniformly to the desired temperature by holding the furnace at a "constant" temperature, without underheating some parts and overheating others. This type of equipment has been found of especial value in studying the heating of different kinds and sizes of sections or numbers of pieces, different methods of loading, speed of loading and unloading, mechanical furnacing, the heat-treatment of large single pieces, such as gun forgings, etc. This apparatus is made by the Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

HYDRAULIC ACCUMULATOR PROTECTIVE VALVE



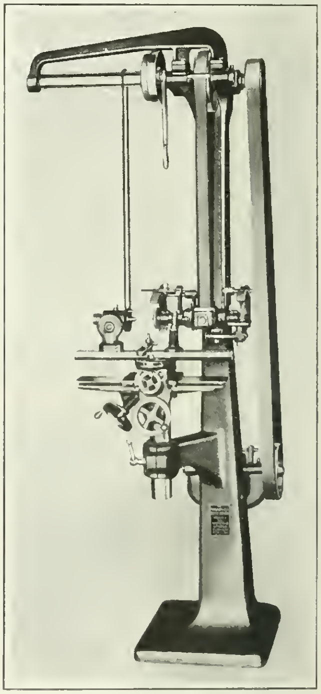
Hydraulic Accumulator Protective Valve

The hydraulic accumulator shown in the accompanying illustration was designed by the Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio, in order to apply the safety-first principle to large accumulator systems. This valve is installed directly at the pipe outlet of the accumulator, with the pilot line connecting to some distant point of the piping system. The hydraulic pressure from the pumps lifts the main check and charges the accumulator. At the same time, the pressure lifts the plunger in the small cylinder, thus holding the main check off its seat regardless of whether the accumulator is being charged or discharged, so long as the pressure on the pilot line is maintained. If a break occurs at any point in the piping system, the pressure is immediately reduced. The loss of pressure in the pilot line and small cylinder allows the spring to lower the plunger, and the flow of the liquid, assisted by the spring above the check, causes the latter to seat. The falling of the accumulator is thus prevented. A small T-valve may be inserted in the pilot line, so that by opening it and relieving the pressure on the pilot line the valve may be tested to be sure that it is working properly. This valve may be made to any size required for large accumulators. The accumulator connection is at *A*, the press and pump line connection at *B*, and the pilot line connection at *C*.

THOMPSON UNIVERSAL CUTTER AND TOOL GRINDER

The universal cutter and tool grinder now being manufactured by the Thompson Grinder Co., Springfield, Ohio, was designed for sharpening all forms of cutters and reamers and, in addition, for performing all the circular, internal, and surface grinding likely to occur in the manufacture of cutters, reamers, counterbores, drill bushings, arbors, and small machine parts. There are three different types of drive for this machine. The particular grinder shown in the accompanying illustration is a self-contained, belt-driven design, having a jackshaft on the rear of the column. This self-contained design may also be arranged with a motor drive, the motor being attached to the rear of the column. The third type of drive is belt-driven from a countershaft.

This universal grinder may be used for such operations as sharpening spiral milling cutters, side milling cutters, inserted-tooth face mills, end-mills, large or small saws, gear-cutters, form cutters, taps, counterbores, reamers, etc. When sharpening side milling cutters, the teeth may be given either straight or concave clearance. The universal head provided with this machine is so arranged that the tool or cutter may be held in any position that may be required relative to the wheel. This head is adjustable in either a horizontal or vertical plane, and it is provided with a bearing which, in conjunction with bushings, collets, or arbors, may be used for holding various cutting tools in position. As end-mills must of necessity be provided with collets, they can be held securely and accurately by the taper shank and, at the same time, be revolved in a substantial bearing which insures grinding the teeth accurately.



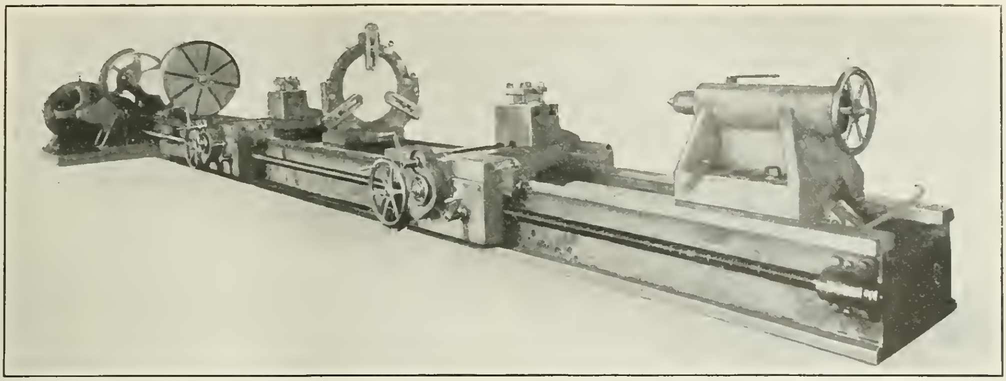
Thompson Universal Cutter and Tool Grinder

In order to increase the range of this machine, it may be equipped with attachments for cylindrical grinding, internal grinding, surface grinding, concave and convex grinding. The cylindrical grinding attachment is shown applied to the machine in the illustration. This attachment includes the drum for the countershaft with hangers and a weighted lever, a universal head spindle with a pulley for a quarter-inch round belt, a universal chuck, a faceplate with a draw-in collet, and an adjustable dog. The internal grinding attachment is used in connection with the circular grinding attachment. The driving pulley is mounted on the grinding wheel spindle in place of the grinding wheel. The attachment is held on the front of the machine in such a way that the belt may easily be tightened.

When the machine is used for surface grinding, the carriage is swiveled at right angles to the grinding wheel spindle and the work is traversed directly under the grinding wheel, the cross-feed being obtained by means of the cross-slide screw. This attachment can be held in the universal head for grinding at any angle. The concave and convex grinding attachment is used when cutters having circular edges are being ground. The center of the attachment is located directly under the front edge of the grinding wheel and the cross-slide is fed in or out to suit the radius required. This attachment is not a part of the regular equipment. Cutter grinding is performed on the left-hand side of this machine, while the right-hand side is arranged for tool grinding. The tool grinding does not interfere in any way with the use or adjustment of the cutter grinding side.

ELYRIA HEAVY-DUTY LATHE

The large heavy-duty lathe here illustrated is suitable for such work as turning guns, propeller shafts, large forgings, etc. This lathe may also be used for projectile work, in which



Heavy-duty 42-inch Lathe for turning Guns, Propeller Shafts, and Similar Work

case it is provided with a shorter bed. The particular lathe illustrated has a 30-foot bed and swings 42 inches over the shears. The maximum distance between the centers with this length of bed is 20 feet. The maximum swing over the carriage is 30 inches. The machine has two carriages, and is driven by a motor which transmits motion to the headstock spindle through gearing, as the illustration shows. This is a 32-horsepower motor, with speed variations ranging from 300 to 1200 revolutions per minute. The ratio between the motor and spindle speeds is 70 to 1. The spindle speeds vary from 4 to 17 per minute. The spindle bearings are babbitted. The size of the front bearing is 12 by 16 inches, and of the rear bearing, 8 by 12 inches. Turning tools made of 1½- by 2¾-inch stock may be used. The shipping weight of the lathe with a 30-foot bed is 49,000 pounds, and the weight is increased 1000 pounds for each additional length of 2 feet. This machine is made by the Elyria Machine Co., Elyria, Ohio.

NEW MACHINERY AND TOOLS NOTES

Lock-nut: Holdfast Nut & Bolt Co., 1405 Corn Exchange Bldg., Chicago, Ill. These nuts have friction metal on one side of the thread which is claimed to adhere firmly to the relatively rough surface of the bolt thread. This metal is on that side of the thread which is not under load stress.

Shell Lathe: Fulton Machine Co., Chicago, Ill. This shell turning lathe is of the single belt drive type and made either in the standard or turret form, as desired. The swing is 20¾ inches over the bed and 9 inches over the tool-slide. It is being marketed by the Dale-Brewster Machinery Co., Chicago, Ill.

Micrometer Height Gage Attachment: Henry O. Costello, 91 Raymond St., Providence, R. I. An attachment for converting an ordinary micrometer into a height gage, thus permitting it to be used the same as a vernier height gage. The measuring points are adjustable so that readings from 0 to 4 inches may be obtained.

Welding Apparatus: Electric Railway Improvement Co., Cleveland, Ohio. A portable arc welding outfit which may be connected to any 110- or 220-volt system. The apparatus is made in two sizes; one weighs 16½ pounds and the other 22 pounds, so that either outfit can readily be carried about.

Tool-holder: Chamberlain Machine Works, Waterloo, Iowa. This tool-holder is designed to hold stellite or the most brittle high-speed steel bits without cracking or breaking. The tool is held in place by a wedge-shaped rack having teeth meshing with a pinion. This pinion is turned by applying a wrench to a square head formed on one side of the pinion.

Punch Press Drawing Attachment: R. D. King, Chicago, Ill. This attachment is used in connection with metal-drawing operations and is designed to provide an equal pressure throughout the entire stroke of the press. The pressure may also be increased or decreased. The press may be used for ordinary blanking without removing the attachment.

Horizontal Boring and Drilling Machine: Newton Machine Tool Works, Inc., 23rd and Vino Sts., Philadelphia, Pa. This machine may be used either as a portable or stationary type. The saddle carrying the spindle may be adjusted vertically on the face of the column, and the latter may be adjusted along the horizontal ways of the base. The spindle has a slow and fast hand feed adjustment.

Rolling Mill Lathe: National Roll & Foundry Co., Avonmore, Pa. Heavy-duty lathe designed for all classes of rolling mill work. The headstock is entirely enclosed with the exception of the faceplate. The motor is directly connected through gearing. Four changes of speed are obtained with the transmission gears, and these changes may be multiplied indefinitely by using a constant-speed motor.

Steel Belt Coupling: Cruban Machine & Steel Corporation, 2 Rector St., New York City. This coupling is formed of sections cut from drawn steel bars of special shape in lengths to suit the width of the belt. The ends of the belt have holes drilled or punched in them to match the screw holes in the coupling. The inner section of the coupling is curved to correspond to the radius of the belt pulley.

Portable Air Compressor: Ingersoll-Rand Co., 11 Broadway, New York City. Motor-driven compressor mounted on a truck having flanged wheels located according to mine track gage. This compressor was designed primarily for mine work, but it may be used whenever compressed air is required for the operation of tools. It is built in several sizes up to a maximum capacity of 415 cubic feet of air per minute and a maximum pressure of 100 pounds per square inch.

Hand Magnet: Cutler-Hammer Mfg. Co., Milwaukee, Wis. A hand magnet for handling small iron and steel parts in quantity, for separating small iron and steel parts from brass, for recovering nails from sweepings, and for similar purposes. The circuit is opened or closed by a trigger located just below the handle. The magnet may be connected with either a 110- or 220-volt direct-current circuit, and it is provided with 5 feet of reinforced flexible cord and a standard attachment plug.

Brazing Torch: Tyler Mfg. Co., 64 Pearl St., Boston, Mass. A portable brazing torch using ordinary illuminating gas for fuel. An air blast is obtained from a small motor-driven blower connecting with the torch through flexible tubing. The motor is a universal type that will operate on either direct or alternating currents. The outfit is designed for connection with ordinary gas supply pipes and electric light systems. It is claimed that with illuminating gas a temperature of 2300 degrees F. may be obtained.

Turret Lathe: A. R. Williams Machinery & Supply Corporation, Buffalo, N. Y. This machine is especially adapted for boring the nose of 6-inch shells and the nose and inside of 4.7-inch shells. The headstock is back-geared and has a two-step cone designed for a 6-inch belt. The spindle has a 1½-inch hole extending through it, and the front of the spindle is recessed 6¼ inches in diameter and 20 inches deep for accommodating a rough 6-inch shell forging. This feature prevents overhang and makes it unnecessary to use steadyrests.

Geared-head Lathe with Single-lever Control: Greaves-Klusman Co., Cincinnati, Ohio. A line of geared-head, single-lever-controlled engine lathes made in 16-, 18-, 20-, 24-, and 30-inch sizes. Any one of ten speed changes may be obtained without stopping the machine and while the tool is cutting, these changes being controlled by a single lever. These machines may be arranged for either a motor drive or a line-shaft drive. The ratio of the direct speeds to those obtained through the back-gears correspond to the correct ratio between finishing and roughing speeds, so that it is simply necessary to shift one lever for making this change.

Dresser for Grinding Wheels: Baldwin, Tuthill & Bolton, Grand Rapids, Mich. A grinding wheel dresser known as the "Metcalf" and consisting of an abrasive wheel of special grade and grain which is mounted on a short shaft between two knobs or handles. These knobs are made of iron to increase the weight and the dresser is held by hand as it is pressed against the wheel to be trued. By holding the dresser in a horizontal position the wheel is given a coarse surface, whereas a close grain surface for finishing is obtained by holding the dresser nearly vertical. It is claimed that this dresser is satisfactory for forming sharp corners on thin delicate wheels as well as for other wheel-truing operations.

USING PIPES AS ROLLERS

BY L. B BREEDLOVE[1]

In the moving of heavy machinery, safes, and similar jobs, it is frequently desirable to use commercial sizes of pipe for rollers, as they will carry a greater concentrated load per pound of metal than solid metal rollers. Owing to the lighter weight and the opening in the center, pipe rollers may also be handled more easily than the solid rollers. Though more expensive than wooden rollers, pipe rollers have a longer life, are more easily turned, and have a lower coefficient of friction.

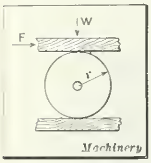


Fig. 1. Diagram showing Application of Force to Load

Rolling friction is, in general, much less than sliding friction. Although few experiments have been made to determine the coefficient of rolling friction, those that have been made seem to indicate that the coefficient is independent of the diameter of the roller. The value of the coefficient of rolling friction for steel rollers on wood varies from 0.06 to 0.10, measured in the same units as the radius. The lower value is taken for hard woods and the larger for soft woods. The value of the coefficient of rolling friction for steel rollers on steel may be taken as 0.003. No definite value of the coefficient of rolling friction for ordinary soft and hard wooden rollers can be assumed as representative, because of the scarcity of data, but the coefficient is larger than those given above. The force F necessary to move a given load W under the conditions given in Fig. 1 is:

$$F = \frac{W}{2r}(a + a_1)$$

where a and a_1 are coefficients of rolling friction for the two contact surfaces. The weight of the roller is neglected. This formula shows that the force necessary to overcome friction varies with the radius of the roller. If hard woods can be secured easily and without much expense, they should be used in connection with the rollers.

As large an outside diameter should be selected for pipe rollers as is deemed practicable under the conditions at hand, and the weight and class of pipe should be such as to safely carry the imposed load with the maximum amount of load per pound of metal. The chart shown in Fig. 2 will be found useful in determining the safe concentrated load for pipe that may be at hand. It shows the relation between the concentrated vertical load in pounds per pound of metal and the outside diameter for commercial sizes of pipes. The loads for the solid rollers were calculated from Joselius' experiments. This chart shows that a solid roller 9 inches in diameter, with an allowable stress in the metal of 12,000 pounds per square inch, will support a concentrated vertical load per pound of metal of 175 pounds, an extra strong pipe, with the same allowable stress, will support 100 pounds, and a double extra strong pipe will support 200 pounds. Both the 3-inch extra strong pipe and the 3-inch solid roller, with an allowable stress in the metal of 12,000 pounds per square inch, will support 500 pounds per pound of metal; pipes smaller than this will support a greater load than the solid rollers, but larger pipes will support a smaller load per pound of metal than the solid rollers. A solid steel roller with an allowable stress in the metal of 16,000 pounds per square inch will support a greater load than the double extra strong pipe with an allowable stress of 12,000 pounds per square inch for sizes larger than 6 inches in diameter. For rollers smaller than 6 inches in diameter, the double extra strong pipe is by far the best.

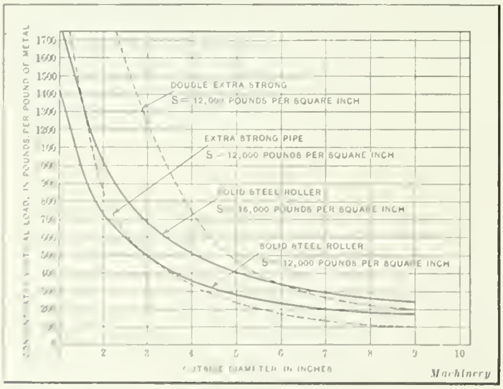


Fig. 2. Curves showing Relation between Concentrated Vertical Load per Pound of Metal and Outside Diameter of Pipe

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[1] Address: National Tube Co., Frick Bldg., Pittsburg, Pa.

* * *

AMERICANIZATION IN INDUSTRIAL PLANTS

In a publication issued by the Solvay Process Co., Syracuse, N. Y., relating to the Americanization of foreigners working in industrial plants through the agency of the management, it is suggested that industrial organizations make a careful census of all non-Americans in their employ and examine the ability of these men and women in the speaking and reading of the English language. The following specific suggestions are also made:

Foremen should be asked and encouraged to cooperate with Americanization work, and through meetings, at some of which outside men of national reputation should speak, they should be given an opportunity to come in contact with the most advanced ideals of Americanization work.

An educational scheme should be adopted in cooperation with the public school system, with classes held at such times as will allow the men or women to attend them either in going to or returning from their work, and the classrooms should be so selected that their location will make it convenient for the employes to attend the classes. For this work, teachers should be hired for full time, and no one should be asked to give his services without proper remuneration. The course offered should be in English and citizenship and should give the student a clear conception of American ideals, a preparation for the taking out of his citizenship papers and a fair command of the language. The attendance of the foreigners who do not understand the English language should be made compulsory and they should be paid for the time spent in the class-room at the average rate of their regular employment. Attendance of the citizenship classes should be voluntary and the men should receive no pay for attending these classes. Classes in English should be held at least twice a week with a minimum of one-half hour at each time and the citizenship class should meet at least for half an hour once a week. No definite increase of wages should be offered for attendance, but advancement of those that show active interest in becoming Americanized should be made wherever possible.

In view of the fact that the military draft requires more and more of our young American-born workers, the foreign-born men and women will constitute a source of labor that is becoming ever more important. Anything that is done to further the Americanization of foreign-born workers is of the greatest importance not only as a national policy, but as a question of management of industrial plants.

* * *

Applications for examination for a commission in the Engineer Reserve Corps will be received from qualified engineers, if made on special blanks which may be obtained from the office of the Chief of Engineers, Washington, D. C., and sent to that office, together with the experience data required, and with the name of the city in which it is desired to be examined. When these applications have been received at the office of the Chief of Engineers, the qualifications of the applicants will be considered and those selected will be notified when to appear at the designated place for the professional and physical examination, which will be conducted by a board of officers sent out from Washington, D. C. The papers of those who qualify will be sent to the Chief of Engineers at Washington, who will take the necessary steps to have them commissioned as officers in the Engineer Reserve Corps.

TRAINING DEPARTMENT OF THE NORTON GRINDING CO.[1]

BY J. C. SPENCE[2]

The Norton Grinding Co. realized as early as 1915 the uselessness of attempting to hire skilled men in a community having so many mechanical industries as Worcester, Mass., and for that reason started a training department in its plant. It has been developed along very simple lines and could be duplicated at any factory practically without cost. In order to start a training department, only two things are necessary: (1) A manager who really wants to help the country to win this war to an extent that he will do his share in breaking in green men; (2) a workman or foreman who has the knowledge and patience to teach green help.

The first objection raised by most machine shop managers is that they have neither the necessary equipment nor the floor space. This idea, however, is usually erroneous, because in every department of a machine shop there is generally a certain amount of simple work to be done. This applies even to the tool-room. It is the custom to give this simple work to the less skilled men and to use the older machine tools for this purpose. This being the case, it is a simple matter to take a number of these machines and concentrate them in one department. Some rearrangement of the shop may be necessary, but this may even be an advantage, as most shops would profit by such a rearrangement of the machines.

The Norton Co.'s Training School for Machine Operators—A Successful Means for meeting the Labor Shortage

After a place has been provided for the training department, it should be started in a small way with one instructor and a few green men. It may be necessary to overcome the deep-rooted resentment on the part of some foremen and workmen who have served a long term of apprenticeship and who object to this rapid method of training help. This objection, however, may be overcome by starting in a small way and by letting it be understood that the school is not intended to produce real machinists, but simply to take from the shoulders of the foremen the burden of breaking in green help.

In the Norton training department no attempt is made to train specialists. The boys and men are given an opportunity to learn a little of all the common machine shop operations, because it is not always known in which department of the shop the man will finally be placed. When an opening occurs, the head instructor of the training department assigns to it the man he thinks is best fitted for the job, regardless of the length of time that he has served in the training department. The last man in might be the first man out, provided he has the qualifications for the job.

The training department runs along as a department of the shop, having its own schedule to meet in the production of single parts and assembled mechanisms. This schedule calls for about one-half the available labor of the department. To fill in the remainder of the time, odd jobs are picked up throughout the plant. The foremen welcome this odd-job department, as it rids them of the many bothersome small jobs that interfere with regular production but that make fine training for beginners and that usually call for the use of several different kinds of machine tools. The tool-room also turns over to the training school its roughing work. If by chance the training department should run low in the right kind of work, the head instructor requests the main shop to supply that kind of work. For instance, if it were necessary to obtain some work for training men in cutting threads in an engine lathe, this work may even be taken away from the turret lathes in the main shop, even though the resulting threads cut would cost ten times as much as they ought to. However, it is a good deal cheaper in the long run to pay a little more for training than to continually pay for the abnormal conditions created by manufacturers hiring help from one another.

In the Norton Grinding Co.'s plant men who have been working in some other line than mechanical work are taken into the plant at the prevailing wage for common labor. Just now, in the Worcester section, this is thirty-five cents per hour, which is an inducement for many men, especially as there is the additional advantage of being able to make a good start toward learning the machinist's trade. Boys not less than sixteen years of age are also taken in the training department. These are paid according to experience and the likelihood of their making good.

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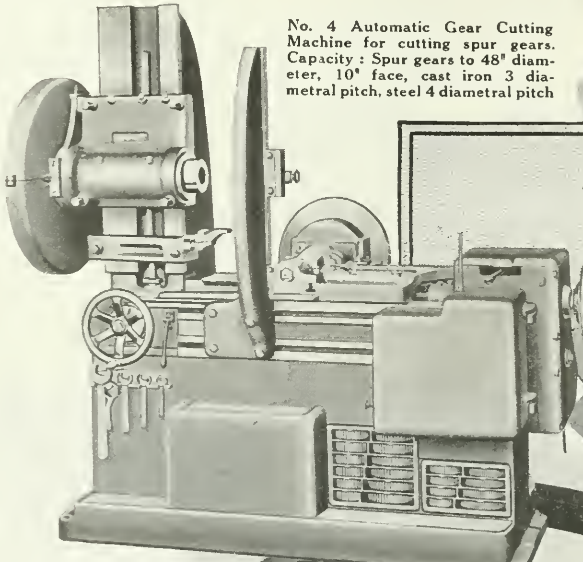
[1] Abstract of paper read at the spring meeting of the American Society of Mechanical Engineers, in Worcester, Mass., June 4 to 7, 1918.

[2] Superintendent, Norton Grinding Co., Worcester, Mass.



No. 4 Automatic Gear Cutting Machine for cutting spur gears. Capacity: Spur gears to 48" diameter, 10" face, cast iron 3 diametral pitch, steel 4 diametral pitch

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CHARLES E. HUGHES' OPINION ON NEW SECOND-CLASS POSTAL RATES

In a letter addressed to Allen H. Richardson, of the Publishers Advisory Board, New York City, Charles E. Hughes expresses his ideas as to the iniquity and danger of the new second-class postal rates and the zone system adopted in connection with the new rates in the following words:

"I have no hesitation in saying that I regard the zone system of postal rates for newspapers and periodicals, coming under the definition of second-class mail matter, as ill advised. The Commission on Second-class Mail Matter (appointed in 1911), of which I was a member, considered this question and reported unanimously against the zone system. We said in that report:

> The policy of zone rates was pursued in the earlier history of our post office and has been given up in favor of a uniform rate in view of the larger interest of the nation as a whole. It would seem to the commission to be entirely impracticable to attempt to establish a system of zone rates for second-class matter. . . . Progress in the post office, with respect both to economy in administration and to public convenience, leads away from a variety of differential charges to uniform rates and broad classifications.

"In my judgment, the zone system for second-class mail matter is unjust to the publisher and unjust to the public. It not only imposes upon the publisher the additional rates upon a sectional basis, but it makes necessary the added expense for the necessary zone classifications at a time when every economy in production and distribution is most important. It introduces a complicated postal system to the inconvenience of the publisher and public when there should be a constant effort toward greater simplicity. There is no more reason for a zone system of rates for newspapers and magazines than for letters. Newspapers and magazines are admitted to the second-class postal rates on the well-established policy of encouraging the dissemination of intelligence, but a zone system is a barrier to this dissemination. If it is important that newspapers and magazines should be circulated, it is equally important that there should not be sectional divisions to impede their circulation through the entire country.

"We are proud at this moment of our united purpose, but if we are to continue as a people to cherish united purposes and to maintain our essential unity as a nation, we must foster the influences that promote unity. The greatest of these influences, perhaps, is the spread of intelligence diffused by newspapers and periodical literature. Abuses in connection with second-class mail matter will not be cured by a zone system of rates. That will hurt the good no less than the bad, and perhaps some of the best sort of periodical literatûre will be hit the hardest. We do not wish to promote sectionalism, and 'one country' means that in our correspondence and in the diffusion of necessary intelligence we should have a uniform postal rate for the entire country. The widest and freest interchange is the soundest public policy. I hope that Congress will repeal the provision for the zone system, which is decidedly a looking-backward and walking-backward measure."

* * *

NATIONAL SOCIETY FOR THE RECONSTRUCTION OF BELGIUM

In order to shorten the time necessary for Belgium to resume its place among the industrial nations of the world, a cooperative society known as "Comptoir National pour la Reprise de l'Activite Economique en Belgique" has been formed. Its object is to further the economical reconstruction of Belgium and it cooperates with and is under the control of the Belgian Government. Its work is to assist the industries in purchasing tools and raw materials, so that work can begin in the reconstructed shops in the shortest possible time. The society is therefore interested in everything—metallurgy, materials for construction of buildings, leathers, textiles, farming implements, chemical products, machine tools, electrical material, optical instruments, motor cars, vans, wagons, oils and greases of all kinds, refractory materials, etc. It is requested that catalogues and price lists, in triplicate, be sent to the society, 15 rue Louis le Grand, Paris, so that orders may be placed as soon as possible.

HELPING UNCLE SAM

The Bureau of Oil Conservation, Oil Divison, United States Fuel Administration, is desirous of securing a combustion engineer for each of the following districts, who will act as an inspector visiting all plants within his district using fuel oil and natural gas: Boston, Providence, New York City, Philadelphia, Pittsburg, Buffalo, Detroit, Chicago, Minneapolis, Tulsa, New Orleans, and San Francisco. It is desirable to have these men act as volunteers where possible, but the Administration is prepared to pay a reasonable compensation for men who cannot afford to give their services to the Government. Only men who have had experience in fuel oil and natural gas combustion would be of value.

The Patent Office requires technically trained persons for its examining corps. Men or women are desired who have a scientific education, particularly in higher mathematics, chemistry, physics, and French or German, and who are not subject to the draft for military service. Engineering or teaching experience, in addition to the above, is valued. The entrance salary is $1500. Examinations for the position of assistant examiner are held frequently by the Civil Service Commission at many points in the United States. One is announced for August 21 and 22, 1918. Details of the examination, places of holding the same, etc., may be had upon application to the Civil Service Commission, Washington, D. C., or to the United States Patent Office, Washington, D. C. Should the necessity therefor arise, temporary appointments of qualified persons may be made pending their taking the Civil Service examination. Application for such appointment should be made to the United States Patent Office, Washington, D. C.

The Bureau of Standards has established a branch of its gage section, at Cleveland, Ohio. This section was opened prepared to receive gages for test on July 1. It is located in the Plymouth Building, 22nd St. and Prospect Ave. The District Office of the Inspection Division of the Ordnance Department is also located in this building. The branch gage laboratory in Cleveland is mainly intended for taking care of muntion limit gage tests in the Cleveland district, and all gages which are ordered by the War Department for test at the Bureau of Standards and delivery in Washington should be submitted directly to the Bureau of Standards, Washington, D. C.

There are available at this branch laboratory facilities for the test of all types of munition limit gages. Equipment has been installed which is practically a duplication of the various machines and special devices used at the Bureau of Standards in Washington, for the test of plain plug and ring gages, profile, and other forms of gages, and especially screw thread gages. The facilities of this branch laboratory are available, without charge, to manufacturers carrying out government contracts for munitions of war. Gages may be submitted by mail, express, or by messenger. When gages are shipped, it is recommended that, whenever possible, they be sent by registered or insured mail, rather than by express, on account of the saving of time. It is requested that all mail and gage shipments be specifically addressed as follows: "Bureau of Standards, Branch Gage Section, Plymouth Building, Cleveland, Ohio."

Persons submitting gages for test are requested to furnish complete information as to the identification and classification of the gages, instructions for test and shipment, and also information such as drawings and specifications, which establish the important dimensions of the gages submitted. If copies of drawings for the Ordnance Office or other gage drawings or part drawings for the Government are submitted with the gages, it will greatly facilitate the test and permit the sealing of the gages.

* * *

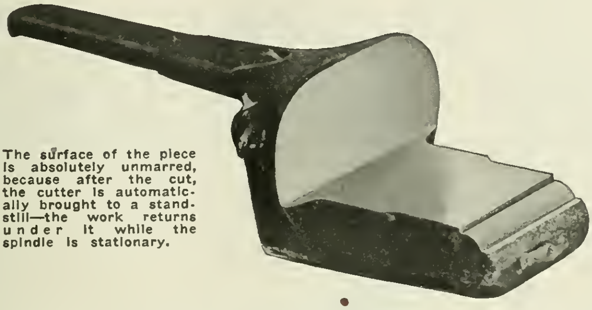
The Richardson Research Laboratory, of Cleveland, Ohio, has succeeded in making a fine platinum wire for cross-hairs in telescopes, which is said to be 0.000795 inch in diameter.

CINCINNATI AUTOMATIC MILLERS

With Intermittent Feed and Automatic Spindle Stop For Manufacturing

RIFLE AND MACHINE GUN COMPONENTS

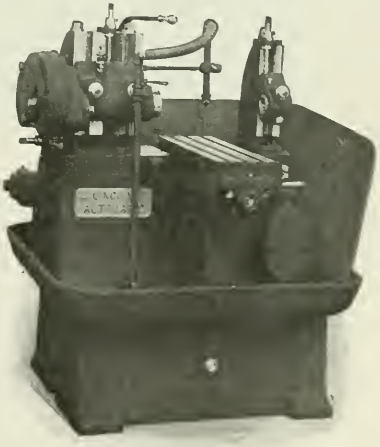
and Similar Parts in Quantities



The surface of the piece is absolutely unmarred, because after the cut, the cutter is automatically brought to a standstill—the work returns under it while the spindle is stationary.

They have the intermittent feeding feature, which has proven so successful on our earlier machines, with this addition — after the cut is taken the spindle is stopped automatically so that the work returns beneath it while the cutter is stationary—no danger of marring the surface of the work because of a revolving cutter.

Consider, too, the advantage of this from the standpoint of safety. The operator removes the finished piece and chucks a new one while the cutter is stationary. He can't get caught by a swiftly revolving although idle cutter. After he chucks the new piece, he moves one lever—and immediately both the spindle and feed movements start again.



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SOME KNOTTY LABOR PROBLEMS

BY ROBERT MAWSON

The editorial "Some Knotty Labor Problems" appearing in the July number of MACHINERY, on page 988, gives food for thought on a subject which is of great importance to the machine tool industry. The labor situation in the small shops which employ a comparatively small number of men has never been more acute or difficult to handle than it is at the present time. In most small shops where less than twenty men are employed, it is necessary to exercise the utmost care in dealing with the employes, as the success of the small shop depends on the individual effort of every employe to a greater extent than does the success of a large shop where hundreds of men are employed. In small shops, the problem of making the business pay is much more difficult than it is in a larger concern, due not only to the labor question but to the small reserve capital usually carried by small concerns and to the narrow margin of spoiled work in a small shop. In many large shops, 5 to 10 per cent of spoiled work is not uncommon, while if a loss of 5 per cent of the products of small concerns is experienced for any length of time, the business might soon become bankrupt. Under these conditions, the employes who prove most satisfactory are men who have had general machine shop practice and have become good all-around machinists.

But right here comes the problem: The good all-around men have graduated over night from machinists to toolmakers and command wages that the small shop cannot pay. The men, therefore, who look for work in small shops are either transient toolmakers demanding rates per hour that cannot profitably be paid, or totally unskilled men. An instance citing the unsatisfactory employment of a man belonging to the former class is given to illustrate some of the difficulties experienced in the employment of this class of men. This man gave a resumé of his experience and training and said he wanted a job in a small shop, as he was tired of the large shops. The firm gave him the rate of pay asked for and he began work. Then the trouble began: First, the shop was not as well lighted as those he had been used to; second, the shop was not kept at the particular temperature that he desired. This fault-finding was, of course, absurd; the man apparently expected the shop to be run for his particular benefit instead of as a business institution established for the purpose of making a living for the owner. But the point is that under normal business conditions the man would not have resorted to this method of fault-finding. The chief trouble, however, was his refusal to do what he considered general machinists' work—in other words, he expected to choose his own work. This, of course, is an impossible condition in a small shop, and his services had to be dispensed with.

A case exemplifying the difficulties experienced in hiring unskilled men occurred in the same shop. A man claiming to be a good machinist was employed in the shop. The first piece of work given him was a simple lathe job. He started up the lathe, but the foreman noticed that the lathe center was squeaking and advised him to put oil on it. The man took the shaft out from between the centers and then carefully put a large quantity of oil on both centers, the live one as well as the dead center. However, he later became a good all-around machinist. After a little candid talk with the foreman, he acknowledged his lack of experience and knowledge as a machinist. He was, however, ready to accept suggestions, and acting upon them, profited thereby.

In view of the existing conditions, the writer believes that the following method would prove satisfactory in dealing with the labor problem: When a man applies for another job in the same vicinity, he must first tell where he is working, or where he worked last, and state what rate of pay he expects. Let it be assumed he asks 55 cents per hour. The second shop foreman should then call up the first shop and say, "Mr. Smith, who worked for you, is here looking for a job and asks 55 cents per hour, we don't know what you paid him, but if you care to meet his figure you can retain him; if not, we are going to hire him."

The writer believes this would help in solving the labor problem. If the first shop foreman thought the man worth the increase, he would get it; the firm would retain their man, and he would be satisfied. This would also create a feeling of cooperation between the various shops engaged on government work, to the mutual advantage of all concerned.

* * *

The Bureau of Standards, Washington, D. C., announces that the bureau will conduct classes of instruction covering the measurements and use of munition limit gages. Two courses have been planned: Course A, which will cover a period of about three weeks, and Course B which will cover a period of about one week. It is intended in these courses of instruction to place in the hands of persons who are using and inspecting gages such information as has been secured by the Bureau of Standards in the test and standardization of munition limit gages.

Course A is intended primarily for men who are directly occupied in gage work, such as gage checkers, foremen of gage shops, or gage inspectors. It is intended to give a complete working knowledge of the measurement of various types of munition gages, together with information as to the acceptance or rejection of gages, and other information pertaining to the use of master gages. Course B is intended for persons who are not directly employed in checking gages, and it aims to convey a general knowledge regarding gaging requirements and fundamentals rather than complete details of gage measurement. The instruction will be accompanied with actual work in the testing and handling of such gages as may be submitted for test during the time classes are being given.

The advantages to be secured in either one of the previously mentioned courses of instruction are available to any government inspector or employe who has to do with the use or measurement of gages. The same opportunities will also be afforded the inspectors or employes of manufacturers carrying out government contracts for war material.

In order for anyone to arrange for either one of the courses of instruction, it is only necessary to make application to the Director, Bureau of Standards, Washington, D. C., through the chief of the office, division, or manufacturer by which the applicant is employed. Such a letter should make clear the exact position which the applicant occupies and the course of instruction desired, and complete evidence that the applicant is absolutely loyal to the United States Government. Applications should be made two or three weeks in advance of the time the applicant desires to report at the Bureau of Standards for instructions.

* * *

CONVENTION OF ELECTRIC HOIST MANUFACTURERS' ASSOCIATION

The Electric Hoist Manufacturers' Association held its June meeting at Montour Falls, N. Y., where the members of the association were the guests of the Shepard Electric Crane & Hoist Co. Twenty-two members were present, representing the following companies: Brown Hoisting Machinery Co., Cleveland, Ohio; Detroit Hoist & Machine Co., Detroit, Mich.; Euclid Crane & Hoist Co., Euclid, Ohio; Link-Belt Co., Nicetown, Pa.; Roeper Crane & Hoist Works, Reading, Pa.; Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.; Sprague Electric Works, New York City; and Yale & Towne Mfg. Co., New York City.

The general topic of the meeting was war service, and the general discussion was directed along lines for coordinating the experience and facilities of the electric hoist manufacturers to be of the most direct and efficient service to the Government for war requirements. The consensus of opinion of the electric hoist manufacturers is that government orders for war purposes should take precedence over all other orders, and if war requirements call for the complete output of all of the manufacturers of electric hoists, it will be desirable to refuse all other business. The most instructing and interesting event of the meeting was a detailed inspection of the plant of the Shepard Electric Crane & Hoist Co., covering design, manufacturing, shop costs, testing, technical history of installations, and welfare work.

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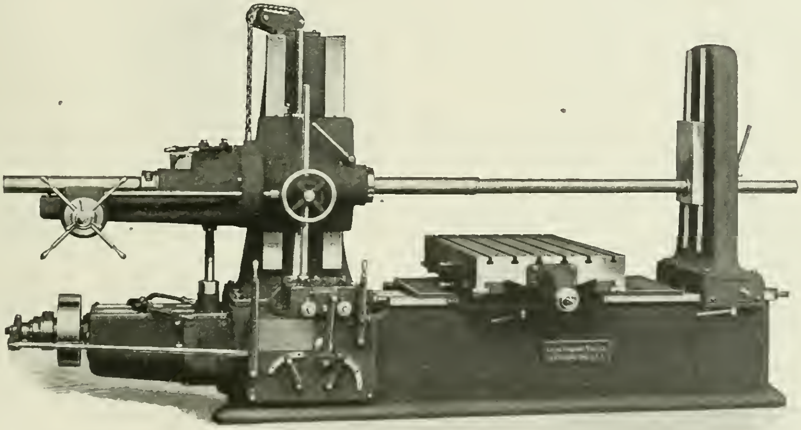

WAS THE STANDARD
IN THE PAST

IS THE STANDARD
OF THE PRESENT (and FIRST CHOICE for GOVERNMENT WORK to which our entire product is now devoted) and it is OUR AIM THAT IT

WILL BE THE STANDARD
IN THE FUTURE

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF CLEVELAND, OHIO, U.S.A.

PERSONALS

L. G. Henderson, secretary and treasurer of Russell, Holbrook & Henderson, Inc., 30 Church St., New York City, has joined the Coast Artillery of the United States Army.

W. H. Callan, general manager plants, and W. P. Pressinger, general manager sales, have been elected vice-presidents of the Chicago Pneumatic Tool Co., Chicago, Ill.

Chester C. Rausch has been appointed assistant to the director of the American Museum of Safety. Mr. Rausch has had a wide experience in engineering, safety, and industrial work.

George W. Agerter, for eight years with the Hunter Saw & Machine Co., is now representative in the Pittsburg district for the Ludlum Steel Co., Watervliet, N. Y., with office in Cleveland, Ohio.

H. O. Penland, who has been sales engineer with the U. S. Ball Bearing Mfg. Co., Chicago, Ill., for a number of years, has been made manager of the Cleveland office, with headquarters at 533 Leader-News Bldg.

G. E. Schultz, formerly with the Industrial Department of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has been made manager of Russell, Holbrook & Henderson, Inc., 30 Church St., New York City.

R. M. Little has been appointed successor to Arthur H. Young as director of the American Museum of Safety. Mr. Little was formerly a trustee of the museum, and is a man thoroughly versed in sociological work.

J. M. Wilson, formerly editor-in-chief of *Canadian Machinery* and allied publications of the McLean Publishing Co., Ltd., Toronto, Canada, is now on the engineering staff of the Standard Parts Co., Inc., Cleveland, Ohio.

Lewis Russell, president and general manager of Russell, Holbrook & Henderson, Inc., 30 Church St., New York City, has given up his position as general manager to join the Ordnance Department of the United States Army.

J. C. Manternach has resigned his position as manager of the Standard Parts Co., Rim and Tube Division, to become president and general manager of the American Welding & Mfg. Co., Warren, Ohio, specialist in electric welded steel bands.

Sidney J. Williams has resigned his position as engineer to the Industrial Commission of Wisconsin to become manager of the Accident Prevention Division of the National Safety Council with headquarters in the Continental and Commercial Bank Bldg., Chicago, Ill.

W. A. Haines has been appointed district representative at Detroit of the Automobile Equipment Department of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Mr. Haines has been assistant district manager of that department of the company for several years.

H. F. J. Porter, industrial engineer, 200 Fifth Ave., New York City, is visiting the plants of the Hercules Powder Co., throughout the Middle West and out to the Pacific coast for the purpose of instituting such methods as may better labor conditions and increase efficiency in production.

A. Niedermeyer, for many years connected with the Worthington Pump & Machinery Corporation, 115 Broadway, New York City, recently as works manager of the Snow-Holly Works of that corporation at Buffalo, N. Y., has resigned his position and will devote his entire time to enterprises of his own.

P. B. Findley, technical editor in the Department of Publicity, Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has entered the training school at the University of Pittsburg to take a special course in radio work with the Signal Corps. Before his connection with the Westinghouse Electric & Mfg. Co., Mr. Findley was editor of the *Electrical Age*.

A. B. Cole has been appointed assistant to the manager of the Department of Publicity, Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., to succeed M. C. Turpin, who is now in the Ordnance Department at Washington, D. C. Mr. Cole will have charge of the editorial work, including preparation of advertising literature and supplying information to the press.

L. C. Sprague has been appointed special representative of the Chicago Pneumatic Tool Co., Chicago, Ill., in connection with the sale of pneumatic tools to railroads. Mr. Sprague was formerly connected with the Railroad Department of the H. W. Johns-Manville Co., of New York City. His long association with the railroads of this country especially fits him for the work that has been assigned to him.

Arthur H. Young, director of the American Museum of Safety since January 1, 1917, has resigned to take charge of the Employe Relations Department of the International Harvester Co., and will take up his new duties immediately. Although giving up the actual direction of the museum's work, Mr. Young will continue to be closely concerned with its affairs, as he has been elected vice-president to succeed the late Dr. Frederick R. Hutton. In recognition of Mr. Young's activities as chief safety expert of the Federal Government, the museum awarded him the Louis Livingston Seaman medal.

J. K. Jensen, of the Department of Defence, Melbourne, Australia, expects to spend some time in the United States on his way to England, in connection with the establishment of a Government arsenal in Australia. While in the United States, he will collect information relating to plants used in the manufacture of all classes of war munitions. Mr. Jensen wishes to receive catalogues and information regarding all classes of machinery equipment and tools suitable for the production of guns, ammunition, small arms, trucks, airplanes, as well as general factory equipment. His address in New York City will be: J. K. Jensen, care of Australian Customs Representative, South Ferry Buildings, 44 Whitehall St., New York City.

OBITUARIES

Hugh Hannan, head of the Hannan-Finton Co., of Springfield, Mass., machinery dealer, died at his home in Springfield June 17. Mr. Hannan went to Springfield about fifty-one years ago and about a year and a half later he started to learn the machinist's trade with Russell & Day. In 1883, he went into business for himself, and ten years later formed the Hannan-Finton Co. He leaves a widow and three daughters.

H. A. Stocker, president of Stocker-Rumely-Wachs Co., of Chicago, dealer in machine tools, died at his home near Chicago on July 3, at the age of fifty-four. In 1895, Mr. Stocker organized the McDowell-Stocker Co., but sold his interest in this company in 1904 and formed, in 1905, the H. A. Stocker Machinery Co., which, in 1917, was combined with other interests, the Stocker-Rumely-Wachs Co. being formed. He was also a director of the Long & Allstatter Co., Hamilton, Ohio, and was interested in the Liberty Machine Tool Co., Hamilton, Ohio, the Massillon Foundry & Machine Co., Massillon, Ohio, and the Rockford Tool Co., Rockford, Ill.

COMING EVENTS

August 29—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

September 10—Twenty-sixth annual convention of the Traveling Engineers' Association, in Chicago, Ill. Secretary W. O. Thompson, General Offices, New York Central Railroad, Cleveland, Ohio.

October 7-12—Joint convention of the American Foundrymen's Association and the American Institute of Metals, Milwaukee, Wis. Concurrent with these meetings there will be an exhibition of foundry equipment, machine tools, and accessories.

NEW BOOKS AND PAMPHLETS

Complete List of Base Prices, Differentials and Extras on Iron, Steel, and Non-ferrous Products. [illegible] pages, 6 by 8½ inches. Published by the Penton Publishing Co., Cleveland, Ohio. Price, $1.

This pamphlet contains a complete schedule of maximum prices on iron, steel, and non-ferrous products, as fixed by the Government through the recommendation of the American Iron and Steel Institute. There have been such numerous changes in prices during the past six months that previous price manuals have been rendered practically obsolete. This booklet has been brought up to date, including June, 1918.

A Handbook for Apprenticed Machinists. Edited by Oscar J. Beale. 141 pages, 4¼ by 6 inches; 87 illustrations. Published by Brown & Sharpe Mfg. Co., Providence, R. I. Price, 55 cents.

This is the third edition of this book, which is for learners in the use of machine tools and is the outgrowth of the needs of the Brown & Sharpe Mfg. Co. in the teaching of apprentices. Its aim is to teach those points in the use of machine tools that are more matters of knowledge than of skill. It does not aim to take the place of an engineer's handbook. The twelve chapters into which the book is divided are headed as follows: Care of Machines, Tools, and Work, Centering and Care of Centers, Turning, Reading Drawings, Measuring, Lacing Belts, Signs and Formulas; Drilling, Counterboring, Tapping, Cutting Speeds; The Screw and its Parts, Figuring Gear Speeds, Figuring Pulley Speeds, Change-gears for Screw Cutting, Angles, Setting a Protractor, Working to an Angle, Circular Indexing, Straight-line Indexing; Subdividing a Thread; Later Points, Cautionary, Conclusion.

Essentials of Sheet Metal Work and Pattern Drafting. By James S. Daugherty. 181 pages, 5 by 7 inches. Published by Frederick J. Drake & Co., Chicago, Ill. Also obtainable from the Peck, Stow & Wilcox Co., Southington, Conn. Price, $1.50.

This book is an elementary and advanced course for the vocational and trade school students and apprentices, and is also intended for sheet metal workers in general, contractors, and teachers and instructors in trade schools. The author, being himself instructor in sheet metal work at the School of Applied Industries, Carnegie Institute of Technology, Pittsburg, Pa., has had a wide experience in the teaching of the subject on which he has prepared a treatise. It will be found of value to sheet metal workers of all kinds. The book was written in answer to numerous requests for information regarding courses in sheet metal work, suitable for trade and manual high schools. It is divided into fifteen chapters as follows: Transferring Patterns to Metal; Cutting Patterns and Templets; Folding Edges and Seaming, Forming, Grooving, Beading, and Crimping; Soldering; Double Hemmed Edge; Wiring Process; Notching and Burring, Double Seaming, Peening, and Raising, Radial Line Developments, Pitched Covers and Flaring

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IN GETTING ENOUGH

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MACHINISTS TOOLS
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A Few Secrets of the Metallurgist Simply Told. By Gerald W. Hinkley. 99 pages, 5 by 7 inches. Published by the Atlas Crucible Steel Co., Dunkirk, N. Y.

The author of this book, a mechanical engineer, who is assistant to the president of the Atlas Crucible Steel Co., has presented in this book a brief outline of a few of the main and most important principles of metallurgy written primarily for the layman. In preparing the work, the author has used his experience and personal observations in the metallurgical laboratory, and has also availed himself of the accumulated information available in the works of many eminent metallurgists. Where opinions differ on metallurgical principles, as is frequently the case, he has attempted to adopt the most logical consensus of opinion. The book should be of interest to all who have to deal with steel, and particularly to those who have to do with its heat-treatment. It deals first with the elementary principles involved in the metallurgy of steel, both carbon and high-speed steel, and then specifically, with the general effect of the more important elements in both steels, after which sections are devoted to the heat-treatment of steel—hardening, annealing, and tempering. An interesting chapter is entitled "What Tool Steel is doing toward Winning the War," and an appendix is added, giving the analysis, uses, and heat-treatment of various grades of tool steels.

Sheet Metal Workers' Manual. By L. Broemel and J. S. Daugherty. 552 pages, 5 by 7 inches. Published by Frederick J. Drake & Co., Chicago, Ill. Also obtainable from Peck, Stow & Wilcox Co., Southington, Conn. Price, $2.

This book may be defined as a practical instruction book on the sheet metal industry and the machinery and tools used in it, and includes information on the subject of oxy-acetylene welding and cutting, as practiced in sheet metal work. It also contains a special course in elementary and advanced sheet metal work and pattern drafting for technical and trade school instructors and students, this course being also intended for sheet metal workers and apprentices in the sheet metal trades. The principal author of this book has been for many years active with the Peck, Stow & Wilcox Co. of Southington, Conn., manufacturer of sheet metal working machinery, and hence is in a position to present an authoritative collection of data on the construction and application of modern sheet metal working machines and tools. Besides the practical treatise on the subject given by Mr. Broemel, the correlated course in sheet metal and pattern drafting prepared by Professor Daugherty, who is instructor in sheet metal work in the School of Applied Industries, Carnegie Institute of Technology, Pittsburg, Pa., adds greatly to the value of the work. The course is presented in such sequence that processes and machine operations are reviewed with each new problem. The book will be found of value to men in the sheet metal trade, and the information contained will save time and labor and aid in the solving of the many problems that daily confront the sheet metal worker. It is divided into chapters as follows: The Sheet Metal Industry; Sheet Metal Working Machinery; Sheet Metal Working Tools; Sheet Metal Working School Shop Equipment; Course in Elementary and Advanced Sheet Metal Work and Pattern Drafting; Outline Course in Sheet Metal Works—Emergency War Training; Oxy-Acetylene Welding and Cutting; Electric Welding; Hand Forging and Welding—Course in Forge Practice; Outline Course in Hand Forging and Welding—Emergency War Training; Brazing; Pipe Bending; Properties of Metals and Their Alloys; Practical Geometry and Mensuration; Useful Tables. The headings of these various chapters will indicate to the man engaged in the sheet metal trade the comprehensive field covered by the book more than would any other method of reviewing its contents.

NEW CATALOGUES AND CIRCULARS

General Electric Co., Schenectady, N. Y. Circular descriptive of Type 1L series transformers for street lighting service.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Circular 7150 of Westinghouse electrical equipment for garment manufacturers.

Smith-Serrell Co., Inc., 144 Cedar St., New York City. Bulletin 26, with new price lists of Francke flexible couplings of the heavy-pattern type.

Worthington Pump & Machinery Corporation, 115 Broadway, New York City. Circular D-702, descriptive of vertical triplex single- and double-acting power pumps.

Loshbough-Jordan Tool & Machine Co., Elkhart, Ind. Circular giving specifications for the Loshbough-Jordan flywheel presses and combination geared presses.

Bolinder's Co., 30 Church St., New York City. Circular illustrating installations of Bolinder's heavy oil engines in full-powered and auxiliary ships.

Sprague Electric Works of General Electric Co., 527 W. 34th St., New York City. Circular of Sprague flexible steel armored cables of the B. B. type.

Wilson-Maeulen Co., 781 E. 142nd St., New York City. Catalogue describing and giving specifications for Wilson-Maeulen pyrometers and auxiliary apparatus.

All-American Truck Co., Sacramento Blvd. and Chicago and Grand Aves., Chicago, Ill. Circular advertising All American kerosene-burning, standard one-ton trucks.

Albro-Clem Elevator Co., 501 Erie Ave., E., Philadelphia, Pa. Circular outlining the advantages that can be obtained through the use of the Hindley worm-gear drive.

Edwin E. Bartlett, Nashua, N. H. Catalogue N, showing the various sizes and types of "Greenerd" arbor presses. A table is included giving essential data for these presses.

St. Louis Machine Tool Co., 932 Loughborough Ave., St. Louis, Mo. Circular of St. Louis polishing machines and "Western" grinders, giving specifications for the various sizes.

Ohio Electric & Controller Co., 5900 Maurice Ave., Cleveland, Ohio. Bulletin 101, giving dimensions, capacity, current required, and other essential data for Ohio mill type lifting magnets.

National Tube Co., Frick Bldg., Pittsburg, Pa. Circular entitled "Service Every Minute," showing illustrations of National pipe that has been in use for many years, indicating its durability.

National Tube Co., Frick Bldg., Pittsburg, Pa. Circular entitled "Twenty-eight Years of Steel 'National' Pipe Progress," showing the progress that has been made in the production of steel pipe.

General Electric Co., Schenectady, N. Y. Bulletin 48024, entitled "Electricity in the Cane Sugar Industry," describing the advantages derived from the application of electrical apparatus in cane sugar mills.

Barnes & Irving, Inc., Grand Opera House Block, Syracuse, N. Y. Circular of Misener expanding rotary hacksaw for cutting circular holes in metal, wood, slate, marble, etc. This hacksaw will cut pipe sizes from ¾ inch to 4 inches in diameter.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Bulletin 259 of safety starting switch for alternating-current squirrel-cage motors. A blueprint is circulated with the bulletin giving dimensions for the two sizes of enclosed safety starter, together with the connection diagram.

Asa S. Cook Co., Hartford, Conn. Catalogue giving specifications for die-headers, shaving and slotting machines, threading and pointing machines, shaver and threader tool grinders, shaker machines, pointing machines, slotting machines, die threading machines, and lag screw threading machines.

Gisholt Machine Co., Madison, Wis. Catalogue entitled "Motor Trucks in the War," containing many illustrations showing the varied uses of motor trucks on war work, as well as illustrations of the Gisholt turret lathe, which is used in manufacturing some of the mechanical parts for these trucks.

Emmert Mfg. Co., Waynesboro, Pa. Catalogue printed in colors, treating of Emmert vertical and horizontal T-squares and drawing boards. These T-squares are designed to effect a saving in time and labor, and to provide an outfit which will enable the draftsman to make full-size drawings while sitting or standing in a normal or healthful position.

Cincinnati Milling Machine Co. and **Modern Foundry Co.**, Cincinnati, Ohio. Pamphlet entitled "Over the Top," containing an account of the activities of these companies and their employes in the Third Liberty Loan campaign and the results of their work. The pamphlet shows views in the various departments illustrating the decorations that were arranged by the employes.

Bastian-Blessing Co., W. Austin Ave. at La Salle St., Chicago, Ill. Catalogue of "Rego" welding and cutting apparatus, lead burning equipment, regulators, etc. Specifications for complete cutting and welding units are given, followed by detailed descriptions of the regulators and torches. It is claimed that these torches are so made that flashback has been entirely eliminated.

American Chemical Paint Co., Liberty Bldg., Philadelphia, Pa. Booklet entitled "The Art of Preparing Steel for Painting," descriptive of the "Deoxidine" patented process for cleaning steel and for preventing its rusting after paint has been applied to the surface. The booklet contains directions both for rustproofing and for cleaning iron and steel surfaces with "Deoxidine," and describes the process in detail.

Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. Catalogue 87, entitled "The Potentiometer System of Pyrometry and Temperature Control," describing a system of pyrometry and temperature control in which the potentiometer method is employed for measuring the electromotive force of thermo-couples. The potentiometer is also applied to a special apparatus for the location of the thermal transformation or recalescence and decalescence points of metals.

Brown Instrument Co., Philadelphia, Pa., is circulating a color chart showing the melting points of chemical elements in degrees Centigrade and Fahrenheit, and the heat colors at different temperatures. The color scale, which is printed in four colors and gives heat colors for fifty elements, should be found valuable in heat-treating work. On the other side of the chart is printed a conversion table of Fahrenheit and Centigrade scales. The card is provided with a cord and hook so that it can be hung up for ready reference. A chart will be sent free to anyone interested.

Plymouth Cordage Co., North Plymouth, Mass. Catalogue entitled "The Story of Rope," treating of the history and modern development of rope-making, with particular reference to the practice of this company. The book is divided into three parts, Part I dealing with the history of the industry, Part II with the raw materials, and Part III with present-day manufacturing processes, methods, and equipment. The production of rope is described step by step, starting with the raw material in its natural state in the fields. The book contains many illustrations and is one that should be of considerable general interest.

Brown Instrument Co., Philadelphia, Pa. Catalogue 11, showing the complete line of Brown indicating and recording pyrometers. The catalogue illustrates high-resistance pyrometers having an internal resistance of from 600 to 1000 ohms. A number of new instruments are shown, among which are a new precision heatmeter and a transformation point pyrometer which determines the transformation points of steel. Various types of platinum and base-metal thermo-couples and protecting tubes are described at length, and suggestions are given for the installation of couples. A copy of the catalogue will be sent free upon request.

Swedish Chamber of Commerce of the U. S. A., Produce Exchange Annex, New York City. Book entitled "Sweden-America," published with the view of interesting American business men in trade with Sweden and to acquaint them with the industries and development of that country. The book, in addition, contains a number of interesting general articles; one that will be of special interest to the machine trade is entitled "American Machines in Sweden." It is stated that America will be able to compete successfully with other countries after the war if proper efforts are made, but that a preparation to forestall competitors after the war is necessary. The book is well printed and has a pleasing typographical appearance.

TRADE NOTES

Economy Drawing Table Co., Adrian, Mich., has increased its capital stock to $150,000. The company has large government contracts, and reports a heavy demand for its tables.

Fulflo Pump Co., Blanchester, Ohio, is erecting two additions to its foundry, consisting of a one-story sand-handling and cleaning room, 48 by 30 feet, and a molding floor, 35 by 80 feet.

Chicago Tool Reclaiming Co., 149 W. Austin Ave., Chicago, Ill., has been organized by H. H. Hartman and F. W. Anderson. The company will specialize in the reclaiming of high-speed milling cutters of all kinds, as well as end-mills, etc. The process of reclaiming employed makes it unnecessary to anneal the tools.

High Speed Hammer Co., Rochester, N. Y., has moved into its new plant at 313 Norton St., which is a one-story brick and concrete building with sawtooth roof construction. The new factory will afford double the former floor space and will facilitate the production of the company's line of riveting and drilling machines.

Union Switch & Signal Co., Swissvale, Pa., has recently installed two 6000-pound, two 3000-pound, and one 2000-pound steam drop-hammers, which makes a total equipment of twelve steam drop and shaping hammers and eighteen board drop-hammers. Plans for the extension of the die room and increased facilities for heat-treating are being made.

Cleveland Milling Machine Co., Cleveland, Ohio, manufacturer of milling machines, cutter grinders, and milling cutters, is constructing a two-story brick office building to take care of the increase in the company's business. This building is a further addition to the three-story building which has recently been erected for taking care of the milling cutter manufacturing department.

Yourevets Home & Foreign Trade Co., Inc., New York office, 120 Broadway; principal office, Petrograd, Russia, a well-known and thoroughly established Russian company, is now making agency arrangements for the sale of machine tools and small tools in Russia after the war, and immediately in the Far East. A. M. Peskine, well known to MACHINERY and to the machine tool trade in this country, is manager of the machine tool department.

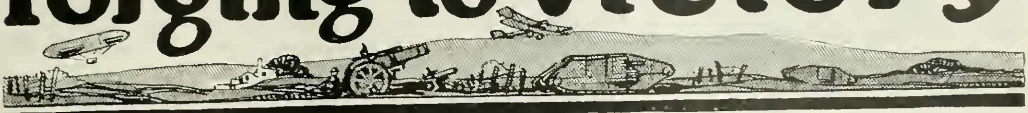
Schoen-Jackson Co., Finance Bldg., South Penn Square, Philadelphia, Pa., and the **Southwark Bronze Co.**, Water and Mifflin Sts., Philadelphia, Pa., have been consolidated under the corporate name of Schoen-Jackson Co. The consolidated company will continue the business carried on by both companies, and owing to its increased resources and facilities it is believed that it will be in a better condition than ever to handle all business in its line that may be offered it.

Standard Pressed Steel Co., Philadelphia, Pa., manufacturer of "Pioneer" steel shaft hangers, "Hallowell" cold-rolled steel shaft collars, and "Standco" hollow safety set-screws, announces that the company has found it necessary to move its general offices and business departments to 20th St. and Indiana Ave., Philadelphia, Pa., in order to take care of the increase in the demand for its products. In the new location, the company will be able to take care of the rapidly expanding business and to give its customers prompt and efficient attention.

American Bronze Corporation, Berwyn, Pa., maker of "Non-gran" bearing bronze, announces that, owing to the great increase in the demand for the company's products, a large addition to the works has been constructed by Crowell, Lundoff & Little, of Cleveland, Ohio. The plant is of the latest type of fireproof construction and will triple the present capacity of the company by September 1. The new buildings have been carefully planned for high efficiency of production; the material moves by the shortest routes from the receiving stores department to the shipping department.

Doehler Die-casting Co., Court, Ninth, and Huntington Sts., Brooklyn, N. Y., has recently broken ground for a new addition to its factory, which will cover 150 feet on Court St. and 200 on Huntington St. The new building will be ten stories high and will be of steel and concrete construction throughout, to conform with the general character of the present structure, the latest addition to which was completed about September 1. New types of automatic die-casting machinery are now in process of construction and will be installed in the new building. The addition will double the present capacity of the plant.

Forging to Victory

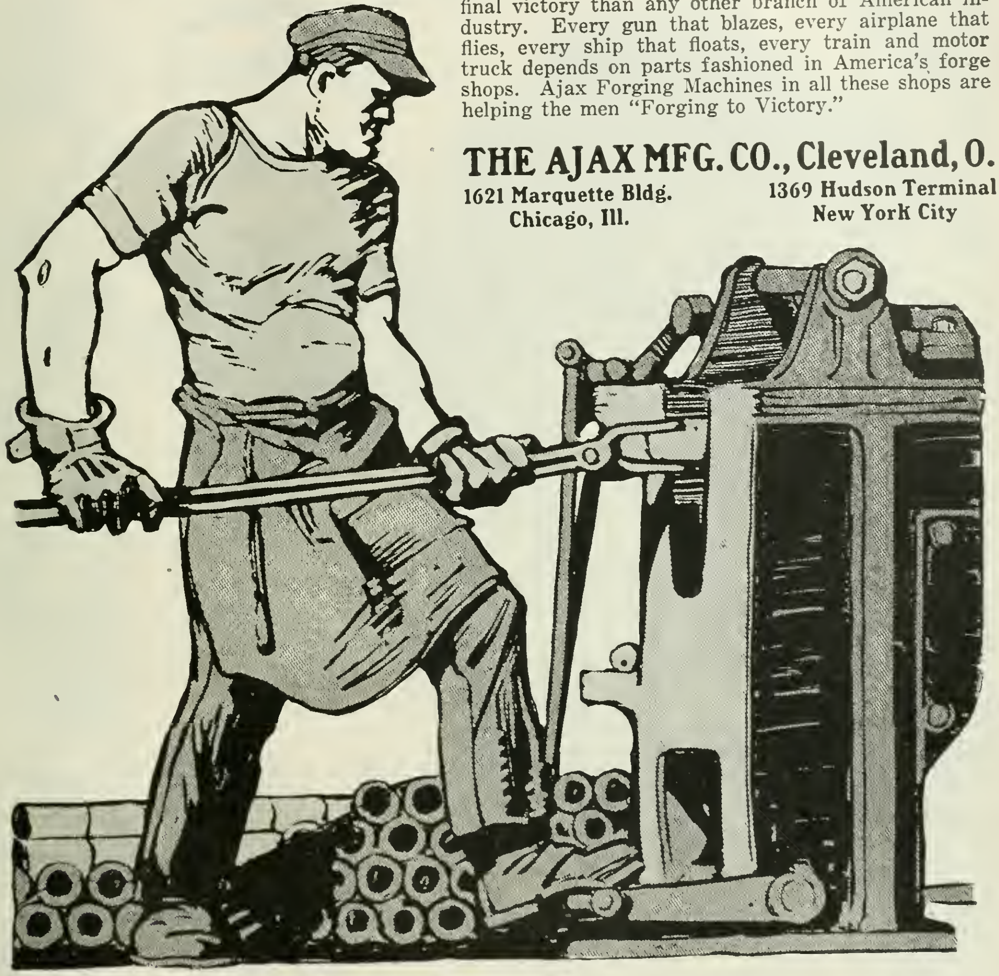


The men in the forge shop will contribute more to our final victory than any other branch of American industry. Every gun that blazes, every airplane that flies, every ship that floats, every train and motor truck depends on parts fashioned in America's forge shops. Ajax Forging Machines in all these shops are helping the men "Forging to Victory."

THE AJAX MFG. CO., Cleveland, O.

1621 Marquette Bldg.
Chicago, Ill.

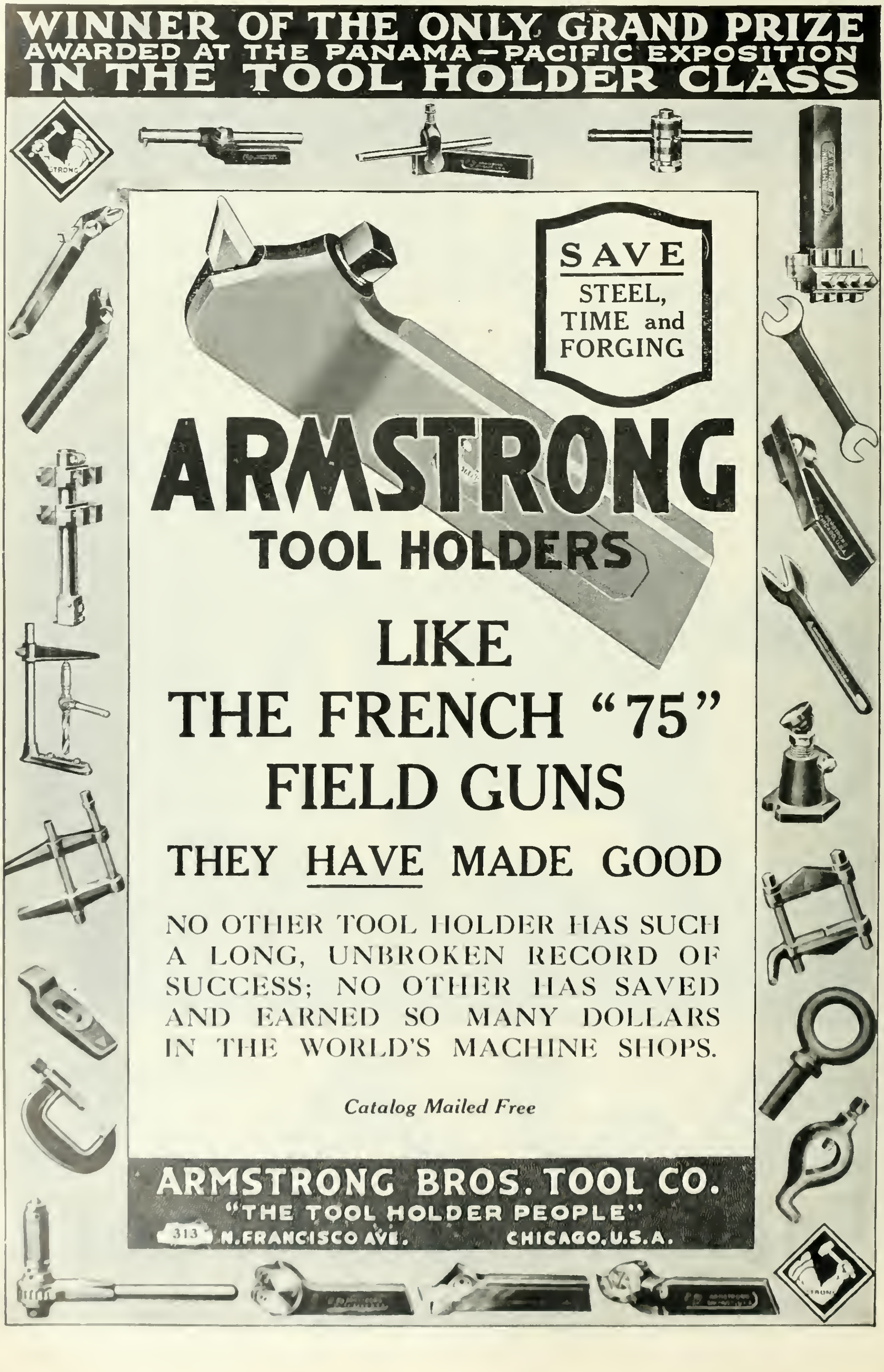
1369 Hudson Terminal
New York City



AJAX

Forging Machinery

Show this advertisement to the men in your shop. Let them see how victory depends on the forge shops as well as the soldiers.



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Catalog Mailed Free

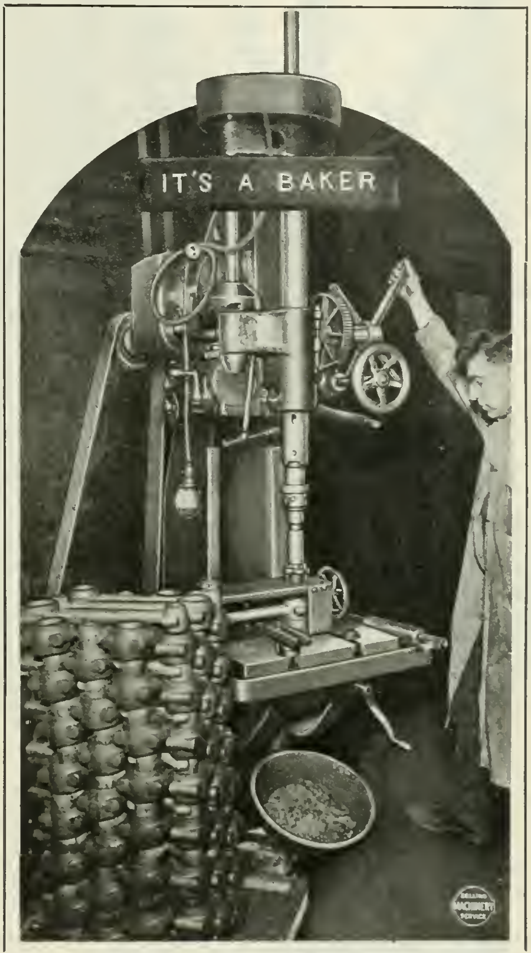
ARMSTRONG BROS. TOOL CO.
"THE TOOL HOLDER PEOPLE"
313 N. FRANCISCO AVE. CHICAGO, U.S.A.

"It's a Baker"

On a Connecting Rod Job

This operator is drilling and reaming holes in connecting rods for high-duty motors—four changes required. Holes are 2⅝ and 1¼ inches diameter, respectively, and by the time the larger has been drilled for 2¼ inches of its length, the cutter is throwing out chips 5/16 inch thick. Only a machine with capacity greater than the tools it drives could handle this job successfully—of course, "It's a Baker."

The Sterling Motor Company manufactures many of these parts, and requires the holes to be absolutely parallel and at exactly right angles to the center of the rod. For this reason, Baker Drills are the choice. They can be depended on to maintain accurate alignments when driving high-speed tools to capacity.



Baker Drills are always popular where the drive is hardest. Let us tell you the reason.

BAKER BROTHERS
TOLEDO OHIO, U. S. A.

Sterling

HACK SAW BLADES

They Wear Well

Blades that wear well—made from finest grade rolled high-tungsten alloy steel—by special machines and processes—the product of twenty years of specialization—blades of real merit.

Diamond Saw & Stamping Works
357-361 Seventh Street
BUFFALO N. Y.

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HOME & FOREIGN TRADE COMPANY

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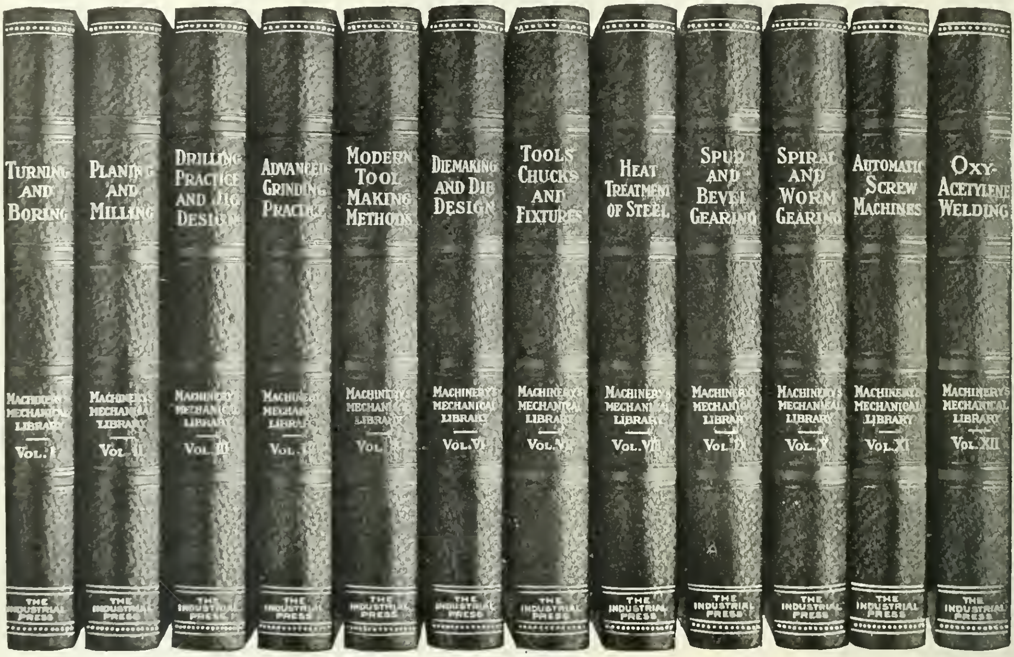
Has opened a Machine Tool Department to specialize in the distribution of American Metal and Wood Working Machinery and small tools in Russia and the Far East, under the direct management of A. M. Peskine, M. E.

This concern has been organized and in active business for more than ten years, is thoroughly acquainted with European and Far Eastern methods of salesmanship and is known among the large manufacturers of Europe and the Far East.

TWENTY-FIVE OFFICES THROUGHOUT RUSSIA

Books for the Mechanical Man Who Wants to Know How and Why



MACHINERY'S Library of Machine Shop Practice and Tool Design

They are clearly written books on machine shop practice and the design of tools, chucks and fixtures. They give a thorough basis of knowledge of the important branches of the machine shop and drafting room. Every clever and ambitious mechanical man needs just such authoritative books to train him to solve the problems he is up against today.

Never before was the mechanical man—trained, practical, resourceful—in such demand—or at such wages.

These twelve books give you the best practical training you can obtain in the operation of the standard machine tools, special processes such as heat-treatment of steel, oxy-acetylene welding, the practical design of gearings, tool making, chucks and fixtures—and every subject is treated in clearcut English. Each volume is well illustrated to make every method and process easily understood.

The binding is of fine waterproof fabrikoid. The books are each about 200 pages and you can still obtain this splendid library of over 2400 pages for yourself and your study for less than 7 cents a day.

Examine these books in your own home. We shall be glad to send them to you for ten days—FREE.—Simply fill out the coupon below—the books go to you the same day your order is received.

Date ....

MACHINERY, 140-148 Lafayette Street, New York.

You may send me, all delivery charges prepaid, MACHINERY'S Mechanical Library, twelve volumes, bound in durable, red fabrikoid, price $23.50. After inspection, I will decide to keep the books on terms of $3.50 in ten days and $2.00 monthly thereafter for ten months, or $22.00 cash 30 days or I will return the books at your expense.

(Delivery charges prepaid in United States and Canada. Foreign orders, F.O.B. steamer. Foreign orders should be accompanied by full cash price $22.00)

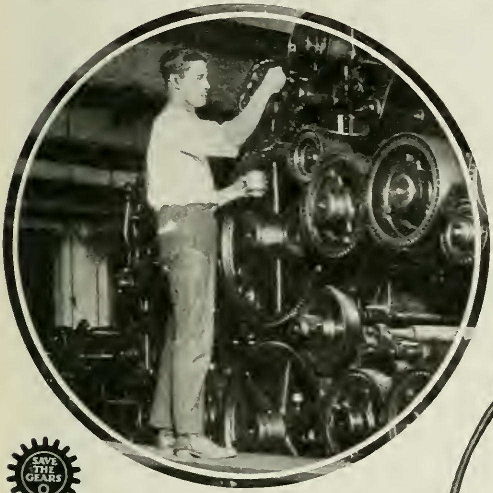
Name ....

Address .... Occupation ....

City .... Works ....

TEXACO

TEXACO
CRATER
COMPOUND



Lubricates—Protects —Silences

"Most satisfactory for its lubricating and noise muffling qualities. Does not run off gears."—The McClure Newspaper Syndicate.

A different signature, but the same story. Texaco Crater Compound lubricates, protects, and silences gears wherever it is used.

SAVE THE GEARS

"Crater on Gears" is a booklet that should be read wherever machinery is used. It's yours for the asking.

TEXACO

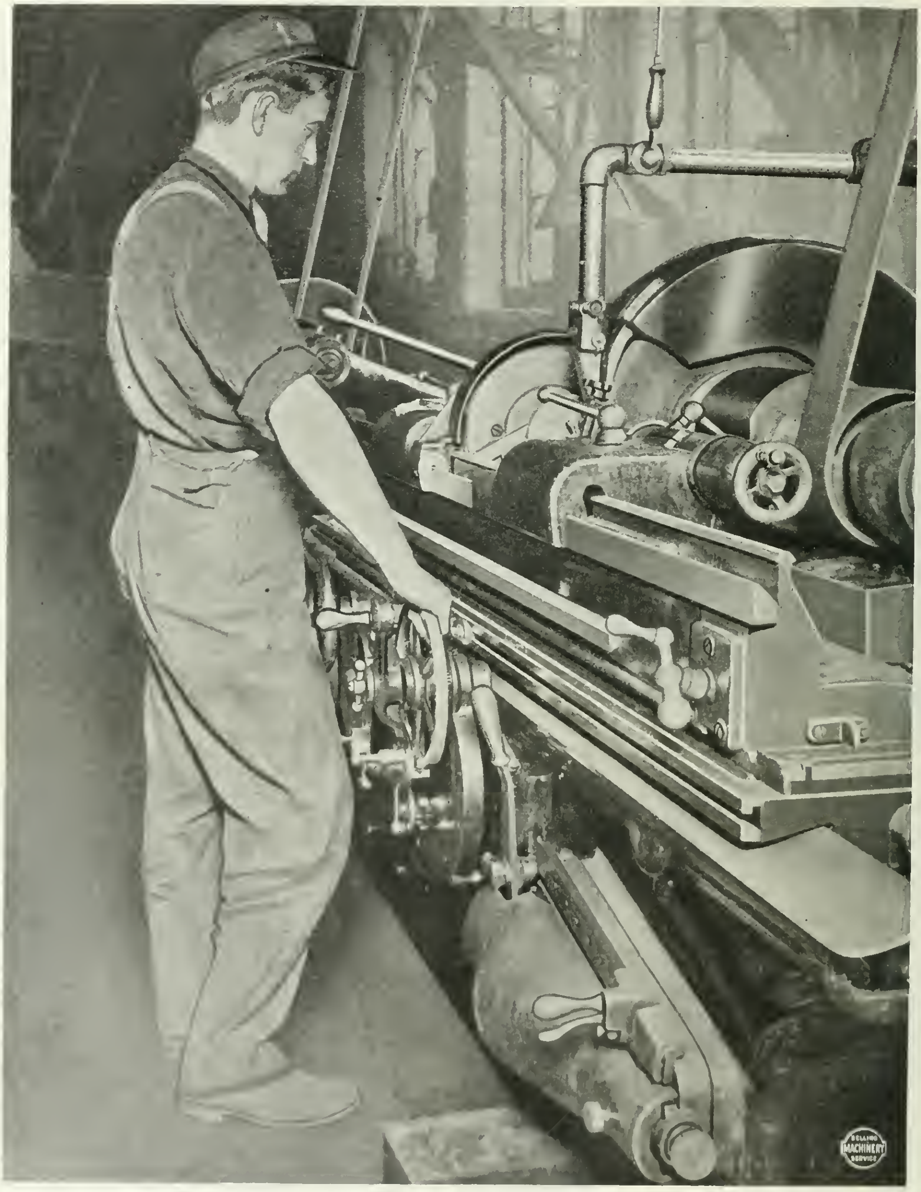
Texaco Crater Compound is a *straight* product, pure, heavy, *free of all fillers.* It will not separate, harden, dry, crack, flake off, throw, run or drip—even under most abnormal conditions.

Texaco Crater Compound clings to metal surfaces that move at maximum speeds, protecting against wear by friction, and against water or chemical corrosion where such danger exists.

"There's a Texaco Lubricant for Every Purpose."

THE TEXAS COMPANY
Department F
17 Battery Place, NEW YORK
HOUSTON CHICAGO NEW YORK
Offices in Principal Cities

TO NORTON GRIND



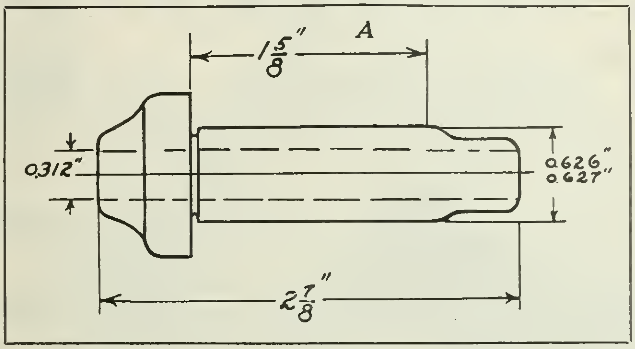
NORTON GRINDING COMPANY,

CHICAGO OFFICE:

AGENTS: Vonnegut Machinery Co., Indianapolis, Ind. Robinson, Cary & Sands Co., St. Paul, Minn., Duluth, Minn. Manning, Maxwell & Moore, Inc., St. Louis, Mo. Henry Prentiss & Co., Inc., New York, N. Y., Boston, Mass., Buffalo, N. Y., Rochester, N. Y., Syracuse, N. Y., Scranton, Pa. The Motch & Merryweather Machinery Co., Cleveland, O., Detroit, Mich., Pittsburgh, Pa., Cincinnati, O. Eccles & Smith Co., San Francisco, Cal., Los Angeles, Cal., Portland, Ore. The Canadian Fairbanks-Morse Co., Montreal, Que., Toronto, Ont., Vancouver, B. C.

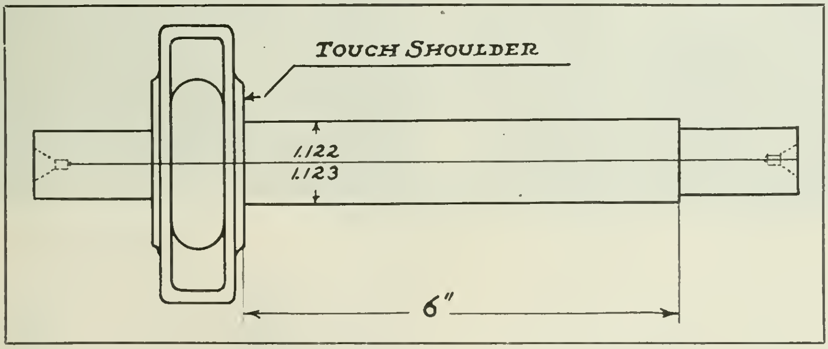
ING MACHINE USERS

Additional Examples of Up-to-Date Profitable Grinding



Our first example is a cast iron valve guide that is ground (diameter A) on an arbor. 0.020 stock is removed. The machine is a 6″ x 32″ Norton Grinding Machine. The wheel is a 14″ x 2″ x 5″ 36 N "Crystolon." Output is 900 pieces in 10 hours.

Our second is a steering gear shaft; .45 carbon steel; 0.035″ stock removed; limit 0.001″. The machine is a 10″ x 24″ Special Purpose "Norton" fitted with a 20″ x 6½″ x 12½″ 3824 Alundum L wheel. Production on this job is 1000 pieces in 9½ hours.



If your Norton Machines are being operated to full efficiency we're satisfied; if not we would suggest that you ask for a Norton demonstrator. We want every Norton Grinding Machine to do its utmost—now and always; but particularly now.

Our Service Department is at your disposal.

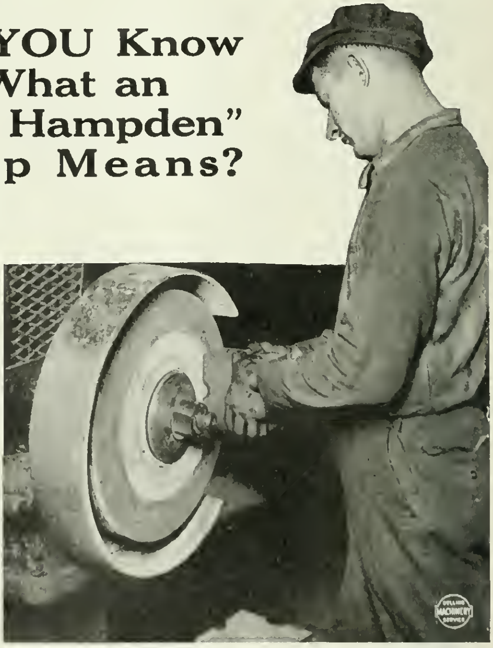
Worcester, Massachusetts, U. S. A.
11 North Jefferson St.

C. T. Patterson Co., Ltd., New Orleans, La. Kemp Machinery Co., Baltimore, Md. W. E. Shipley Machinery Co., Philadelphia, Pa. English Tool and Supply Co., Kansas City, Mo. Alfred Herbert, Ltd., Coventry, Eng., Paris, France, Milan, Italy. The F. W. Horne Company, Tokio, Japan. Iznosskoff & Company, Petrograd, Moscow and Ekaterinburg, Russia

N 206

Hampden Corundum Wheels

Do YOU Know What an "All Hampden" Shop Means?



Here are two of sixteen busy Hampden Corundum Wheels employed in a busy "All Hampden" shop. By the way, an "All Hampden" shop is one in which only Hampden Corundum Wheels are used.

The operators are grinding forging machine dies of heat-resisting steel, as hard a metal as can be made. The smaller wheel is cleaning out grooves or "fluting" the dies; the larger one is dressing off the flat faces.

There's little consideration shown the wheel when these heavy chunks of hard steel are jammed up to it. Hampden Corundum Wheels show up here as strongly as they invariably will under more favorable conditions.

We want you to put Hampden Corundum Wheels to a test. You'll like them.

We will be glad to help on your grinding problems in whatever way we may. Write us.

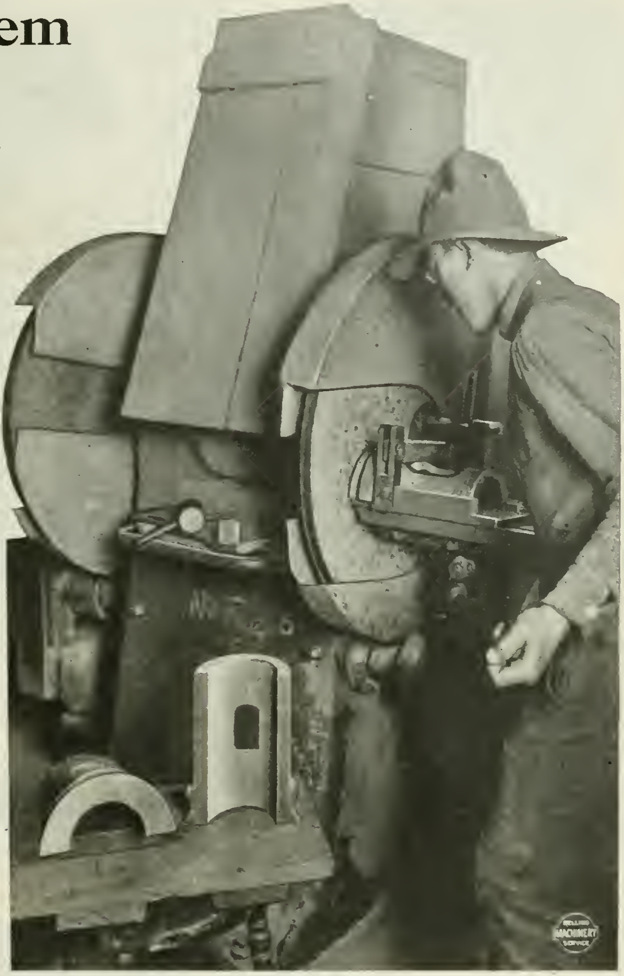
Hampden Corundum Wheel Co.

Springfield, Mass., U. S. A.

Some System Here—

and the Important Part of it is the

Gardner Grinder



The No. 7½ Gardner Grinder shown is used by the Bronze Metal Company of Bristol, Pa., for grinding bronze castings of all kinds and degrees of hardness. It has been photographed at its principal occupation, preparing bushings and bearings for subsequent turning operations.

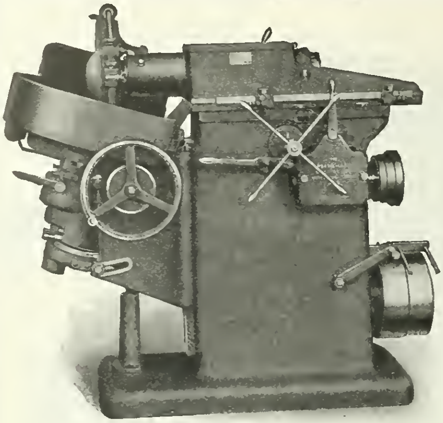
This machine handles two of these parts at a time, first surfacing what becomes the longitudinal axis of the finished cylinder and then squaring the ends. "Gardnergrinding" brings the rough faces to substantially level surfaces, removing 1/32″ or more of stock. Fifteen to eighteen pairs—60 to 70 surfaces—are "Gardnerground" per hour, keeping two turret lathes well supplied.

You'll do well to make "Gardnergrinding" a part of *your* system. We'll be glad to send you full details as to its application to your work. Write us.

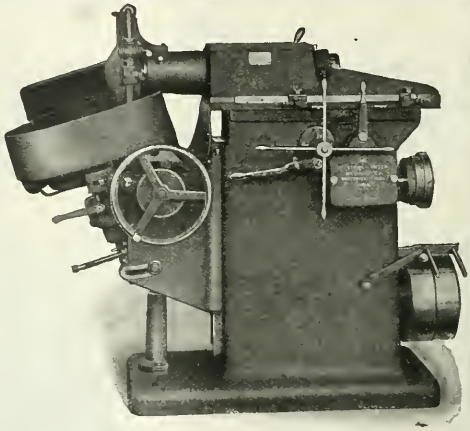
The Gardner Machine Company

BELOIT THE LARGEST MANUFACTURERS OF DISC GRINDERS IN THE WORLD **WISCONSIN**

OVER-SEAS REPRESENTATIVE
ALMACOA ALLIED MACHINERY COMPANY OF AMERICA ALMACOA
120 BROADWAY, NEW YORK, U.S.A.
PARIS TURIN ZURICH BARCELONA



Work Table Can Be Tilted 16½° Either Way

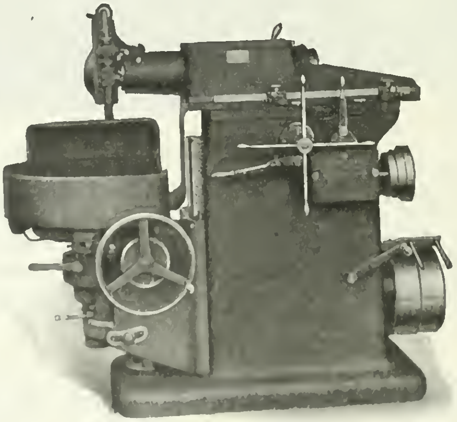


A New Model
16-Inch Rotary Surface Grinder

Insistent demands from satisfied users of our 8″ and 12″ sizes of grinders, for a machine with even greater capacity have led us to design a 16″ machine. Hand and automatic feeds, friction clutches, perfectly maintained adjustments of work table and slides, wide range and a superior magnetic chuck of our own design, are contributing features to the success of these machines. For all classes of surface grinding, engineers now specify a

PERSONS-ARTER

The work table at its lowest position allows the grinding of work 10″ thick under a full diameter wheel.

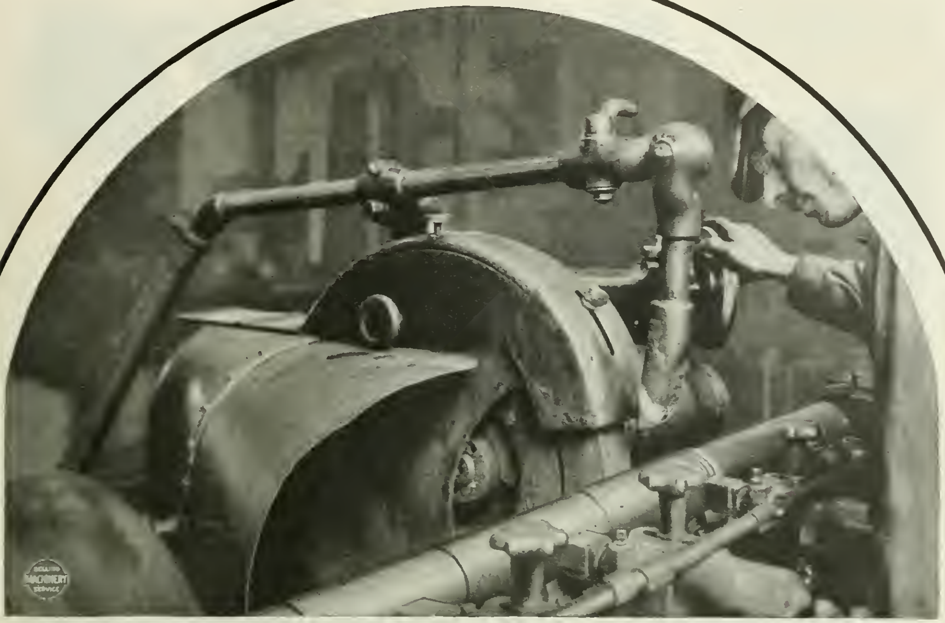


Within range Persons - Arter machines can handle much of the work usually given to rectangular types of grinders.

Let us show you what Persons-Arters can do for you

THE PERSONS-ARTER MACHINE COMPANY

72 Commercial Street Worcester, Mass.



An Abrasive Boro-Carbone Wheel That Has Made A Record

Boro-Carbone
TRADE MARK
for high tensile materials.

Electrolon
TRADE MARK
Silicon Carbide
wheels for low tensile materials.

"ABRASIVE" BORO-CARBONE WHEELS

THIS is not a production story. It has a more distinctive theme—inspection. Every shaft ground by this wheel is inspected and re-inspected and, despite the fact that limits are .001 and the stock 60 point carbon steel forgings, never fails to come through with flying colors.

The wheel with this 100 per cent efficiency record is Comb. 24 Grade L Boro-Carbone, 18 inches diameter, 2 inch face. The shafts—parts for centrifugal pumps—are 41½ inches long and 2⅜ inches diameter, excepting for a distance of 8¾ inches near the center, where the diameter is 2¾ inches.

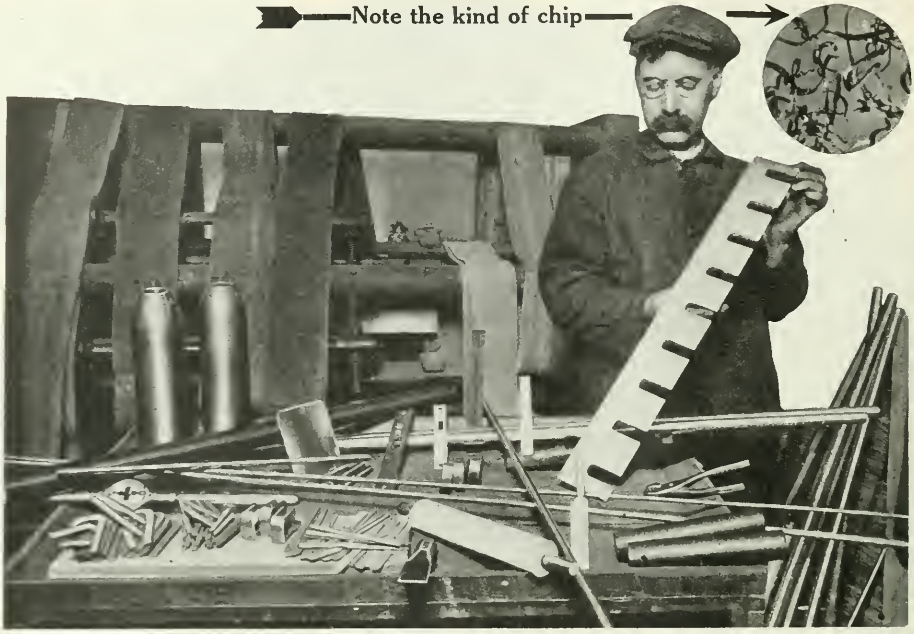
This work must pass a rigid government inspection and great care was used to secure the right wheel. Boro-Carbone fully justified the choice.

Boro-Carbone can always be depended on. It is only a case of fitting the wheel to the work and on this point we are always ready to cooperate—write us *your* requirements.

ABRASIVE CO.

Main Office and Works
Bridesburg, Philadelphia

Chicago Store
566 West Washington
Boulevard

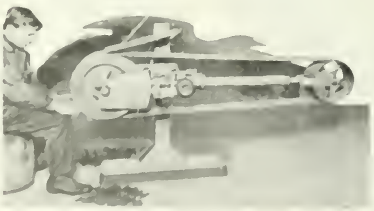


Your Attention is Called to the Variety of "Blevney" Output

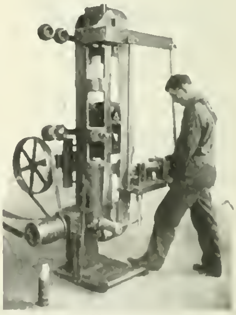
IN GRINDING, POLISHING AND FINISHING

There are twenty-five kinds of work on the table in the above photograph—shells, steel and fibre tubing, planer knives, door locks, rubber wringer rolls, pliers, precision measuring scales, taps, dies and wrench parts, trench mirrors, etc.—all products of Blevney Cushion Belt Grinders.

Below are shown the two styles of Blevney Grinders—types A and B. These machines will speed up your grinding and finishing. The cutting principle is the same in both machines. The abrasive belts run over corrugated cushion belts, which form teeth in the former. Ample chip clearance and consequent clean, sharp grinding are thus assured.



Send for further details of the Blevney System. They are bound to interest you



BLEVNEY MACHINE COMPANY

GREENFIELD, MASS., U. S. A.

OVER-SEAS REPRESENTATIVE

ALMACOA ALLIED MACHINERY COMPANY OF AMERICA ALMACOA
120 BROADWAY, NEW YORK, U.S.A.

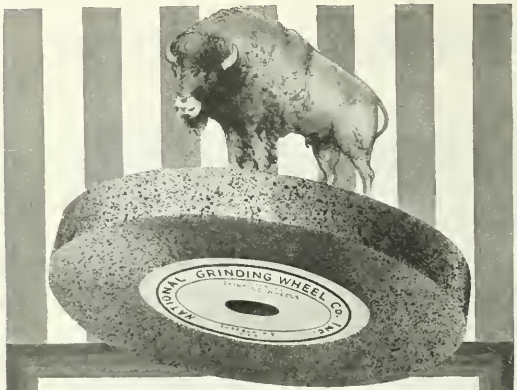
Grand Rapids Drill Grinders Are Different

They embody new principles of construction and operation. They grind drills correctly—both theoretically and practically. They grind perfectly faster than you can grind "good enough" by hand. They are practically "fool proof." A boy or girl can run one. They embody degrees of refinement in design, workmanship and material never before attempted in this class of machines. They will not only start right but they will stay in service.

The Grand Rapids Drill Grinder Book tells all about them and a lot about Twist Drills too. Tell us where to mail your copy.

Grand Rapids Grinding Machine Co.

29 Ottawa Avenue, N. W.
GRAND RAPIDS, MICH., U.S.A.


NATIONAL GRINDING WHEEL CO. INC.

We cannot
make all
the
Grinding Wheels
used, so
we make the
BEST.

Try
"THE WHEEL
THAT
TALKS
FOR
ITSELF"

Manufactured by

NATIONAL GRINDING WHEEL COMPANY, INC.
2986 MAIN ST. BUFFALO, N. Y.

The H. P. No. 1 Truer

For Precision Grinding Wheels

The H. P. No. 1 Truer and Dresser is an unusually efficient tool for truing precision wheels used on rough and semi-finish grinding operations. It may be used for wet or dry dressing, is dust and water proof and has forced lubrication. Cutter guaranteed for 1000 dressings. All shanks interchangeable. Safety guards protect operator from possible breakage of cutters and from emery particles.

10 Days' Free Trial
Send for complete details

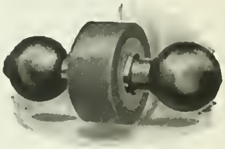
THE H. P. COMPANY
45-47 EAST FORT ST.
DETROIT, MICH.

METCALF EMERY WHEEL DRESSER
"IT'S A WONDER"
Indispensable for grinding wheels 12 x 1 inch or smaller, turning perfect square, bevel or V edges

60,000 SOLD

FINE FOR
Machine Shops
Tool Rooms
Filing Rooms
Metal Parts
Motors
Engines
Crank and
Cam Shafts
Etc.

FINE FOR
Fire Arms
Munitions
Hardware
Screws
Brass Goods
Woodworkers
Steel Mills
Car Shops
Ship Yards
Arsenals, etc.



$4.50 NET FACTORY *4-page descriptive circular on request*
Plant operators order from 1 to 60 at a time

BALDWIN, TUTHILL & BOLTON, Sole Makers
GRAND RAPIDS Orders for domestic and export shipment invited MICHIGAN, U.S.A.

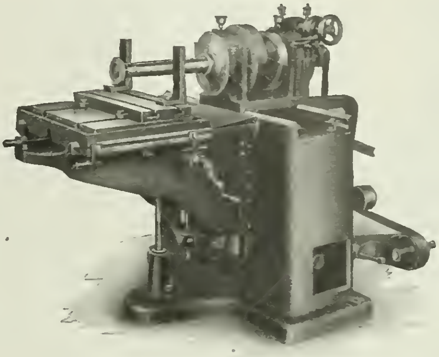
Send for
Catalog of our
full line. It will pay you.

THE READY TOOL
COMPANY
650 Railroad Ave.
Bridgeport
Ct.

Makers of the Tool with the Tool-Steel Bearing

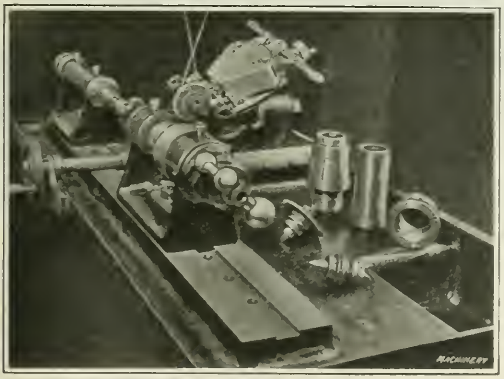
MADISON CYLINDER GRINDER

A simple, rigidly constructed cylinder grinding machine particularly adapted to a wide range of work.



Write for Particulars.

MADISON MACHINE TOOL COMPANY
FORMERLY E. A. FULLER SALES COMPANY
609 East Washington Avenue Madison, Wisconsin



The New
COMMUNITY
Thread-Gage
Grinding Machine

The photograph shows end view of Community Thread-Gage Grinding Machine, showing Graduated Swivel to adjust for Helix Angle.

THE United States Army Ordnance Department gage checker's report on the Edison Company's thread-gages used on 240 mm. trench mortar shells reads—"Gages accepted. Leads and angles checked and found O.K." The British Ministry of War Inspection Laboratories have also checked and reported favorably on thread-gages made for the United States Army Signal Corps and ground on the Community Thread-Gage Grinding Machine.

For quantitative production of thread-gages the Community Thread-Gage Grinding Machine has set a new standard. For instance, male thread gages 1/8 to 1/2 inches in diameter are ground in 10½ minutes to 1 inch diameter at an average of twenty minutes each. The gages ground on the Community Thread-Gage Grinding Machine are accurate to within 0.0001 inch for the lead and five minutes for the angle.

Send for further details without delay.

Community Machine & Tool Works
INCORPORATED
154-156 Grand St. New York City

THOMSON SPOT WELDING

Welding Garden Hoes for the "Kiddies" is Thirty-three and One-third Per Cent Cheaper than Riveting—and Stronger

This Thomson Spot Welder is a recent installation, so the operator is not yet sufficiently experienced to make the most of its possibilities, but already the cost of welding these children's garden hoes has dropped 33 1/3 per cent in this New England plant. Two "spots" secure the blade to the shank and without pushing himself very hard, the operator completes 1000 hoes, or 2000 welds, per hour. When he gets the hang of the machine he will do even better.

The old way was to rivet drilled holes and not only the output but results have improved by the change—especially from the "kiddies" point of view—for rivets frequently work loose, when put to the test of "real gardening" and the spot welded hoe can be depended on for a full term of service.

Thomson Spot Welding has been applied to assembling all kinds of hardware specialties and hundreds of other operations.

We are opening new fields every day and will be glad to prove its cost cutting application to your work.

THOMSON SPOT WELDER CO.
LYNN.
84 State St., Boston 30 E. 42nd St. New York City 603 Finance Bldg., Phila.

Thomson Process
Electric Welding

THOMSON ELECTRIC WELDING

Two Welding Machines Keep Five Men Busy Assembling

The work being handled in this busy corner of a wire goods shop is wire guards such as are used to protect electric light bulbs. This is one of the operations where assembling is done on a form, indexed automatically for welding. In this case, one operator makes eleven welds; the form is then transferred to a second man, whose machine is set for a closer working distance, and he also makes eleven welds. Both operators work so fast that they keep five men busy assembling—production running as high as 4840 welds or 220 lamp guards per hour.

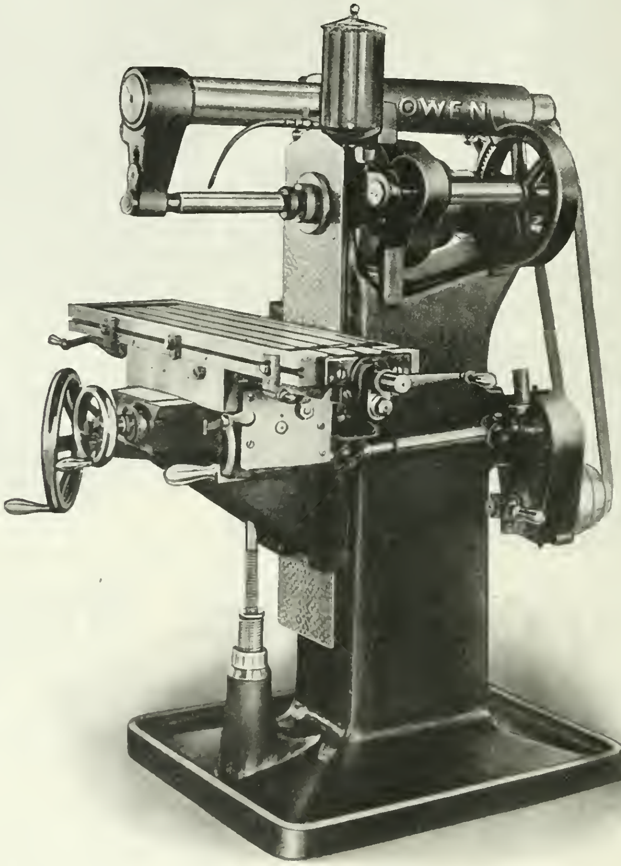
There are 14 Thomson Welders, all told, in this plant—eight years in use and their speed records still the boast of the shop. Thomson Electric Welding Machines are built in types and sizes to handle a constantly broadening range of work. In every case, welding proves fully as strong—in some instances stronger—than the methods it replaces, as well as faster and more economical.

May we estimate on your requirements?

THOMSON ELECTRIC WELDING CO.
MASS., U.S.A.
1127 Majestic Bldg., Detroit
311 Falls St., Niagara Falls
4100 Langdon St. Cincinnati, O.
323 N. Sheldon St., Chicago, Ill.

OWEN

No. 0 PLAIN BACK-GEARED MILLING MACHINES



The Owen No. 0 Plain Back-geared Milling Machine is a strong, rigid tool with great pulling capacity. It has 12 spindle speeds and provides 8 changes of feed for each. Spindle is of crucible steel, has 13/16″ hole through it, and runs in phosphor bronze boxes. Spindle and boxes are both made to compensate for wear. Table is automatically fed in either direction, automatic stop releases the work where desired, adjustable dials indicate in thousandths the three table movements. Range 24″ longitudinal, 6″ cross, 15″ vertical. Power longitudinal feed.

BICKETT MACHINE & MFG. CO., Cincinnati, Ohio

New York Selling Agents

YOUNG, CORLEY & DOLAN, Inc., 115 Broadway, New York City

A Simple Matter of Dollars and Cents

The work is pistons for Franklin engines, straight and taper sections to be finish turned—the straight section to 3.250″ diameter, plus or minus 0.001″. These pistons are of Lynite, rough turned on a big automatic with about 1/32 inch left on the diameter for finishing, for which operation they are transferred to a Porter-Cable Manufacturing Lathe.

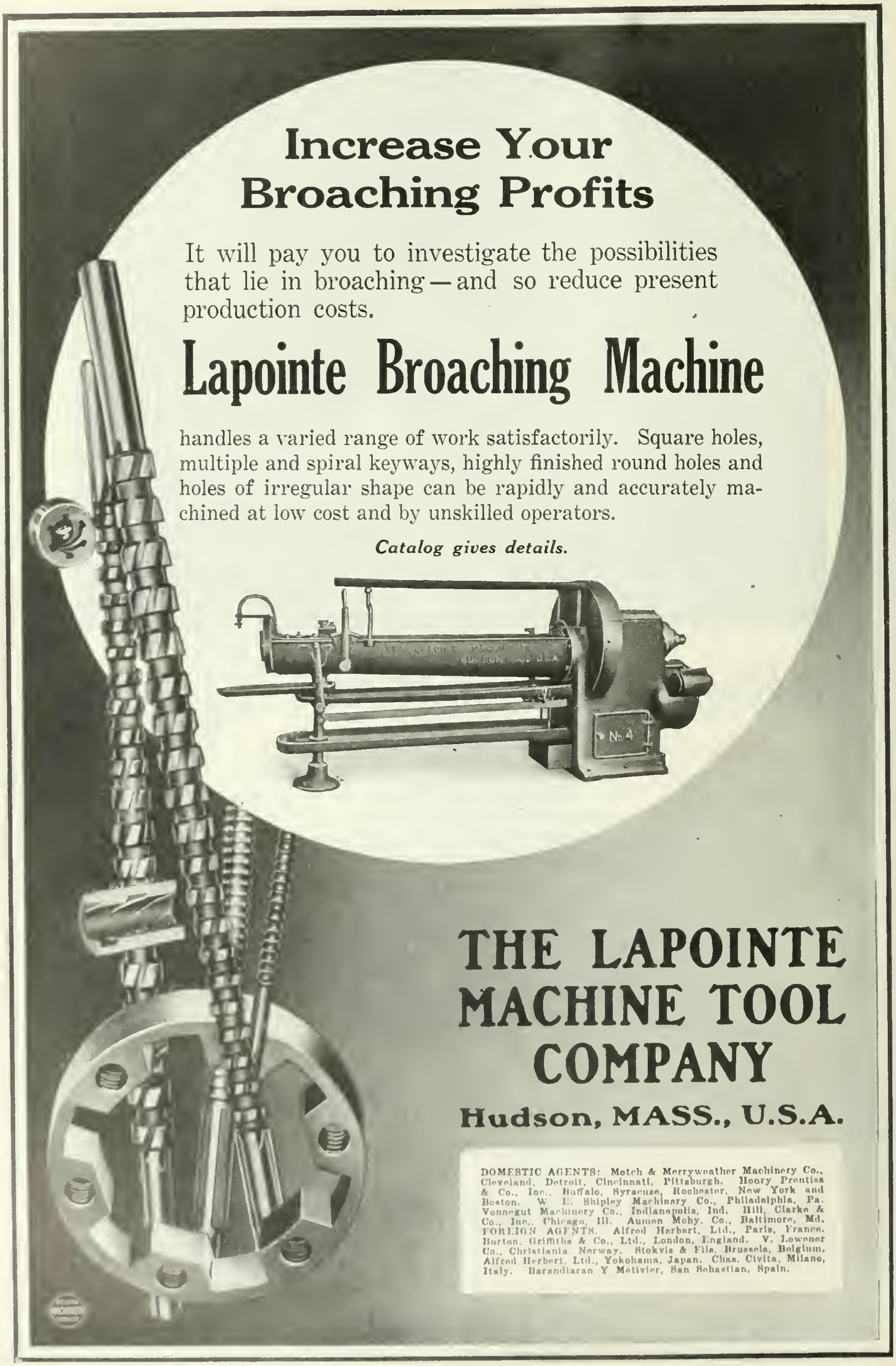
Why? To save money. The Porter-Cable Lathe is pre-eminently a second operation machine, designed for speed in close limit operations. The Franklin people, in company with many other prominent manufacturers, find it far more economical to keep their big, expensive automatics on the heavy end of turning operations and put the fine finishing up to the "Porter-Cable" which gives a smoother finish and practically eliminates hand work in fitting. There is nothing technical or obscure about it—just a simple matter of dollars and cents.

On this particular job, the work is supported at one end on a center and at the other by a special holder which also drives it.

There are six Porter-Cables in the Franklin installation, all in constant demand. Catalog gives all the details.

THE PORTER-CABLE MACHINE COMPANY
SYRACUSE NEW YORK, U. S. A.

EXPORT REPRESENTATIVE: Benjamin Whittaker, 2 Norfolk St., Strand, W. C., London



Increase Your Broaching Profits

It will pay you to investigate the possibilities that lie in broaching—and so reduce present production costs.

Lapointe Broaching Machine

handles a varied range of work satisfactorily. Square holes, multiple and spiral keyways, highly finished round holes and holes of irregular shape can be rapidly and accurately machined at low cost and by unskilled operators.

Catalog gives details.

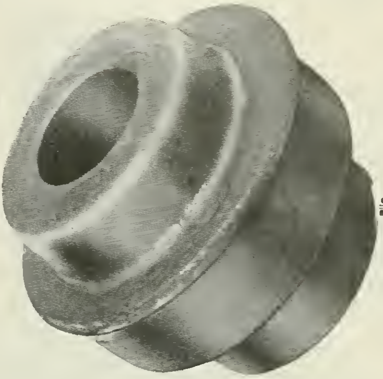
THE LAPOINTE MACHINE TOOL COMPANY

Hudson, MASS., U.S.A.

DOMESTIC AGENTS: Motch & Merryweather Machinery Co., Cleveland, Detroit, Cincinnati, Pittsburgh. Henry Prentiss & Co., Inc., Buffalo, Syracuse, Rochester, New York and Boston. W. E. Shipley Machinery Co., Philadelphia, Pa. Vonnegut Machinery Co., Indianapolis, Ind. Hill, Clarke & Co., Inc., Chicago, Ill. Aumen Mchy. Co., Baltimore, Md. FOREIGN AGENTS. Alfred Herbert, Ltd., Paris, France. Burton, Griffiths & Co., Ltd., London, England. V. Lowener Co., Christiania, Norway. Stokvis & Fils, Brussels, Belgium. Alfred Herbert, Ltd., Yokohama, Japan. Chas. Civita, Milano, Italy. Barandiaran Y Motivier, San Sebastian, Spain.

THE NATIONAL MACHINERY CO
TIFFIN, OHIO, U.S.A.

Save Stock and Machining on Your Gear Blanks



In Making Such Forgings on the

NATIONAL

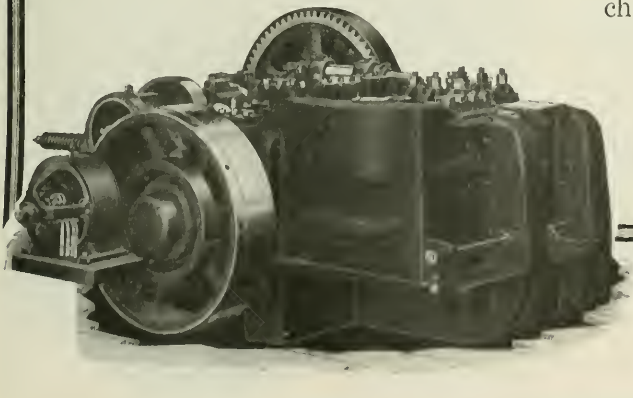
Heavy-Pattern Forging Machine
(All Steel)

you eliminate the flash, excessive draft and the tong-hold necessary when producing such parts under the hammer.

Generally such parts are alloy steel, which is expensive and tough to machine, and if made on the Automatic or Turret Lathe the cost is high.

The National method of upsetting such gear blanks is the economical way, because with National construction—long "suspended" type slides and provisions for maintaining alignment—you can work to close dimensions, effecting big saving in stock and machining.

Are you receiving National Forging Machine Talks?



The National Machinery Co.
TIFFIN, OHIO, U. S. A.

After the War, What?

Six thousand (more or less) writers, authors, politicians, men of big business, bankers and taxi-cab drivers have undertaken to tell us what is going to happen after the war. And one man's guess is as good as another's.

Our guess is that the world will continue to make one complete revolution every twenty-four hours, as per usual—and that we will all continue to eat and wear clothes and do just about as we always have done.

And businesses will grow or fail—and advertisers will advertise. We are of the opinion that some things will be done a little better than ever before and that advertising is one of them. We are laying plans right now to develop and better the advertising and marketing of mechanical products, especially machine tools and machine tool accessories.

Any man or concern in our field who wants help on his particular problems is invited to write us.

MACHINERY :: New York

SELLING
MACHINERY
SERVICE

"MORRIS"—"Built for Results"

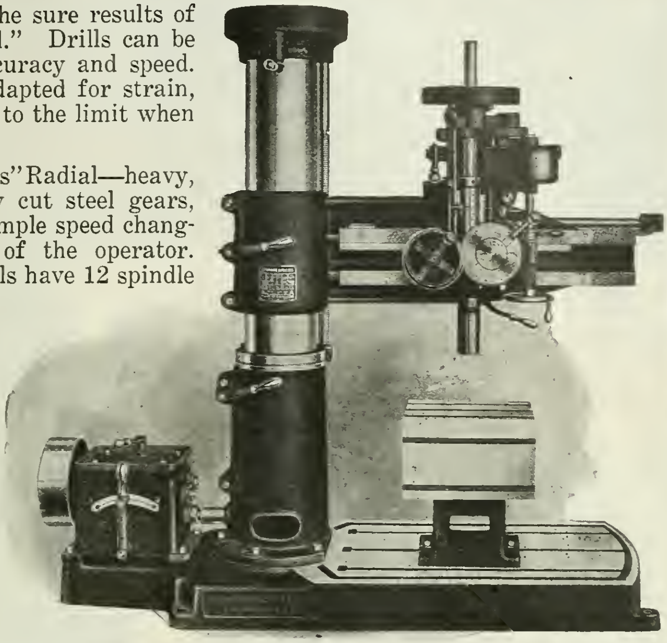
Production and profit are the sure results of installing a "Morris Radial." Drills can be driven to capacity with accuracy and speed. Sturdily built, rigid and adapted for strain, this machine can be pushed to the limit when necessary.

A few features of the "Morris" Radial—heavy, semi-steel column, correctly cut steel gears, double friction clutch and ample speed changes all within easy reach of the operator. The 2½, 3 and 3½ foot drills have 12 spindle speeds. The 4 and 4½ foot drills have 18 spindle speeds.

Ask for Catalogue.

**The
MORRIS MACHINE
TOOL COMPANY
CINCINNATI, OHIO, U.S A.**

REPRESENTATIVES: Niles-Bement-Pond Company, 111 Broadway, New York City, N. Y., Boston, Mass., Chicago, Ill., Detroit, Mich., Philadelphia, Pa., Pittsburgh, Pa., Plainfield, N. J., St. Louis, Mo. Niles Tool Works Co., Cleveland, O., Hamilton, O., Pratt & Whitney Company, 16 Fremont St., San Francisco, Cal., Birmingham, Ala., Cincinnati, O. The John Bertram & Sons Co., 1002 C. P. R. Building, Toronto, Ontario, Montreal, Quebec, Dundas, Ontario, Winnipeg, Manitoba.



THE HAMMOND MFG. CO.
386 Frankfort Ave. Cleveland, Ohio

"Speeding Up"
with a
HAMMOND
HIGH-SPEED SENSITIVE
RADIAL DRILL

HERE is a Hammond radial drill operator who regularly taps 27 holes in 23 cast-iron cylinders per hour, a daily (9½ hours) output of 220 accurately tapped cylinders. And these holes are distributed over three sides of the casting: 24 are 5/16", 18 pitch; 3 are 3/8", 16 pitch.

Hammond Radials do cut costs—it has been demonstrated many times. No moving of heavy work for each hole. A single motion brings the drill over any part of the work. Drill radius, 48 inches. Belt or motor driven. Furnished in wall type if desired. Regularly equipped with three spindle speeds, 380 to 1000 r.p.m. Upon specification can be furnished with speeds of 750 to 2000 r.p.m. or 190 to 500 r.p.m.

Self-contained friction tapping attachment (furnished when ordered), capacity up to ½" standard taps, backs the tap out at a speed 50% higher than the cutting speed.

*Write today and find out how
a Hammond Radial will cut
your drilling and tapping costs*

Let Us Help You Serve Effectively

Service is vitally necessary in business today that we may pull together to accomplish our common aim.

The General Electric Company has located industrial power experts at all large cities in this country to serve industry's electrical requirements. For instance, experienced textile mill electrical engineers will be found in all textile centers. Among other industries so served are the iron and steel, coal and metal mining, cement, clay and glass, lumber and woodworking, grain and sugar, canning, packing, and refrigeration, shoes and rubber, paper and wood pulp, tobacco and cigars, chemicals and gas, and the construction and shipbuilding.

These experts are prepared to co-operate with industrial engineering firms to show the best way to drive a machine or a factory to get maximum production of highest quality at minimum power cost.

Back of these experts is the experience gained in supplying much of the electric power equipment now used in American industry and a corps of scientists with research facilities for pioneer work.

Call on us to help perfect your service to American business.

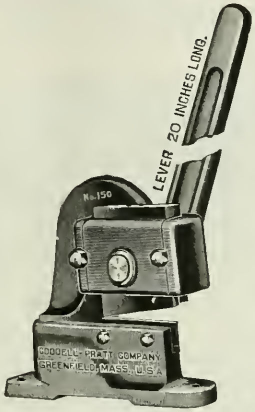
43-43

GENERAL ELECTRIC COMPANY

General Office, Schenectady, N. Y. Sales Offices in All Large Cities

GOODELL-PRATT
1500 GOOD TOOLS

Here are Two *Invaluable* Bench Tools


LEVER 20 INCHES LONG.
No. 150
GOODELL-PRATT COMPANY
GREENFIELD, MASS., U.S.A.

Bench Shear

GOODELL PRATT CO. GREENFIELD MASS. U.S.A.
No. 140

Bench Punching Machine

The Goodell-Pratt Bench Shear is a dandy little tool. The frame is so designed that sheets of any width may be readily cut. The lever is 20 inches long, and the tool steel blades have 4-inch cutting edges. All iron parts are finished in red and black enamel—steel parts are polished. Net weight 31 pounds.

The Goodell-Pratt Bench Punching Machine is an exceptionally powerful and clean cutting machine for punching holes in thin sheet iron or steel. It is provided with a 24-inch handle and a 3/8-inch round punch and die. It is well designed, and carefully made. Iron parts are finished in red and black enamel—steel parts are polished. Depth of throat 4 inches. Net weight 54 pounds.

These two tools are fully described on pages 270 and 271 of our Tool Book Number 13—that's our latest edition. Keep your copy near you for quick reference to "the famous 1500."

GOODELL-PRATT COMPANY
GREENFIELD *Toolsmiths* **MASS., U. S. A.**

Several Ways to Do It

This Engineer Picks the MURCHEY Way as Best

Again the production engineer's solution of the job lies in Murchey Taps and Dies.

Shell Makers Ought to Know This

To be sure, there are several ways of threading the inside and outside of 75 m. m. high explosive adapters, but undoubtedly only one way is *best*. This production engineer has found that way via Murchey Taps and Dies. How many men discover this fact will depend on the number willing to try Murchey Taps and Dies on this class of work.

We solicit further enquiries.

MURCHEY MACHINE & TOOL CO.

DETROIT (34 Porter Street) MICHIGAN

Great Britain, Ireland and British Colonies, Coats Machine Tool Company Limited London Newcastle-on-Tyne Glasgow. France, Fenwick Freres & Company, 8 Rue de Rocroy, Paris

Colonial

Red Star Tool Steel

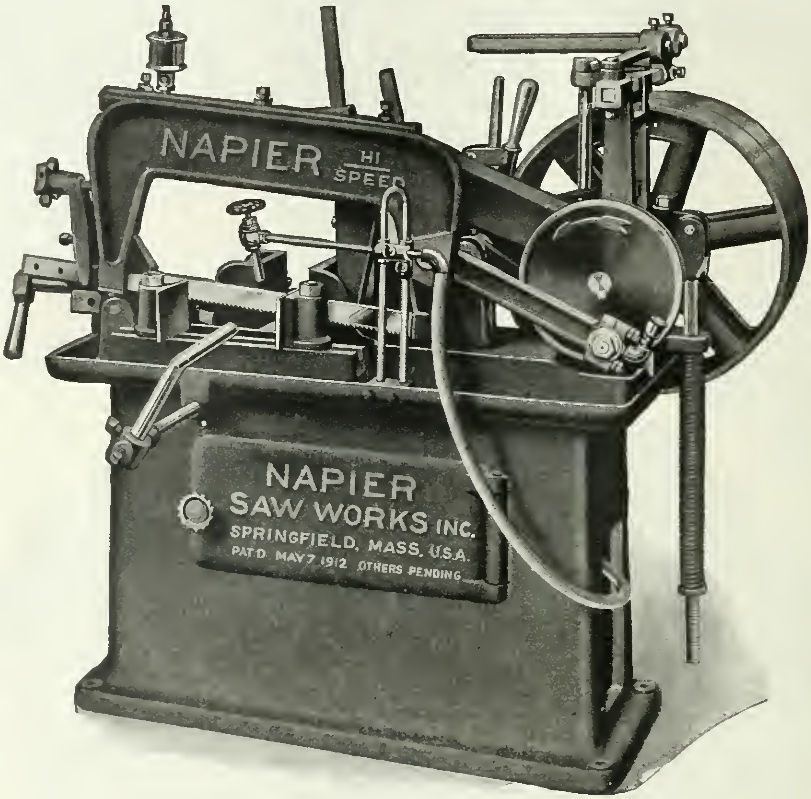
TRADE MARK REGISTERED

The lock manufacturer to whom we are indebted for these photographs is one of the biggest in his field—his locks are known and used all over the world. He buys Red Star Colonial Steel for dies—uses it for a wide variety of requirements—finds it the most satisfactory steel —most economical.

Colonial Red Star will meet most or all of *your* tool requirements—*most profitably.* Ask to be shown.

COLONIAL STEEL COMPANY

Pittsburgh New York Detroit Boston St. Louis Philadelphia Chicago



Napier Hi-Speed Hack Saw Machine

AN automatic spring tension feed that does away with the old method of gravity feed so destructive to blades.

This machine takes the vibration almost entirely from the small teeth of the Hack Saw Blade—an achievement impossible with any other system of feed.

Vibration absorbed means that blades will last much longer.

Has automatic lifting device, and lubricating system. Can be adjusted easily to give any desired pressure on blade.

A rugged tool for economy and production. Write for descriptive circular.

Napier Products

Band Saw Machines	Hack Saw Machines
Band Saws	Hack Saws

Napier Saw Works, Inc. No. 5 Napier St. **Springfield, Mass.**

12

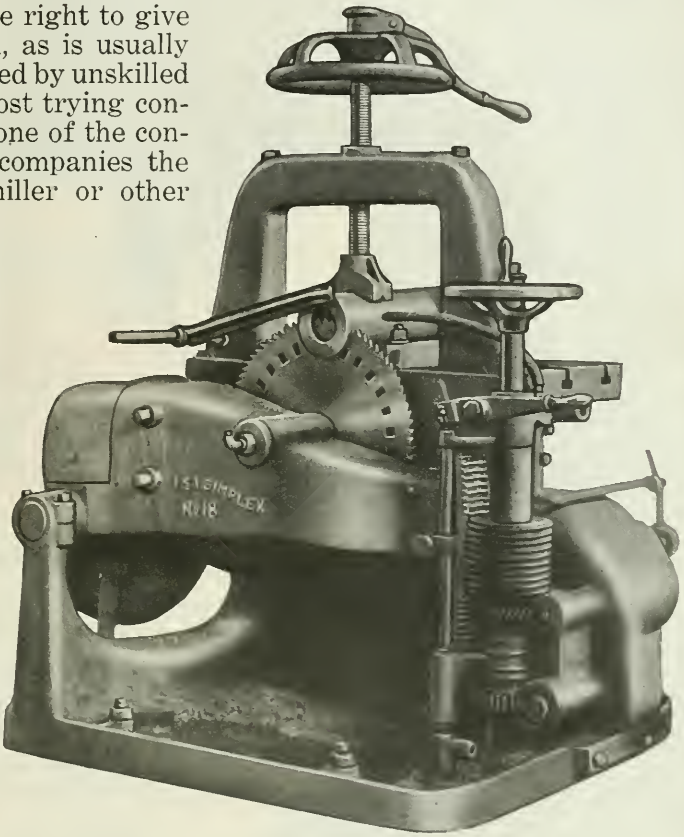
Saws for Service

A cold saw must be right to give good service when, as is usually the case, it is handled by unskilled labor under the most trying conditions and with none of the consideration that accompanies the use of a lathe, miller or other machine tool.

We have sufficient data obtained in plants operating on work somewhat out of the ordinary to prove that the Lea-Simplex Cold Saw is one saw that *is* right.

The Lea-Simplex Cold Saw shown has its blade half way through a piece of steel tubing of five inches outside diameter and with one inch wall. This machine has been working on a wide variety of work for the last two years and has given unqualified satisfaction at all times.

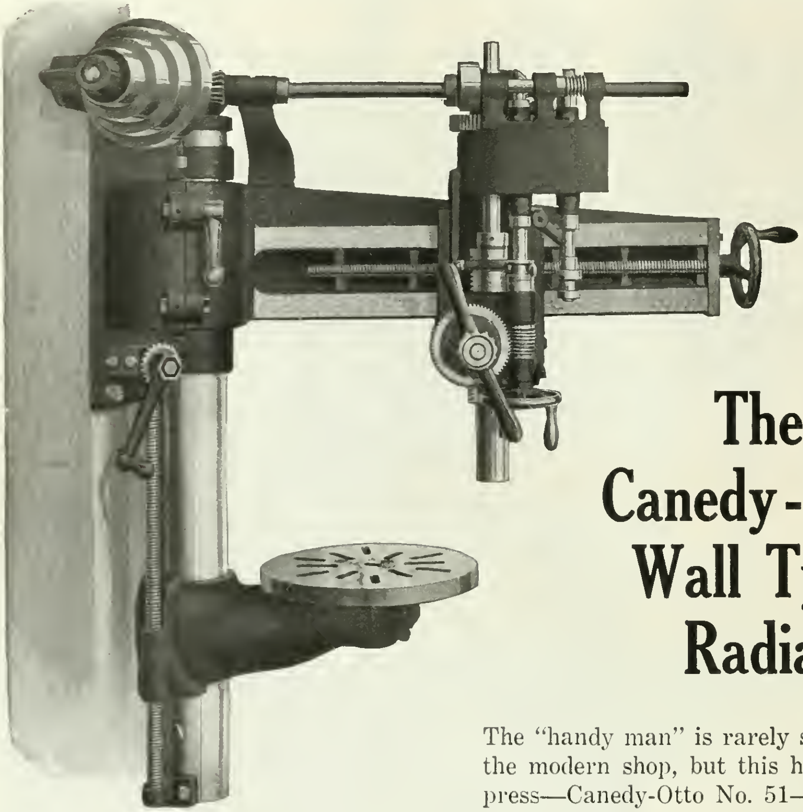
Photograph and data through the courtesy of the Kutztown Foundry & Machine Company of Kutztown, Pa.



LEA—SIMPLEX Cold Saws

Lea-Simplex Cold Saws are simply constructed, have few working parts, and are readily accessible. Table may be raised or lowered, feeds and speeds varied and all other adjustments performed from one position. Ample clamping facilities eliminate the possibility of slipping, centrifugal pumping system keeps the blade well lubricated, up-feed of saw insures immediate chip removal by gravity. May we send the rest of the details?

The Earle Gear & Machine Company
4705 Stenton Avenue Philadelphia, U. S. A.



The Canedy-Otto Wall Type Radial

The "handy man" is rarely seen about the modern shop, but this handy drill press—Canedy-Otto No. 51—is firmly established in shops all over the country.

It has the "quality" construction of our massive floor type radials, with automatic cut off, instantaneous feed changes, quick return lever and other conveniences which adapt it to a wide range of drilling up to 1¼ inches.

By letting the walls supply the necessary support and omitting the base, with one or two other non-essentials, we have brought the price of a full fledged radial within the reach of every shop owner. **Details on Request.**

A
LOW COST
HIGH CLASS
MACHINE

PRICES:

No. 51—2½ foot arm,	$252.00
No. 51—3½ foot arm,	267.00

F. O. B. Chicago Heights

Carried in Stock by Leading Jobbers and Machine Dealers Everywhere

---

CANEDY-OTTO MANUFACTURING CO.
CHICAGO HEIGHTS ILLINOIS, U. S. A.

Repelling a Raid!

Eternal Vigilance -- Quick Action! are the principal factors which defeat attempts to raid from the air.

"Red Cut Superior"

The Nationally Known —— First Quality

HIGH SPEED STEEL

is made for the hardest kind of war service--Turning or boring big guns or small guns--Big shells--small shells--iron or steel--forgings or castings--any and all machine work, where speed and extreme quantity production will be deciding factors in winning the War.

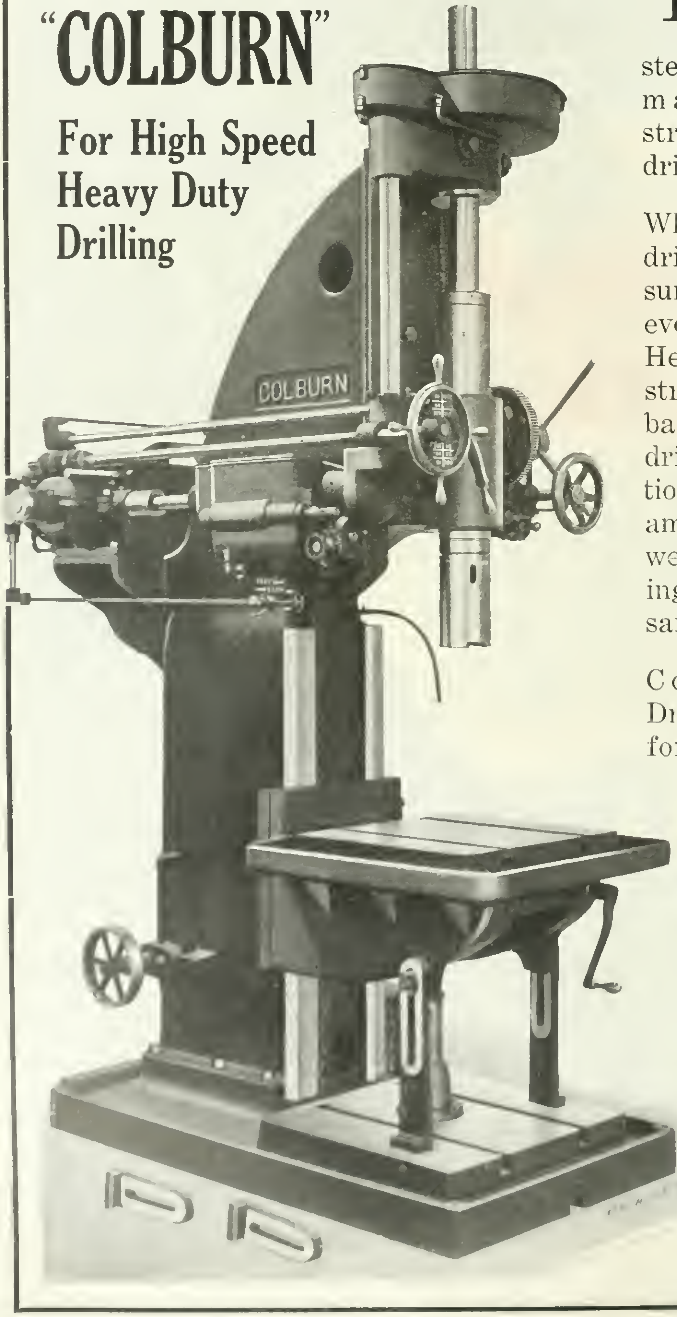
VANADIUM ALLOYS STEEL CO.
PITTSBURGH; PA.——Works: LATROBE, PA.

There is no
Known Substitute
for Goodness

If interested in High Speed Steel and you care to receive our printed matter at intervals, send us your name and address for our mailing list

Rigid Construction and Abundant Power

The
"COLBURN"
For High Speed
Heavy Duty
Drilling



YOU'RE not getting your money's worth out of high speed steel tools, unless your machines have the strength and rigidity to drive them to capacity.

When it comes to heavy drilling, the "Colburn" assures full value from every ounce of tungsten. Heavy box column construction, all steel gears, ball bearing spindle drive, automatic trip, friction brake, etc., provide ample tool protection as well as the necessary pulling power to drive them safely at top speed.

Colburn Heavy Duty Drills set new standards for speed and economy wherever they are installed.

Made in several sizes for drilling up to 5 inches in solid steel.

Details and production data on request.

COLBURN
MACHINE
TOOL CO.
Franklin, Pa., U.S.A.

Vulcan Crucible Steel Co.
ALIQUIPPA *Established 1900* PA., U. S. A.
Makers of Wolfram High Speed Steel
BRANCHES:
Boston . . . . 102 Purchase Street
Chicago . . . . 16-18 So. Clinton Street
Detroit . . . . 310 New Telegraph Bldg.
Montreal . . . . Herald Bldg.
Newark, N. J. . . . . 52 No. 11th Street
St. Lou . . . . 1[illegible]5 International Life Bldg.

FOR FINE JIG WORK

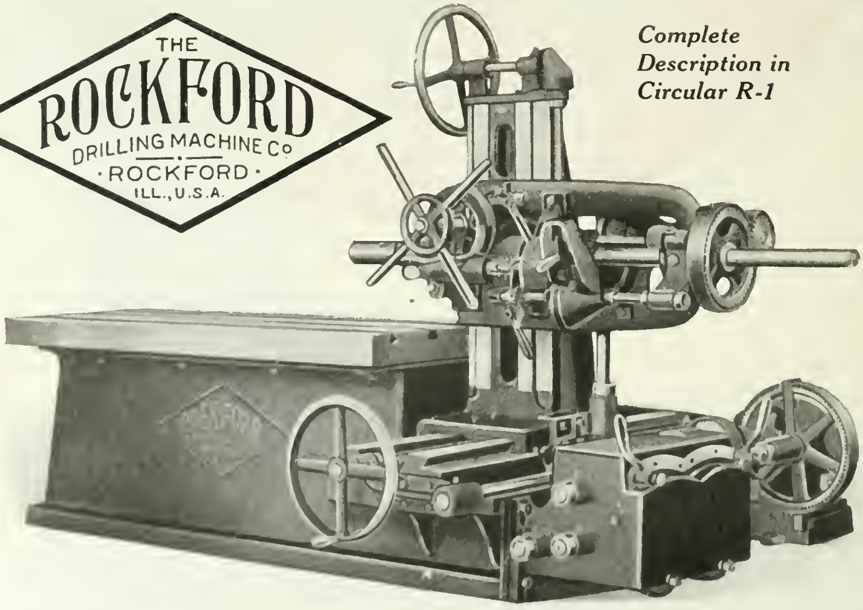
The Rockford Horizontal Drilling Boring and Tapping Machine

Designed to provide a heavy duty production tool with sufficient accuracy to handle the finest jig work, the Rockford "Horizontal" Drill is built extra heavy, is well balanced and equipped with journals and sliding surfaces of ample width and carefully ground.

The table is stationary and the working mechanism has lateral and vertical adjustment which permits the spindle to operate anywhere on a surface 18 inches high by 36 wide.

Spindle is of special high grade steel, with ball thrust bearings and capacity to drive 3 inch high speed drills and 8 inch boring tools—even larger if coarse feeds are avoided. The machine may be equipped with a variety of attachments and is made to drive with Two, Three or Four Step Cone, Gear Box with Tight and Loose Pulleys, Constant Speed Motor with Gear Box or Variable Speed Motor, directly connected.

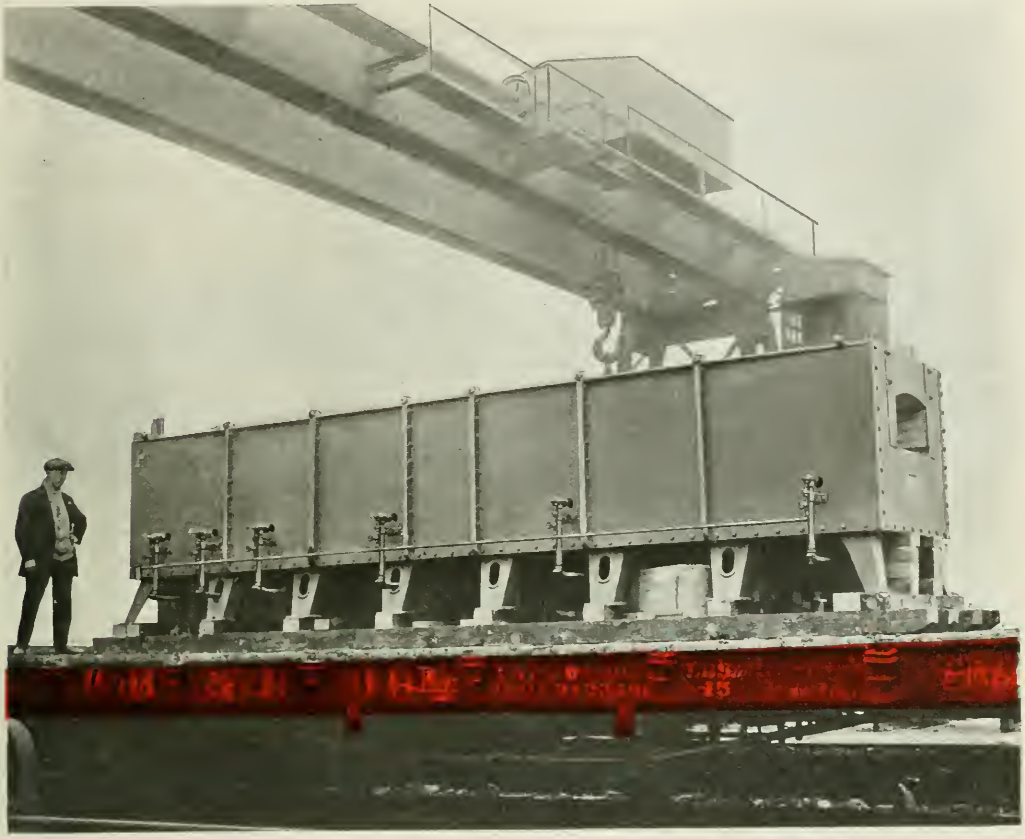
THE
ROCKFORD
DRILLING MACHINE Co
·ROCKFORD·
ILL., U.S.A.



Complete Description in Circular R-1

ROCKFORD DRILLING MACHINE COMPANY

ROCKFORD ILLINOIS, U. S. A.



Ready for Quick Installation

Strong Carlisle & Hammond

INDUSTRIAL FURNACES

For Oil, Natural Gas or Manufactured Gas

Catalog S-M describes the full line of furnaces and accessories. When you write for it, ask any question you wish about heat-treating. The catalog and advice are both free.

When you buy a S-C-H Furnace you are buying quick results, not an erection problem. The illustration shows a 20 ft. shell furnace. After unloading, all that is necessary is to bolt on the doors and standards, connect the fuel and air and it is ready for business. No foundation to build, no mechanics or materials to clutter up your shop. It is ready to start producing a few hours after it is received.

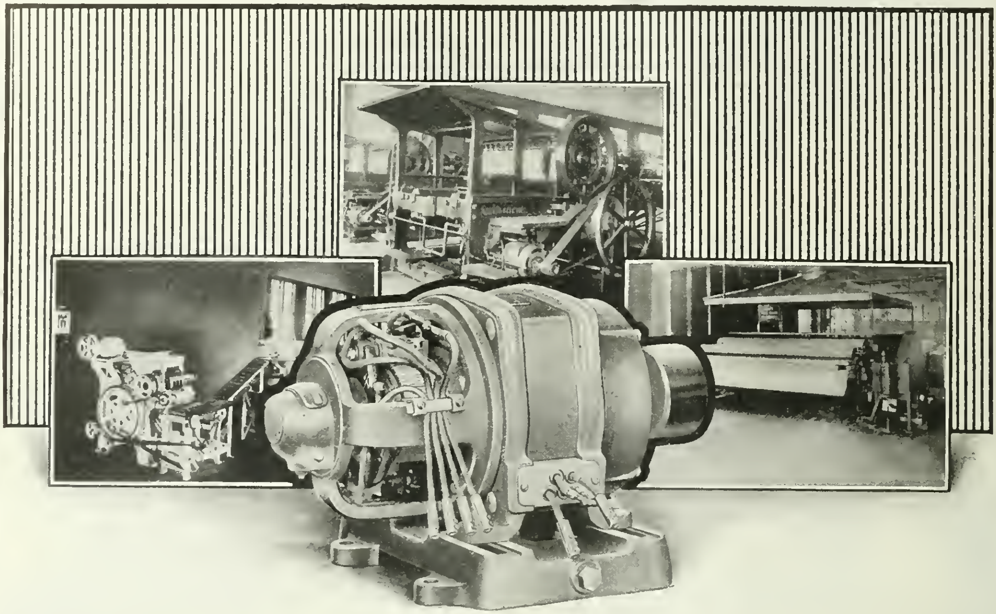
The smaller sizes are shipped complete and all that is necessary is to set them on the floor, connect the fuel and air and go to work.

The S-C-H line consists of 75 standard furnaces—a furnace for every possible heat-treating need. With them may be had every accessory that is used in a heat-treating department.

THE STRONG, CARLISLE & HAMMOND CO.

FRANKFORT AVENUE **CLEVELAND, OHIO**

Boston New York Chicago ←BRANCHES→ Philadelphia Detroit Pittsburgh



RI Single Phase Motors

are particularly well suited to services where reversal of rotation is required—Elevators, Small Cranes, and Hoists—as well as certain machines used in bakeries, laundries and other industries.

Standard 60-cycle non-reversing continuous duty type RI motors can be made reversible at reduced intermittent duty rating by simply bringing out extra leads from the windings to a double-pole, double-throw switch.

The type RI reversing motors are built in sizes from 1/4 to 5 h.p., 110/220 volts.

Shipment on popular sizes and frequencies can be made from stock.

Call up the nearest G-E sales office or G-E Motor Agency for the size you need.

General Electric Company

General Office: Schenectady, N.Y.

ADDRESS NEAREST OFFICE

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[illegible] Va.
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[illegible] Y.
[illegible] Mont.
[illegible] W. Va.
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[illegible]
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Columbus, Ohio
*Dallas, Tex.
Dayton, Ohio
Denver, Colo.
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Erie, Pa.
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Springfield, Mass.
Syracuse, N. Y.
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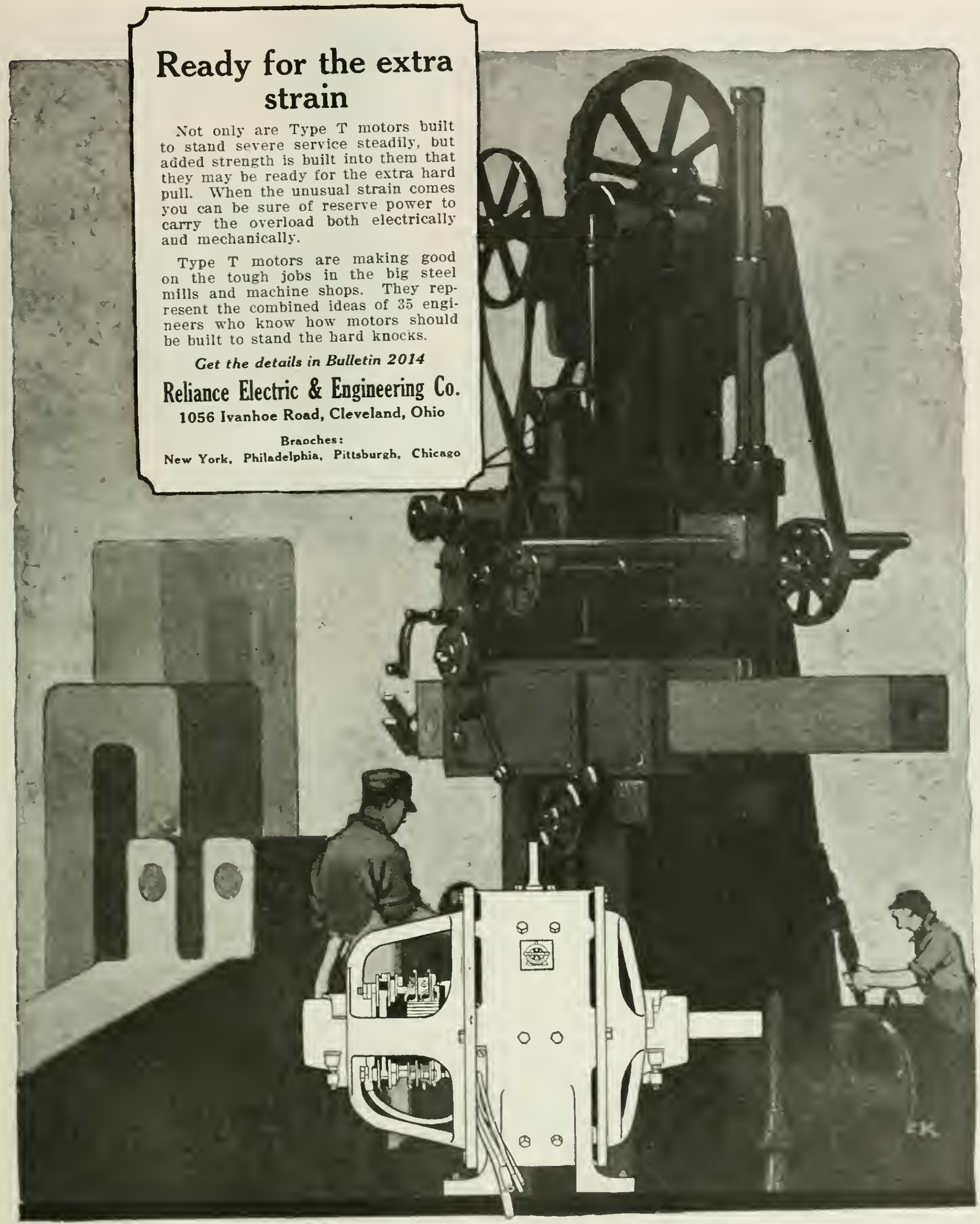
Washington, D. C.
Youngstown, Ohio

*[illegible] General Electric Company. For CANADIAN BUSINESS refer to Canadian General Electric Company, Ltd., Toronto, Ont.
GENERAL FOREIGN SALES OFFICES: Schenectady, N. Y., 120 Broadway, New York City, 83 Cannon St., London, E. C., England

45—5



Ready for the extra strain

Not only are Type T motors built to stand severe service steadily, but added strength is built into them that they may be ready for the extra hard pull. When the unusual strain comes you can be sure of reserve power to carry the overload both electrically and mechanically.

Type T motors are making good on the tough jobs in the big steel mills and machine shops. They represent the combined ideas of 35 engineers who know how motors should be built to stand the hard knocks.

Get the details in Bulletin 2014

Reliance Electric & Engineering Co.
1056 Ivanhoe Road, Cleveland, Ohio

Branches:
New York, Philadelphia, Pittsburgh, Chicago

Type T Heavy Duty
RELIANCE MOTORS
Direct Current

That's what the men in the shop say. And that's what you will say about every job done with a DUMORE.

It sets a new standard of accuracy in tool grinding. Chatter marks, taper and bell-mouth are unknown. It is portable, easily carried from one place to another and quickly set up.

In principle, construction and performance the DUMORE grinder stands without an equal. The dynamic balance of the armature and the high spindle speed — 30,000 R. P. M.—insures an even, correct cutting speed to wheels, a high class tool, and absolutely accurate results.

No matter what your equipment is, you should have a DUMORE. Let us tell you more about it.

WISCONSIN ELECTRIC COMPANY
2500 16th Street RACINE, WIS.

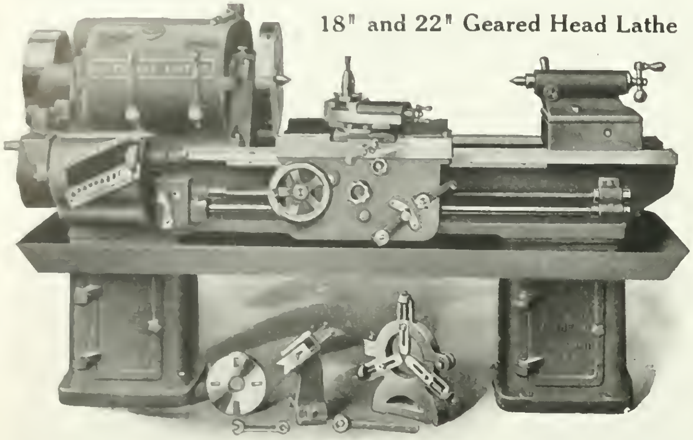
DUMORE PORTABLE ELECTRIC GRINDERS

"Believe me — that's some job of grinding!!!"

DUMORE Grinder with equipment A.

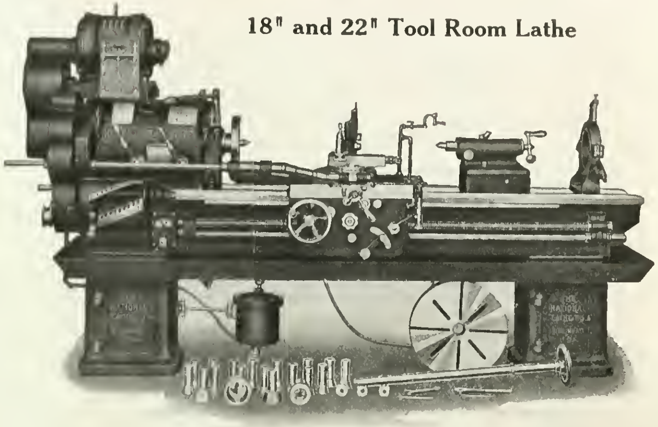
One of five different types.

18" and 22" Geared Head Lathe



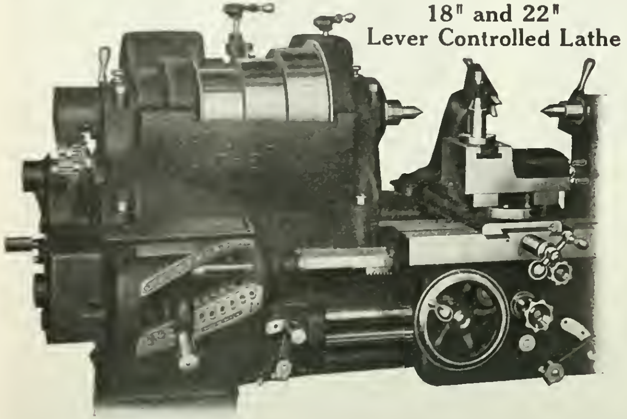
Another "Good One" is our National 24" Heavy Duty Lathe

18" and 22" Tool Room Lathe



FOUR GOOD ONES—NONE BETTER

18" and 22"
Lever Controlled Lathe

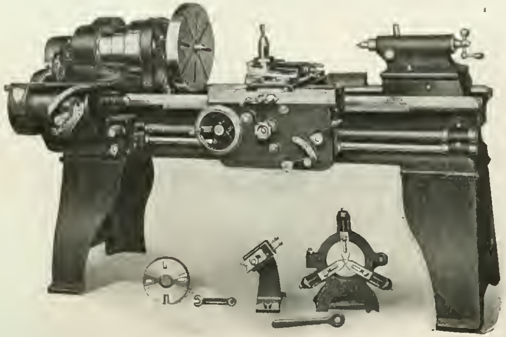


The National Lathe Co.

Cincinnati
Ohio

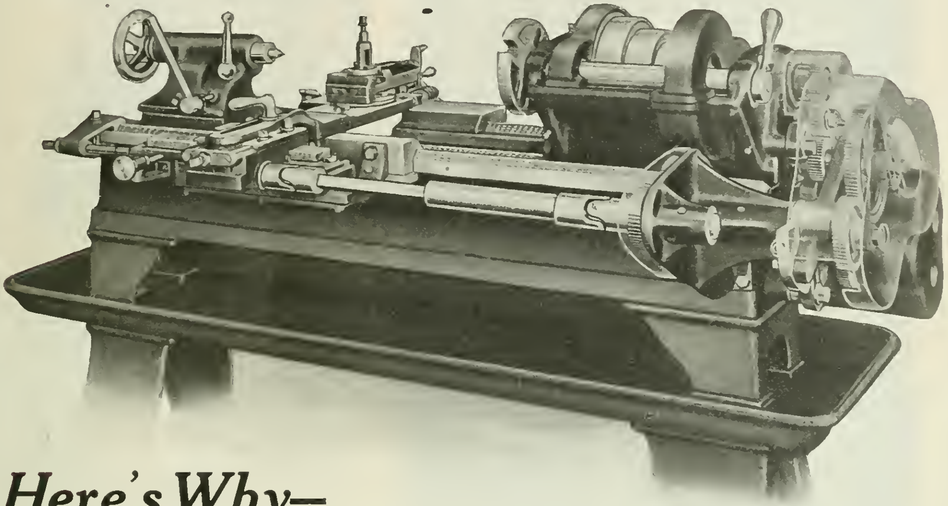
Write us for full information

17" and 20" Cone Pulley Lathe



THE MULLINER LATHE

Is The Ideal Lathe for Foreign Contract Work



Here's Why—

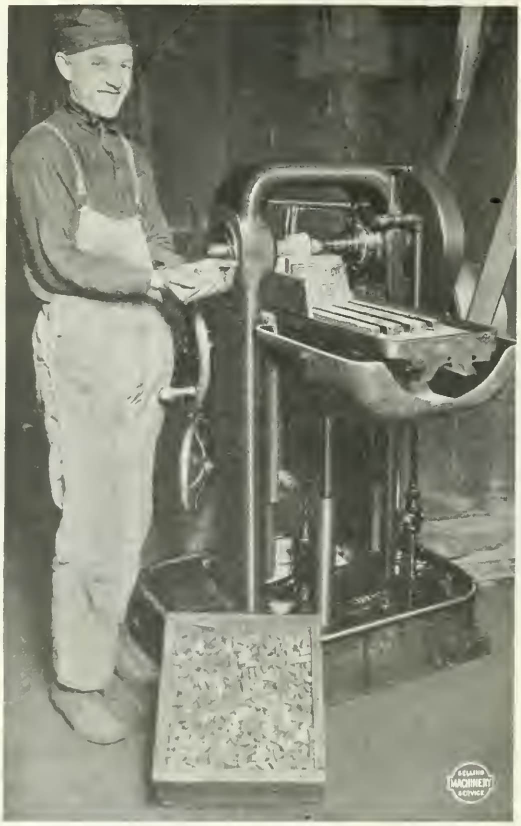
The Mulliner Quick Change Lathe is provided with an unusually wide range of feeds. It is equipped with an auxiliary quadrant also, located on the end of the bed, which carries the gears connecting the head with the quick change mechanism, and permits the use of such extra gears as will be necessary to cut *all special or metric threads* not regularly provided for in the standard equipment.

The metric transposing gears afford fifty metric leads ranging from 0.225″ to 16 millimeters pitch. The transposing formula shows the method of applying extra gears for metric threads not within this regular range.

This feature coupled with guaranteed accuracy to which a splineless lead screw materially contributes, makes the Mulliner Lathe ideal for metrically gauged contract work without necessitating a complete metric arrangement of the machine, to the exclusion of all other work.

Built in 12″ and 14″ sizes. Further details on request.

MULLINER-ENLUND TOOL COMPANY, Inc.
SYRACUSE NEW YORK, U. S. A.

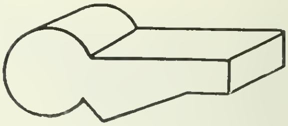


Milling the Pawls for Lowell Reversible Ratchet Wrenches

One Briggs Miller Helped

Now There Are Two

The Briggs Miller is milling pawls for Lowell Reversible Ratchet Wrenches made by the Lowell Wrench Company, Worcester, Mass. It took little more than a year for this company to decide that a second Briggs Miller could still further add to the growing popularity of its improved product. The two now installed are turning out an enormous amount of work, establishing beyond doubt their popularity in handling parts of this character.



To produce from the block the pawl shown in the accompanying sketch requires two milling operations—one finishing the upper half of the circular end and the flat surface to the left of it, the other finishing the lower half of the circular end and the various angular surfaces to the left of it.

No better machine for high production on this job than the Briggs Miller could be found. And for quality—well, you see what it did for this company's product. Will you give it an opportunity on yours?

Let us tell you more about this wide ranged machine

GOOLEY & EDLUND, Inc., Cortland, N. Y.

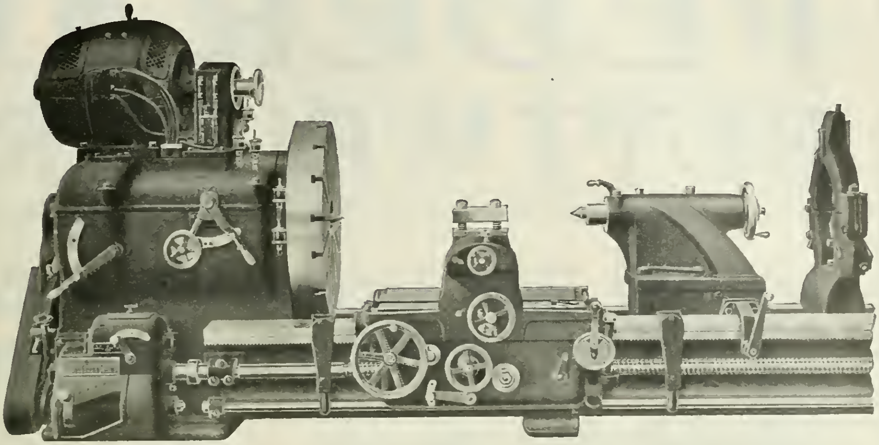
DOMESTIC AGENTS: Chandler & Farquhar Co., Boston, Mass.; Vandyck Churchill Co., New York and New Haven; Swind Machinery Co., Philadelphia, Pa.; Syracuse Supply Co., Syracuse, N. Y.; C. H. Adams, Rochester, N. Y.; Brown & Zortman Machinery Co., Pittsburgh, Pa.; [illegible] Miller Machinery Co., Detroit, Mich.; Federal Machinery Sales Co., Chicago, Ill.; Vonnegut Machinery Co., Indianapolis, Ind.; Cleveland Tool & Supply Co., Cleveland, O.; Bowman Blackman Mch. Tool Co., St. Louis, Mo. FOREIGN AGENTS: [illegible] & Co., Ltd., London, Manchester and Glasgow; Andrews & George, Tokyo.

OVER-SEAS REPRESENTATIVE

PARIS
TURIN

ALMACOA ALLIED MACHINERY COMPANY OF AMERICA ALMACOA
120 BROADWAY, NEW YORK, U.S.A.

ZURICH
BARCELONA



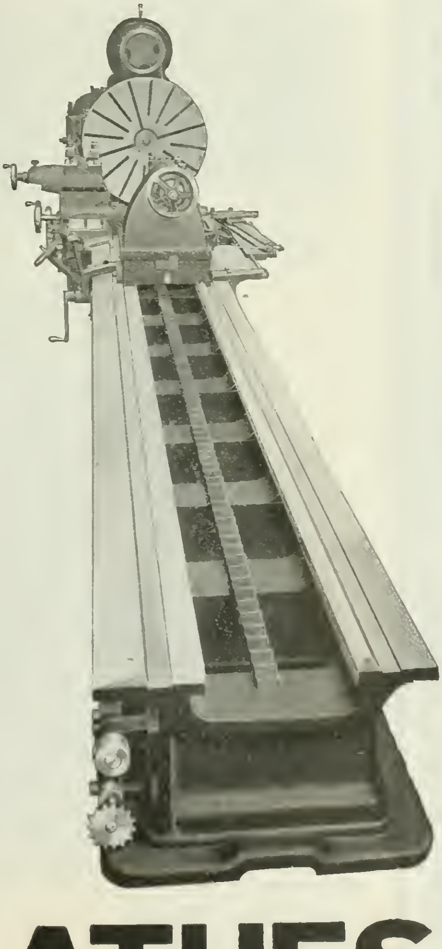
THESE are massive lathes of unusual power, as will be apparent on seeing them. They are essentially production tools, but their effectiveness adapts them for all lathe work.

All steel gearing. FORGED STEEL INTERNAL GEAR in face plate.

TOOTHED, POSITIVE CLUTCHES for carriage feeds.

Ninety-four different speeds by means of headstock containing only 10 gears in combination with 3:1 D. C. motor. Speeds cover range of nearly 200:1.

Lower view shows end of lathe and exhibits the front guide which constitutes the desirable "LONG NARROW GUIDE" for carriage. Carriage has gibs at front and under faces of guide which make it impossible for carriage to cock or lift.



H-S-G
TRADE MARK

**THE HOUSTON
STANWOOD & GAMBLE
COMPANY**

CINCINNATI U. S. A.

30, 36, 42, 48, 54 and 60 in. Sizes

LARGE LATHES

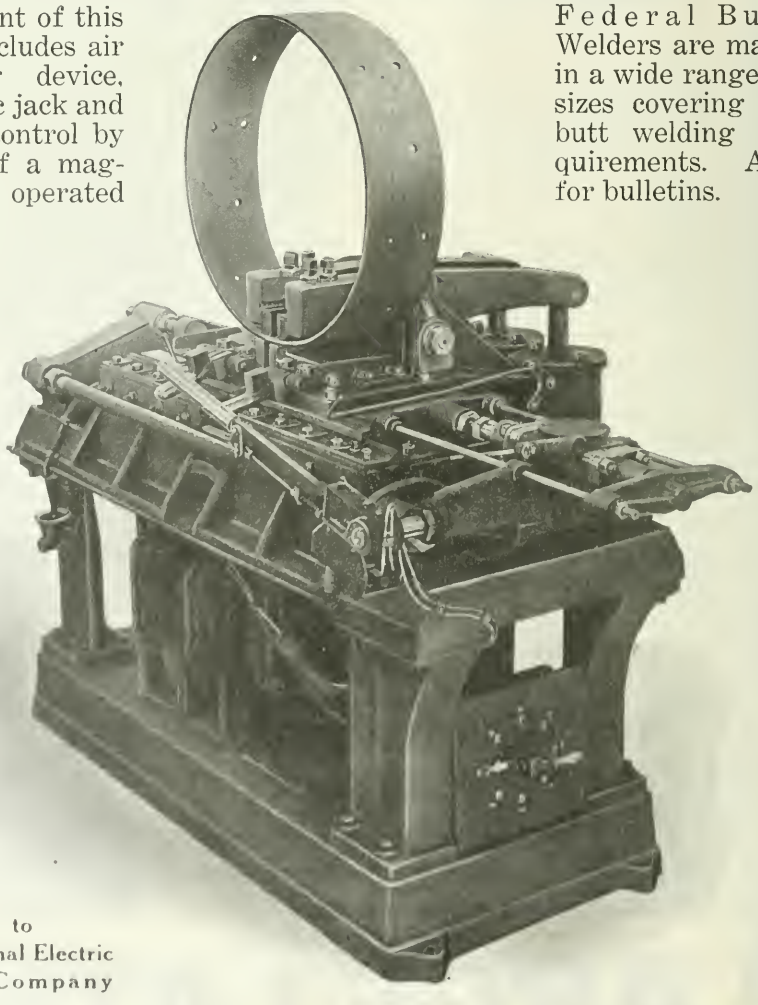
FEDERAL BUTT WELDERS

Welding Steel Tractor Wheel Rims

The accompanying photograph shows a 15-A Federal Butt Welder set up for welding steel tractor wheel rims 24″ diameter, ⅜″ thick and 8″ wide.

Equipment of this model includes air clamping device, hydraulic jack and remote control by means of a magnetically operated switch.

Federal Butt Welders are made in a wide range of sizes covering all butt welding requirements. Ask for bulletins.

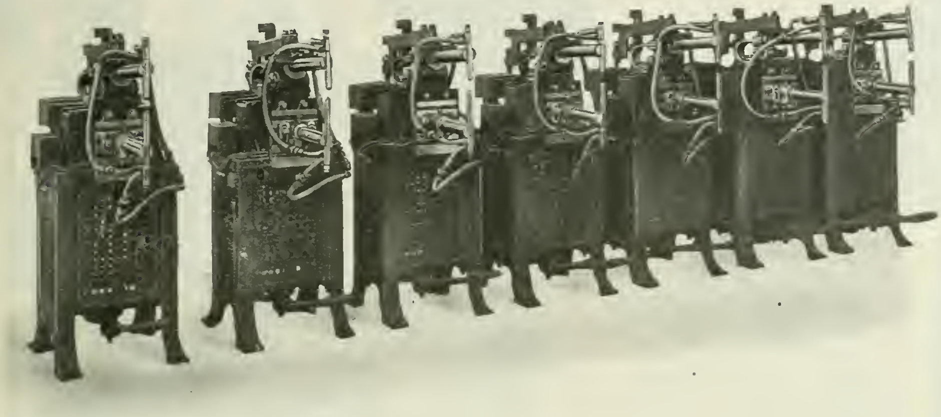


Successors to
The National Electric
Welder Company

THE FEDERAL MACHINE &

FEDERAL SPOT WELDERS

Proved Quicker and Better on This Important War Work

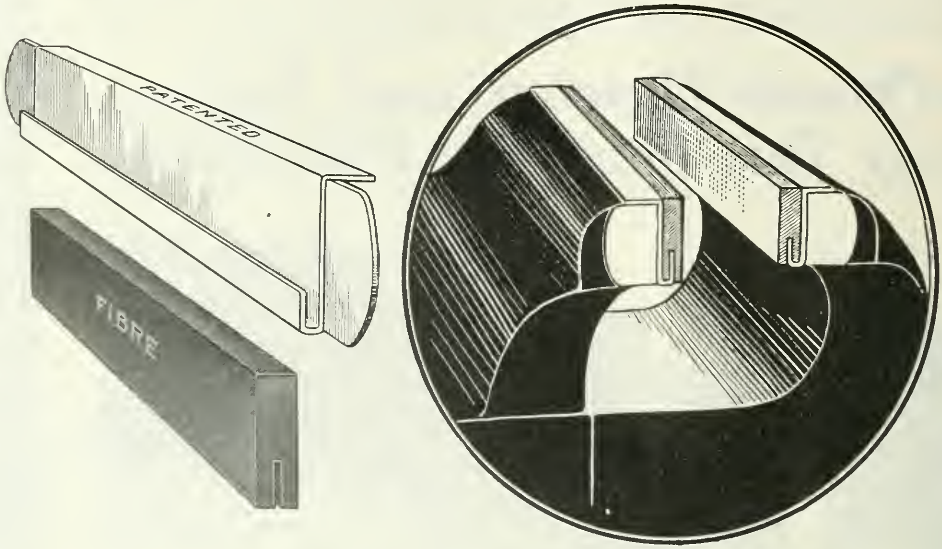


A certain large stamping concern agreed to supply a vast number of water-tight sheet metal parts for war work within an unusually short time. Riveting machines started the job; but the battery of seven "Junior" Spot Welders shown above was substituted as both quicker and better. The company's engineers estimated that the spot welded parts produced by seven operators in a given time were five times as great as could be assembled with punch presses and rivets. Besides there **could be no rivet leaks in the finished parts.**

Can't you make a profitable Federal substitution in your plant? Bulletins upon request.

WELDER CO., Warren, Ohio, U. S. A.

Repeat Orders Tell The Story!



Ideal Vise Liners have been on the market less than six months and are in use in several hundred of the largest shops in the country. The majority of these plants have sent in repeat orders for these liners and report entire satisfaction. Are you using Ideal liners on your vises? Write today for circular, or ask your supply dealer.

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HOHNSBEEN MANUFACTURING CO.
MINNEAPOLIS, MINN., U. S. A.

Hobs—Milling Cutters—Gauges —extremely accurate—long lived—delivered quickly.

Quality tools of the highest order

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W&B

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Drop Forged parts are submitted to unusual strains these days. Rush conditions of men and machines have made it so.

Successive steps in Whitman & Barnes Drop Forgings are so cautiously guarded that strains or flaws in the finished products are eliminated.

Methods of handling different metals with the art of knowing their right heat treatment and forging present no difficulties to "W & B" experienced workers.

Your drop forgings will be made to your most minute specifications, uniform in quality, identical with all Whitman & Barnes drop forged products—excellent for their precision and goodness.

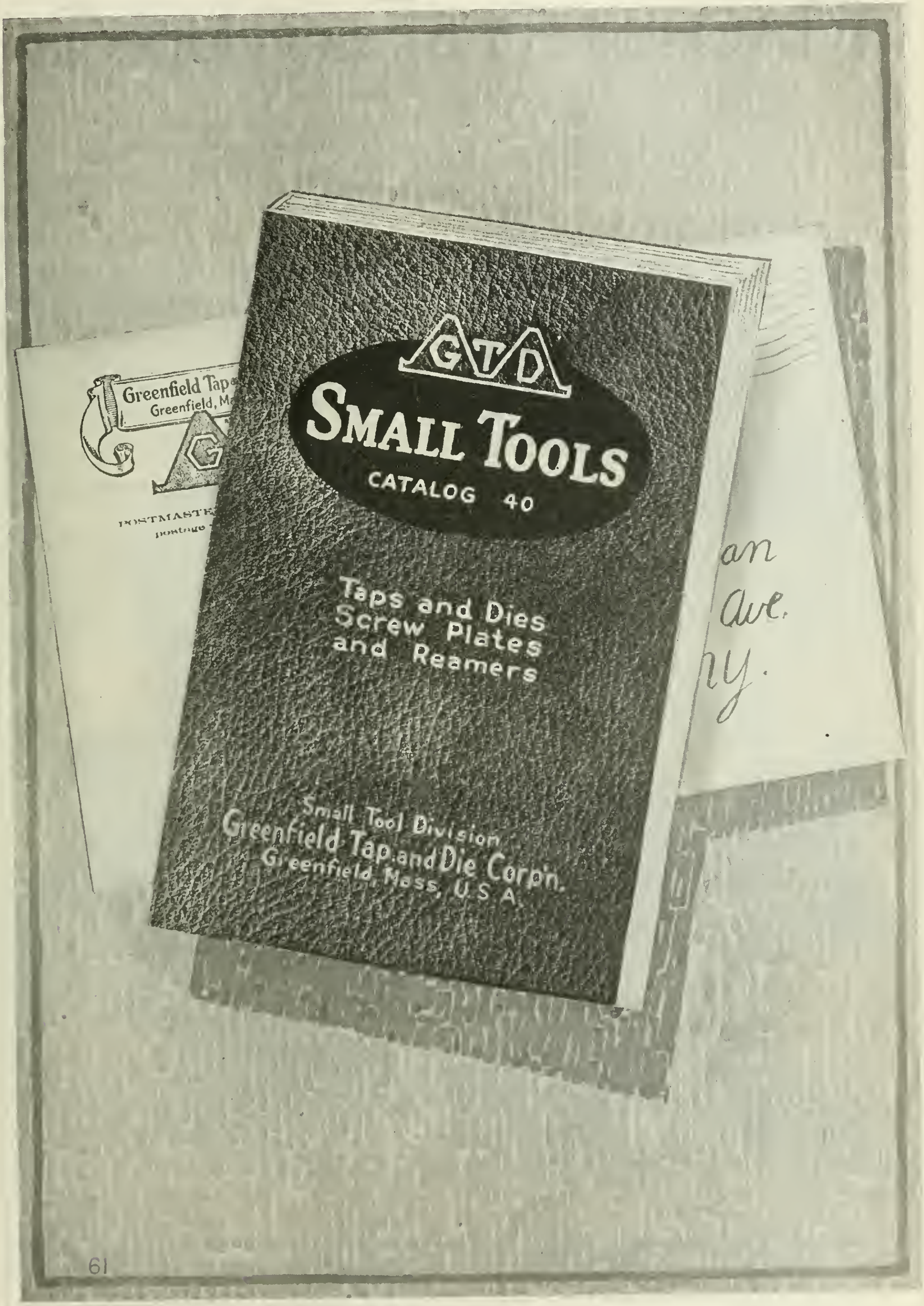
Send us your specifications or wire for consultation with a "W & B" engineer.

W&B

The Whitman & Barnes Mfg. Co.

ESTABLISHED 64 YEARS

1000 West 120th Street CHICAGO, ILL.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SMALL TOOLS
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61

MACHINERY'S Encyclopedia

The first and only modern mechanical reference work that is comprehensive in scope, comprising a broad engineering and mechanical education. The Encyclopedia is in seven splendid volumes and is the finest product of MACHINERY'S experienced publishing organization. A very valuable feature of this important work is:—

The Guide to Systematic Reading

which, with the complete and detailed Index to the Encyclopedia, occupies the seventh volume. This Guide puts the whole range of mechanical knowledge before the student in twenty-one carefully prepared courses of study. The way in which the various subjects are treated in the Guide can only be learned from the Guide itself. But here is a glimpse at the two courses on electricity for example, just to indicate the definite and thorough way in which the reader is aided:—

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After a short but very clear and practical explanation of the fundamentals of electricity and electrical machines, with paragraphs on Terms used in Electrical Engineering and Main Classes of Electrical Apparatus, the course on Electricity and Electrical Machines carries the student in a clear, systematic and consecutive way through the various divisions of this important subject.

Beginning with Electricity and Magnetism there are paragraphs on Generators and Motors for Direct and Alternating Current, Transformers, the Operation of Electric Machinery, Electric Controlling Devices, Primary and Storage Batteries, and Power Stations and Transmission Lines.

Applications of Electricity

is the second course on Electricity given in the Encyclopedia Guide. It begins with a brief statement of the various applications of Electricity discussed in the Encyclopedia and then takes up in detail the various specific applications of electricity to the work of the machine shop, under such headings as Motor Drive for Machine Tools; Motor Drive for Woodworking Machines; and Wiring for Motor-driven Machinery. There are then sections on Motor Applications for General Purposes; Application of Motors to Fans and Blowers; Electric Drive for Pumps; and Electric Brakes. There is a comprehensive study of Electric Lighting; and Electrometallurgy and Electroplating are given adequate treatment.

There is a valuable discussion of Electrolysis and its Mitigation; and there is a final section on Electric Shock and Care of Electric Burns.

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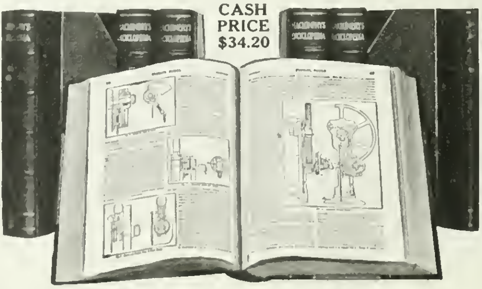

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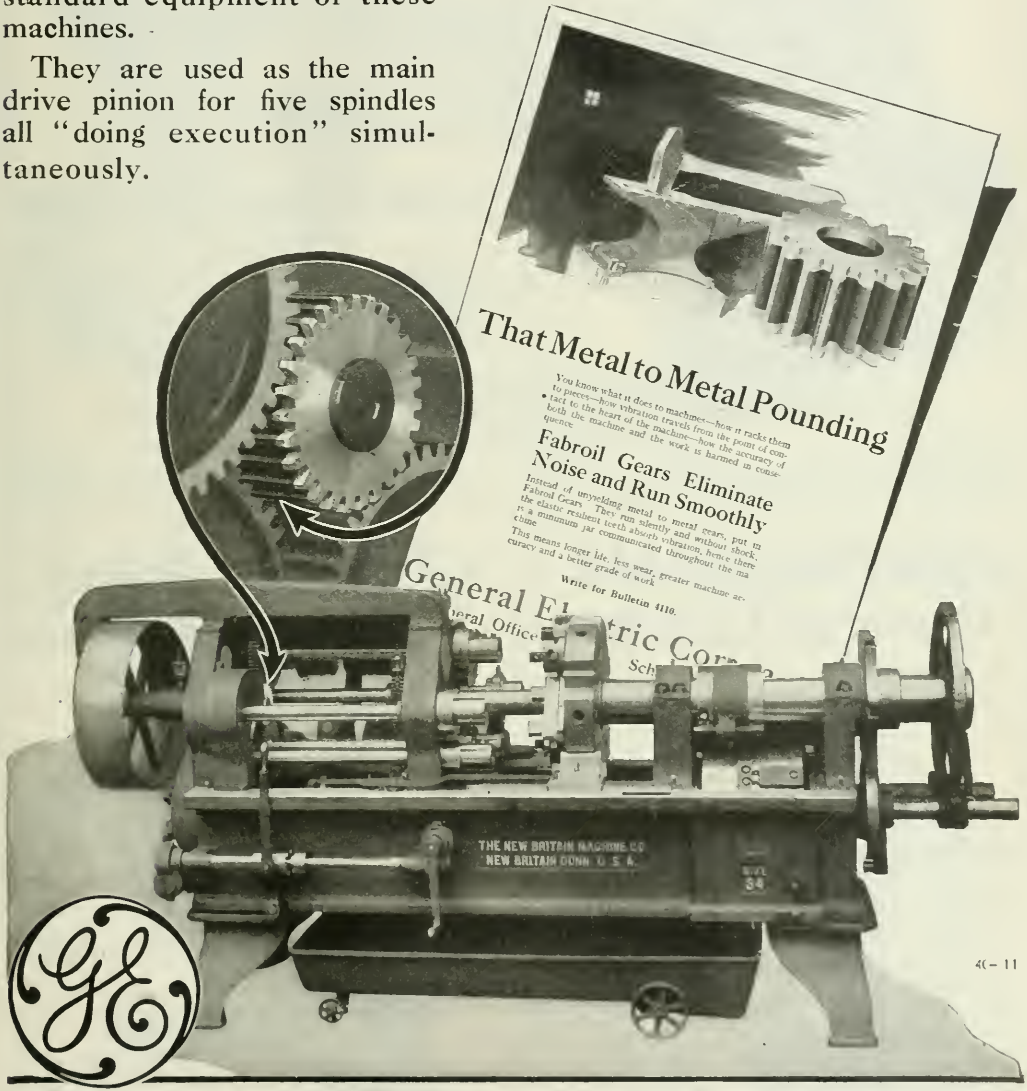
Fabroil gears are part of the standard equipment of these machines.

They are used as the main drive pinion for five spindles all "doing execution" simultaneously.



That Metal to Metal Pounding

You know what it does to machines—how it racks them to pieces—how vibration travels from the point of contact to the heart of the machine—how the accuracy of both the machine and the work is harmed in consequence

Fabroil Gears Eliminate Noise and Run Smoothly

Instead of unyielding metal to metal gears, put in Fabroil Gears. They run silently and without shock, the elastic resilient teeth absorb vibration, hence there is a minimum jar communicated throughout the machine

This means longer life, less wear, greater machine accuracy and a better grade of work

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GENERAL ELECTRIC COMPANY

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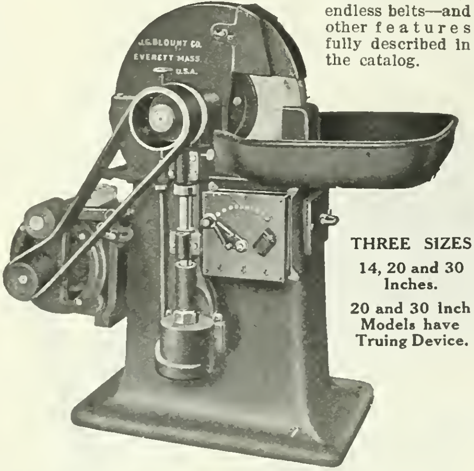
WET TOOL GRINDER

A smooth drive for accuracy, continuous operation for economy—both assured by distinctive features of this popular tool grinder.

Extra long, self oiling bearings, vertical centrifugal pump, balancing blocks on flanges, our patent belt tightener—which permits the use of endless belts—and other features fully described in the catalog.



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14, 20 and 30 Inches.
20 and 30 Inch Models have Truing Device.

J. G. BLOUNT COMPANY
EVERETT MASS., U. S. A.

You Wouldn't Team a Mule and a Thoroughbred!

Neither should you nullify the effect of a high-priced grinding machine by using an indifferent, "balky" wheel.

STAR
Grinding Wheels

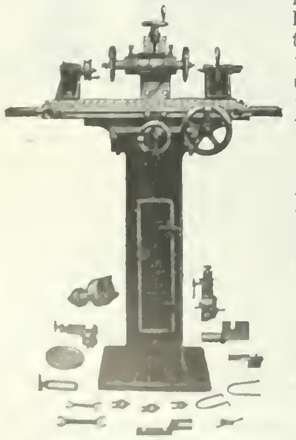
work in perfect accord with the grinder; accuracy and evenness of performance are characteristic features.

All shapes, grades and sizes listed in our catalog.

STAR CORUNDUM WHEEL CO.
DETROIT, MICHIGAN

DRAPER & HALL
Universal Grinders

Are what their name implies—*universal.* They are particularly free from vibration, due to the stability of the work table (which is placed directly over the center of the column) and the unusual heaviness of the longitudinal slide.



Rigid, simple and compact, these machines handle internal and surface grinding within their range accurately and economically.

Interchangeable attachments a feature.

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The DRAPER & HALL COMPANY
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"WILLEY"
Portable Electric TOOLS

simplify inconvenient jobs

Let Us Tell You How

JAMES CLARK, Jr., ELECTRIC CO.
INCORPORATED
522 W. Main Street, Louisville, Kentucky
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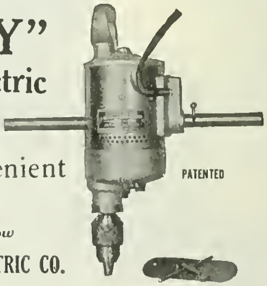
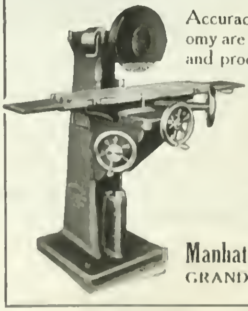


"WILLEY" TOOLS ALWAYS CORRECT ELECTRICALLY—MECHANICALLY

Get the Best in a Surface Grinder



Accuracy, speed, convenience and economy are essentials. Add to these power and production and there you have the

"MANHATTAN" Surface Grinder

Other good points are oversize bearings and feed dials graduated to thousandths. Circular for details.

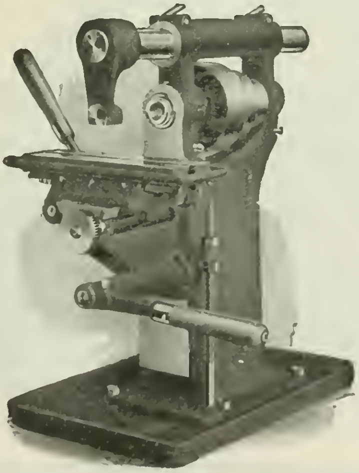
Manhattan Machine & Tool Works
GRAND RAPIDS MICHIGAN

Though we are carrying a large stock of "MaxF" Wheels, in styles and sizes to meet every requirement, the demand for these economical and dependable wheels is such that for prompt delivery we recommend you to place your order now. Catalog on request.

MAXF GRINDING WHEEL CORP.
CHESTER, MASSACHUSETTS

CHICAGO AGENTS: Hoffman & Meyer, 15-17 South Clinton Street.
ST. LOUIS AGENTS: St. Louis Grinding Wheel Co., 2400 N. Tenth Street.

Burke Bench Milling Machine



Reliability and convenience are cleverly combined in this small machine. Compact, rigid, and a rapid producer of accurate work, this Burke No. 3 is one of the most satisfactory small work machines on the market. Our line of milling, drilling and tapping machines, etc., is complete and all "Burke Standard."

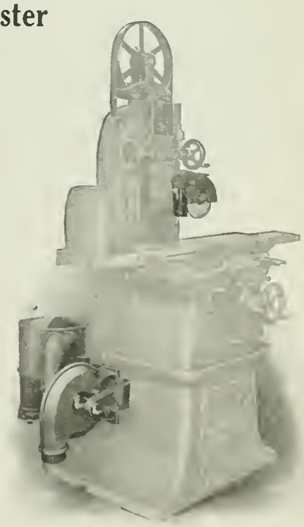
CATALOGUE?

THE BURKE MACHINE TOOL CO., Conneaut, Ohio

The Abrasive Grinder

with Exhauster Attachment

The attachment shown has a centrifugal dust separator and the special hood is equipped with adjustable dust guard.



Particulars on request

ABRASIVE MACHINE TOOL CO.
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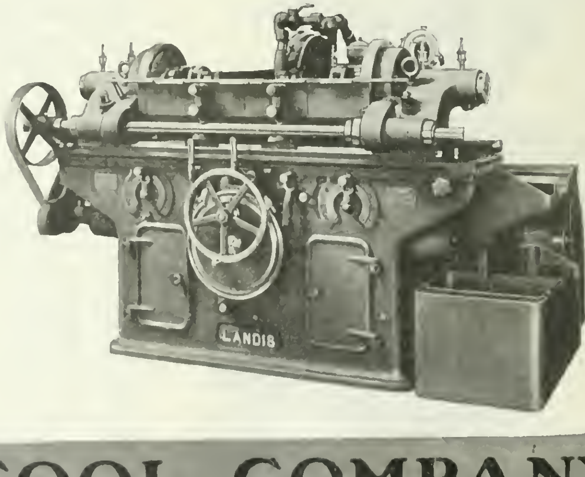
Airplane Crankshafts

Airplane Crankshafts are accurately ground on LANDIS Crankshaft Grinding Machines.

The LANDIS is especially adapted to fulfill the demand of the airplane program for big production of accurate crankshafts. Constructed so that the work is supported in clamping holders and not compressed between centers, there is no end pressure to cause buckling or distortion. The crank is driven from both ends.

If you grind crankshafts send us your drawings—we'll tell you the rest of the story.



LANDIS TOOL COMPANY

NEW YORK OFFICE
50 Church St.

Main Office and Works, WAYNESBORO, PA.

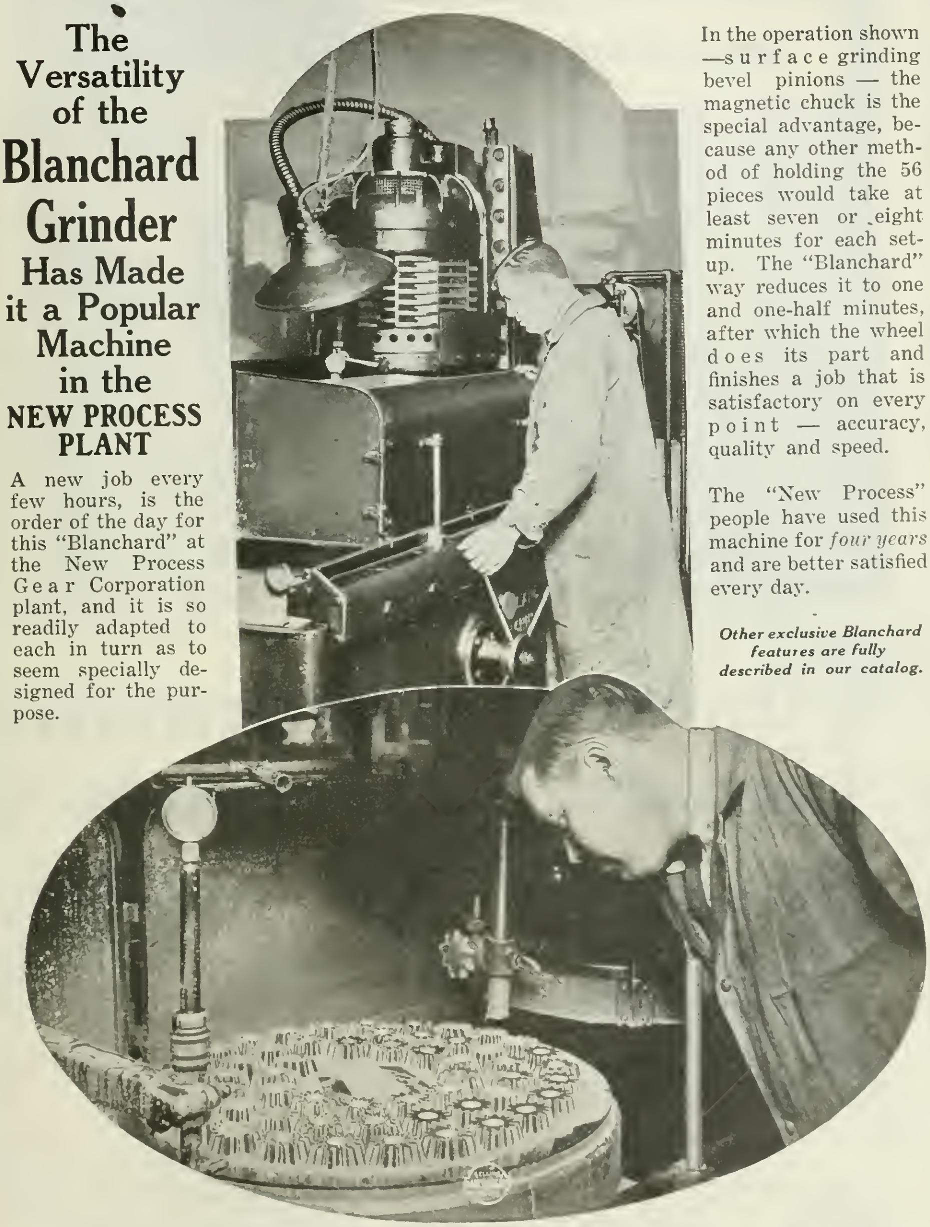
AGENTS: Dewatre Machine Co., Birmingham, Ala. Harron, Rickard & McCone, San Francisco and Los Angeles.

Universal Grinding Machines
Internal Grinding Machines
Plain Grinding Machines
Crank Grinding Machines
Roll Grinding Machines
Cam Grinding Machines

"*Blanchardized*" Bevel Pinions

The Versatility of the Blanchard Grinder Has Made it a Popular Machine in the NEW PROCESS PLANT

A new job every few hours, is the order of the day for this "Blanchard" at the New Process Gear Corporation plant, and it is so readily adapted to each in turn as to seem specially designed for the purpose.



In the operation shown—surface grinding bevel pinions — the magnetic chuck is the special advantage, because any other method of holding the 56 pieces would take at least seven or eight minutes for each set-up. The "Blanchard" way reduces it to one and one-half minutes, after which the wheel does its part and finishes a job that is satisfactory on every point — accuracy, quality and speed.

The "New Process" people have used this machine for *four years* and are better satisfied every day.

Other exclusive Blanchard features are fully described in our catalog.

THE BLANCHARD MACHINE COMPANY

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CAMBRIDGE, MASS., U. S. A.

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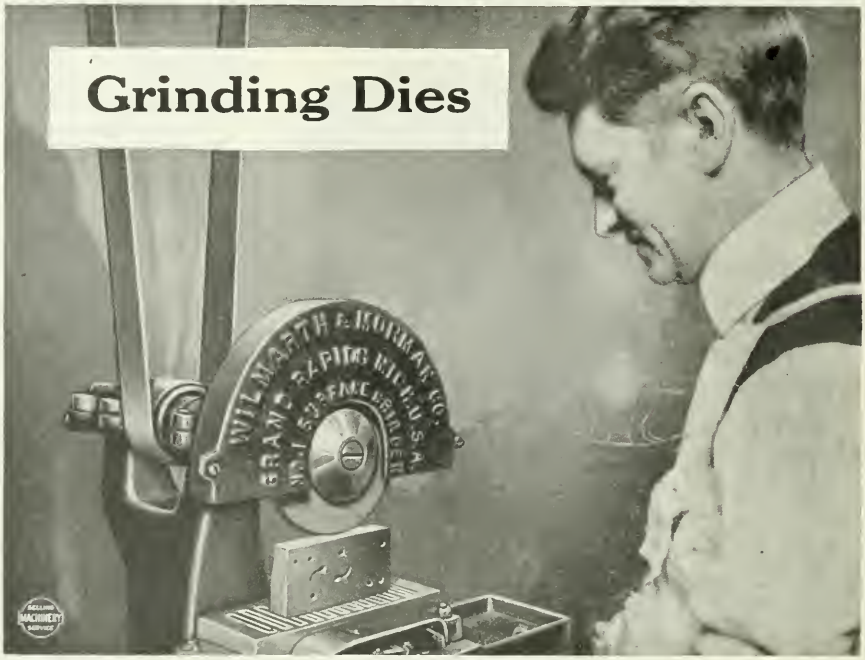


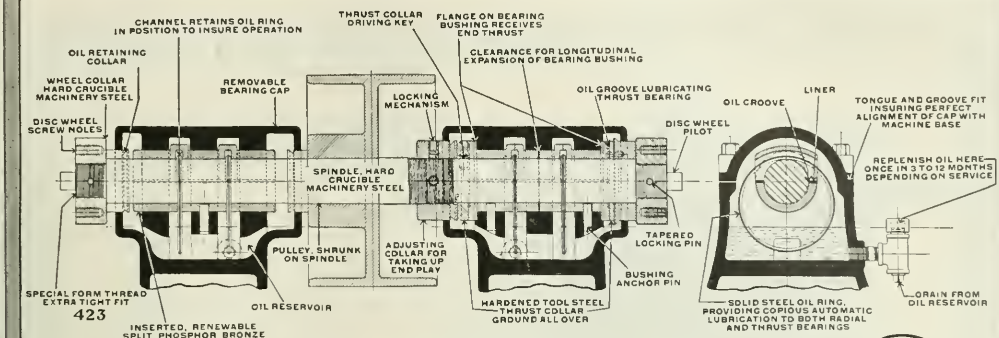
Wilmarth & Morman Grinding Machines

There are several things worth seeing in Hartford in addition to Connecticut's handsome capitol building. Hartford is known as a training ground for good mechanics. Work produced in this city is known for its quality. Tools and machines made here are used all over the world. And in this mechanical center the N & W Tool Company have built an enviable reputation as makers of tools, jigs, dies, etc., etc. Mr. Nielsen picks his machines carefully and says there is no better grinder than the Wilmarth & Morman. It is the most popular machine in the shop—and one of the most profitable.

Let us tell you more about it

WILMARTH & MORMAN CO.
1180 Monroe Avenue, N. W.
GRAND RAPIDS MICHIGAN, U. S. A.

Manufacturers of Drill Grinders, Surface Grinders, Universal Grinders


CHANNEL RETAINS OIL RING IN POSITION TO INSURE OPERATION
THRUST COLLAR DRIVING KEY
FLANGE ON BEARING BUSHING RECEIVES END THRUST
OIL RETAINING COLLAR
CLEARANCE FOR LONGITUDINAL EXPANSION OF BEARING BUSHING
WHEEL COLLAR HARD CRUCIBLE MACHINERY STEEL
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OIL GROOVE LUBRICATING THRUST BEARING
LINER
OIL CROOVE
TONGUE AND GROOVE FIT INSURING PERFECT ALIGNMENT OF CAP WITH MACHINE BASE
DISC WHEEL SCREW NOLES
DISC WHEEL PILOT
REPLENISH OIL HERE ONCE IN 3 TO 12 MONTHS DEPENDING ON SERVICE
SPINDLE, HARD CRUCIBLE MACHINERY STEEL
TAPERED LOCKING PIN
PULLEY, SHRUNK ON SPINDLE
ADJUSTING COLLAR FOR TAKING UP END PLAY
BUSHING ANCHOR PIN
SPECIAL FORM THREAD EXTRA TIGHT FIT
OIL RESERVOIR
HARDENED TOOL STEEL THRUST COLLAR GROUND ALL OVER
SOLID STEEL OIL RING, PROVIDING COPIOUS AUTOMATIC LUBRICATION TO BOTH RADIAL AND THRUST BEARINGS
DRAIN FROM OIL RESERVOIR
INSERTED, RENEWABLE SPLIT PHOSPHOR BRONZE BEARING BUSHING

423

BESLY SPINDLE CONSTRUCTION

PATENT APPLIED FOR

BESLY CHICAGO

The Greatest Advance in Disc Grinder Design in Fifteen Years

THE BESLY DUST PROOF AUTOMATIC RING-OILING SPINDLE CONSTRUCTION

Maximum Stability *Maximum Durability*
Maximum Reliability
Minimized Frictional Resistance with Minimum Attendance

OIL WELLS, OIL RINGS

Oil wells are especially large capacity; that on the No. 17 BESLY GRINDER with 2½" diameter spindle being 7" deep.

Two extra large diameter solid steel oil rings are provided for each bearing. These oil rings operate through channels in bearing bushings so designed that it is impossible for the rings to become displaced and fail to function.

OIL CHANNELS

A perfect "flood" of oil is continuously transmitted to Radial and Thrust bearings while grinder is running. The oil channels in faces of thrust bearings are of a special design which sets up a pumping action—forcing the oil copiously between the thrust collars.

BEARING BUSHINGS

Bearing bushings are split, inserted and renewable; of a special Phosphor Bronze. Bearing surfaces are of such large proportions that there is practically no wear.

THRUST PROVISION

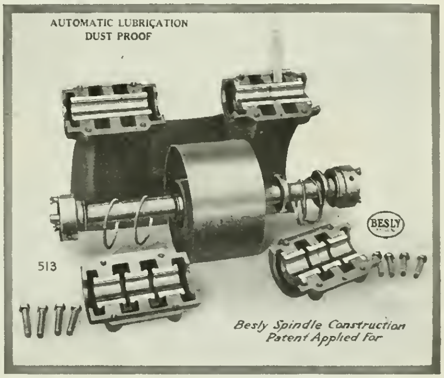
End thrust is taken on hardened and ground tool steel collars against the flanged ends of right-hand bearing bushings. End play is taken up easily, accurately and quickly by means of adjusting collar threaded on spindle and located under rim of spindle pulley.

ALL END PLAY TAKEN UP

The BESLY GRINDER may be safely operated with all end play taken up in spindle. The Bronze Bearing Bushing which receives the end thrust is provided with clearance to compensate for any expansion which may take place in the bushing. Therefore, it is impossible for this bearing to bind between the thrust collars and seize.

This is a very important feature, as any looseness or end play in spindle will naturally affect the accuracy of the work to be ground.

AUTOMATIC LUBRICATION
DUST PROOF



Besly Spindle Construction
Patent Applied For

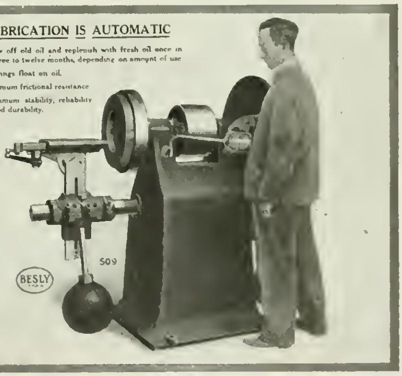
LUBRICATION IS AUTOMATIC

Draw off old oil and replenish with fresh oil once in three to twelve months, depending on amount of use

Bearings float on oil.

Minimum frictional resistance

Maximum stability, reliability and durability.



INSIST ON BESLY GRINDERS

BESLY
CHICAGO

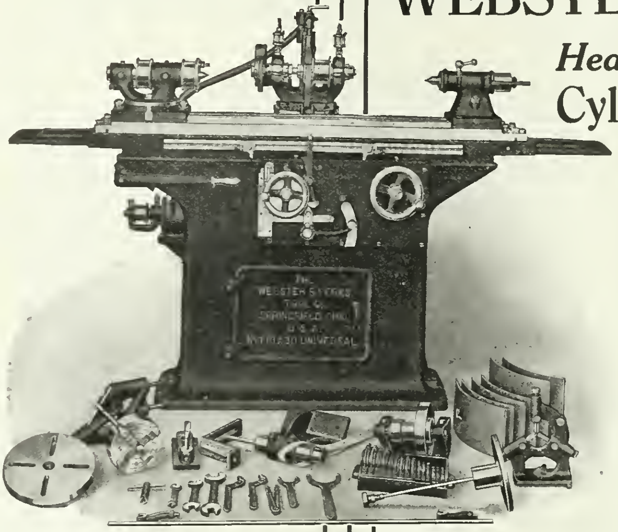
CHARLES H. BESLY & CO.

Originators of Disc Grinders

120B North Clinton Street, CHICAGO, ILL., U.S.A.

WEBSTER & PERKS

Heavy Duty Universal Cylindrical Grinder

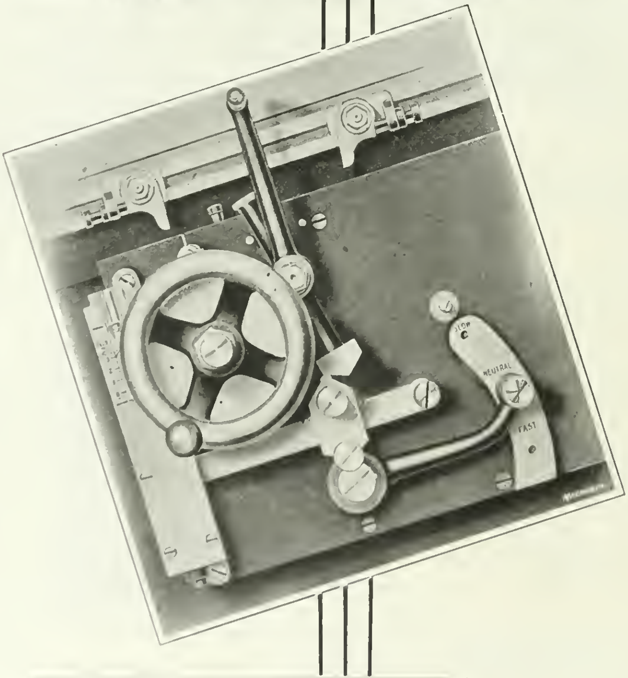


A Machine of Unusual Features

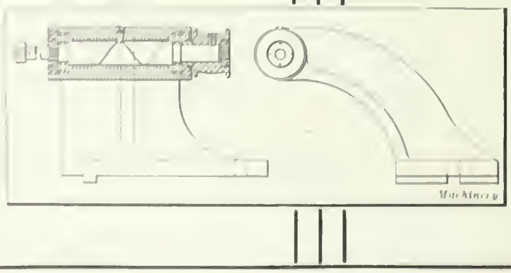
The new No. 1 (10" x 30") W & P Universal Cylindrical Grinder has a simple, positive automatic cross feed which provides a safe means of feeding the wheel at any predetermined point. Micrometer adjustment from 0.00025" to 0.004" is quickly obtained by simply turning knurled nut.

Hyatt Roller Bearing Countershaft is furnished, meaning lower power consumption and longer life for the countershaft; internal grinding attachment and counter-bracket, as well as dead center pulley, equipped with adjustable ball bearings; extremely rigid sliding table; heavy and uncommonly long head stock and head stock base.

Center illustration shows feed mechanism of this new machine; diagram below, the internal grinding attachment.



Let us send all the details on this modern Cylindrical Grinder. Twenty-five years of experience in grinding machine construction guarantee the correctness of this latest model.



The Webster & Perks Tool Co.
Springfield Ohio, U. S. A.
P. O. Box 1301

ALUNDUM
POLISHING GRAIN
HITS THE MARK

SCORES HIGH IN A VAST NUMBER OF COMPETITIVE TESTS WITH EMERY AND OTHER ABRASIVES

It
Rings the
Bulls-Eye
of Superior
Performance

NORTON COMPANY
WORCESTER, MASS.

NEW YORK STORE
151 Chambers Street

ELECTRIC FURNACE PLANTS
Niagara Falls, N. Y. Chippawa, Ont., Canada

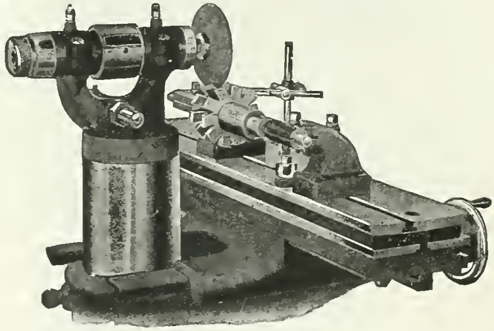
CHICAGO STORE
11 N. Jefferson St.

Universal in the correct sense of the word. It handles *all* work within its range.

Greenfield

TRADE MARK REG. U.S. PATENT OFFICE

A strong, rigid, accurate and convenient grinder. An ideal machine for any tool room.



The "Quick Change" Universal Grinder

Set-ups on the Greenfield Universal Grinder—21 in all—may be quickly and easily changed to accommodate work. This is an important feature in the busy tool room. Changes provide for grinding straight, taper and rose reamers; flutes of taps, tapered arbors, flat keys, gauges, flat bar work, slitting saws, small internal work, countersinks and counterbores; spur, bevel, spiral, formed, and end milling cutters; angular, small end, gear, convex and inserted tooth cutters.

GREENFIELD MACHINE CO.
Greenfield Mass., U.S.A.

GM

DETROIT WHEELS

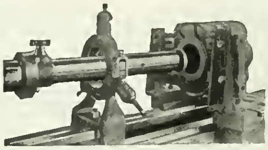
"Give the best possible results from a given amount of time and cost."

Turned, Trued and Balanced

The wire web construction of Detroit Grinding Wheels makes them just that much stronger and better adapted to resist centrifugal strain. They are uniform, made in all grades in a range of shapes and sizes to meet every grinding requirement. Cool, free cutting, long wearing wheels which can be absolutely duplicated.

Write us your needs

Detroit Grinding Wheel Company
Detroit Michigan, U. S. A.



Perfection CYLINDER GRINDER

A durable, economical attachment for cylindrical grinding on hollow spindle lathes with a swing not under 14".
A self-centering device and micrometer attachment permit extremely accurate grinding.

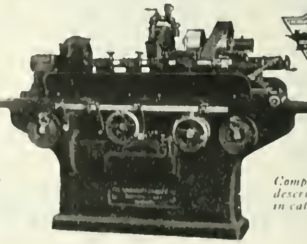
Capacity Model "A" from 2" to 6½". Model "T" from 6" to 12" diameter. Circular.

WOOD & SAFFORD MACHINE WORKS
GREAT FALLS MONTANA

The "CINCINNATI"

A Heavy Duty Manufacturing Grinder

Made in eight sizes — 12" x 36" to 16" x 80". Box section, heavily ribbed base. Spindle of special analysis steel is hardened, ground and lapped and runs in phosphor bronze boxes.



Complete description in catalog

The Cincinnati Grinder Co., Cincinnati, Ohio, U. S. A.

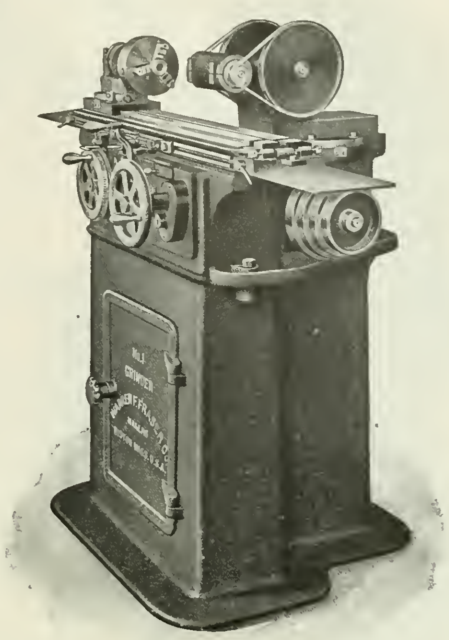
The Fraser Universal Grinding Machine

Accurate, speedy, efficient, this adaptable machine will handle any class of grinding not requiring special features.

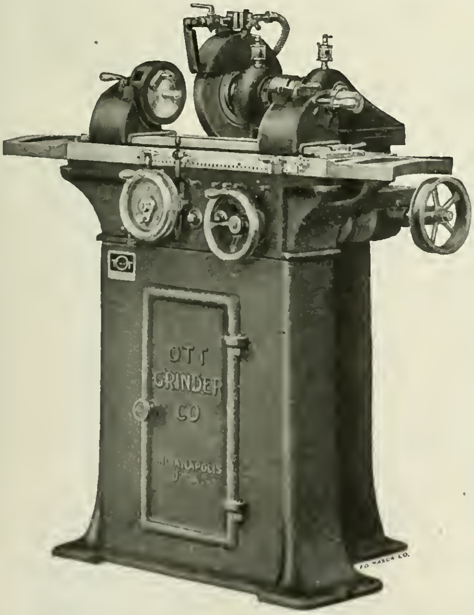
It is an ideal machine for the all-round shop where grinding needs are varied. Easily convertible for cylindrical, surface or internal grinding, it embodies a small grinding department in itself and each separate job is evidence of its ability for accurate finished work.

Let us explain the possibilities of the Fraser Universal Grinding Machine

The Warren F. Fraser Co.
FACTORY AND GENERAL OFFICES
Westboro, Mass., U. S. A.
BOSTON BRANCH: 201 Devonshire Street



Capacity: Cylindrical work, 8"x20"; Flat work, 5"x20"; Internal Grinding up to 8" outside diameter.



OTT GRINDER COMPANY
217 West Tenth Street
INDIANAPOLIS, IND., U. S. A.

The New Ott 5"x18"

For a Bigger, Better Output of Straight or Taper Cylindrical Parts

THIS new Ott Grinder is particularly well adapted for the economical production of large quantities of small duplicate straight or taper cylindrical parts requiring close limits.

It has automatic feeds, Non-Gran bearings, massive wheel stand, head and foot stocks, large self-feeding oilers and adjustable universal back rest and Hyatt roller bearing countershaft.

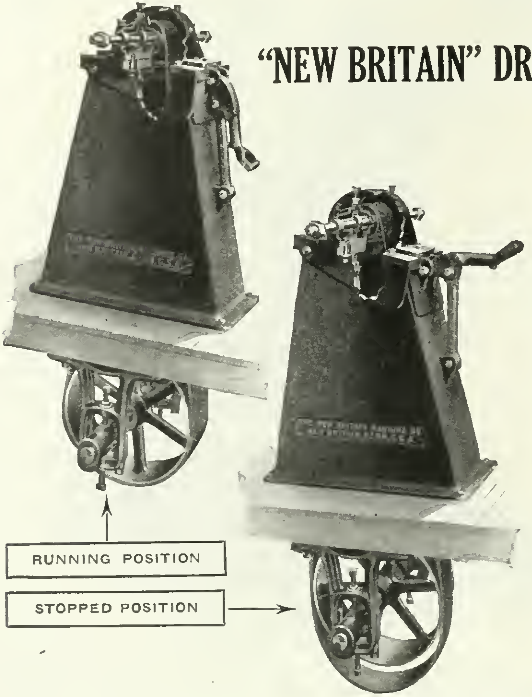
It is capable of handling a big percentage of work now being ground on larger and higher priced machines. It requires but 31" x 68" floor space and effects further savings in power, time and labor.

Get all the Details at Once

Less *Power*, Less *Floor Space*, Less *Care*

are required by

"NEW BRITAIN" DROP-HEAD POLISHING MACHINES



INCREASED cost and the difficulty of obtaining fuel are giving fresh impetus to the elimination of power losses. Demands for increased output call for plant enlargement, unless more efficient machinery is available. Labor shortage is directing the attention of factory managers toward those products which are designed with a view to time and labor-saving in their operation and upkeep.

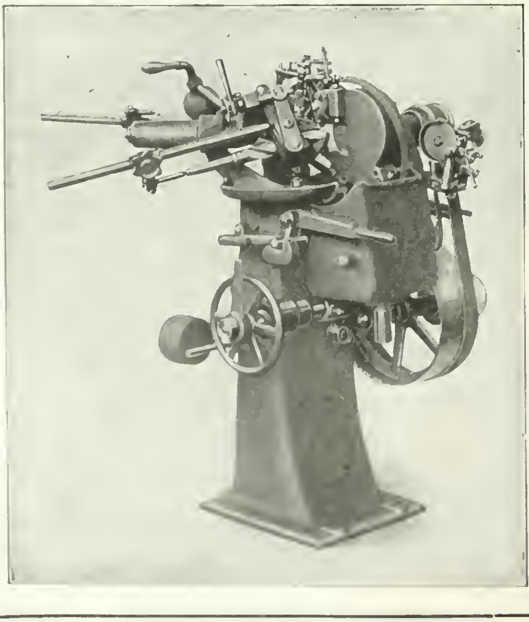
The "New Britain" Drop-Head Polishing Machine, by reason of its elimination of idlers, loose pulleys, and shifting belts, very considerably reduces the power consumption. Twice as many of these machines can be installed in a given floor space as may be accommodated of the back-belted type. The enclosed belt, protected against dust, oil and moisture, and provided with means for tightening without shortening; self-aligning, self-oiling bearings; and the quick-starting quick-stopping feature, combine to make the "New Britain" a great time and labor saver.

Made in floor and bench types, with either plain or ball bearings. Write for Bulletins No. 1225 and No. 1226.

"Built Like a Machine Tool"

The New Britain Machine Company
"Shop Furniture Originators" NB New Britain, Conn. U.S.A.

William Sellers & Co., Incorp. Philadelphia, Pa.



LABOR SAVING MACHINE TOOLS

If you want to reduce the cost of sharpening your drills, increase their output and improve their condition

Install a Sellers Drill Grinder in your tool-room

Drills correctly ground and pointed by it do much more work before regrinding, feed easier and cut faster than when sharpened in any other way.

It does not require a mechanic to grind a perfect drill. Operated by a boy or handy man, it will soon pay for itself in the decreased cost of sharpening, to say nothing of the improved condition of your drills.

Shafting—Injectors
Tool Grinding Machines

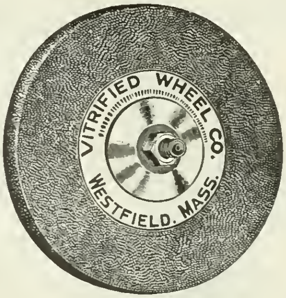
Back of Vitrified Wheels

is the knowledge that comes from long experience in selecting and grading abrasives, compounding bonding mixtures and proportioning, forming and baking the wheels;

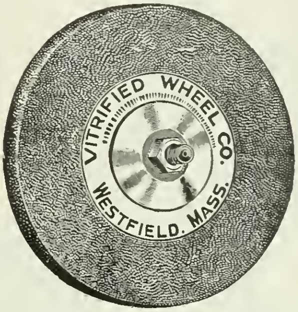
BUT—

Vitrified Wheel Service does not end there. Our knowledge and experience are always at your disposal. Our catalog is complete and contains much useful data; but don't hesitate to write us should you need further cooperation in selecting the wheel to meet your particular requirements.

VITRIFIED WHEEL CO.
WESTFIELD MASSACHUSETTS, U. S. A.



VITRIFIED



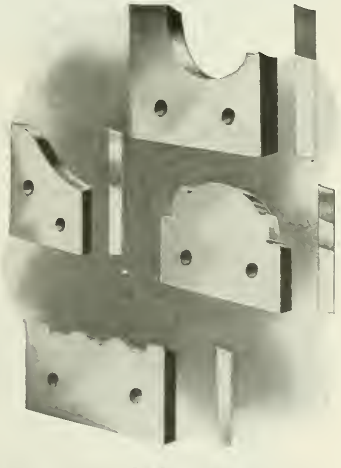
FISCHER PROFILE GRINDING MACHINES

Best Where Flat Irregular Shapes Are Ground

The Baldwin Locomotive Company uses 34 Fischer Profile Grinding Machines in one department. They are of great value in grinding practically any shape or contour and automatically providing the desired amount of clearance.

In producing exact duplicates in quantity they are unsurpassed for speed, accuracy and economy.

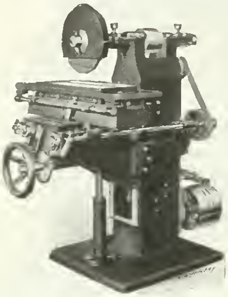
Let us send all the particulars.



FISCHER MACHINE COMPANY
PHILADELPHIA, PA.

DOMESTIC AGENTS: Charles A. Strelinger Co., Detroit, Mich. FOREIGN AGENTS: Coats Machine Tool Co., Ltd., Thanet House, Strand, London, Glasgow and Newcastle-on-Tyne. Aux Forges de Vulcain, Paris, France. Yamatake & Co., Tokio, Japan. Henry Coe & Clerici, Milan, Italy.

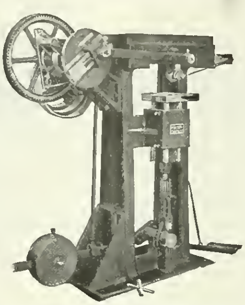
Noble & Westbrook Machines



For Finishing

This is the new Noble & Westbrook Automatic Surface Grinder. Working parts are thoroughly protected from abrasive dust. Simple adjustments. Feed screw dials are graduated to .001″. Capacity 8″ x 20″.

See catalog on complete line of grinders and polishers



For Marking

The Dwight Slate Marking Machine cuts a clean, permanent name or trademark in any material suitable for impressions. Catalog No. 5 contains list of prominent users.

Complete steel lettering and die engraving department.

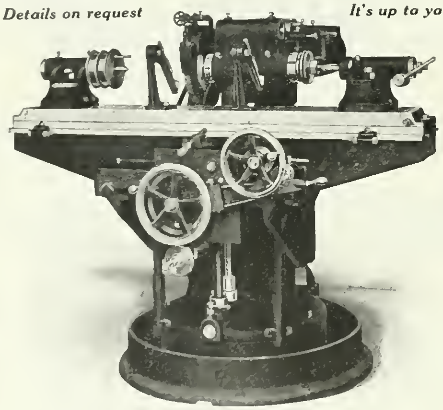
NOBLE & WESTBROOK MFG. COMPANY
19 ASYLUM STREET HARTFORD, CONNECTICUT

For Immediate Delivery

The Thompson Grinder

Consider the advantage of having this universal grinder added to your toolroom equipment "immediately." Designed on the stationary head principle, with rotating column and swivel table—quickly adjusted for any form of plain, surface, edge, die, cutter and internal grinding. An asset in any shop—a godsend to an overworked toolroom.

Details on request *It's up to you*



Full description in catalog

THE THOMPSON GRINDER CO.
Springfield, Ohio, U. S. A.

EMERY WHEEL DRESSERS

No. 0 For Small Wheels **No. 2 For Large Wheels**

NO. 1 FOR REGULAR SHOP USE

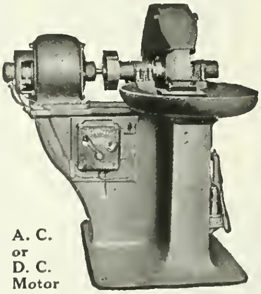
These Dressers in connection with our Cutters make a most powerful and efficient tool, especially our No. 0 for small wheels 6 inches and under, and No. 2 which is made proportionately larger and stronger for large wheels.

CUTTERS

We make the regular "Huntington" (pattern) for No. 0 and "Huntington" (pattern) Paragon Cutter and Roughing Cutter for Dresser No. 1 and the "Huntington" (pattern) and Roughing Cutters for Dresser No. 2. Let us send you descriptive circular and prices.

GEO. H. CALDER, Lancaster, Pa., U. S. A.

Bridgeport Belt and Motor Driven Grinders



A. C.
or
D. C.
Motor

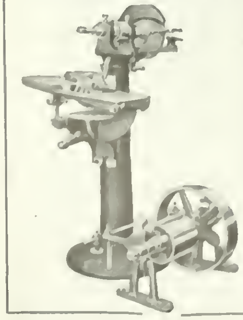
—wet, dry or combination of both—cup, ring wheel, knife, etc.—meet all tool room requirements.

This Motor Driven Wet Tool Grinder is rigid, well balanced, made in five sizes, for 14 to 42 inch wheels—as pictured or with drop bowl for grinding long tools.

Write us

THE BRIDGEPORT SAFETY EMERY WHEEL CO., INC.
Bridgeport Conn., U. S. A.

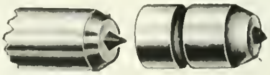
THE WATERBURY GRINDER



Strong, speedy, accurate, economical, durable — more adjectives *could* be used, but it is simpler to say—dependable—for the Waterbury Grinder is just that. A *dependable* machine for tool or surface grinding and a genuine economy in the shop.

Circular ?

The Blake & Johnson Co.
WATERBURY, CONN., U. S. A.



End View

FRANCIS

Diamond Grinder Tools

for truing emery and carborundum wheels are giving great satisfaction everywhere because of the hard and high quality diamonds used. They will keep your abrasive wheels in good cutting condition.

Ask for descriptive circular and let us send you an assortment for selection.

FRANCIS & CO.

50 State St.,
Hartford,
Conn., U. S. A.

Established in 1799
First National Bank
Bldg

End View

The Price of Diamonds

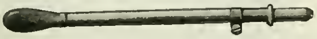
DESMOND-STEPHAN MFG. CO.
GRINDING WHEEL DRESSERS
URBANA OHIO

for dressing Grinding Wheels is becoming almost prohibitive.

DIAMO-CARBO
Emery Wheel Dressers

are an inexpensive and effective substitute for the black diamond—and will do the same work at a price that permits a dresser for each wheel. Wearing qualities are unsurpassed, upkeep is nil and there is a decided saving from all standpoints.

Will you try one at our expense ?



No. 3—10 inches long, $3.50

No 5—12 inches long, $4 00

THE DESMOND-STEPHAN MFG CO.
URBANA OHIO, U. S. A.

Alfred Herbert, Ltd., Coventry, Agents for Great Britain. The Canadian Desmond-Stephan Mfg. Co., Ltd., Hamilton, Ont., distributors for Canada.

PRODUCTION
SURFACE GRINDER

Adjustable Taper Spindle
All Surfaces Hand Scraped
Graduated Feeds

Surface of Platen 15 x 5 in.
Traverse Movement 8 in.
Vertical Movement 9 in.
Stone 6 x ½ x ½ in.
Speed of c/shaft 400 r. p. m.
Weight 435 lbs.

$150.00

Write for Catalog.

New Jersey Machinery Exchange
Newark New Jersey, U. S. A.

NEW SELF-LUBRICATING

EMERY WHEEL DRESSER and CUTTERS

"We have found it the most economical and efficient device we have used for the purpose."
THE FAVORITE STOVE AND RANGE CO.,
Piqua, Ohio.

THE HETHERINGTON CO., Piqua, Ohio
Geo. W. Goodchild & MacNab, London, Eng., Agents for Great Britain

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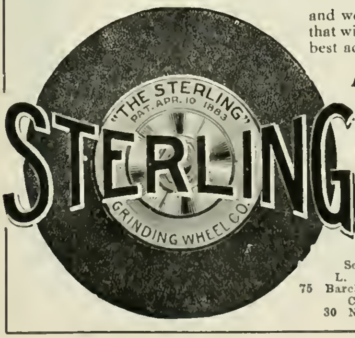
TELL US WHAT YOU GRIND



and we'll pick the wheel that will do your work to best advantage—

A STERLING
Grinding Wheel

fast, free-cutting and economical of power. *Catalog?*

THE STERLING GRINDING WHEEL COMPANY, TIFFIN, OHIO

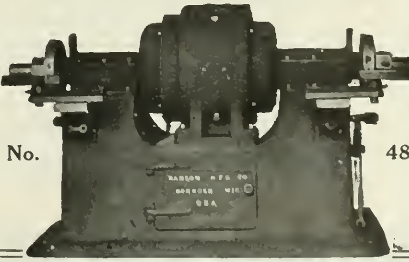
Selling Agency:
L. Best Company,
75 Barclay St., New York,
Chicago Store:
30 North Clinton St.

RANSOM GRINDERS

Motor driven, they save power, cost and upkeep of transmission equipment and are readily installed or relocated.

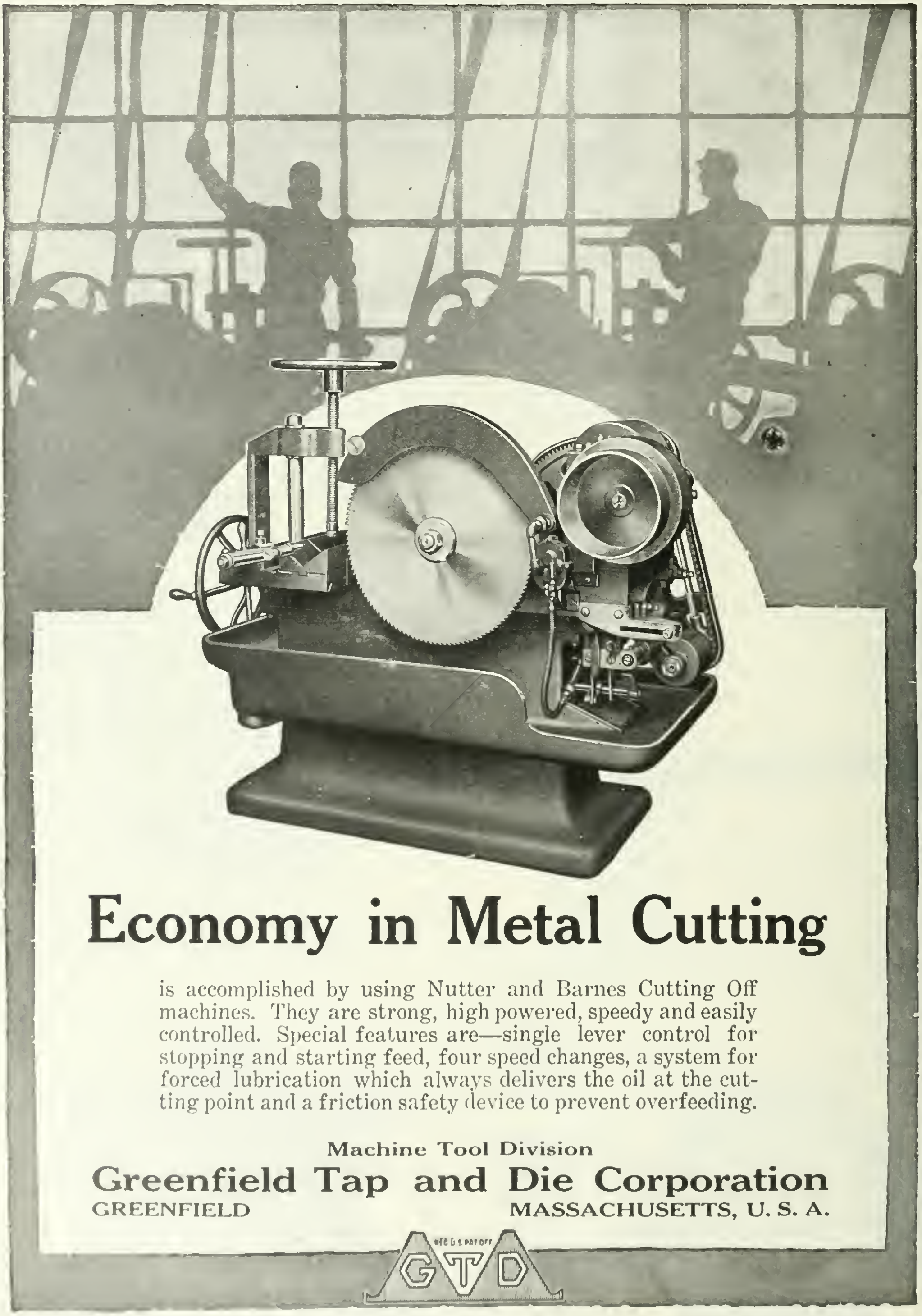
No. 48, for extra heavy duty, is of massive proportions. High carbon steel arbor, with ring oiling, dust proof boxes, maintains true alignment, and our Patent Speed Controller prevents wheels over-speeding. Ideal for steel foundry work and similar severe service—a well liked model of a popular line.

Complete Catalog on Request



No. 48

RANSOM MANUFACTURING CO.
OSHKOSH WISCONSIN, U. S. A.



Economy in Metal Cutting

is accomplished by using Nutter and Barnes Cutting Off machines. They are strong, high powered, speedy and easily controlled. Special features are—single lever control for stopping and starting feed, four speed changes, a system for forced lubrication which always delivers the oil at the cutting point and a friction safety device to prevent overfeeding.

Machine Tool Division
Greenfield Tap and Die Corporation
GREENFIELD MASSACHUSETTS, U. S. A.

REG U S PAT OFF
GTD

No. 107 "Wells"
Manufacturers' Lathe

JUST THE THING!

Solves the problem of employing unskilled labor for turning out quantities of small brass parts.

The hand turret and cross carriage permit the completion of several operations without removing the parts. The stock is fed by a hand lever. There is nothing to get out of order.

It is easily operated—a very important feature where women are employed.

Write for Particulars and New Machine Tool Catalog No. 39.

MACHINE TOOL DIVISION
Greenfield Tap and Die Corporation
GREENFIELD MASSACHUSETTS, U. S. A.

BLUE CHIP STEEL

We've tried to make our advertising carry the conviction that Blue Chip High Speed Steel is uniform, dependable steel. If it does carry that conviction it has accomplished its purpose.

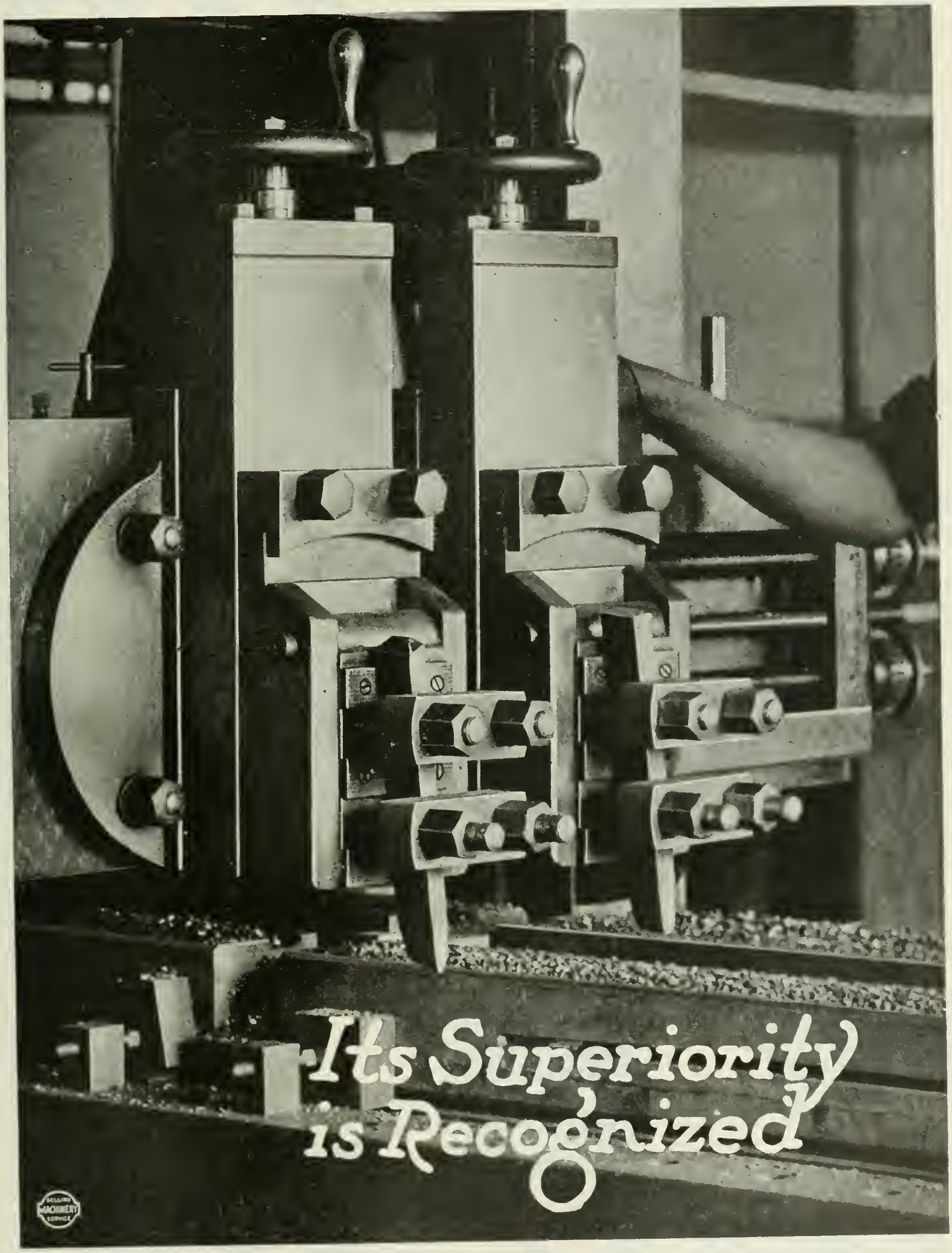
Blue Chip Steel needs no recommending in the plants where it is known. For years it has been used by concerns we all look upon as leaders—used for making all manner of cutting tools and to meet greatly varied requirements. And it has made good.

Give Blue Chip High Speed Steel the opportunity to convince you of its superiority. Write for more details.

FIRTH-STERLING STEEL CO.

McKEESPORT, PA., U. S. A.

BOSTON NEW YORK PHILADELPHIA CHICAGO CLEVELAND PITTSBURGH


Its Superiority
is Recognized

Tycos

PYROMETERS

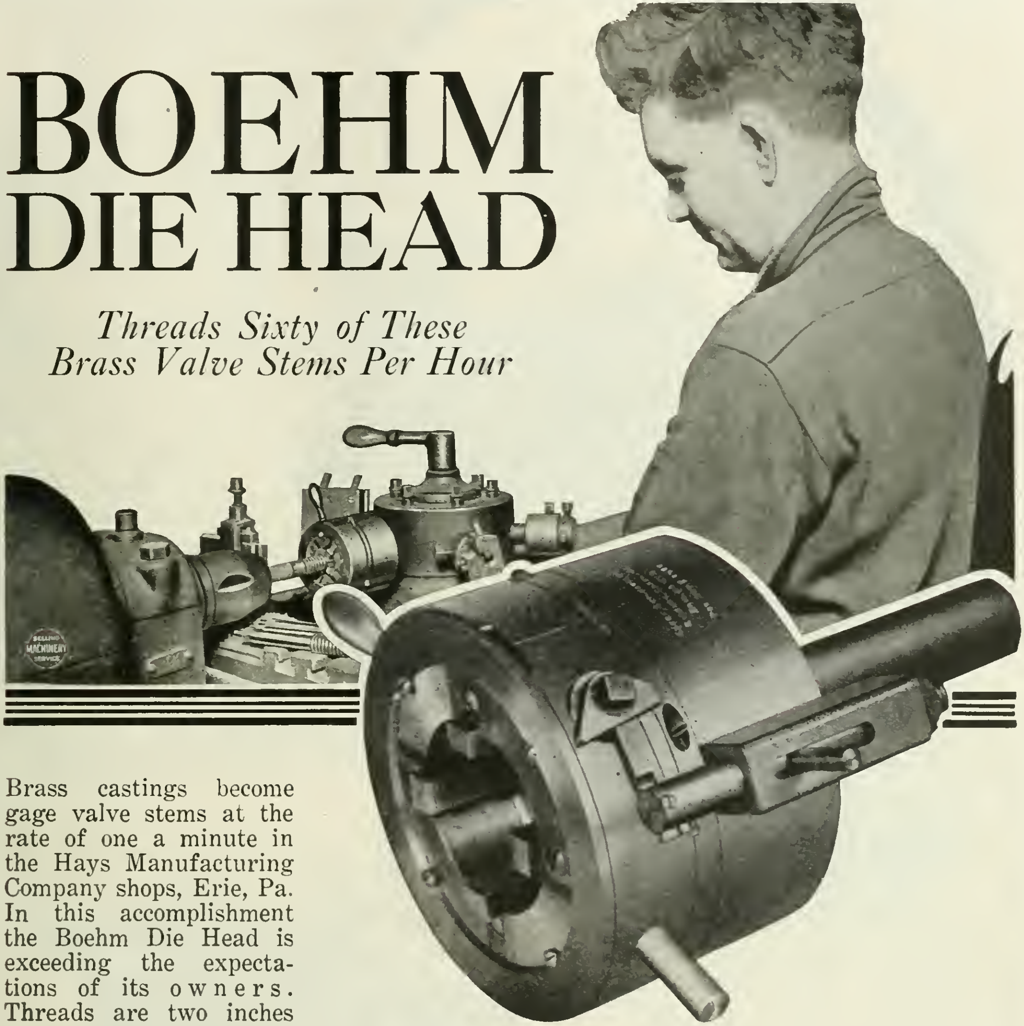
Preferred Investments

AVAIL YOURSELF OF OUR CATALOGS AND INFORMATION

The Taylor-Cambridge Division
Taylor Instrument Companies
Rochester, N.Y.

BOEHM DIE HEAD

Threads Sixty of These Brass Valve Stems Per Hour



Brass castings become gage valve stems at the rate of one a minute in the Hays Manufacturing Company shops, Erie, Pa. In this accomplishment the Boehm Die Head is exceeding the expectations of its owners. Threads are two inches long, six pitch, Acme, and are completed in one cut.

The Boehm Die Head is well made to "make good" under all conditions.

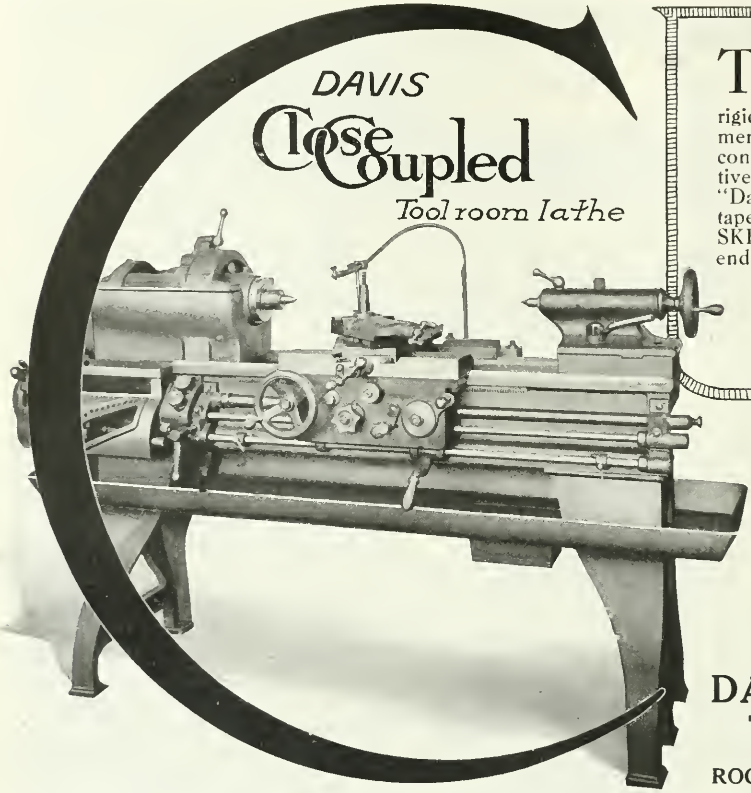
The Boehm Die Head found its stride in this concern more than two years ago and has stuck to it ever since. The scrap heap, conspicuous by its absence, makes this speed still more remarkable. Speed with precision is the Boehm characteristic.

The uniform method of securely holding the chasers makes for exact duplication. There's sound principle in the design; few parts in the construction. It is simple, accessible and economical.

Put a Boehm Die Head on your machine. It's a practical spur to laggard production. Do it now.

RICKERT-SHAFER CO., 612 W. 12th St., ERIE, PA.

New York Office: 50 Church Street



DAVIS Close Coupled Tool room lathe

THREE point support for a machine is a feature of importance in assuring rigidity and accurate alignment under varying working conditions. It is a distinctive feature of this 14¼ inch "Davis"—which also boasts taper spindle bearings, with SKF self-aligning ball bearing end thrust, reverse mechanism and automatic stop (contained in one rod) and other points equally interesting to discriminating manufacturers.

Hole in Spindle 1½"
Cone Diameter 4" to 9"

Cuts Threads 1½ to 80

Complete description on request

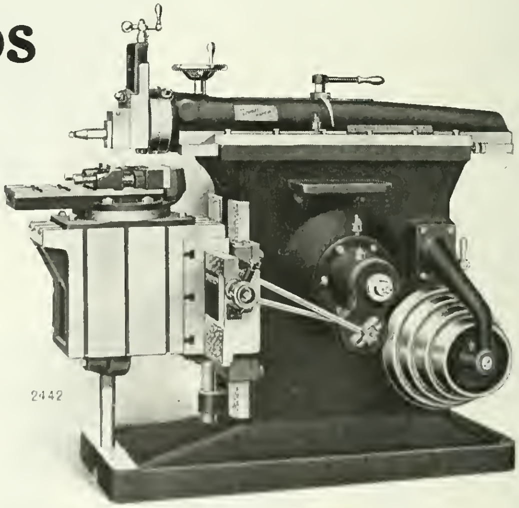
DAVIS MACHINE TOOL CO., Inc.
ROCHESTER, N. Y. U. S. A.

Tapered Gibs

Giving full length metal contact.

Endwise adjustable by single screw.

Our gibs do not rest on points of set screws, but flat against a solid bearing giving practically a solid metal contact.



Our Heavy Duty Shapers also have many other excellent features. Ask for our new Catalog J.

THE CINCINNATI SHAPER COMPANY
CINCINNATI, OHIO, U. S. A.

Our Improved

Gear Tooth Rounding Machine

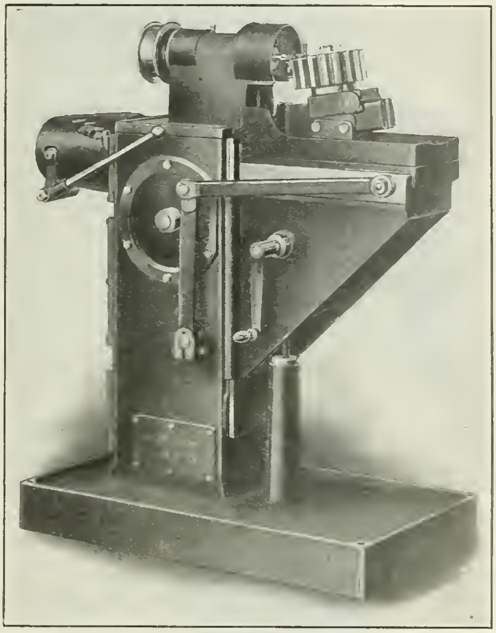
Is Quick, Accurate and Convenient

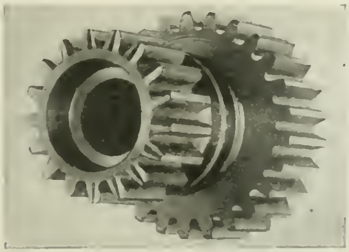
For rounding sliding gear teeth our new improved Gear Tooth Rounding Machine has no equal. It is fast, accurate and convenient.

Makers of machine tools, automobiles, tractors, etc., and gear contractors will find it an unusually profitable investment.

Anyone can operate it. It has few parts and is durably constructed for long, steady usage. It occupies but little floor space.

It has a capacity for any pitch from 2½ to 20; gears up to 30 inch diameter by 12 inch face.





THIS 17-TOOTH 5-PITCH GEAR ROUNDED IN 1 MINUTE 8 SECONDS FLOOR TO FLOOR TIME

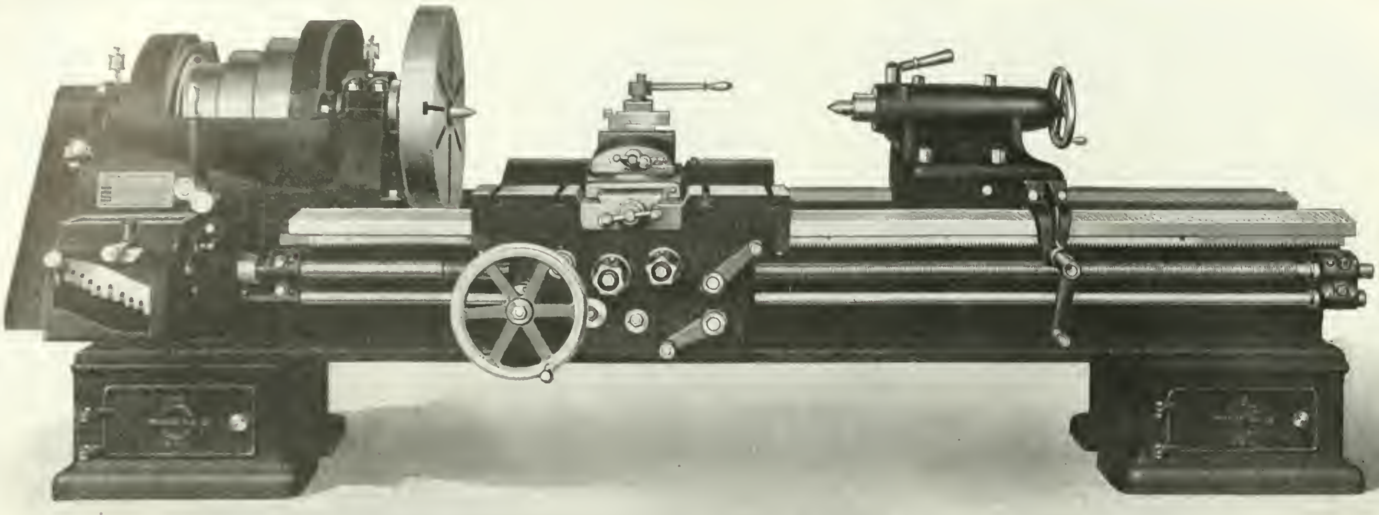
Here is Its Production Record

This machine will round 27 6-pitch chrome nickel gear teeth in one minute, other pitches at proportionately good speeds.

Let us send you further particulars. Write at once to insure early delivery.

CHAS. H. WALKER MACHINERY CO.

42-44 East Larned Street DETROIT, MICH., U. S. A.



MONARCH *24", 26", 28" and 30"* LATHES

Illustration above shows 24″ x 12′ lathe with quick change gears and double back gears.

Swing over shears 24¼″.
Hole through spindle 2⅛″.
Front spindle bearing 4⅝″ x 7 3/16″.
Back spindle bearing 3 x 4⅞″.
Diameter pulleys 11, 14, 17″.
Width belt 4½″.
Width carriage bridge 10½″.
Length carriage bearing on bed 34″.
Diameter tail spindle 3⅜″.
Countershaft equipped complete with Hyatt roller bearings; size pulleys 18″ x 6″.
Weight 8500 lbs.

Consult the Monarch Dealer nearest you regarding delivery and prices. Catalog on request.

THE MONARCH MACHINE TOOL CO.

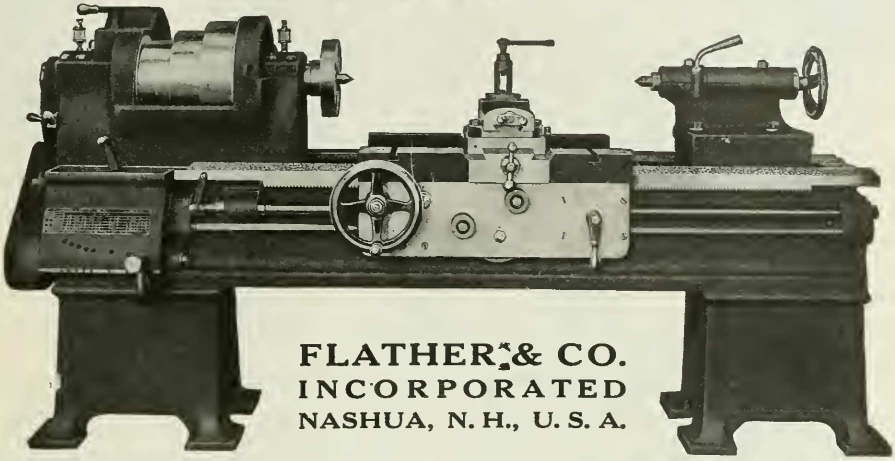
SIDNEY OHIO U. S. A.

DOMESTIC AGENTS: Lynd-Farquhar Co., Boston, Mass. Brownell Machinery Co., Providence, R. I. Purinton & Smith Co., Hartford, Conn. Kemp Machinery Co., Baltimore Md. Vandyck Churchill Co., New York City, N. Y. Morris Machinery Co., Newark, N. J. Syracuse Supply Co., Syracuse, Buffalo and Rochester. Simmons Machine Co., Albany, N. Y. Monarch Machinery Co., Philadelphia, Pa. J. S. Miller Machinery Co., Pittsburgh, Pa. W. M. Pattison Supply Co., Cleveland, O. Coghlin Machinery & Supply Co., Toledo, O. Patterson Tool & Supply Co., Dayton, O. Osborne & Sexton Machinery Co., Columbus, O. Vonnegut Machinery Co., Indianapolis, Ind. Greensboro Supply Co., Greensboro, N. C. Oliver H. Van Horn Co., New Orleans, La. Charles A. Strelinger Co., Detroit, Mich. McMullen Machinery Co., Grand Rapids, Mich. Federal Machinery Sales Co., Chicago, Ill. Badger Packard Machinery Co., Milwaukee, Wis. Northern Machinery Co., Minneapolis, Minn. Colcord Wright Machinery & Supply Co., St. Louis, Mo. English Tool & Supply Co., Kansas City, Mo. Sunderland Machinery & Supply Co., Omaha, Neb. Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo. Salt Lake Hdwe. Co., Salt Lake City, Utah. General Machinery Co., Spokane. Hallidie Machinery Co., Seattle. Eccles & Smith Co., Portland, San Francisco and Los Angeles.

"There's Something in a Name!"

FLATHER
LATHE

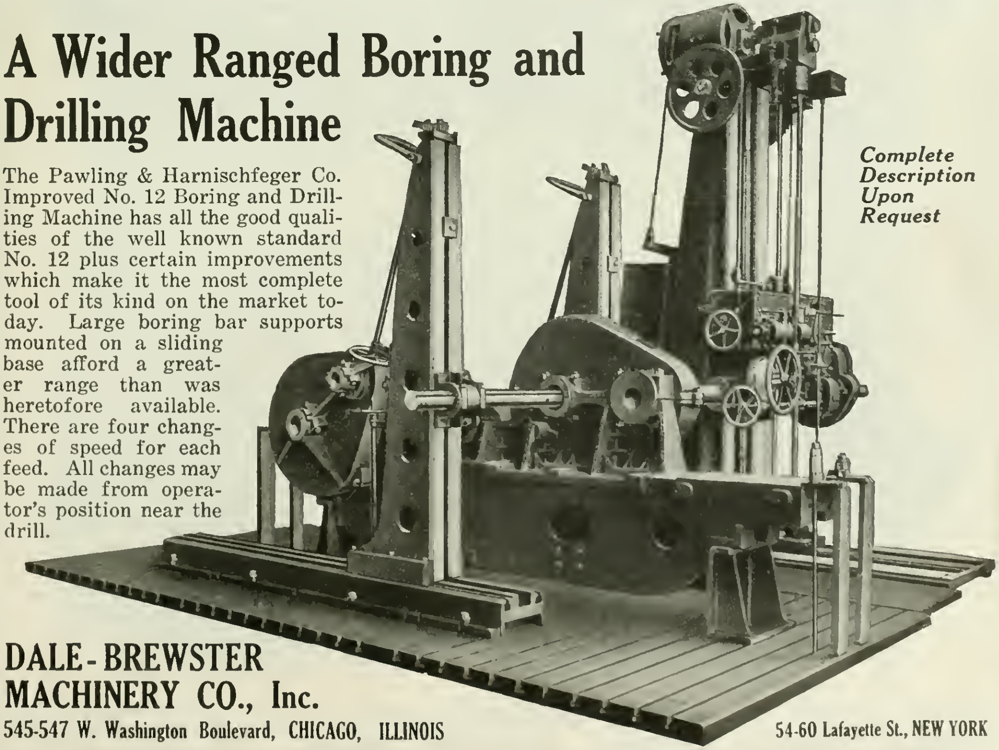
This 20″ Double Back Geared Lathe possesses every feature for quantity, quality and economical production. Sound principles and special characteristics are built into every Flather Lathe. Send for the catalog.



FLATHER & CO.
INCORPORATED
NASHUA, N. H., U. S. A.

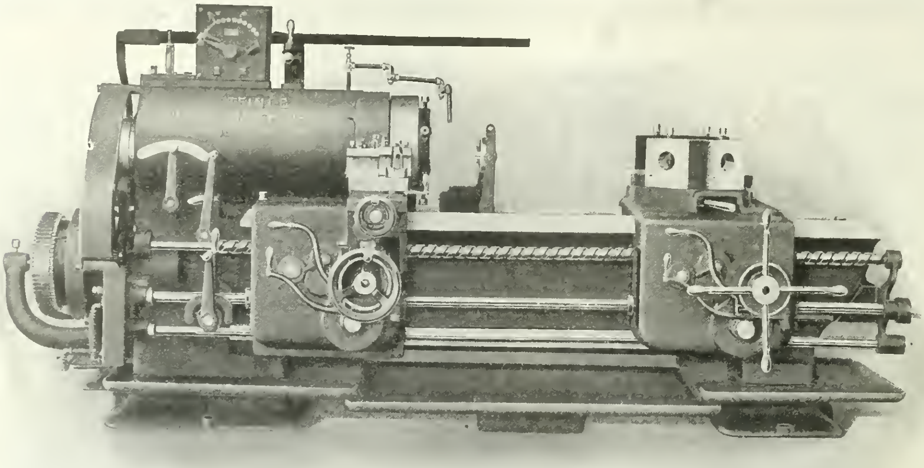
A Wider Ranged Boring and Drilling Machine

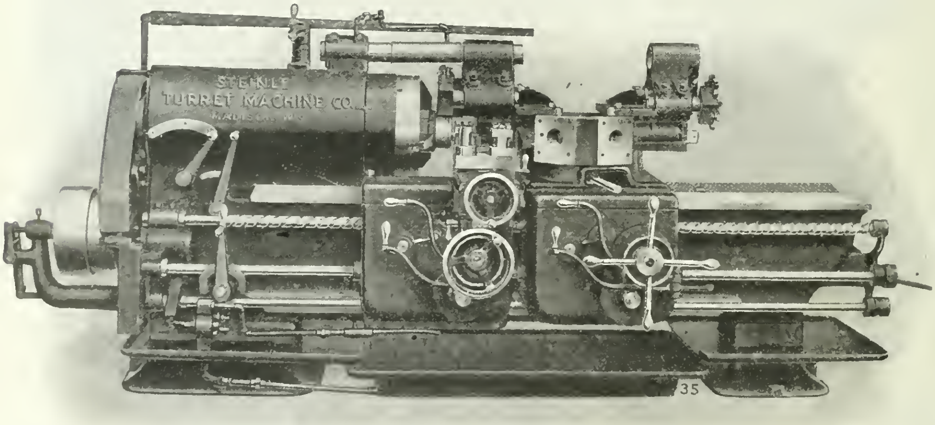
The Pawling & Harnischfeger Co. Improved No. 12 Boring and Drilling Machine has all the good qualities of the well known standard No. 12 plus certain improvements which make it the most complete tool of its kind on the market today. Large boring bar supports mounted on a sliding base afford a greater range than was heretofore available. There are four changes of speed for each feed. All changes may be made from operator's position near the drill.

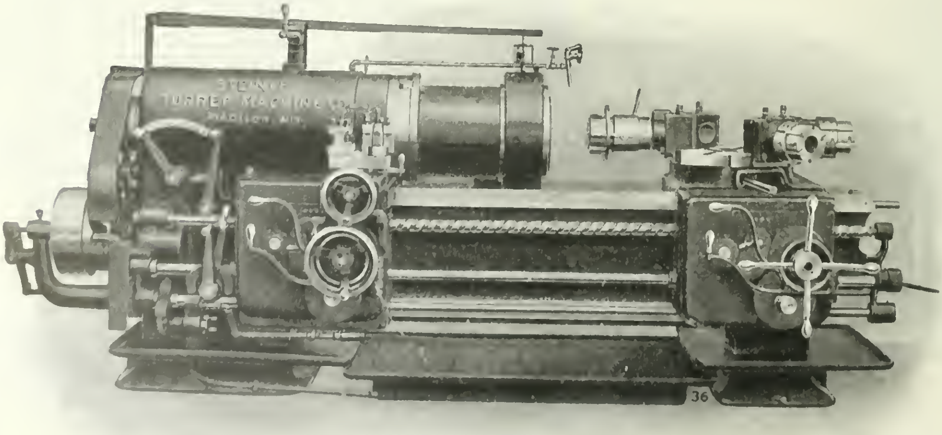


Complete Description Upon Request

DALE-BREWSTER
MACHINERY CO., Inc.
545-547 W. Washington Boulevard, CHICAGO, ILLINOIS
54-60 Lafayette St., NEW YORK







WRITE FOR INFORMATION

STEINLE TURRET MACHINE COMPANY, Madison, Wisconsin, U. S. A.

CLEVELAND

20" Heavy Duty Motor Driven Engine Lathe

THE Cleveland 20″ Heavy Duty Motor Driven Engine Lathe performs an invaluable service in heavy manufacturing shops and busy shops in general. Its specialty is turning out a maximum amount of heavy work under pressure.

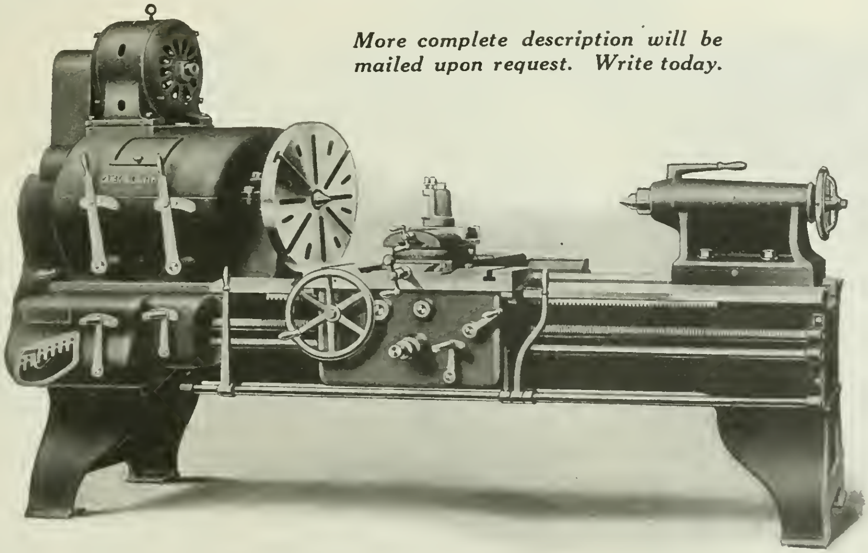
It is rigidly reinforced without becoming cumbersome, has all controls convenient to operator, and may be relied upon at all times for its readiness and accuracy.

Cleveland 20" Heavy Duty Motor Driven Engine Lathe

It has an unusually wide and deep bed with numerous box section ribs, compensating vee in front and flat way in rear for carriage.

Geared headstock of improved construction affords nine quickly available speeds by the operation of two levers.

Apron is of double wall construction; carriage is extremely large and heavy. Many other features are worthy of your prompt consideration.



More complete description will be mailed upon request. Write today.

The Cleveland Machinery & Supply Co.

General Offices: **Cleveland, Ohio**

Factories: **Hamilton, Ohio Columbus, Ohio Richmond, Ind.**

DISCOVERED
An AMES LATHE
on a
"Reel" Peaceful Job

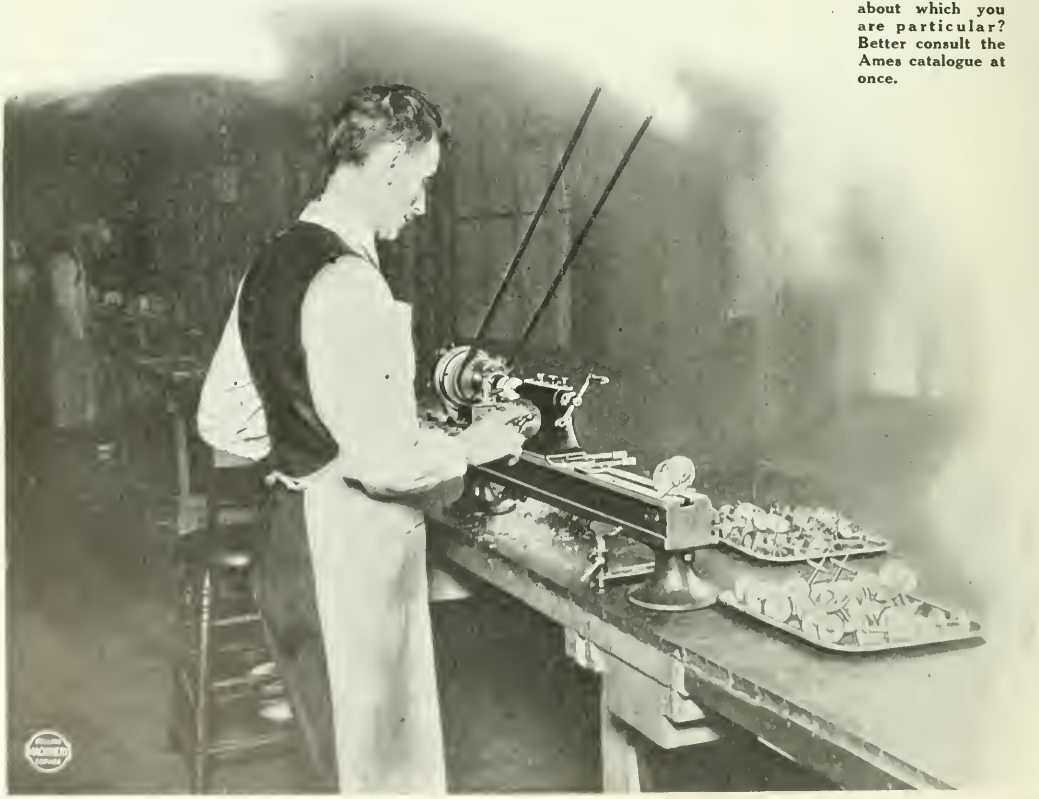
B.C. AMES Co
WALTHAM MASS. U.S.A.

B. C. AMES COMPANY
Waltham, Mass.

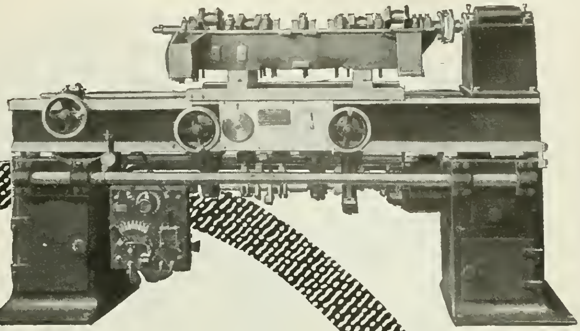
SMALL as they are, Ames Lathes are contributing in no unimportant way to the maintenance of the sinews of war. We have seen them in many shops, producing accurate ammunition dies and handling similar work for the cause.

But not all the Ames Lathes have been commandeered to help in the foremost business of the day—the one in the photograph, for instance, works in the Horton Manufacturing Company's plant at Bristol, Conn., on a "reel" peaceful job. It is making fishing reel parts, and the reputation of the company behind it is sufficient testimony for the reliability of the product.

Have *you* a light manufacturing job about which you are particular? Better consult the Ames catalogue at once.



IF YOU HAD THIS MACHINE



you could turn out a much smoother running product and do it quicker and cheaper.

If you have never felt justified in going to the expense of accurately balancing the rotating parts of your product or have depended on the old tedious cut-and-try method you will immediately appreciate the importance of the

CARWEN

Dynamic Balancing Machine

(AKIMOFF PATENTS)

After obtaining the static balance of a crankshaft, place it in the Carwen and while it is rotating you can measure accurately the correction needed to secure true running balance. By applying the dial reading to the chart you can determine just how much and where to take off (or add to) so as to eliminate vibration.

The entire operation takes less than five minutes, and the vastly improved running qualities obtained are even more important than the time saved.

We make these machines in sizes suitable for balancing objects weighing from 5 oz. up to 15,000 lbs. and their use is just as practical on medium quality products as on those where price does not enter into consideration.

We will gladly make a demonstration without cost.

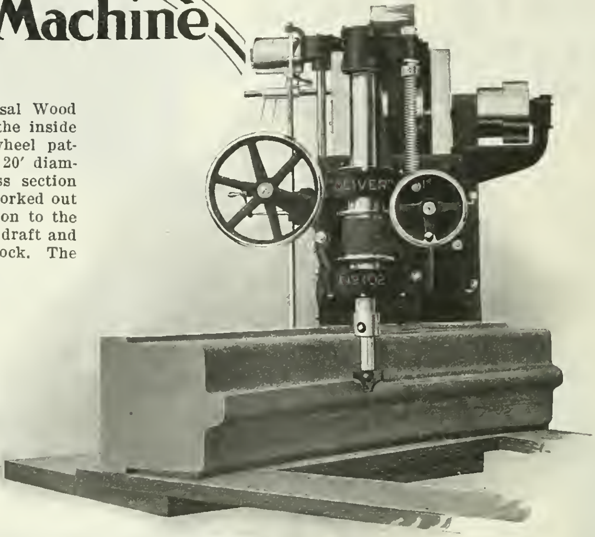
The Carlson-Wenstrom Co.
Erie Avenue at Richmond Street
Philadelphia, Pa.

Illustrated Booklet describing the principle involved and its application sent upon request

Makers also of CARWEN Double Row Ball Bearings

OLIVER
Wood Milling Machine

Don't think because you used to dig out your pattern work by hand methods that you need to continue to do it now.



Cut shows No. 102 Universal Wood Milling Machine finishing the inside of heavy segment of fly wheel pattern. It is a 6′ section of 20′ diameter fly wheel with a cross section 14½″ by 15½″. This was worked out of the rough glued up section to the true circle and with proper draft and fillet cut out of the solid stock. The ends were squared off true to the correct angle.

Time 8 hours.
Figure the saving.

Send for descriptive literature.

Oliver Machinery Co.
Grand Rapids, Mich.

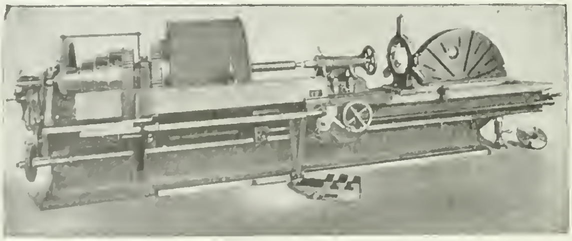
It will handle all of your work with every convenience—

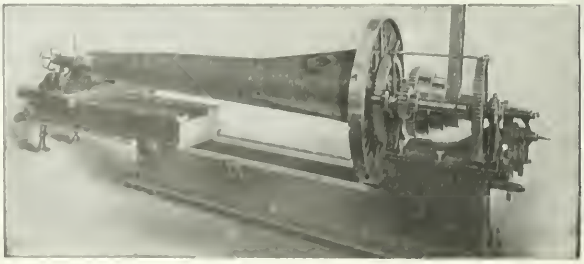
and can be kept busy every hour of the day owing to the great range and adaptability—

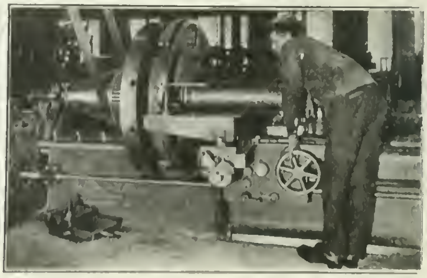
The Harrington Extension Bed Gap Lathe

The bed is made in two parts, the upper arranged to slide on the lower, so that the length of the gap can be varied or the distance between centers nearly doubled. No time is lost while the operation is going on, and no rigidity or accuracy is sacrificed.

Edwin Harrington, Son & Co., Inc., Philadelphia, Pa.

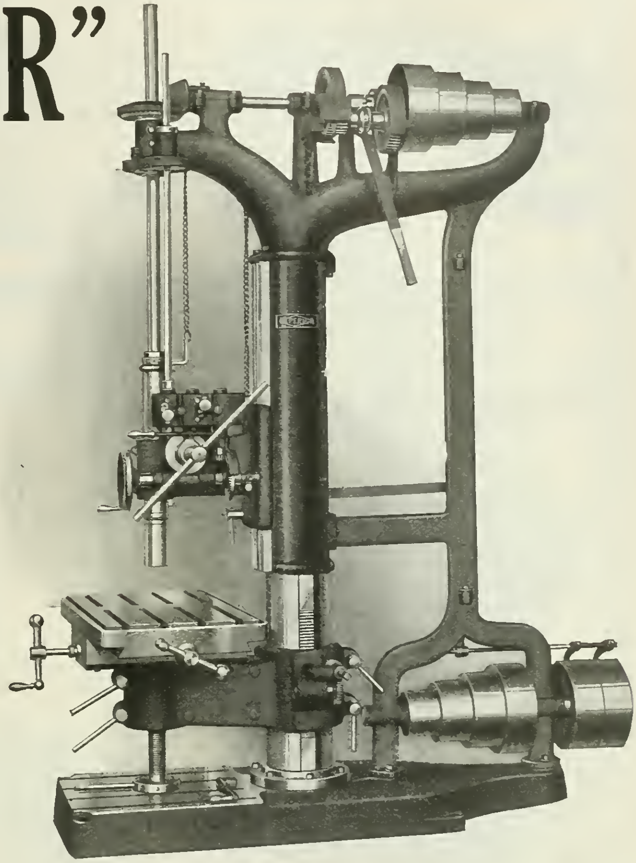

Extension Attachment for turning long distances across the gap


A Job on Long Centers


Extension Tool Block for turning short distances over the gap

"SUPERIOR"

Sliding Head Vertical Drilling Machines



Built in
25", 28", 32" and 36"
Sizes

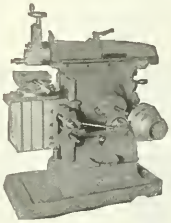
Here's a line of drilling machines, designed for manufacturing and jobbing purposes, in which many refinements of design and construction, not found in the average standard machine, have been incorporated. Particular attention has been given to accuracy and alignments; adjustable automatic stop reduces drill breakage to a minimum; bearings on column are extra long and the table is rigidly supported.

Friction Tapping Attachment and Special Compound Table broaden the range of these machines, and their convenience and adaptability reduce the cost of even the simplest operation to a minimum. Material and workmanship are fully guaranteed and each machine is thoroughly tested under its own belt before shipment.

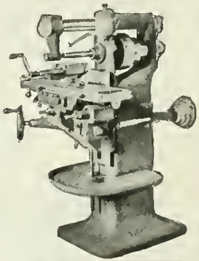
Complete description and specifications of these wide range machines sent on request.

THE SUPERIOR MACHINE TOOL CO.
KOKOMO, INDIANA, U. S. A.

Steptoe Shapers and Milling Machines



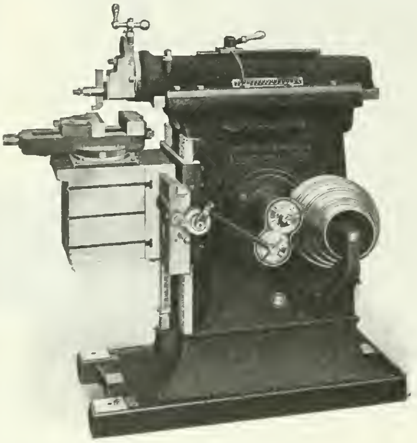
Represent seventy-three years of experience in the manufacture of high grade machine tools and thousands of our machines are in shops giving daily satisfaction.



The John Steptoe Company
BRIGHTON CINCINNATI, OHIO

WE CONFINE OURSELVES TO BUILDING

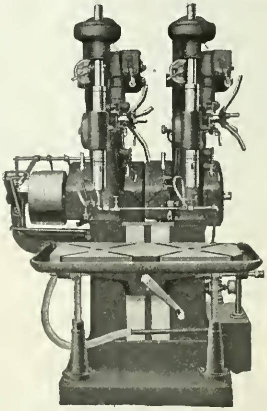
Shapers Exclusively



Crank Sizes: 12, 14, 16, 20, 25, 28 and 32 inch
Geared Sizes: 28, 32 inch

Smith & Mills Company
CINCINNATI OHIO, U. S. A.

Save Labor by Using the Self-Oiling All Geared Gang Drill



It is so strong, so powerful, so positive, so accurate, so rapid and so easily controlled that your operators will turn out more work of a better character than they can accomplish on any drill having cone and inherent belts to shift, to slip, to give trouble, waste time and make expense. Our Self Oiler offers you *Maximum Value* in a drilling machine. It is unequaled in power, speed and productive capacity. ***Send for Catalog "M"***

BARNES DRILL COMPANY
814 Chestnut St. (Incorporated 1907) **ROCKFORD, ILL.**

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YOUNG, CORLEY & DOLAN, Inc.

Machine Tools

New York
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No. O. Plain
Nos. 2 and 3 Plain and Univ.

Bickett Planers
36 inch, 42 inch, and 48 inch

Rivett Grinders (N.Y. Dist.)
Automatic Internal Grinders
Hand and Auto. Radial Grinders

Weigel Drilling Machines
21" and 25" Upright Drills.

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Cylindrical 18" x 50", 18" x 60", 18" x 72"

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3 ft. Plain

Greaves Engine Lathes

Our N. Y. Warehouse stock list of New Machinery mailed upon request.

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New York
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Drilling Machines

Henry & Wright Drilling Machines are doing

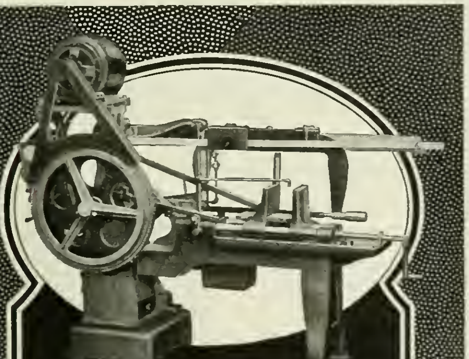
More Drilling Than All the Armies in the World

Drilling millions of holes ¾" and under in every conceivable kind of war munitions. They are preferred because of their many advantages.

THE HENRY & WRIGHT MFG. CO.
HARTFORD, CONN.

OVER-SEAS REPRESENTATIVE
ALMACOA ALLIED MACHINERY COMPANY OF AMERICA ALMACOA
120 BROADWAY, NEW YORK, U.S.A.

PARIS TURIN ZURICH BARCELONA



ATKINS KWIK-KUT
METAL CUTTING MACHINES

Use practically the entire blade in cutting. Compare this with the blade surface you are now using—add the numerous other advantages of the Kwik-Kut Machine and you have the reasons why an Atkins Kwik-Kut Machine will save you time, money and blades.

Write for large descriptive folder

E. C. ATKINS & COMPANY, Inc.
The Silver Steel Saw People
Home Office and Factory, Indianapolis, Ind. Canadian Factory, Hamilton, Ont.
Branches carrying complete stocks in the following cities:
Address E. C. ATKINS & CO.

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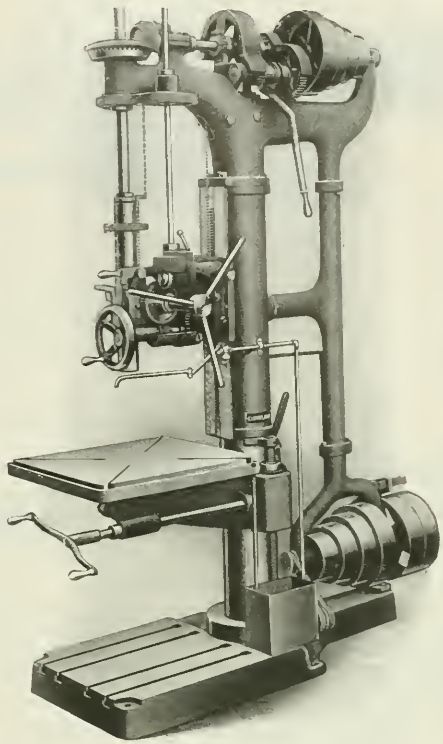
Forethought in Construction



CLEVELAND

32" Upright Drilling Machine

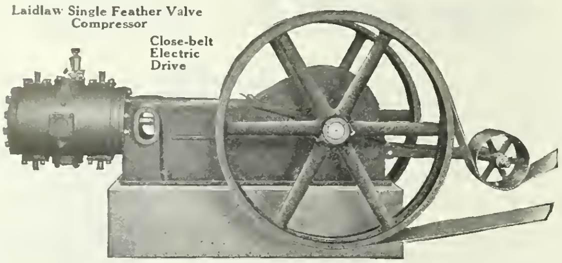
Many tools of yesterday, designed without forethought, are unable to cope with requirements of today. Be sure the drill you buy has, in power, strength and capacity, a margin of safety for the future. The Cleveland has large diameter spindle of special hammered steel, counter balanced, and equipped with patent quick-return mechanism; unusually heavy column, firmly braced; large table, well provided with T slots; easily adjusted automatic stop to down feed, set by graduations on the spindle.

An improved lubricating system insures safe, satisfactory drilling at maximum speeds.

Send for further details.

The Cleveland Machinery & Supply Co.

General Offices: CLEVELAND, OHIO, U.S.A.
Factories: Hamilton, Ohio Columbus, Ohio Richmond, Indiana


Laidlaw Single Feather Valve Compressor
Close-belt Electric Drive

LAIDLAW
Feather Valve
Reg. U. S. Pat. Off.
AIR COMPRESSORS

There's economy and good service in the close-belt type of Laidlaw Feather Valve Compressor. Enclosed frame provides automatic oiling and protection from dirt and flying grit. It requires little attention. Above all, it has the marvelously durable and efficient Feather Valve.

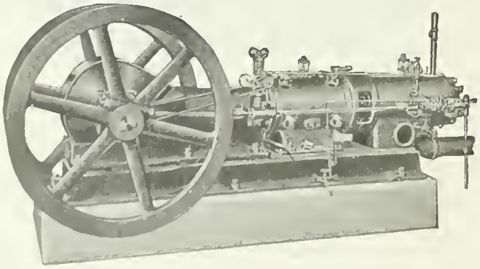
A complete line of Single Power Driven Feather Valve Compressors is shown in Bulletin L531-129. Write for your copy.

Worthington Pump and Machinery Corporation
115 Broadway, New York
Laidlaw Works, Elmwood Place, Cincinnati, O.
Branch Offices in all Principal Cities
L293.4

The Laidlaw Compressor is the Product of a Worthington Plant.

WORTHINGTON
A big line to choose from—a safe line to choose
AIR COMPRESSORS PUMPS CONDENSERS OIL ENGINES

Chicago Pneumatic Simplate Valve
Fuel Oil Air Compressors



Chicago Pneumatic Fuel Oil Driven Simplate Valve Air Compressor will operate on any mineral oil of 28 degrees Beaume scale or lighter, containing not over one per cent sulphur, including Star Oil, Diesol, Calol, Stove Oil, Solar Oil, Gas Oil, Kerosene and distillates between Kerosene and Lubricating Oil. Stationary or portable.

Made in capacities up to 600 cu. ft. of free air per minute.

Write for Bulletin 34-K.

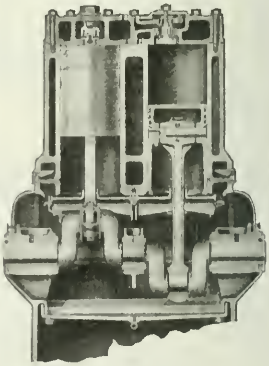
CHICAGO PNEUMATIC TOOL COMPANY
1060 Fisher Bldg. CHICAGO
52 Vanderbilt Ave. NEW YORK
Branches Everywhere

The Curtis Compressor

Efficient Cooling **Few Parts**
Light Disc Valves, Small Clearances

No stuffing boxes, shoes, slides or guides, less friction and wear, lower maintenance. Will run 10 to 15 times as long with the same amount of oil as competing makes, yet will lubricate all parts properly and keep oil out of the discharge line.

Full Self-Oiling
Controlled Splash
Regulatable, Sight
Feed Cylinder Oiling



Write for descriptive bulletin C-1

Orders for Curtis Product for Government Work and Essential Industries Given Preference Treatment.

Curtis Pneumatic Machinery Co.
1568 Kienlen Ave. St. Louis, Mo.
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A Little Air Power
At Slight Production Cost

This is the function of Ingersoll-Rand Class "ER" and "FR" Compressors.

These small machines are built in quantity on a quality basis. You can obtain any of the various sizes of either type and benefit immediately by the employment of the air power it provides—for a few more air tools will greatly increase the productivity of your men.

It will prove a profitable investment, for you will secure a machine of high efficiency maintained over a long life of uninterrupted service. The cost of operation is low—power requirements are slight and the item of maintenance is a small one.

You obtain all the advantages of Ingersoll-Rand Plate Air Valves, automatic lubrication, automatic regulation and efficient drive. The last may be either long belt from line shaft, short belted electric motor or piston valve steam engine.

Capacities range from 50 to 1000 cu. ft. at pressures from 10 to 250 lb. per sq. in.

You will want to know more about these machines. Ask for the Bulletins.

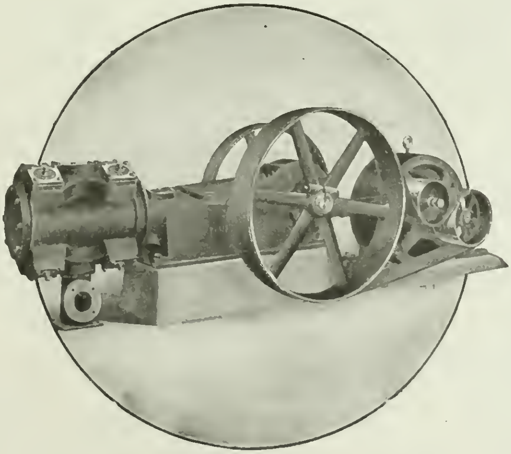
No. 3130—Class ER, Belt-Driven
No. 3031—Class FR, Steam-Driven

Ingersoll-Rand Company

11 Broadway
New York

165 Q. Victoria St.
London

Offices the World Over



Ingersoll-Rand Class ER Compressor

298-C

Electrite Uranium

High Speed Steel for Planer Tools

The Tool—

Inconspicuous But Most Important

Casting and machine in the accompanying photograph are both of more than usual size. The tool, however, though inconspicuous in the performance, is the most vital factor in the production. Given a machine sufficiently powerful, the right tool will "come through" in practically any service.

Concerns that count, count on Electrite Uranium for cutting tools. Have you discovered it yet?

Get in touch with us now. Let us convince you

LATROBE ELECTRIC STEEL CO., Latrobe, Pa.

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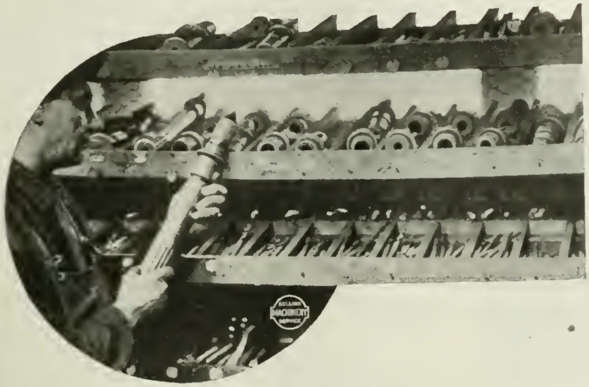
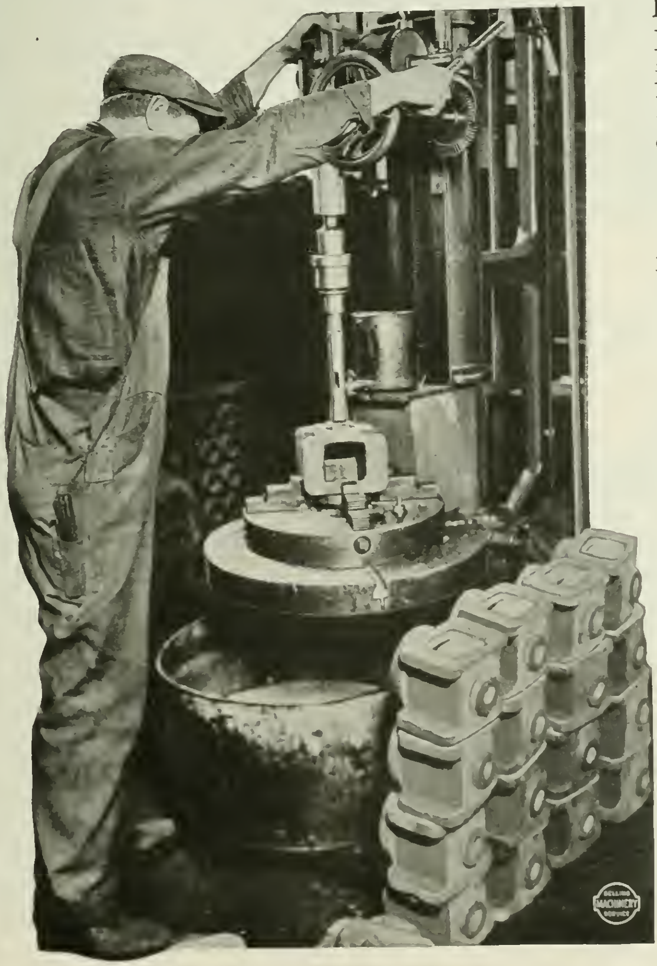


Used on Practically Every Machine in the Shop



Wizard Chucks and Collets

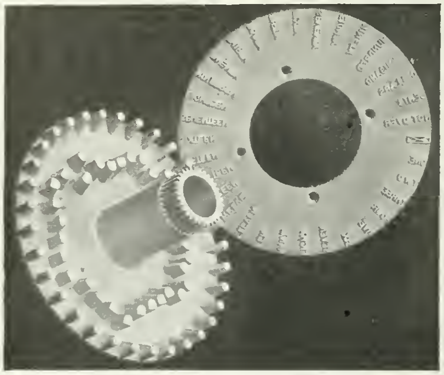
It is only about a year and a half since the Howard Iron Works, Buffalo, N. Y., put in its first Wizard Chuck, but now the "Wizard" outfits in use number seventy-five.

Almost every machine is so equipped. Besides their big time saving feature, which permits changing tools without stopping the spindle, the men like the simple, responsive action and the powerful way a "Wizard" holds big tools to heavy work.

We will be glad to send a Wizard Outfit on trial.

The McCrosky Reamer Co.
MEADVILLE, PA.

Export Agent:
Benjamin Whittaker
21 State St., New York, N. Y.



Doehler Die-Cast Check Protector Parts

DOEHLER
DIE-CASTINGS

With labor at a premium and with the prevailing difficulty of obtaining machine tools, Doehler Die-Castings, requiring the use of but a minimum of labor and little if any machine equipment, have been of material help in solving the production problems for some of the leading manufacturing concerns in the country. This has been accomplished most satisfactorily from the standpoint of EFFICIENCY as well as ECONOMY.

DOEHLER DIE-CASTING CO.

MAIN OFFICE AND EASTERN PLANT
BROOKLYN, N.Y.

WESTERN PLANT
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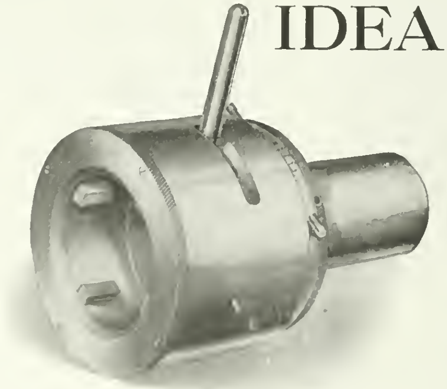
NEW JERSEY PLANT
NEWARK, N.J.

Die-Castings in Brass and Bronze, Aluminum and White Metal Alloys,
Die-Cast Babbitt and Babbitt-lined Bronze Bearings.



IDEAL DIE HEADS
HAVE SMALL O. D.

The die head shown here is a 4″ type "B." Its capacity is 3″ to 4″, the outside diameter is only 6¼″, and the length 4 15/16″. The weight is 50 pounds, which proves that its construction is not only compact, but solid and strong. This die is very valuable to makers of screws, since it can be used on smaller machines than any other make of the same capacity, and often eliminates the necessity of purchasing a new and larger screw machine.

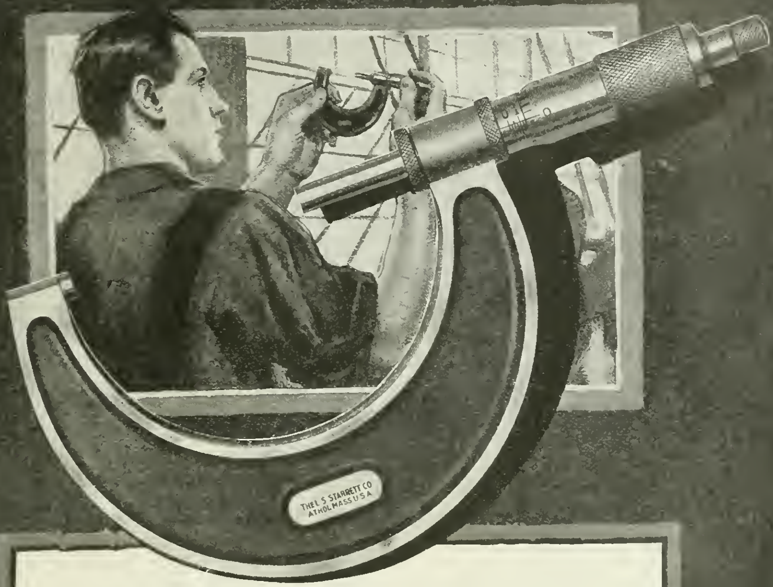
Prompt deliveries can be had on both dies and chasers.

THE IDEAL TOOL
& MFG. COMPANY
BEAVER FALLS, PENNA.

AGENTS: Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York City; [illegible] Machinery Co., Widener Bldg., Philadelphia, Pa.; [illegible] Machinery and Supply Co., Dime Bank Bldg., Detroit, Mich.; H. E. Barton Tool Co., 100 S. Jefferson St., Chicago, Ill.

**Ideal
All Ways**

Starrett Tools


THE L S STARRETT CO
ATHOL MASS U.S.A.

The Skillful Workman's Choice

In the kit of the first-class man you will always find Starrett Tools, for such a man knows how essential they are for high grade work and for the jobs requiring extreme accuracy.

Micrometers, gages, calipers and dividers, vernier calipers, rules, levels and tapes in great variety are included in the Starrett Line of 2100 fine tools.

Catalog No. 21-D sent free on request

The L. S. Starrett Company

The World's Greatest Toolmakers

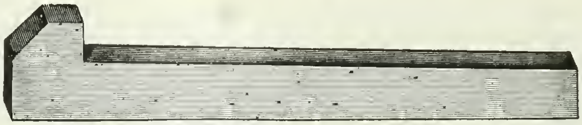
Manufacturers of Hack Saws Unexcelled

ATHOL, MASSACHUSETTS

New York London Chicago

42-784

STARRETT TOOLS



Nothing to Do but Drive

You are not put to the trouble of filing and fitting when you use our Finished Machine Keys. We finish them *complete*—all ready to drive, and you can always depend upon accurate machining and true size. We have special facilities for making Machine Keys any length, width, depth, style or taper. If your keys are costing too much—get our prices.

Our specialties include: Machine Racks, Cold Drawn Shafting, Screw Stock, Flats, Squares, Hexagons and Special Shapes. Send for interesting Catalog.

STANDARD GAUGE STEEL COMPANY, Beaver Falls, Pa., U. S. A.

BRANCH OFFICES: Chicago, Ill., and Philadelphia, Pa. Pacific Tool and Supply Co., San Francisco, Cal. Dilworth Lockwood & Co., New York. R. B. Ridgley Detroit, Mich. A. L. Maeder Co., Portland, Ore. Hall & Pickles, 64 Port St., Manchester, England.

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Seamless Tubing

STEEL — BRASS — COPPER — BRONZE
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Shafting and Screw Steel

Springs
Metal Stampings
Cold Rolled Strip Steel
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Tool and Alloy Steels
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JULIUS BLUM & COMPANY

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Highest Quality

Ferro Tungsten

Do You Analyze Your Ferro-Tungsten?
If Not, It Would Pay You To Do So—

The value of a product is largely controlled by the purity of the materials of which it is made.

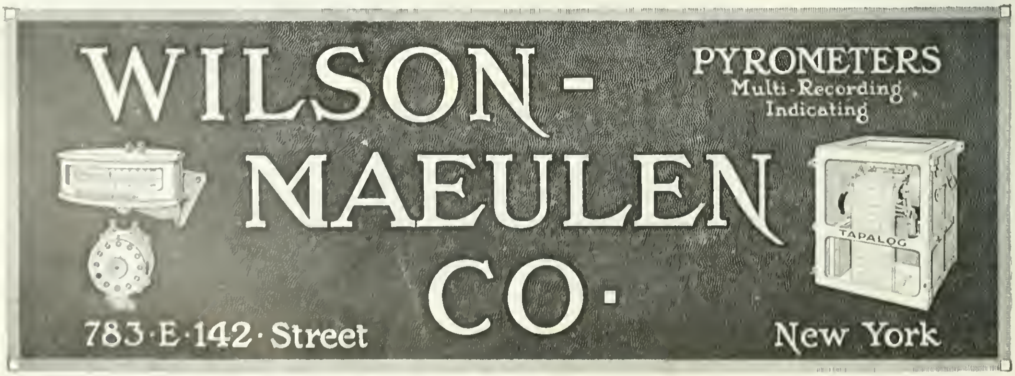
We Guarantee —
Our Ferro-Tungsten to this analysis:

Tungsten	70 to 80%
Carbon—not over	½%
Sulphur—not over	.05%
Phosphorus—not over	.08%

Our facilities are of the very best due to a strictly modern plant and equipment. We are able to offer quick deliveries. Write, Wire or Cable for prices.

THE VANADIUM-ALLOYS STEEL CO.
LATROBE, PENNA.

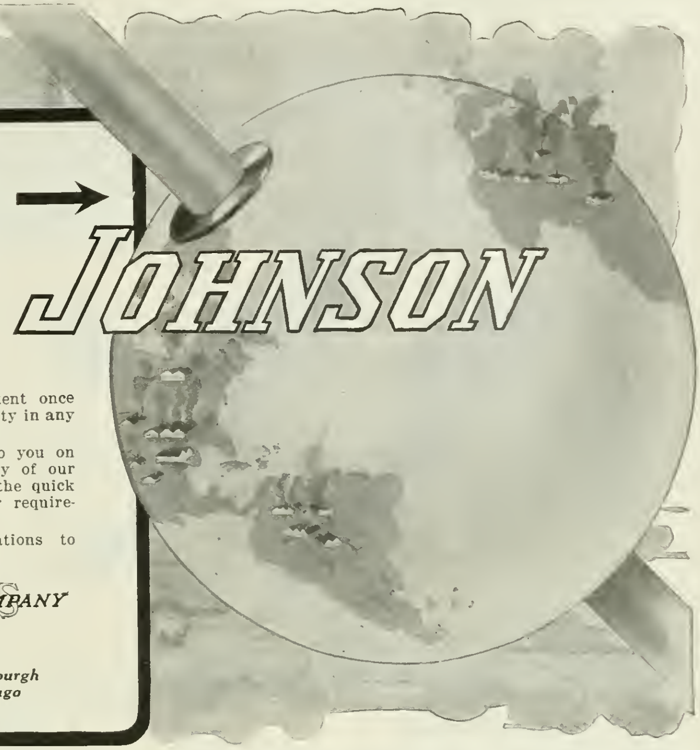
Makers of "Red Cut Superior"—A Quality High Speed Steel



WILSON-MAEULEN CO.

PYROMETERS
Multi-Recording
Indicating

783 E 142 Street New York



A World of Industry Revolves on Johnson "Friction-Resisting" Bronze Bushings

Johnson Bronze Bushings are noted for their consistent, efficient performance.

They resist friction to an extent once considered a physical impossibility in any bronze alloy.

Why not let us demonstrate to you on your next order the superiority of our product and our facilities for the quick and accurate handling of your requirements?

Send blueprints and specifications to Dept. M.

BUSHINGS

JOHNSON BRONZE COMPANY
NEW CASTLE, PA.
Branch Offices
New York *Pittsburgh*
Detroit *Chicago*
San Francisco

Our representative will call and explain why you should use Precision Die Castings.

Take For Instance

on a casting like this, you can buy it for less than cost of rough casting plus machining cost, if you use

PRECISION DIE CASTINGS

PRECISION DIE CASTINGS solve your problem of increased cost, because they eliminate much machining and a great deal of labor.

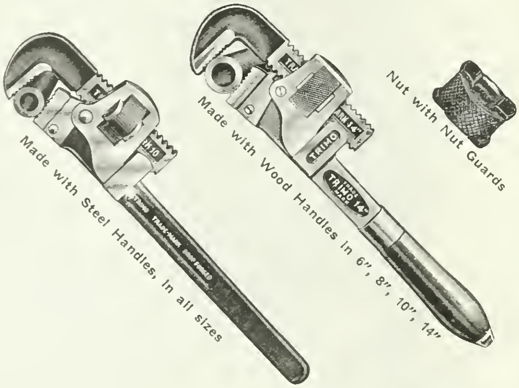
Alloys and metals in Precision Die Castings are so treated that they are not subject to the slightest variations; they are moulded and tested under sound mechanical principles.

For more economical production, use Precision Die Castings.

PRECISION CASTINGS CO., Inc.
Die Castings Plant - Syracuse, N. Y.
Brass, Bronze and Aluminum Foundry, Pontiac, Mich.

When Ordering STILLSON WRENCHES Demand TRIMO with the Steel Frames and Nut Guards

Of all Stillson Wrenches TRIMO is the Best


Made with Steel Handles, In all sizes
Made with Wood Handles In 6", 8", 10", 14"
Nut with Nut Guards
TRIMO
TRIMO 14"

SEND FOR CATALOG No. 38.

Made by TRIMONT MFG. COMPANY
55-71 Amory Street Roxbury, (Boston), Mass.

The Awkward Time-Wasting Movements of the Unskilled Operator

May be saved on nut turning by using the

FAVORITE REVERSIBLE RATCHET WRENCH

that works with a quick, straight ahead ratchet movement, doing away with the half turn of the old-fashioned, open end wrench with its frequent slipping off the nut.

Built Strong for Rough Usage

GREENE, TWEED & CO.
Sole Manufacturers
109 Duane Street
NEW YORK

Style D
19 other styles and sizes.

A chest for every requirement.

SAFEGUARD YOUR TOOLS 24 HOURS IN THE DAY

You will be contented, satisfied, because you will always know where to find your tools when you look for them. The

UNION TOOL CHEST

has a place for every tool. You know immediately if it is misplaced or borrowed. Plain or quartered oak, or leatherette covered, perfectly fitted drawers, some lined with felt.

Ask us about our "Satisfaction or Money-back" guarantee.
Write for Our Catalog and Prices.

Various styles and sizes. There is a UNION Tool Chest for your particular needs.

If there is no dealer near you, write for our special offer.

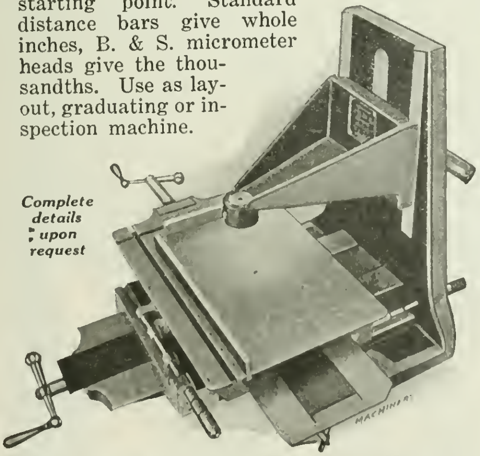
UNION TOOL CHEST CO.
10 RAILROAD STREET ROCHESTER, N. Y.

The Craley "Master Toolmaker"

A Rapid and Accurate Device

For locating and machining holes in dies, jigs, master-plates, etc. Adjust bushing to work and use as a master-plate; no layout required, no cumulated error; inner edge of guide strips is your zero or starting point. Standard distance bars give whole inches, B. & S. micrometer heads give the thousandths. Use as layout, graduating or inspection machine.

Complete details upon request



CRALEY MANUFACTURING COMPANY
MOUNT JOY PENNSYLVANIA, U. S. A.

For General Purposes

Service-Satisfaction in the use of Babbitt Metal depends as much upon the process of manufacture as upon the metal and chemical formula.

Ajax Bull Babbitt is the product of experts. It possesses uniform hardness, high anti-frictional properties, and endurance to withstand severe, steady service.

there's none better

Ajax Bull Babbitt costs only about one-third as much as Genuine Babbitt—and gives more economical results than cheap commercial lead babbitts.

Ajax Bull Babbitt is guaranteed to give satisfactory service under any but extremely heavy loads. Try it—for general purposes there's none better.

Complete information for the asking

The Ajax Metal Company
Established 1880
Main Office and Works: Philadelphia, Pa.
Southern Plant: Birmingham, Ala.
OFFICES:
New York Boston St. Louis San Francisco
Chicago Washington Pittsburgh

You Can Use Our Equipment

Immediate increased production—without the addition of a single machine or man, without a dollar's investment in new buildings—

Immediate increased production with lower manufacturing costs.

That's what you can accomplish, if you are now machining brass, bronze or aluminum parts, including bushings and bearings.

For increased output does not require enlarging your own facilities. You can use ours—and save by doing it.

Unless your shop is an exception, every man and machine in it now engaged in finishing bushings, bearings and other small brass, bronze or aluminum castings represents a waste of time and energy.

Put these men and machines on better paying work — work that you can't get done so well or so cheaply elsewhere—and turn the job of supplying machined brass, bronze and aluminum parts over to us.

Other manufacturers who have

LYNX

AND LYNITE

to Increase Your Production

done this have found that it not only has enabled them to boost their output but also to save money. For we specialize in this work and do the whole job of casting and machining.

The extent to which we have proved the soundness of this plan is indicated by a remarkable growth in our machine-shop business, to the point where today it requires a plant containing 36,000 square feet of floor space.

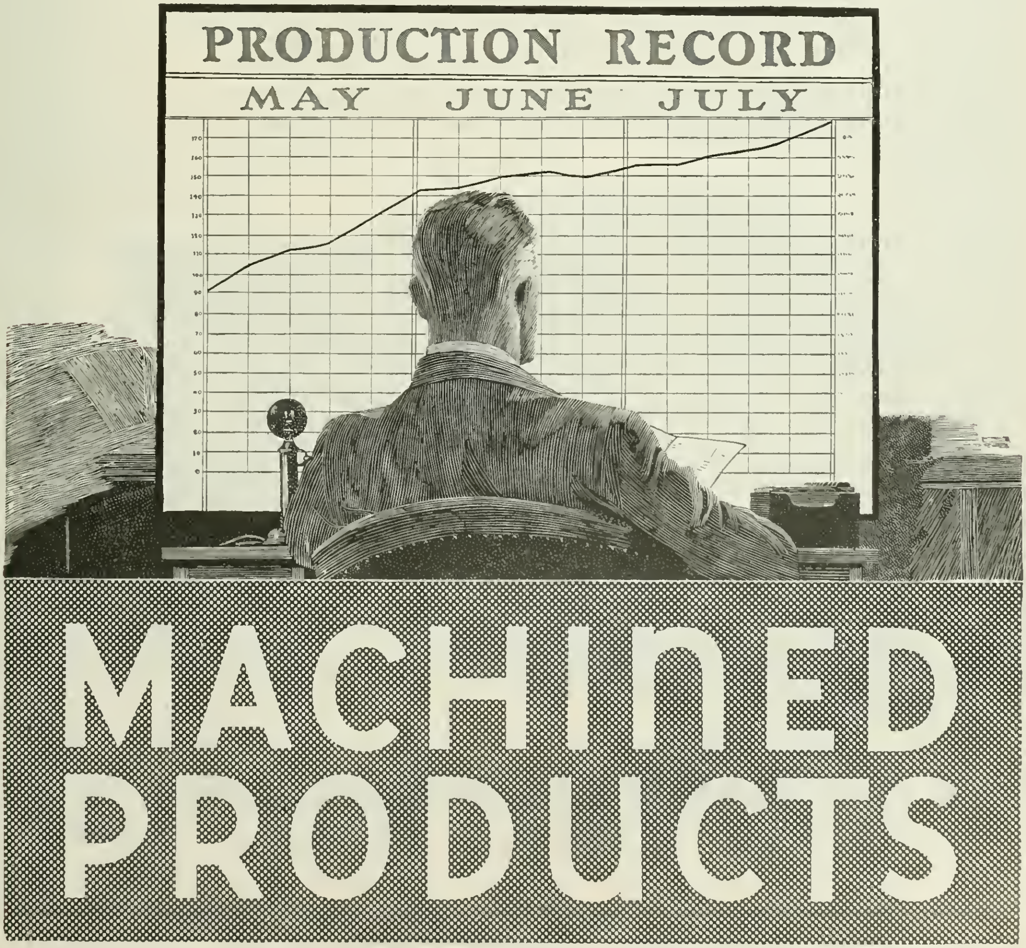
You can quickly satisfy yourself about it without spending a cent. Just let us quote on your next job.

Every Finished Piece either Lynux or Lynite—In addition to those other advantages mentioned, every casting turned out of our shops is made of either *Lynux* or *Lynite.*

Lynux includes more than 100 standard brass and bronze alloys —*Lynite* a large number of aluminum alloys.

Let us send you our mailings on subjects of interest to users of bushings and bearings.

THE ALUMINUM CASTINGS COMPANY
LYNITE and LYNUX Products
Eight Plants in
Cleveland Detroit Buffalo Manitowoc, Wis. Fairfield, Conn.

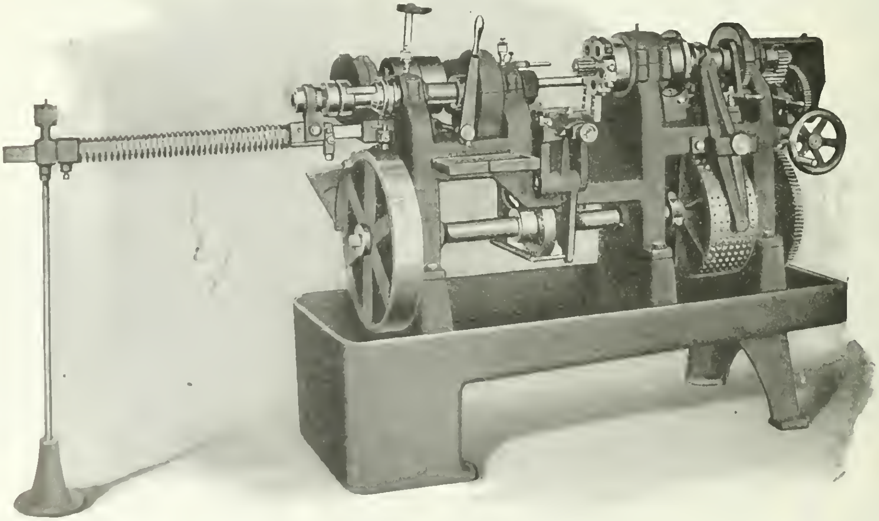


CHICAGO AUTOMATIC

Simplicity and Strength

The Chicago Automatic is everywhere recognized for its extreme simplicity and unusual strength. All working parts—readily accessible—are heavy enough to withstand the severest strains a machine of its type is obliged to meet. Strong, positive locking devices guarantee a rigid turret and permanent alignment. Spindle, heavy and of good size, turns in one direction only. No reversing of machine—no belt shifting.

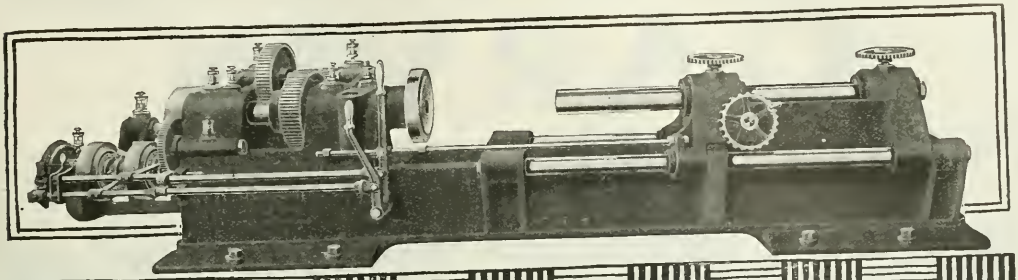
Many other features distinguish the Chicago Automatic. We'd like to tell you more about this machine.



No Countershaft Required

WM. F. DAVIS MACHINE TOOL CO., Inc.

CHICAGO	CLEVELAND	WASHINGTON	NEW YORK
549 W. Washington Boulevard	508 Leader-News Building	945 Pennsylvania Avenue	85 Liberty Street



No. 23 Boring Machine

Simple in construction

Hundreds in use

Easy to operate

Least expense for upkeep

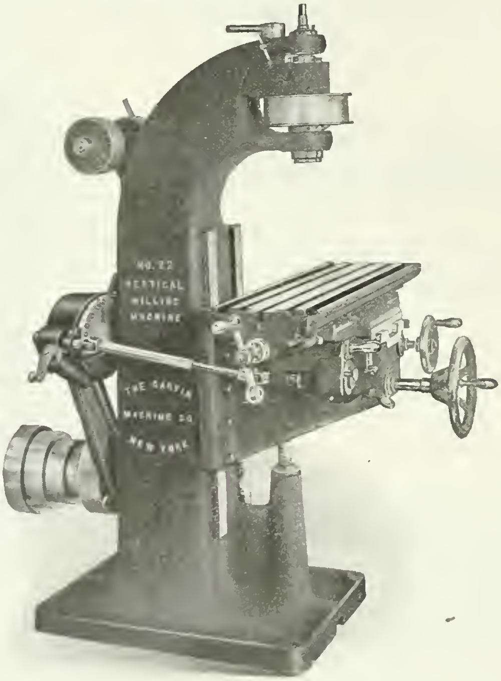
Leads in boring shells

Short and sure deliveries

Catalog and full information on request

Amalgamated Machinery Corporation
72 West Adams Street
CHICAGO

GARVIN
VERTICAL MILLING MACHINES
Used by Leading Concerns



No. 22 Vertical Machine
Use Code—Aptness

Have the solidity of the horizontal type of Milling Machine, together with the convenience of the Vertical Milling Machine.

The machine is equipped with our

**SOLID TOP EXTENDED (Patented) KNEE
SQUARE LOCKED**

doing away with all possibility of weakness of saddle fit to knee.

Positive Feed Change Box giving twelve instantaneous changes of feed.

The feed can be changed while the machine is in cut.

The design is suitable for high speeds, the spindle being driven direct or through double back-gearing to slow down for large cutters.

A Rotary Table is a most important adjunct to the machine and forms the most efficient feed for circular milling, finishing circular slots and edges, etc.

Send for our complete catalogue.

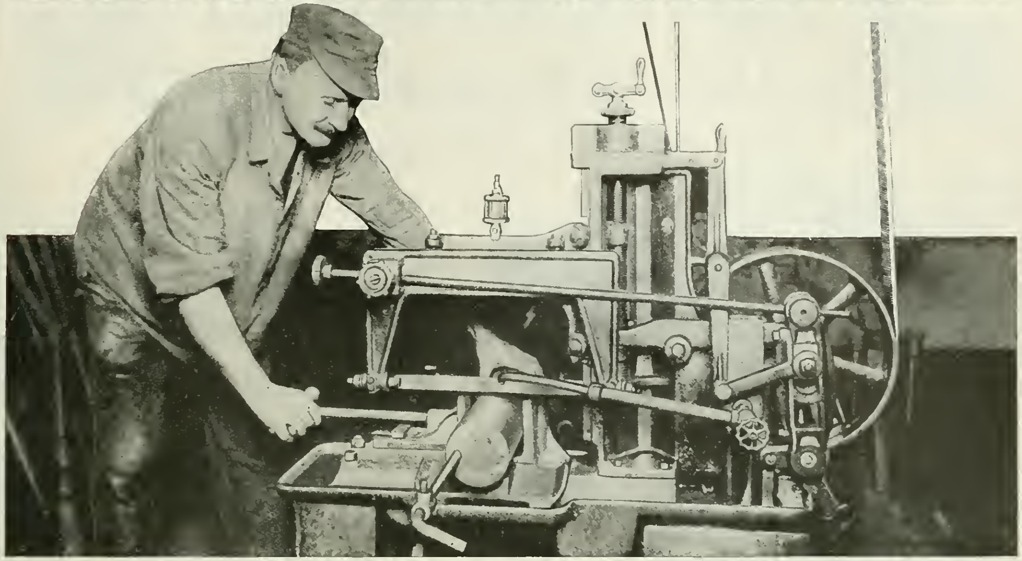
FOR FURTHER INFORMATION { ASK YOUR DEALER OR WRITE US DIRECT

MANUFACTURED BY

THE GARVIN MACHINE COMPANY

Spring and Varick Streets
50 years in **NEW YORK CITY**

VISITORS WELCOME



SIMONDS

Blades on a Power Hack Saw

THREE conditions govern every Hack Sawing job; the machine, the material, and the blade. When the first two are neglected it does not make much difference what kind of a blade you use. But when machine and material conditions are understood and the proper size blade is selected *then you will notice,* beyond a doubt, *the extra wear* and *the quicker cut* obtained *with a Simonds blade.*

We will be glad to discuss with you the question of proper blades for different kinds of work.

SIMONDS MANUFACTURING COMPANY

"The Saw Makers"

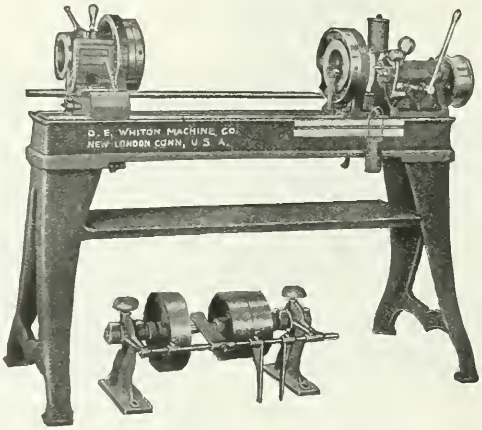
FITCHBURG, MASS.

17th St. & Western Ave.
CHICAGO, ILL.

St. Remi St. & Acorn Ave.
MONTREAL, QUE.

NEW YORK CITY
SAN FRANCISCO, CAL.
NEW ORLEANS, LA.
SEATTLE, WASH.
LOCKPORT, N. Y.
MEMPHIS, TENN.
VANCOUVER, B. C.
LONDON, ENGLAND
PORTLAND, ORE.
ST. JOHN, N. B.

THE WHITON
REVOLVING CENTERING MACHINE
FOR ACCURATELY CENTERING FINISHED SHAFTS



The cut shows new **Revolving Centering Machine**—a large size of the well-known machine of this type. It is heavier throughout and has capacity to center shafts up to 5 inches in diameter.

Constructed same as the smaller machine and embodies all the special features.

Circulars and prices sent upon application.

THE D. E. WHITON MACHINE COMPANY
NEW LONDON, CONNECTICUT, U. S. A.

DRILL VISE

DRILL SPEEDER

For use in Drillers from 20-inch to largest Radial
For Twist Drills 0" to ¾" requiring speed up to 3000 R. P. M.

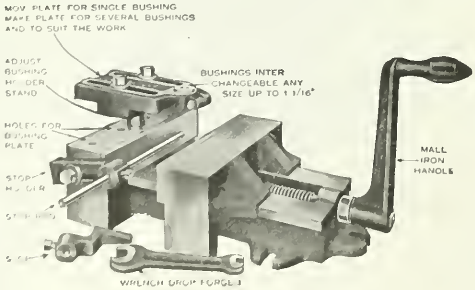

MOV PLATE FOR SINGLE BUSHING
MAKE PLATE FOR SEVERAL BUSHINGS
AND TO SUIT THE WORK
ADJUST BUSHING HOLDER STAND
BUSHINGS INTERCHANGEABLE ANY SIZE UP TO 1 1/16"
HOLES FOR BUSHING PLATE
MALL IRON HANDLE
STOP HOLDER
WRENCH DROP FORGED

Fig. 1. With Jig Attachments.

Always a good vise for general shop use on driller, miller, shaper, or planer, and at the same time holds work for duplicate drilling without the cost of a jig.

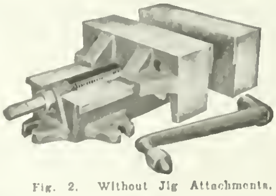


Fig. 2. Without Jig Attachments.

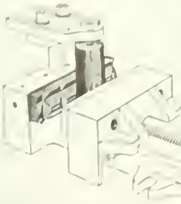


Fig. 3.—V-Jaw for Round Work.

VISE

No. 3, jaws 6", opens 4½", with attachments, $22.00; without, $20.00. List.

No. 4, jaws 9", opens 7"; with attachments, $27.50; without, $25.00. List.

No. 5, jaws 12", opens 9½", with attachments, $40.00; without, $36.00. List.

—

DRILL SPEEDER

No. 2, with chuck, drills 0" to 5/16". List, $25.00.

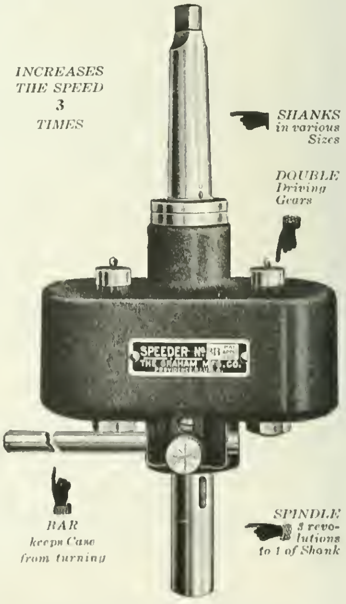
No. 3, with chuck, drills 0" to ½". List, $27.50.

No. 3B, with No. 1 Morse hole instead of chuck, $27.50.

No. 4, with chuck, drills 0" to ¾". List, $10.00.

No. 4B, with No. 2 Morse hole instead of chuck, $33.00.

No. 2L, with chuck, drills 0" to ⅝". Has feed lever mechanism. List, $33.00.


INCREASES THE SPEED 3 TIMES
SHANKS in various Sizes
DOUBLE Driving Gears
SPEEDER No. 3B PAT. APPL.
THE GRAHAM MFG. CO.
BAR keeps Case from turning
SPINDLE 3 revolutions to 1 of Shank

This cut shows Nos. 3B and 4B only. There are two other styles and sizes.

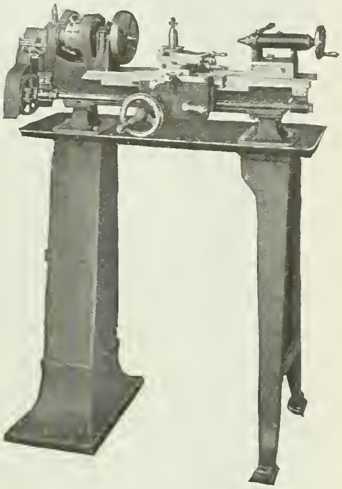
All Patented. Send for Circular.

The Graham Mfg. Co.
Providence, Rhode Island

Great Britain: Burton, Griffiths & Co., Ltd.
France, Italy, Switzerland, Spain and Holland
Fenwick Freres & Co.

OVER THE TOP
with the
"DALTON SIX"

YOU can go "OVER THE TOP" in your production with a "DALTON SIX". Don't ask us why. Ask the manufacturer who uses them; not one machine only, but in many cases ten to one hundred in the same plant.



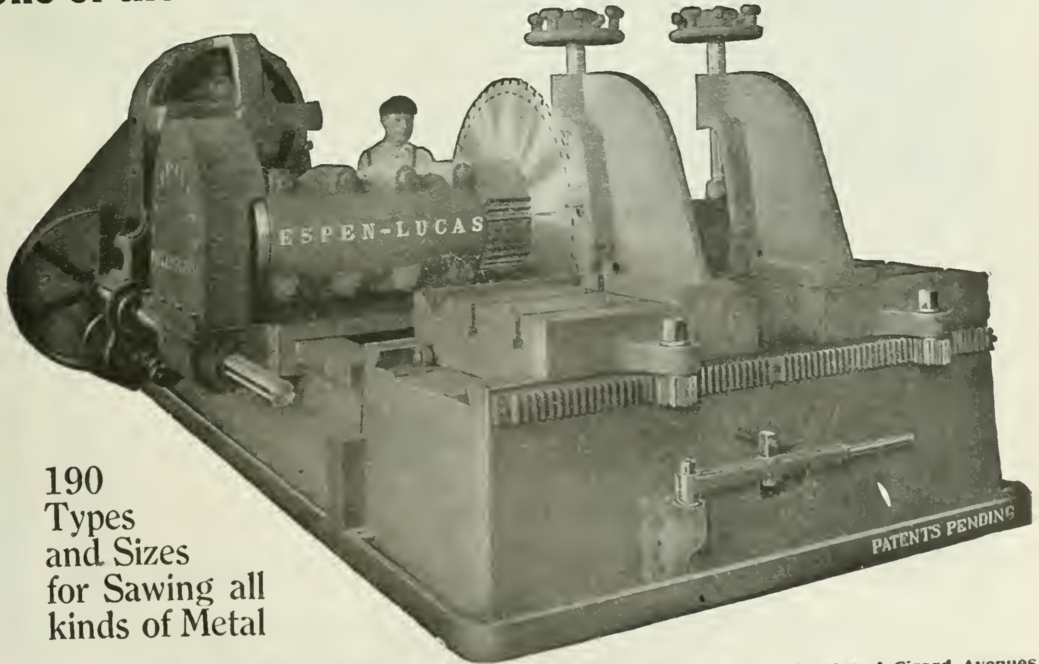
Send for Bulletin B-611

DALTON MANUFACTURING CORPORATION

1915 PARK AVENUE, NEW YORK, U. S. A.

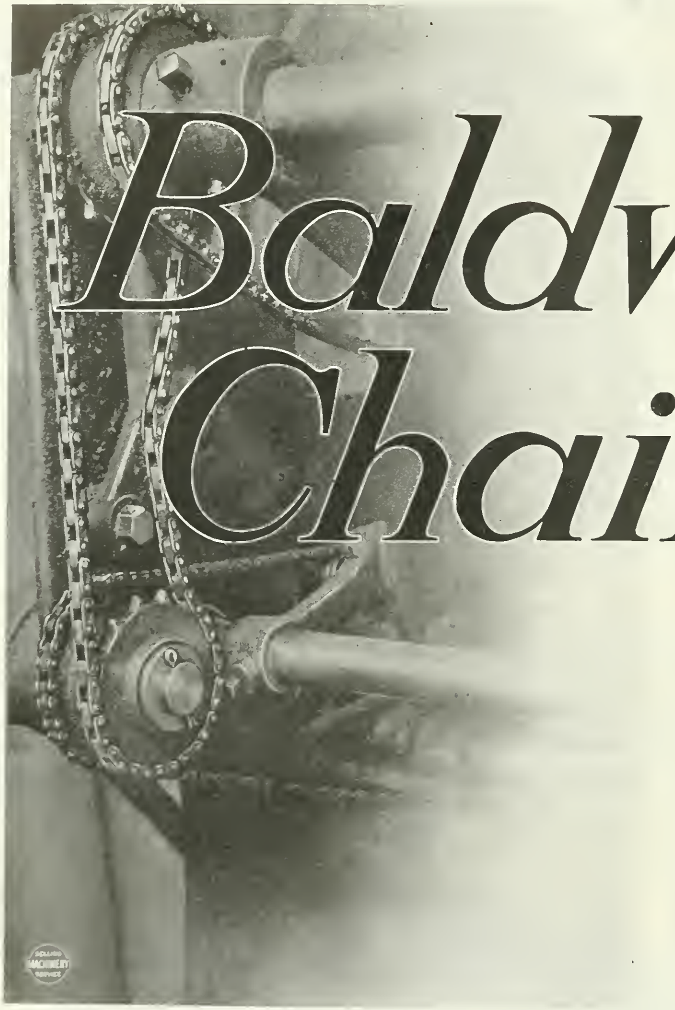
Cable Address "ALEDAL New York"

One of the Fastest Cold Sawing Machines in the World



190
Types
and Sizes
for Sawing all
kinds of Metal

THE ESPEN-LUCAS MACHINE WORKS, Front and Girard Avenues
PHILADELPHIA, PA.



Baldwin Chain

For Power Transmission Purposes where Conditions are Severe

Watch a Kidder Printing Press in operation. Note the smoothness and regularity of its action, for which the makers give Baldwin Chain a fair share of the credit.

In equipping the Kidder Press they were confronted with a difficult driving problem. The intermittent load made a belt drive impossible, because it might slip, and center distances of 24 and 28 inches put gears out of the question.

After exhaustive experiments they put a couple of Baldwin Chains on the job, provided the vertical drive with an adjustable idler, to maintain the proper tension on the chain, and their troubles were over.

Every Kidder Press put on the market in the past 12 years has been equipped with Baldwin Chains. Their action is positive and reliable and they do not stretch.

No load too heavy for a Baldwin Chain. Try one—write Department S.

BALDWIN CHAIN & MANUFACTURING CO.
WORCESTER, MASS., U. S. A.

AGENTS: [illegible] New York City. W. D. [illegible] 1307-1611 Prairie Ave., Chicago, Ill. N. A. Petry Co., Inc., 1307 Race St., Philadelphia, Pa. [illegible] 175 Massachusetts Ave., Boston, Mass. M. A. Bryte, 788 Mission St., San Francisco, Cal. Motor & Machinery [illegible] Co., [illegible] Cleveland, Ohio. [illegible] Automobile & Supply Co., St. Louis, Mo. C. J. Smith Co., St. Paul, Minn. J. M. [illegible] Bldg., Minneapolis, Minn. The Werthlin-Mann Co., 318-320 West Third St., Cincinnati, O.

LINK-BELT

SILENT CHAIN DRIVES

Hasten War Munitions Production

TODAY, conservation is the watchword throughout the nation, not only in food and fuel consumption, but human energy and power as well. "Who Saves Serves."

Link-Belt Silent Chain Drives not only save power, but they speed up production and enable each man to accomplish more work each day as well. They are helping to hasten the production of war munitions everywhere.

Long after belts have slipped a million times—long after gears fail to mesh properly and are making a noise like a "rattle trap"—years longer, Link-Belt Silent Chain Drives will be operating as smoothly and efficiently as ever.

For Link-Belt Silent Chain Drives are "flexible as a belt, positive as a gear, and more efficient than either." Proof is given in our Machine Tool Drive Book No. 312. Send for a copy.

LINK-BELT COMPANY

PHILADELPHIA CHICAGO INDIANAPOLIS

New York - 299 Broadway
Boston - 49 Federal St.
Pittsburgh 1501 Park Bldg
St Louis Cent. Nat'l Bank Bldg.
Buffalo 696 Ellicott Square
Wilkes Barre, 2d Nat'l Bk. Bldg.
Cleveland, 429 Rockefeller Bldg
Detroit 732 Dime Bank Bldg.
Minneapolis 418 S. Third St
Kansas City Mo 407 Finance Bldg
Seattle 576 First Ave. S
Portland, Ore First and Stark Sts
San Francisco 461 Market St
Los Angeles, 161 N Los Angeles St
Denver, - Lindrooth, Shubart & Co., Boston Bldg
Louisville, Ky Frederick Wehle, Starks Bldg
Knoxville, Tenn. - - D T Blakey, Empire Bldg
New Orleans - C O Hinz, Hibernia Bank Bldg
Charlotte, N C., - - J S Cothran, Com'l Bank Bldg
Toronto, Can. - - - Canadian Link Belt Company Ltd

138

"Pioneer"

STEEL HANGERS

Have Taken The Hard Work Out of Shaft Hanging

There was a time when hanging shafting was a back-breaking job.

Now it is different—because "Pioneer" Steel Hangers weigh about one-third as much as the old-style cast iron.

The cost of the millwrighting is also very materially reduced and the "Pioneer" does not break—Never.

Its price is no higher.

Ask for a copy of our new booklet "Transmission Data". Contains some plain truths worth reading.

STANDARD PRESSED STEEL CO.

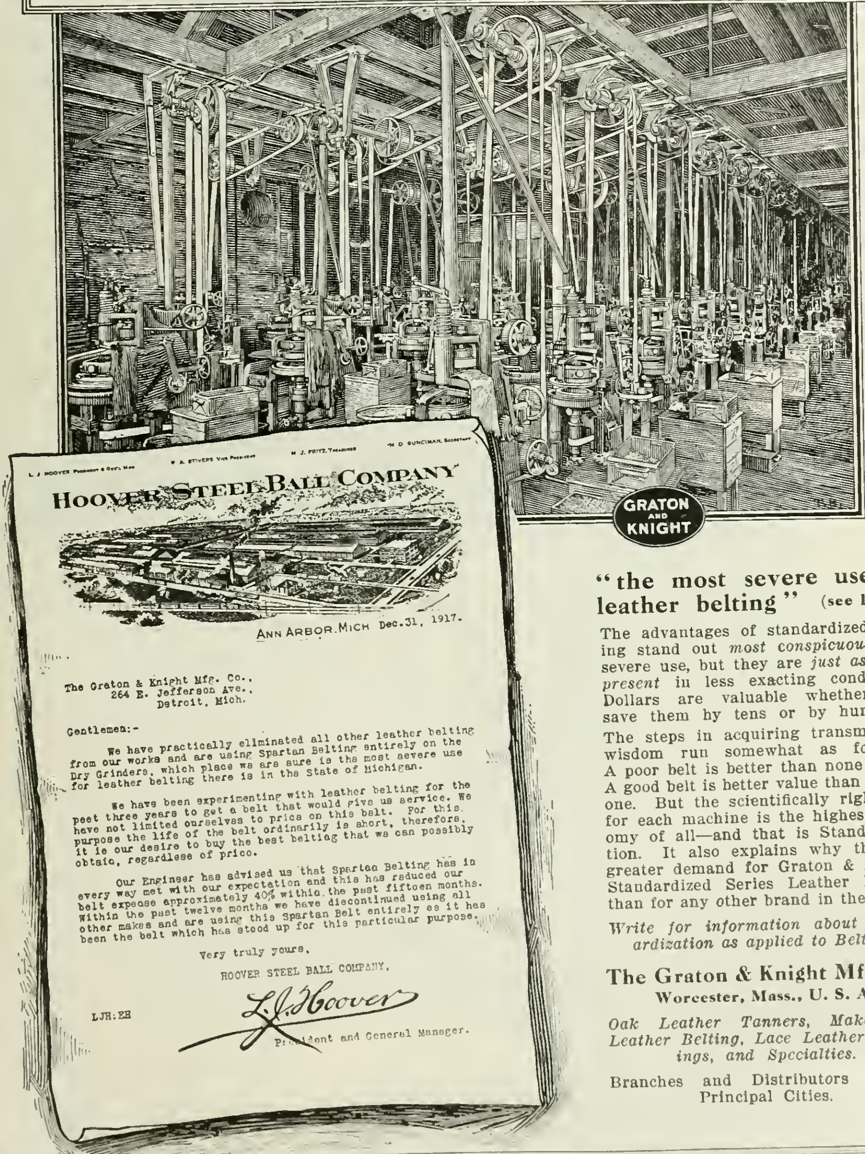
PHILADELPHIA, U. S. A.

GRATON & KNIGHT

Standardized Series

LEATHER BELTING

Tanned by us for belting use



L. J. HOOVER President & Gen'l Mgr. F. A. STIVERS Vice President H. J. FRITZ, Treasurer H. D. RUNCIMAN, Secretary

HOOVER STEEL BALL COMPANY

ANN ARBOR, MICH Dec. 31, 1917.

The Graton & Knight Mfg. Co.,
264 E. Jefferson Ave.,
Detroit, Mich.

Gentlemen:-

We have practically eliminated all other leather belting from our works and are using Spartan Belting entirely on the Dry Grinders, which place we are sure is the most severe use for leather belting there is in the State of Michigan.

We have been experimenting with leather belting for the past three years to get a belt that would give us service. We have not limited ourselves to price on this belt. For this purpose the life of the belt ordinarily is short, therefore, it is our desire to buy the best belting that we can possibly obtain, regardless of price.

Our Engineer has advised us that Spartan Belting has in every way met with our expectation and this has reduced our belt expense approximately 40% within the past fifteen months. Within the past twelve months we have discontinued using all other makes and are using this Spartan Belt entirely as it has been the belt which has stood up for this particular purpose.

Very truly yours,

HOOVER STEEL BALL COMPANY.

L. J. Hoover

LJH:EH

President and General Manager.

"the most severe use of leather belting" (see letter)

The advantages of standardized belting stand out *most conspicuously* in severe use, but they are *just as truly present* in less exacting conditions. Dollars are valuable whether you save them by tens or by hundreds.

The steps in acquiring transmission-wisdom run somewhat as follows: A poor belt is better than none at all. A good belt is better value than a poor one. But the scientifically right belt for each machine is the highest economy of all—and that is Standardization. It also explains why there is greater demand for Graton & Knight Standardized Series Leather Belting than for any other brand in the world.

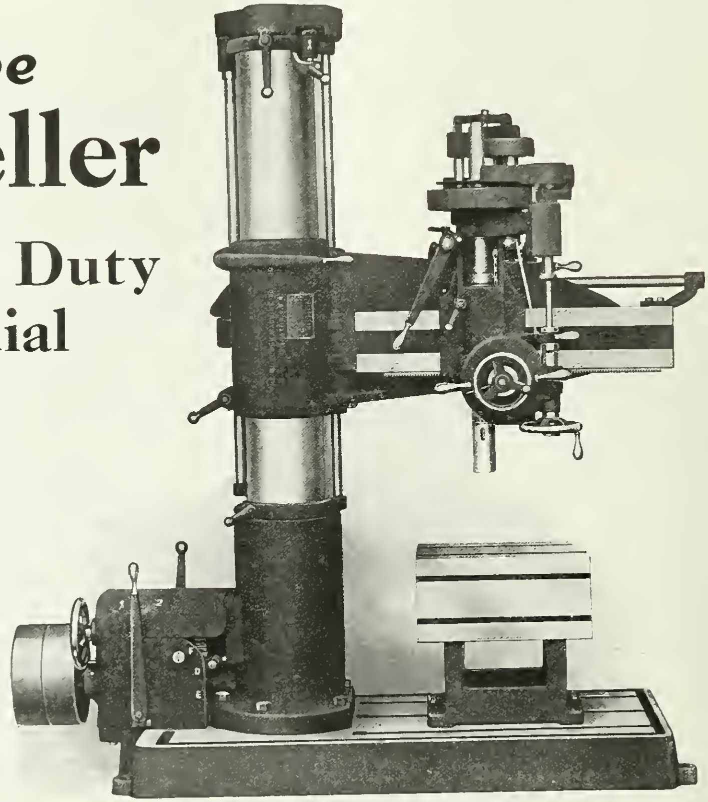
Write for information about Standardization as applied to Belting.

The Graton & Knight Mfg. Co.
Worcester, Mass., U. S. A.

Oak Leather Tanners, Makers of Leather Belting, Lace Leather, Packings, and Specialties.

Branches and Distributors in all Principal Cities.

The Mueller Heavy Duty Radial



Just as American men responded to the call to arms, American machines rose to their allotted task. The Mueller Radial has been among the leaders from the start—a pace setter for the hard, continuous production necessary to supply the needs of the fighting forces.

Well designed, well constructed, readily controlled and fool proof, this heavy duty machine drives high speed drills to capacity and has a reputation for seldom being down for repairs.

Special features include patented, one piece, re-inforced column, long bearing of arm on column, combination positive and friction feed, friction reverse, etc. Let us tell you all about it.

THE MUELLER MACHINE TOOL CO.

CINCINNATI *Radial Drills and Lathes* OHIO, U. S. A.

A Word to the Wise About

WEIGEL

Weigel 25-inch Vertical Drilling Machine, a machine that "Made Good" quickly. Here's the reason—

We say that the new Weigel 25″ Vertical Drilling Machine has "taken hold" of the market. Buyers have accepted this improved machine. It has "made good" in a surprisingly short time.

Gold bricks as a commodity have entirely succumbed. Particularly in the machine tool industry, one has to have "the goods" in order to "get across."

The sole purpose of this advertisement is to convince you that you can easily convince yourself that the makers of the new Weigel have "the goods." And our advice is:

(1) See it work, or

(2) Ask somebody who has seen it work, or

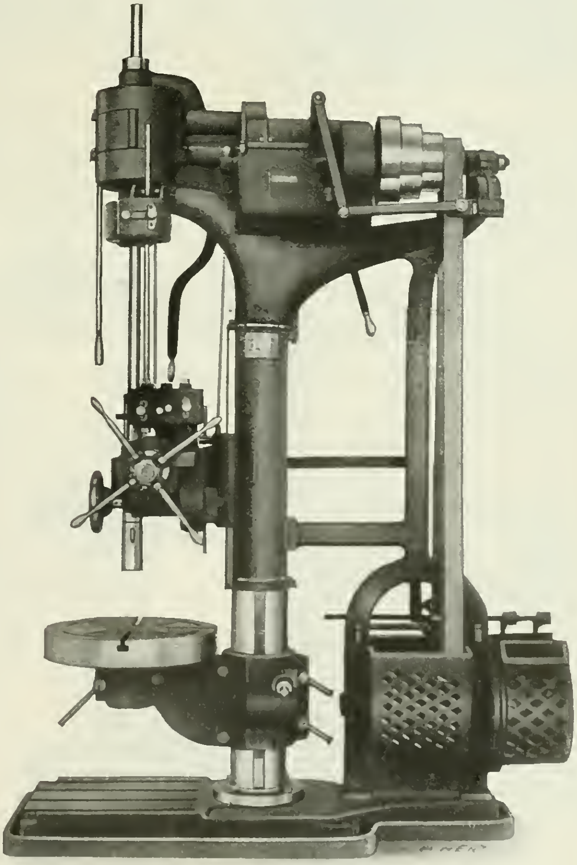
(3) At least send for the specifications.

Most important of all, though—do it now.

That's the Weigel ⟶

Weigel Machine Tool Company
PERU INDIANA

The makers of this new machine have designed and built high grade machine tools for more than thirty years—the reason beyond a doubt for the instant popularity of the newest of their creations. The new Weigel drills to the center of a 25⅝″ circle, and is furnished with our improved friction type back gears, with special babbitted bearings, or with Damascus bronze bearings throughout.



Quick, Complete Demagnetization

Removes the Only Objection to the Use of the Magnetic Chuck

The Smith Demagnetizer demagnetizes parts quickly, completely and at but a fraction of the present cost, thus removing the sole objection to the use of magnetic chucks. The rate of production is limited only by the speed with which the operator can feed the parts to the machine.

Made in a variety of sizes.
Send for complete details.

Wm. F. Davis Machine Tool Co., Inc.

CHICAGO
549 W. Washington Blvd.

CLEVELAND
508 Leader News Bldg.

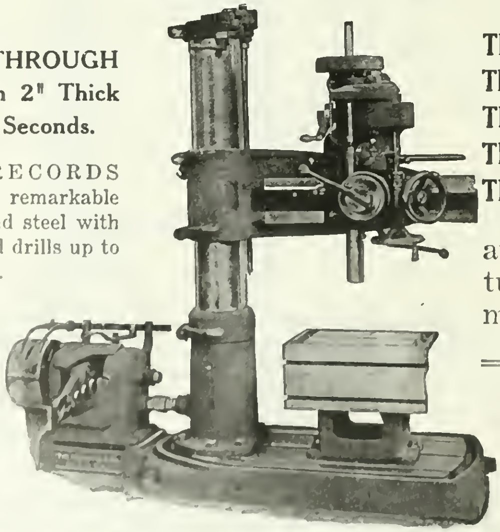
NEW YORK
85 Liberty Street

WASHINGTON
945 Pennsylvania Avenue

FOSDICK 2 and 2½ FT. HEAVY DUTY RADIALS

1" Drill THROUGH Cast Iron 2" Thick in 7 4/5 Seconds.

OTHER RECORDS equally as remarkable in iron and steel with high speed drills up to 2½ inches.



Send for drilling and tapping test sheet

The INTERCHANGEABLE DRIVE
The EXTRAORDINARY POWER
The LUBRICATING SYSTEM
The HARDENED BEVEL GEARING
The BRONZE BUSHINGS

and many other valuable features will be found in these machines.

THE FOSDICK MACHINE TOOL COMPANY

CINCINNATI OHIO, U. S. A.

AGENTS: Biggs-Watterson Co., Cleveland, Ohio. Colcord-Wright Mchy. & Supply Co., St. Louis, Mo. Eccles & Smith Co., San Francisco, Cal., Los Angeles, Cal., Portland, Oregon. Fairbanks Co., New York City, N. Y., Hartford, Conn., Albany, N. Y. E. A. Kinsey Co., Cincinnati, Ohio, Indianapolis, Ind. J. L. Osgood, Buffalo, N. Y. Peninsular Machinery Co., Detroit, Mich. H. A. Smith Machinery Co., Syracuse, N. Y. Swind Machinery Co., Philadelphia, Pa. Somers, Fitler & Todd Co., Pittsburgh, Pa. Stocker-Rumley-Wachs Co., Chicago, Ill., Milwaukee, Wis. Taylor Machinery Co., Boston, Mass. A. R. Williams Machinery Co., Ltd., Toronto, Ont., Canada. Burton, Griffiths & Co., Ltd., London, England. Fenwick Freres & Co., Paris, France. Wynmalen & Hausmann, Rotterdam, Holland. Rylander & Asplund, Stockholm, Sweden. Wilh. Sonesson & Co., Malmo, Sweden, Copenhagen, Denmark. Roku-Roku Shoten, Tokyo, Japan. R. L. Scrutton & Co., Sydney, Australia.

Efficiency in the *highest degree* is what the U. S. Government desires, and that is why it is such a large purchaser of

Gray's Sheet Metal Cutter No. 1

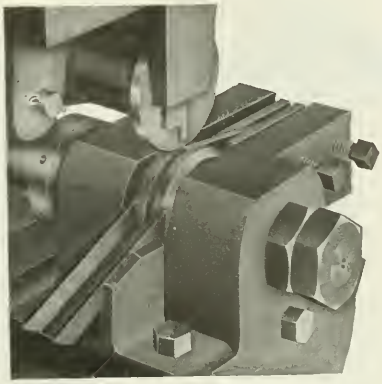
(PATENTED)

Not a Rotary Shear

This machine cuts Sheet Metal up to 3/16" in thickness, into any conceivable shape, and leaves every portion in its former flat condition.

Ordinarily a saving of 10 per cent justifies installing a more modern machine. On work within the scope of this machine, present users are saving from 75 to 90 per cent in labor alone. It does mechanically what you have heretofore been doing by hand and usually with skilled labor. Don't overlook the saving in material, due to method of cutting. It is a big item in itself.

Saving of man power today is of the greatest importance, and if you are not yet familiar with the possibilities of this machine, become so at once.



End View Showing Cutting Mechanism

Write for Illustrated Circular

W. J. SAVAGE COMPANY, Inc.
KNOXVILLE TENN.

Rowbottom for Cams

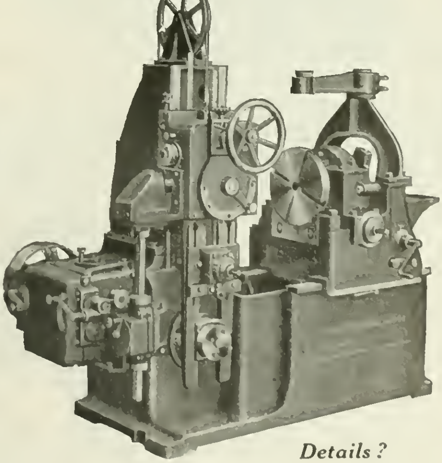
It is one thing to design a cam that will "perform a required amount of work in a given time;" but quite another to cut and finish it economically—unless you have a

ROWBOTTOM CAM MILLING MACHINE

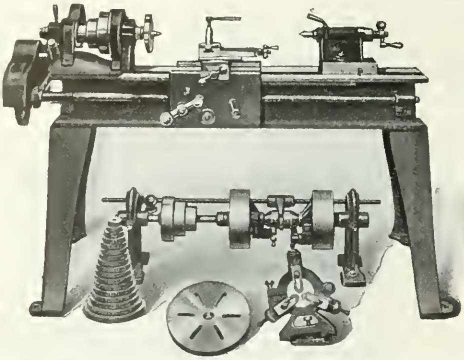
Specially designed to cut and finish cams—barrel, face, frog, yoke, box, etc.—this machine is a rapid, accurate producer and imparts a fine, smooth finish to the work.

If you cut many cams, you'll find this machine a profitable investment; if few, it will pay you to let us cut them for you the "Rowbottom" way.

The Rowbottom Machine Co.
Factory WATERVILLE, CONN. WATERBURY, CONN., U.S.A.



Details ?



The VICTOR LATHE

is an ideal machine for precision manufacturing, tool room and experimental work. Regularly cuts threads from 4 to 40—special and metric threads with extra gears. It swings 10″ over ways, is 9″ between centers, has power cross feed, longitudinal power feed, reverse lever on headstock and fully covered gears. Furnished with bench or floor legs, countershaft or foot power.

Better description in circular

VICTOR LATHE COMPANY
151 Lafayette Street NEW YORK CITY

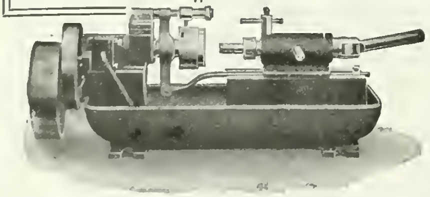
H & G

Threading Machines

are well liked by munition makers and airplane manufacturers. They are designed for high grade precision work such as threading nickel steel airplane parts and similar exacting work.

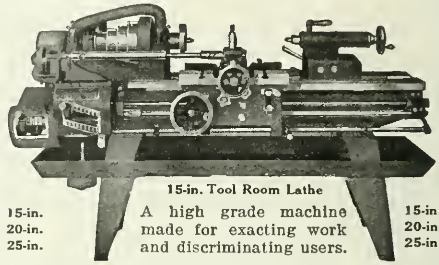
Equipped with the H & G Automatic Self-Opening Die Head they cut threads to a given point or right up to the shoulder and maintain true alignment.

New catalog gives all the details



Eastern Machine Screw Corp.
New Haven, Conn., U. S. A.

CRAWFORD LATHES



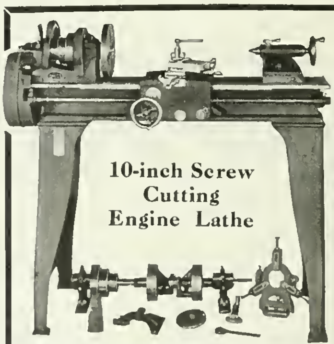
15-in. Tool Room Lathe

15-in.
20-in.
25-in.

A high grade machine made for exacting work and discriminating users.

15-in.
20-in.
25-in.

CRAWFORD MACHINE TOOL CO., Inc.
21 Park Row NEW YORK



10-inch Screw Cutting Engine Lathe

The "SUMMIT"

Is the outgrowth of twenty-five years' experience in machine-tool building—a practical lathe, efficient, durable and a more than creditable producer.

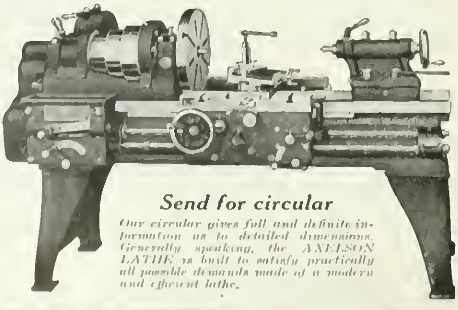
Write for details

SUMMIT MACHINE WORKS, 54 Hermon St., Worcester, Mass.

AXELSON LATHES

RENDER SATISFACTION

Viewed from every angle: Materials, Workmanship, Practicability and from every other viewpoint, AXELSON LATHES are *extraordinary* machines.



Send for circular

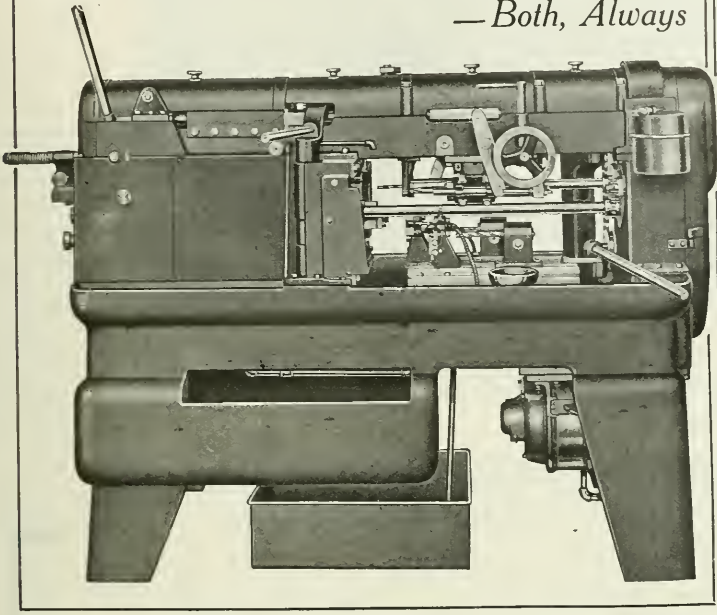
Our circular gives full and definite information as to detailed dimensions. Generally speaking, the AXELSON LATHE is built to satisfy practically all possible demands made of a modern and efficient lathe.

ACCURACY and RIGIDITY are two prominent attributes which distinguish the AXELSON LATHES and make them *different* from every other existing lathe.

Axelson Machine Company
Department E. Los Angeles
California, U. S. A.

THE CONE Accurate AUTOMATIC

Not "Quality First," Not "Quantity First"—
—Both, Always



The Cone *Accurate* Automatic is an exceptionally well designed and well constructed machine. For producing high quality work at consistent costs, it has no equal.

Adjustable bearings, which compensate for wear and insure permanent accuracy, are an exclusive feature. There are many others which help to make a prompt investigation worth while.

Let us send you more detailed information

CONE AUTOMATIC MACHINE CO., Inc.
Windsor Vermont

Agent for Michigan Territory:
J. C. AUSTERBERRY
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Unusual Capacity

Distinguishes "W & P" Planers. Designed to economically fill the needs of the modern shop—powerful, speedy, accurate—these machines turn out the maximum of fine work. Full range of sizes and several styles. Write us.

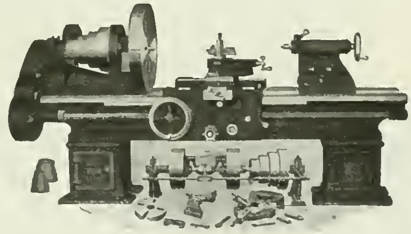
WOODWARD & POWELL PLANER CO.
WORCESTER, MASS., U. S. A.

DAVIS
11-inch Lathe

No frills or needless ornament. Just a plain 11" lathe. An honest, dependable machine that will do more than most small lathes and "do it better." A1 material and workmanship.

C. F. DAVIS MACHINE CO., Inc.
133 ANDREWS ST. ROCHESTER, N. Y.
Also Manufacturers of Davis Keyseat Cutters

SOUTH BEND LATHE



South Bend Lathes Have Been on the Market Twelve Years

Swing Over Bed, Inches	Length of Bed Feet	Distance Between Centers, Inches	Hole Through Spindle, Inches	Approximate Weight on Skid	Code
13¼	5	32	¾	1,000	Hasen
15¼	6	40	1⅛	1,425	Jadin
16¼	6	36	1 5/16	1,700	Juddo
18¼	8	57	1 5/16	1,950	Kell
21¼	10	75	1½	3,300	Penti
24¼	12	95	1¾	4,420	Polly

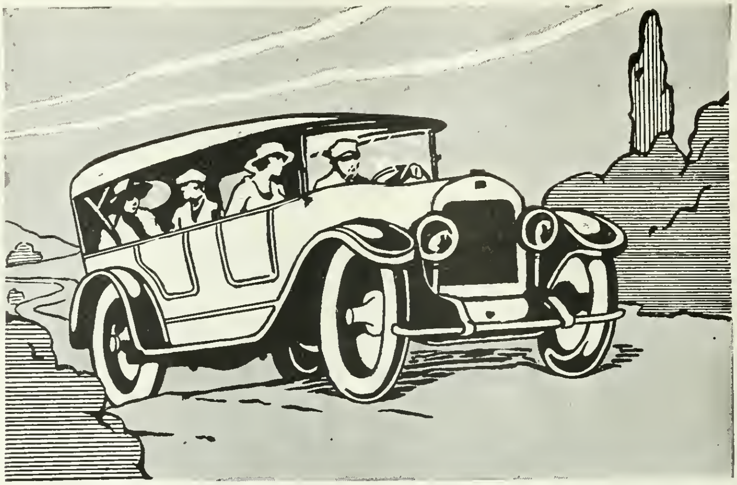
Prompt Delivery

Made with straight or gap bed. Price includes all the equipment shown in illustration.

Many large, busy plants are increasing their production by using South Bend Lathes on duplicate work

Dealers in every large city. Send for free Catalog illustrating and describing entire line.

SOUTH BEND LATHE WORKS
420 E. Madison St. Established 1906 South Bend, Ind.



At Buick

The Part Brown Pyrometers Play in Great American Industries

Fourth of a series of talks showing how completely Brown Pyrometers cover the entire field of heat treating.

When Uncle Sam went to war a year ago, the great automobile industry instantly stepped forward offering its army trucks, Liberty Motors, motor parts, forgings and its immense wealth.

Hand in hand with its enlistment came Brown Pyrometers, redoubling its efforts, handling the heat treating, hardening and annealing—doing their full share in the gigantic work—standardized by such plants as Buick, Maxwell and Haines.

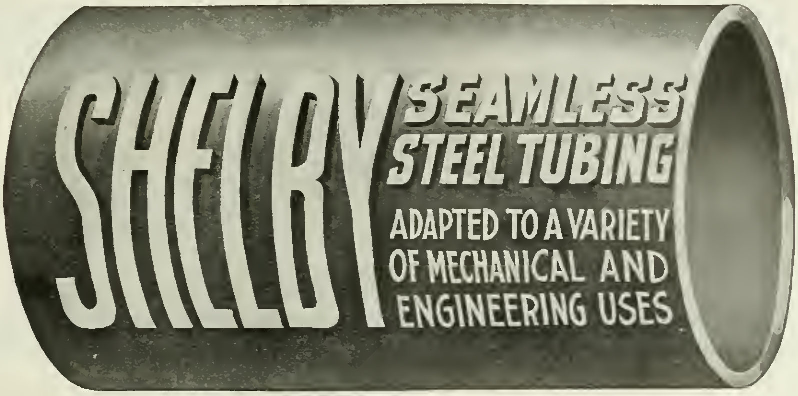
So here again is the prowess of Brown Pyrometers proven. They lead unconditionally. And what they have done is YOUR guarantee. Put them to the test in your plant now.

Shipped on 30 days' trial if you will. Write today for details to the Brown Instrument Co., Philadelphia, or one of their district offices in New York, Pittsburgh, Detroit, Chicago, or St. Louis.

Brown Pyrometers

Brown Pyrometers control the heat treating furnaces at the Buick Automobile Plant, Flint, Michigan.

The Brown Central Station Pyrometer shows signal man the right heats.



Why "SHELBY" Seamless Steel Tubing Saves Labor, Tools and Mechanics' Time

¶ In determining the various wall thicknesses, sectional contours, alloys and anneals of "SHELBY" Seamless Steel Tubing for Mechanical Purposes, the manufacturers have given much study to various problems associated with the ultimate use and the manipulation of this highly adaptable material.

¶ Standards of mechanical construction have been freely consulted; conditions of service have been considered; and comparisons have been made as to the feasibility of seamless tubing in certain work which hitherto had required material formed from solid stock after laborious effort.

¶ As a result, certain sizes and kinds of "SHELBY" Cold Drawn Seamless Steel Tubing are made which may be used with comparatively little or no special machining or finishing in numerous instances. Any variation in gauge will be found negligible and will require no correction except on work running into the very fine fractions of an inch or where a highly finished surface is required.

¶ The hollow construction reduces boring and drilling to their lowest terms—all that is required in most cases being a light reaming or surface finishing. Much labor is thereby eliminated and a consequent saving of time is effected. Tools are saved, as the amount of superfluous stock to be removed is considerably reduced when "SHELBY" Cold Drawn Seamless Steel Tubing is used in place of solid or forged stock, and that which is removed is of such uniformity that wear and tear on tools is of slight consequence.

¶ "SHELBY" Seamless Steel Tubing is made in a wide variety of special shapes such as hexagon, rectangular, oval, etc., which under ordinary circumstances would require considerable labor and time to produce from solid, round or square stock; these special shapes often being used as they are received from the mill, without additional machining.

¶ The advantages of "SHELBY" Seamless Steel Tubing for saving time, labor and tools are based on the inherent high qualities of the material from which it is made; the modern, accurate methods of manufacture pursued; and an appreciation of the requirements of present-day machine shops, tool rooms and industry in general.

¶ "SHELBY" Seamless Steel Tubing is maintained at the high peak of quality by a self-contained organization controlling the manufacture from ore to finished product. In awarding the Grand Prize, the Superior Jury of Awards, Panama-Pacific International Exposition, stated that "SHELBY" Seamless Steel Tubing represents "the highest development of the art." The significance of this statement is realized more fully by considering the amplitude of the line in which "SHELBY" Seamless Steel Tubing is manufactured.

NATIONAL TUBE COMPANY

General Sales Offices: Frick Building Pittsburgh, Pa.

DISTRICT SALES OFFICES: Atlanta Boston Chicago Denver New Orleans New York Philadelphia Pittsburgh Salt Lake City St. Louis St. Paul

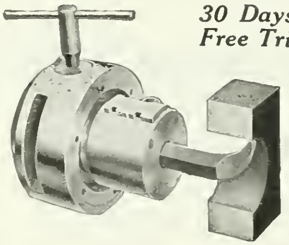
PACIFIC COAST REPRESENTATIVES: U. S. Steel Products Co., San Francisco, Los Angeles, Portland, Seattle

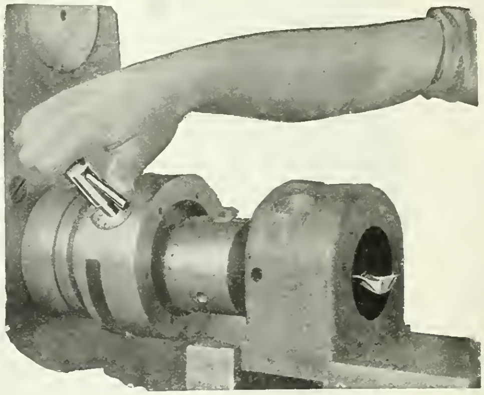
EXPORT REPRESENTATIVES: U. S. Steel Products Co., New York City

CASLER
Offset Boring Heads

are adapted for use on turret lathes, milling, drilling and boring machines. They may be quickly and accurately set to the size required by means of an adjusting screw, the whole device then locked as rigidly as a one-piece tool. One tool can bore any number of diameters within the range of adjustment—10 inches.

30 Days Free Trial



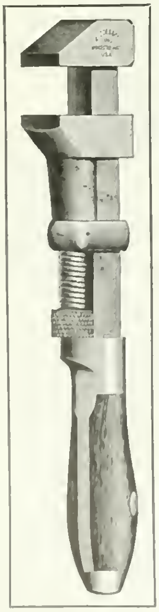


Eliminate Uncertainty

Old-style adjustment of the boring tool and the dependent accuracy of the cut relies solely on the steadiness of the hand making the adjustment. The Casler Offset Boring Head eliminates this uncertainty.

Write for further details

MARVIN & CASLER CO.
CANASTOTA, N. Y.

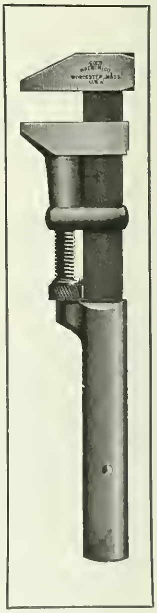


Why Does a "Coes" Wrench Last So Long?

Because it is considerably stronger in every detail of its make-up than any other wrench you ever used. For instance, the back or bar of a "Coes" is of fully hardened steel and cold-swaged; the jaws are heavy, and never slip once they take a "bite" on a nut or bolt head. A "Coes" is

Strong Where Strength Is Needed

Thirty per cent stronger, by actual test, than other wrenches. You may pay just a little more for a "Coes" Wrench, but your dealer will *show you* wherein the difference in price lies. A trial of a "Coes" will *convince you.*



The "Coes" catalogue sent on request.

COES WRENCH COMPANY, Worcester, Mass., U. S. A.

AGENTS: J. C. McCarty & Co., 29 Murray St., New York. 438 Market St., San Francisco, Cal. 1515 Lorimer St., Denver, Colo.
AGENTS: John H. Graham & Co., 113 Chambers St., New York. London, E. C., 118-122 Holborn. Fenwick Bros., Paris, France.

Pay Less for Trucking Equipment and Pay Less for Man Power to Operate It

YOU pay for the trucker's time. If he uses from 50 to 75 per cent of his time in getting castings or machine parts on and off of fixed platform trucks—and careful investigation proves that to be the usual percentage when such trucks are used—that money is wasted and lost.

The National-Chapman System of trucking, using detached skids either as permanent mounts or as general burden bearers, saves this money. In addition, these trucks are faster. They roll along the floor almost as easily as if on tracks and turn sharp corners and work in narrow aisles where an ordinary truck would jam. They give better and quicker deliveries to machines and to all employees whose output depends upon an uninterrupted flow of material to work on. In stock and store rooms they are invaluable.

Illustrated Catalog MB, showing types and sizes, sent on request

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8 Mechanic St. **Chicopee Falls, Mass.**

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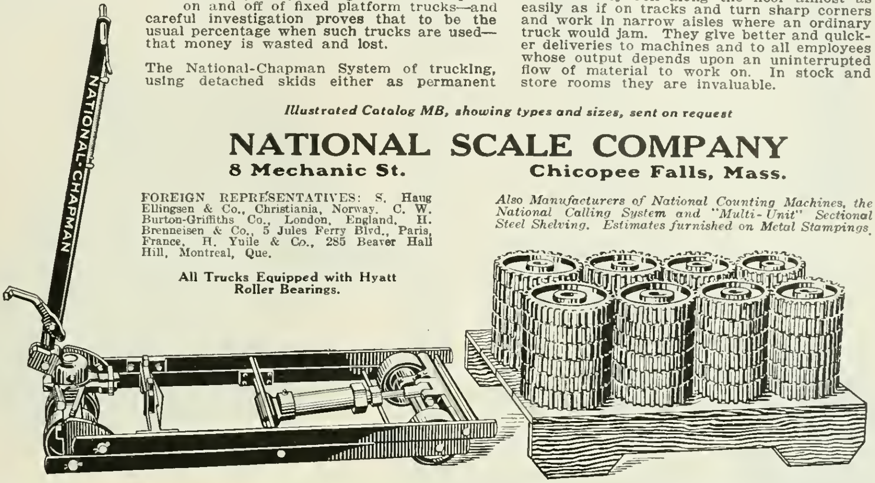
Also Manufacturers of National Counting Machines, the National Calling System and "Multi-Unit" Sectional Steel Shelving. Estimates furnished on Metal Stampings.

All Trucks Equipped with Hyatt Roller Bearings.



Testing is the Only Way

To guarantee every finished piece of work you must know the exact character of the metal in it, whether it comes squarely up to requirements and what is its strength (i.e. hardness). In other words, *test your product.*

The Scleroscope will quickly measure the hardness and elasticity of any steel. You will then *know* the resistance of your product. Steel plants, automobile manufacturers and shell makers use it; so simple to operate that skilled labor is unnecessary; huge or minute objects can be tested equally well.

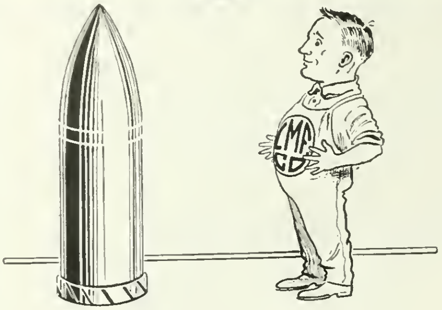
Send for our free Booklet and learn how you can apply the Scleroscope to your business.

Shore Instrument & Mfg. Company, Inc.

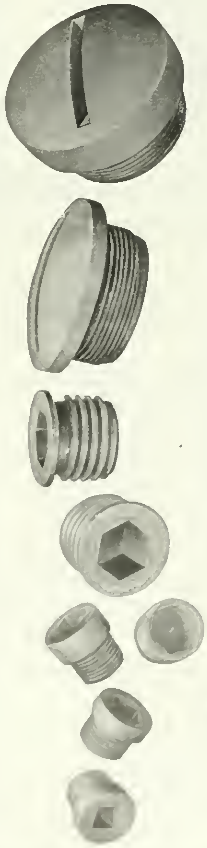
555-557 W. 22nd Street, NEW YORK

FOREIGN AGENTS: Agent for Great Britain and Colonies, Coats Mch. Tool Co., Ltd., Caxton House, London, S. W.; Glasgow: Newcastle-on-Tyne. Yamatake & Co., Tokyo, Japan. Iznosskoff & Co., Petrograd, Russia. Aux Forges de Vulcain, Paris, France. R. S. Stokvis & Zonen, Ltd., Belgium and Holland.

"Quality" Die Castings



"I can make a mighty good plug for it, but I wouldn't want it to plug me."



FUSE-HOLE plugs for projectiles of all sizes are being made by our "Quality" automatic die-casting process in large quantities—accurate and economical—to the great convenience and satisfaction of our customers.

Do you make shells?

Let us quote

LIGHT MFG. & FOUNDRY CO.
Pottstown, Pa. U.S.A.
DETROIT OFFICE, PENOBSCOT BLDG.

Milling Cutter, Reamer and Drill Salvaging

We recut your milling cutters, mechanically correct, without disturbing the original temper.

Our prices and quality of work are guaranteed to be correct. A trial order will convince you.

GORHAM TOOL CO.
Globe Bldg., Cor. Fort and Brush Sts.
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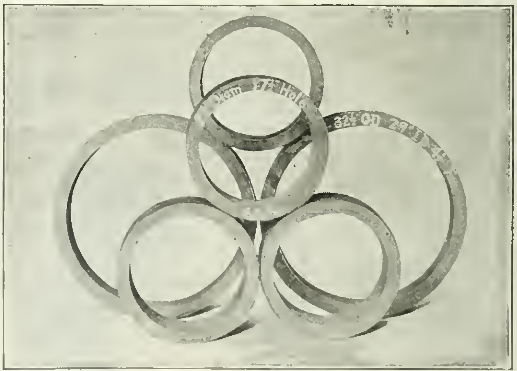


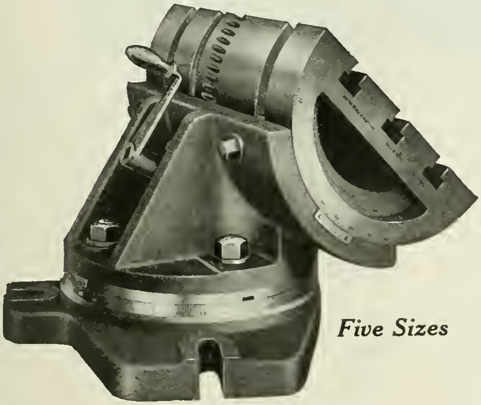
Dyson's Forgings stand the test of time and hard use. Forgings of all kinds, 2¾" nuts to 5 ton shafts.

Weldless steel rings, gear blanks, spindles, etc. Specialties—all heat treated by the Dyson process and guaranteed to meet the most exacting specifications.

Let us estimate on your work

JOSEPH DYSON & SONS
CLEVELAND OHIO, U. S. A.

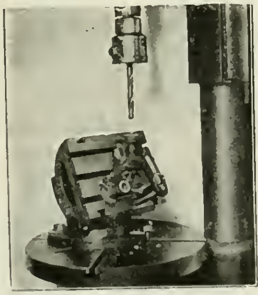
Save Resetting Time With
UNIVERSAL
ANGLE PLATES



Five Sizes

The Universal Angle Plate will save time wherever used. Adapted for use with lathes, planers, grinders, millers, drill presses, shapers, etc., and will make a universal machine of a plain miller or grinder. It moves through 360° horizontally, 90° vertically, and has a vernier attachment reading to 5′ which permits the use of this tool on especially fine work.

These Plates are increasing production for the American Ordnance Base, also for the Bethlehem Shipbuilding Corporation and hundreds more for equally prominent organizations in England, France, Italy, Canada, India, Australia and Japan.



Let us tell *you* all about it.

Write us today.

BOSTON SCALE & MACHINE CO.
100 RUGGLES STREET BOSTON, MASS.

HOOVER
STEEL BALLS

4,500,000 Motor Cars and Motor Trucks Carry Them

This number of passenger and commercial cars represents 95 per cent of the total in North America.

Automotive bearings demand the finest and most durable steel balls. The fact that in this field the Hoover Steel Ball is without any serious competition, indicates the esteem in which automotive engineers hold them.

Not only in North America are Hoover Steel Balls regarded as the standard of high quality—they are so considered throughout the world, by mechanical engineers in every industry in which steel balls are used to overcome friction.

The Hoover Steel Ball has, through force of merit, supplanted the high grade steel balls formerly supplied to the world only by Germany, and have brought supremacy in this industry back to the United States, where it originated.

This leadership has been re-secured by American initiative, American science and American efficiency, through which the Hoover Steel Ball Company has been able to produce finer and more durable steel balls in larger quantities and at lower cost than ever before.

The romance of the steel ball industry makes a deeply interesting tale of the triumph of American financial, industrial and scientific preparedness and progressiveness. This story, told in a book, "The Evolution of the Steel Ball Industry," will be sent on request.

HOOVER STEEL BALL CO.
ANN ARBOR MICH., U. S. A.

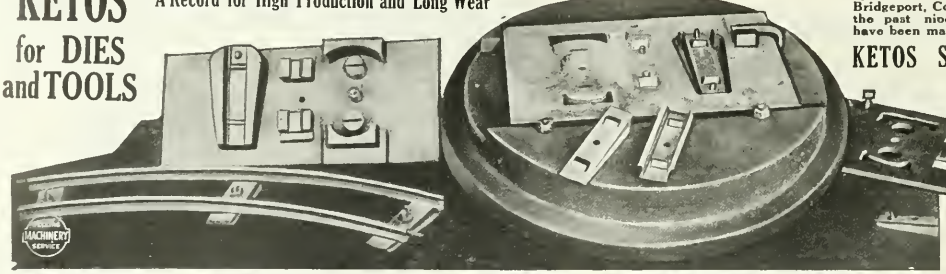
HOOVER
Steel Balls

"KETOS" for DIES and TOOLS

A Record for High Production and Long Wear

All of the dies used by the Ives Company, Bridgeport, Conn., for the past nine years have been made from

KETOS STEEL



HAWKRIDGE BROTHERS CO., 303 Congress St., Boston, Mass., U. S. A.

REGISTERED TRADE-MARK

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CARPENTER
THREADS

For 48 years, manufacturers have been cutting Carpenter Threads—uniform, accurate, economical threads, that invariably pass inspection, insure quick assembling and ready interchangeability of duplicate parts.

If this is the service you are after specify

CARPENTER
TAPS and DIES

Catalog

The J. M. Carpenter Tap & Die Co.
PAWTUCKET RHODE ISLAND

The Ideal Indicator

Price Only $3.00

Accurate, durable, compact and extremely sensitive, the Ideal Test Indicator is completely self-contained and indicates to thousandths in any position. Easily read without eye strain; handy to have in your tool kit for testing accuracy of machine, instrument and tool work.

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JOHNSON & MILLER
42 Murray Street NEW YORK

No. 10
BRONZE

For Grinder, Lathe and other Machine Tool Bearings

Booklet upon request.

Lumen Bearing Company
BUFFALO, N. Y., U. S. A.

STEEL STAMPS

BURNING BRANDS
STEEL LETTERS
FIGURES, METAL CHECKS
Send for Catalog

The Schwerdtle Stamp Co.
Bridgeport, Conecticut

Industrial Military and Marine

WILLSON
SAFETY GOGGLES

Adjustable or Rigid Goggles

Write for details

One pair or 20,000 per day

T. A. WILLSON & CO., Inc., Factory and Main Offices, Reading, Pa.

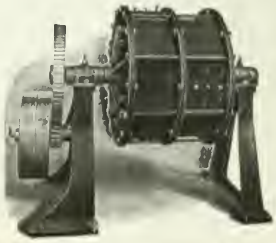
POLISH BY THE ABBOTT PROCESS

Save money, time, power and, above all, save labor. One operator runs a battery of four or five

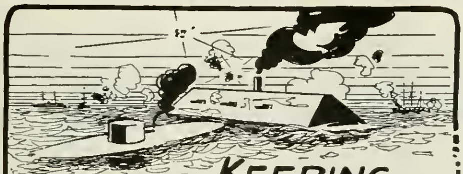
Abbott Burnishing Barrels

each polishing hundreds of metal parts which would require several men to finish with buffing or hand polishing machines.

Details on Request.
Samples Burnished Free.



THE ABBOTT BALL COMPANY
ELMWOOD, HARTFORD, CONN., U. S. A.



KEEPING A JUMP AHEAD

JUST as modern fighting craft has outstripped the monitor—invincible of old—so have modern forgings improved over those of many years ago.

Modern ideas and up-to-date equipment make Bay City Forgings the leaders in the field. We make forgings of all kinds, rough finished or machined—of the best stock. Try us.

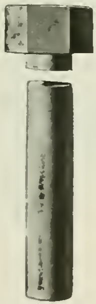
Write for Prices

THE BAY CITY FORGE COMPANY
Erie Pennsylvania

Cap Screws and Bolts

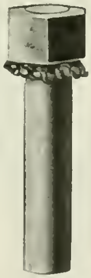
HEADS ELECTRICALLY WELDED

Ready to Weld



1

Welded



2

Finished

3

We make a specialty of electrically welded cap screws and bolts made to customers' specification. Also made in U. S. and S. A. E. standard sizes.

Will be pleased to submit samples and quote on your requirements.

THE METZGER WELDING CO.
Station A CINCINNATI, OHIO

APEX

STEEL

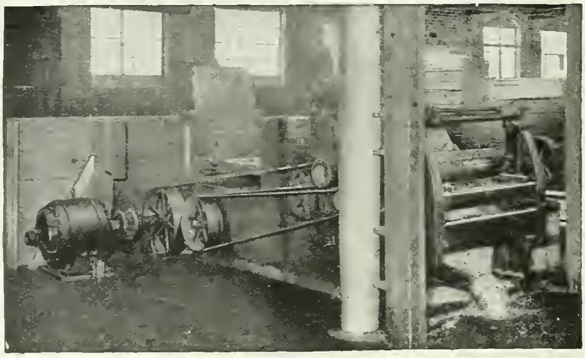
IF YOU feel you'll need.
• • •
SOME HIGH Speed Steel.
• • •
IN A hurry.
• • •
THIS MONTH.
• • •
AND YOU'RE banking.
• • •
ON OUR Accommodation Department.
• • •
AS USUAL.
• • •
WE HAVE to admit.
• • •
WE'RE WORRIED.
• • •
BECAUSE THE showing.
• • •
THE A. D. is making.
• • •
LATELY.
• • •
ON THEIR ability.
• • •
TO DO extraordinary things.
• • •
QUICKLY.
• • •
IS SOONER or later.
• • •
BOUND TO attract.
• • •
THE GOVERNMENT.
• • •
AND THEY'LL all be drafted.
• • •
OR SOMETHING.
• • •
MEANWHILE, HOWEVER.
• • •
SEND YOUR hurry orders.
• • •
ALONG.
• • •
AND WE'LL hope.
• • •
FOR THE best.
• • •
WE THANK you.
• • •

J. J. deB.

With apologies to K.C B.

APEX STEEL CORP.
50 Church Street NEW YORK CITY

Saving in First Cost on Polyphase Motors



Wagner Type BW (Self-Starting) Polyphase Motor in Lumber Mill

The Wagner Type BW (self-starting) Polyphase Motor requires no external starting device. A simple single throw switch serves to start and stop the motor.

Eliminating the starting device means a considerable saving in first cost without affecting the Quality. If you can buy dependable quality motors for no more than "just motors" cost you, is it wisdom to neglect to investigate?

The Wagner Type BW (self-starting) Polyphase Motor has been popularly called

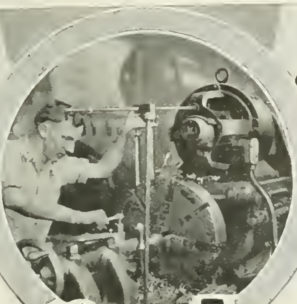
'The Public Servant'

because it is suited to such widely diversified uses.

Let us send you Bulletin 11124, descriptive of "The Public Servant."

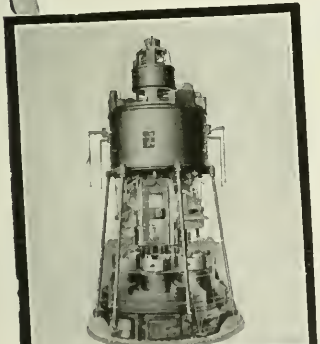
Wagner Electric

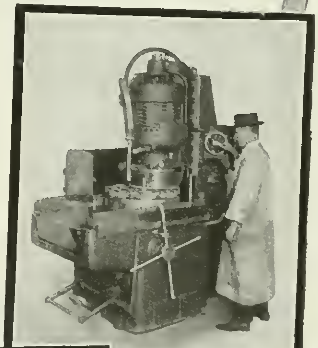
Manufacturing Company, St. Louis, Mo.



Westinghouse War Service

Westinghouse War Service aims to determine, by careful analysis, a workable plan for installing Electric Drive in existing line-shaft-and-belt-driven plants WITHOUT DISTURBING the orderly execution of war work.





WHAT IS YOUR PROBLEM?

Let us help you solve your problem. Westinghouse Electric Drive will give you refinements in speed control and economy, never to be hoped for with the very best line shaft drive.

WHAT CAN BE DONE TODAY TO INCREASE PRODUCTION

That is the big problem. Let us help you decide this important question. We have helped others, and can help you.

Westinghouse Electric and Manufacturing Co.
East Pittsburgh, Pa.

When the machine tool builder and the motor manufacturer cooperate on the best manner and means of driving machine tools, the best results accrue to all concerned.

Thousands of Westinghouse Motors are employed in the production of Motor Trucks for war service.

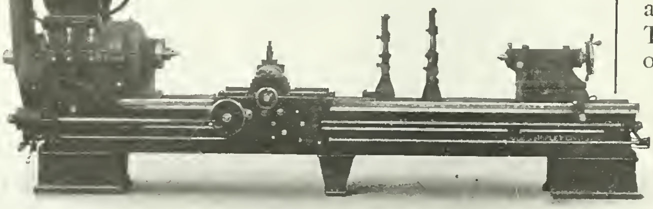
The more direct the application of the motor, the greater the saving in power.

Today we cannot be too economical in the use of power as a means of conserving fuel.

Ideal Machine Tool Drive

INTER-POLE MOTORS

Maximum Power—Minimum Space



POWER, dependability and compact simplicity make Inter-Pole Motors the ideal drive in shops where time and space are important factors.

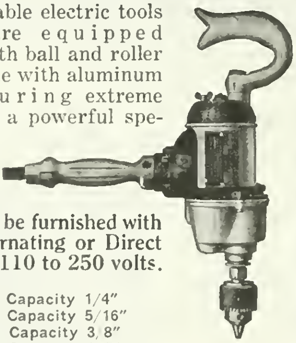
They will carry temporary overloads of fully 100 per cent and reverse from maximum speed in either direction within a few seconds.

Ask for a Bulletin

ELECTRO DYNAMIC CO.
BAYONNE NEW JERSEY

Thor Universal Electric Drills

Licensed Under Burke Universal Motor Patent



The only portable electric tools made that are equipped throughout with ball and roller bearings. Made with aluminum cylinder, insuring extreme lightness, and a powerful specially constructed motor, resulting in increased capacity. Can be furnished with Universal, Alternating or Direct current motor 110 to 250 volts.

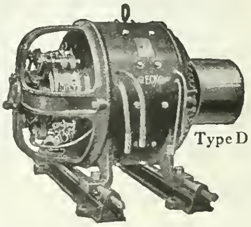
000 Drilling Capacity 1/4"
00 Drilling Capacity 5/16"
0 Drilling Capacity 3/8"
01 Drilling Capacity 1/2"
1 Drilling Capacity 9/16"

No. 6 Electric Grinder.

INDEPENDENT PNEUMATIC TOOL CO.
CHICAGO NEW YORK PITTSBURGH DETROIT
SAN FRANCISCO BIRMINGHAM MONTREAL

ECK "HIGH-GRADE" MOTORS

WITH COMMUTATING POLES AND SELF-ALIGNING BALL BEARINGS



Type D

Sizes 40 H. P. and Smaller.

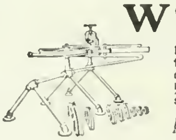
Unequaled Electrical and Mechanical Performance for Machine Tool Applications.

Send for Bulletin No. 1100-B for complete description.

ECK DYNAMO & MOTOR CO., Belleville, N.J.

WONDER PIPE, TUBING AND SOLID BAR BENDERS

9 MODELS

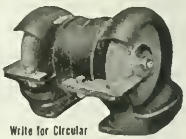


Model A

Bend all sizes of standard or double thick steel, wrought iron, brass and copper pipe from 1/8" to 6"; tubing from 1/2" to 7"; round, square and twisted solid stock from 1/4" to 1 1/2".

American Pipe Bending Machine Co., Mfrs.
73 Pearl Street Boston, Mass., U. S. A.

This Bench Grinder



is the F & M Motor Grinder, a simple, compact, convenient machine for the foundry, machine or blacksmith shop. It has dustproof ball bearing motor and takes 6" or 12" wheels.

Write for Circular

FORBES & MYERS, 178 Union St., Worcester, Mass.

STOW GRINDERS

**Portable
All sizes**

**Rope and
Motor driven**

No welding job is finished unless properly ground. Write today for details with illustrations.

STOW MFG. COMPANY
Binghamton, N.Y.

Oldest Portable Tool Manufacturers in America

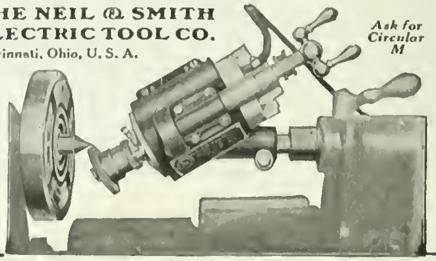
LATHE CENTER GRINDER

Will grind lathe centers mechanically with scientific accuracy in fraction of time required with other methods.

Builders of "Ideal" Patented Portable Electric Tools, Grinders, Drills, Saws, Screw Drivers, Nut, Bolt and Log Screw Setters

THE NEIL & SMITH ELECTRIC TOOL CO.
Cincinnati, Ohio, U. S. A.

Ask for Circular M



"Van Dorn"

For the job that's beyond the bench or post drill—in construction or repair work—

Van Dorn Portable Electric Drill

is the solution.

Equipped with special Van Dorn motor, for direct or alternating current. Attach it to the nearest lamp socket and it's ready for high speed or heavy duty drilling.

What are you drilling, reaming or grinding? There's a Van Dorn Portable Electric Tool to do the work cheaper.

Our Catalog M and practical suggestions we will submit will prove helpful to you.

DISTRICT SALES OFFICES:

Boston, Mass., 170 Purchase Street. New York, N. Y., 30 Church Street. Pittsburgh, Pa., 707 Empire Bldg. Cincinnati, Ohio, 1102 Second Nat'l Bank Building. Chattanooga, Tenn., Chattanooga Armature Works. Chicago, Ill., 601 Monadnock Building. Milwaukee, Wis., 524 Wells Building. St. Paul, Minn., 1005 Germania Life Building. Denver, Colo., 408 Gas & Electric Building. Los Angeles, Cal., 1019 Wright & Collander Building. San Francisco, Cal., 66 Eighth Street. St. Louis, 1122 Pine St. Detroit, 43 E. Larned St.

The Van Dorn Electric Tool Co.
Cleveland, O.

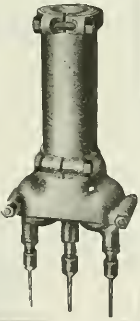
THREE HOLES TO ONE

Sellew Adjustable Drill Heads

enable you to drill three holes at a time instead of one.

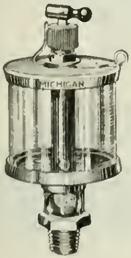
Special Heads made to suit your work.

Get in touch with us for the sake of economy and a greater output.



Sellew Machine Tool Company
Pawtucket, Rhode Island

Michigan Lubricator Co.
Detroit, Michigan, U. S. A.

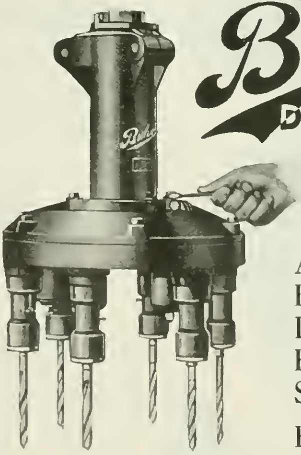


Michigan oilers and grease cups insure efficient lubrication. Used by leading tool builders everywhere for the past 30 years.

Write for prices and printed matter.

MA-28

The Buhr DRILL HEAD



No. 2—6 Spindle Adjustable
Buhr Patent Ball Bearing
Drill Head

Adjustable Ball Bearing Drill Heads From 2 to 12 Spindles

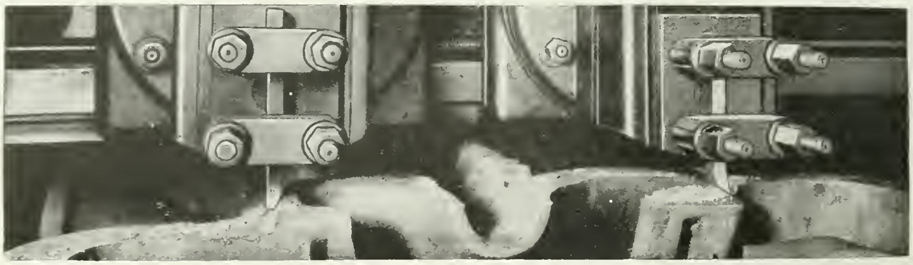
Fixed Center

Any Number of Spindles

NELSON-BLANCK MFG. COMPANY
DETROIT MICHIGAN

EUROPEAN OFFICE,
Coronation House, 4 Lloyds Avenue, London, E. C.
Gaston Marbaix, Factory Agent

URANIUM

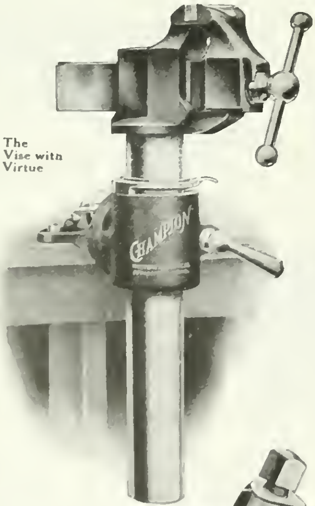


Uranium High Speed Steel makes good cutting tools for *any* service. The extra tough acid proof bronze pump castings shown in the accompanying photograph offer a fitting test of efficiency. Tools of Uranium High Speed Steel were *the only ones that "stood up" on this job.*

Write us or see your own dealer

STANDARD ALLOYS COMPANY

Forbes and Meyran Aves. **PITTSBURGH, PA.**



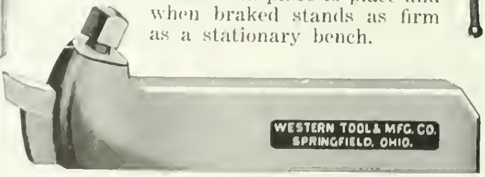
The Vise with Virtue

Champion Tools and Shop Furniture

Champion Tool Holders are large factors in the economy of high speed steel. The close up grip of the set screw and the heavy support under the cutting edge hold the tool rigid, prevent chatter, and permit using the steel to the last piece.

A versatile tool. **The Champion Vise** can be raised and lowered, and swiveled into almost any position. It holds odd shapes as well as ordinary work and a single lever locks it securely. Full line.

The Champion Vise Stand—a convenient, movable Vise Stand, Work Bench and Tool Tray combined. It is easily rolled from place to place and when braked stands as firm as a stationary bench.



Catalogue of the full "Champion" Line on request.

THE WESTERN TOOL & MFG. CO.

SPRINGFIELD **OHIO, U. S. A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Great Britain, Italy, France, etc. V. Lowener, Copenhagen, [illegible] [illegible] & Co., Rotterdam. W. R. Grace & Co., Chili, Peru and [illegible] LOCAL AGENTS: Any first-class Hardware House.

One Cowan Truck *and* Fifty Platforms

"Keep Things Moving"

No Congestion or Confusion Here

The Terry Turbine Company of Hartford, Conn., do all their trucking with one Cowan Truck and about fifty platforms. One of these platforms, of special design, is shown carrying sixteen diaphragms to a machine, *where the loaded platform will be left.* With work may be moved to a series of operations, stored and shipped without re-loading. This is the unit system of transveying. It is an effective means of increasing production through the reduction of handling charges and the elimination of disorder and delay.

THE COWAN TRANSVEYOR
TRADE MARK REG. U.S. PAT. OFFICE

THE unit system of transveying and some of its striking possibilities are fully explained and illustrated in our catalogue. Let us send you a copy.

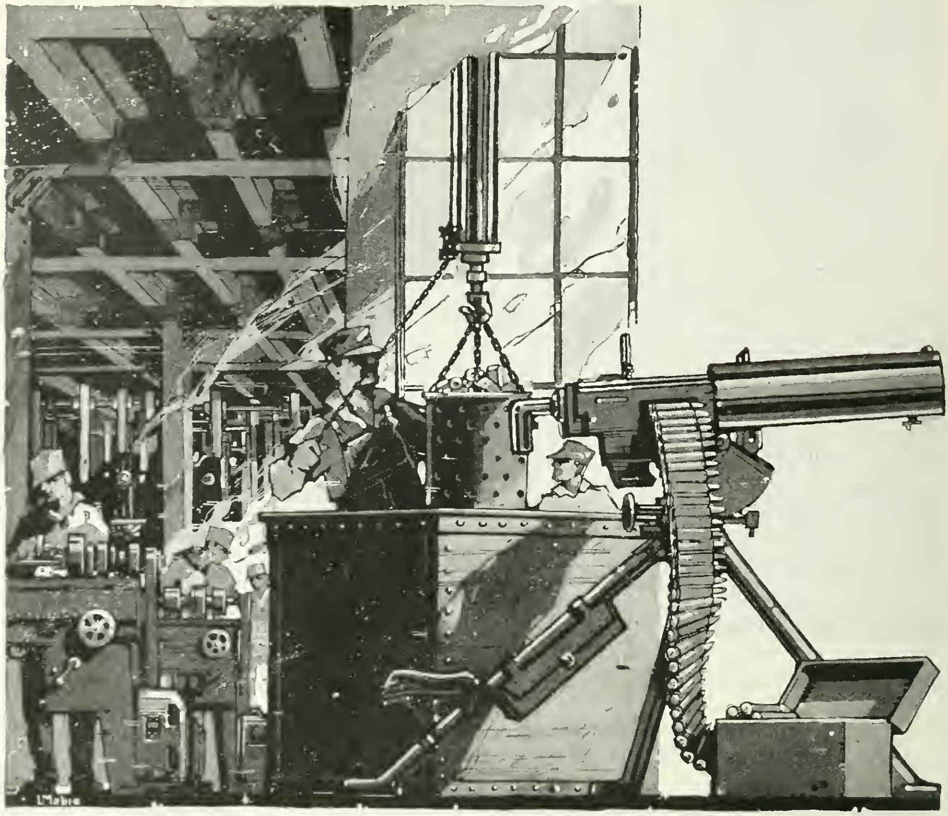
THE problem of moving and storing material is receiving close attention to-day as a field for greatly improved methods. As a result the Cowan system is coming into its own, and our transveyors are being used in every phase of shop work.

How are you moving your material?

Cowan Truck Company

Makers of the Cowan Transveyor

88 Water Street Holyoke, Mass., U. S. A.



OAKITE CLEANS

Machine Gun Parts, Cartridges, H. E. Shells and all types of Munitions.

OAKITE Materials backed by OAKITE Methods will speed up your production and eliminate cleaning troubles.

Write for Booklet 857. It tells how.

OAKLEY CHEMICAL CO.
26 Thames Street New York

COCHECO BELTING

Keep the Shop Belts Turning

Speed Up Victory

Don't run the risk of a shut-down—a delay that may count dearly on material urgently needed. Don't take a chance on equipment that hasn't proved itself dependable.

Cocheco Belting—tanned by the slow-but-sure white oak bark process, curried, stretched, stripped, properly matched and inspected all along the line—can be depended on to keep the shop belts turning.

Cocheco Belting is Quality Belting—sold on merit. Ask for more information.

I. B. WILLIAMS & SONS, Dover, N. H.

BOSTON, MASS., 157 Summer Street NEW YORK, N. Y., 71-73 Murray Street CHICAGO, ILL., 14-16 N. Franklin Street

THE NEW GENESEE FACING TOOL

Chip space never varies, no matter how often blades are ground, nor does the tool once set in machine have to be removed for grinding. Blades are simply replaced in slots and are automatically aligned. No special holder is needed for grinding them. Blades will outwear three to five solid tools and may be replaced at small cost. Made in 4 sizes—each size takes a variety of pilots.

Ask for full details

For Greater Economy in Facing, Counter Boring, Etc.

GENESEE MFG. COMPANY ROCHESTER, N. Y.

Of What Does This Remind You?

SUPPOSE that you had on hand when your last tap was broken a commercial device built specially to remove the broken pieces of tap, a commercial device not a home-made article, would you not have saved a great deal of time?

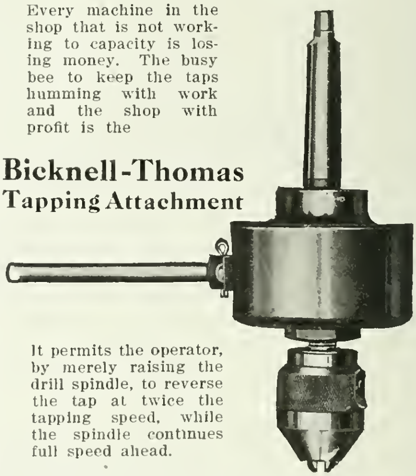
Write us for information

The Walton Company
Hartford, Conn.

ANY DRONES IN YOUR HIVE?

Every machine in the shop that is not working to capacity is losing money. The busy bee to keep the taps humming with work and the shop with profit is the

Bicknell-Thomas Tapping Attachment



It permits the operator, by merely raising the drill spindle, to reverse the tap at twice the tapping speed, while the spindle continues full speed ahead.

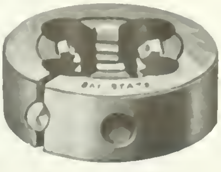
Two sizes—for taps from 3/16" to 3/8" and 5/16" to 3/4" respectively. Write for details.

BICKNELL-THOMAS CO.
GREENFIELD, MASS.

Don't Judge By Appearances

In selecting equipment—especially threading tools—don't forget that the final grinding and polishing gives all tools a clean-cut, efficient appearance—whatever their quality. In judging

BAY STATE TAPS AND DIES



remember that these finishing touches cover uniformly A-1 products, guaranteed accurate and durable from the core out by a firm of national repute.

You'll find a trial order the most convincing proof

BAY STATE TAP & DIE CO., Mansfield, Mass., U. S. A.

REPRESENTATIVES FOR ENGLAND: Geo. W. Goodchild & Macnab, 50-58 Eagle St., Southampton Row, London, W. C. REPRESENTATIVES FOR SCANDINAVIA: Wilh. Sonesson & Co., Ltd., Malmo, Sweden.

Better Forgings
Mean Better Machines

Make a change now for the better

JOHNSTON & JENNINGS

Addison Road and Lake Shore R. R. Tracks
CLEVELAND, OHIO

GUARANTEED FORGINGS
for all
MACHINE PARTS

Wyman-Gordon Company
Worcester, Mass. Cleveland, Ohio

PHOENIX DIE CASTINGS

Produced in an up-to-date plant with all modern facilities

Send us samples or specifications for estimate

PHOENIX DIE CASTING COMPANY
21 Illinois Street BUFFALO, N. Y.

THRIFT

One of the lessons the war is teaching is thrift. Slowly but surely—in many cases against their wills—the people of America are learning the value of that homely virtue.

NATIONAL

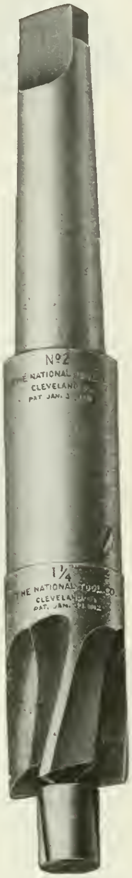
Patent Interchangeable Counterbores

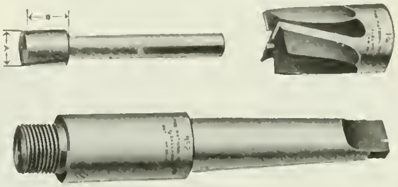
prove how easily and with what advantage thrift may be practiced in the small tool field.

The National Patent Counterbore is made in three parts — only the cutter (one-quarter of the whole tool) being of high-speed steel. The shank and pilot are made of more durable and less expensive steel—a clear saving of 75 per cent of tungsten on the initial investment.

When the cutter is replaced, the contribution to the scrap heap is small—especially as the spiral flutes, which give a shearing cut, extend well back, so that — barring accident — the tool can be used till two-thirds of its length has been ground away. The shank and pilot are rarely subjected to strain and outlast any number of cutters.

Full description in Bulletin.

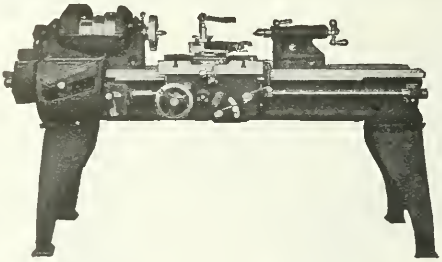




Manufactured by

THE NATIONAL TOOL COMPANY
CLEVELAND, OHIO, U. S. A.

CHICAGO OFFICE: 24 SOUTH JEFFERSON STREET
PHILADELPHIA OFFICE, 11 NORTH 6th STREET



Read Our Specifications

Before going ahead get a copy of our specifications of this 14″ engine lathe. It's a

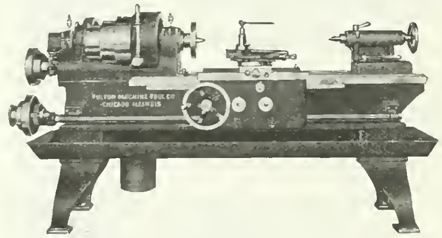
CARROLL-JAMIESON Screw Cutting Lathe

It has double back gears, quick-change gears giving thirty-two changes of feed without removing a gear, nine spindle speeds, 2½″ belt drive from three-step cone.

Drop a line now for a set of specifications.

THE CARROLL-JAMIESON MACHINE TOOL CO., 257 Davis St., Batavia, Ohio

George H. Alexander, Coleshill Street, Birmingham, England, Selling Agents in the British Isles.



FULTON HEAVY DUTY MANUFACTURING LATHES

are tools of unusual power and speed, strongly and simply constructed and easy to operate.

Swing 18¼ inches—7 ft. bed. Plain or friction head as desired.

Complete details upon request

Fulton Machine Tool Co.
1438 BRYAN PLACE CHICAGO, ILL., U. S. A.

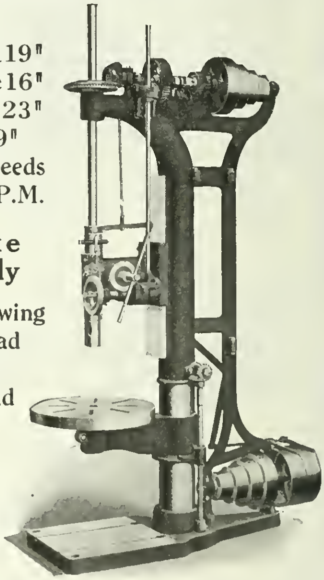
Sibley Sliding Head Drill

24″ Swing
Max. Height 119″
Table Traverse 16″
Head Traverse 23″
Spindle Feed 9″
8 Spindle Speeds
16 to 294 R.P.M.

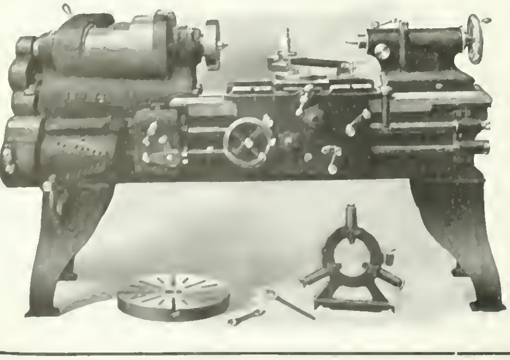
We Make Drills Only

16″ to 30″ Swing
Stationary Head
Sliding Head
Traveling Head
High Speed
Sensitive

Write for Catalog



SIBLEY MACHINE CO.
8 Tutt Street South Bend, Ind., U. S. A.



16″ Lehmann Lathe Swings 18¼″

We Also Make

18″ Lehmann Lathe—Swings 20¼″

Built for Heavy Duty and Accuracy

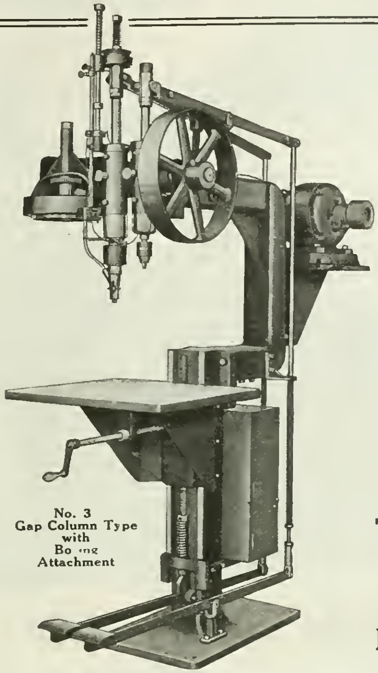
3-STEP CONE for 3″ belt, DOUBLE BACK GEARS, CHILLED BED, HIGH CARBON STEEL SPINDLE, PHOSPHOR BRONZE BEARINGS, DOUBLE PLATE APRON STEEL GEARING, BALL THRUST BEARING for lead screw, cuts threads 2 to 112 to the inch without change of gears, GEARED FEEDS from .007 to .4. 9′ bed takes 5′ between centers, net weight 3020 lbs. on 16″ lathe. *Write for circular illustrating NEW and INTERESTING FEATURES of these lathes.*

LEHMANN MACHINE CO., 606 to 612 So. Broadway **ST. LOUIS, MO.**

THE REYNOLDS SCREW DRIVING MACHINE

BILLIONS of screws are being driven every day in the nation's work-shops. And Millions of these Billions are driven at top speed and low cost with

THE
REYNOLDS
SCREW DRIVING
MACHINE



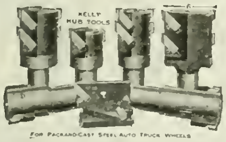
No. 3
Gap Column Type
with
Boring
Attachment

MAGAZINE fed, automatic and adapted to set screws of any size in wood or metal, these machines are an economy in the large or small shop. They can be handled by unskilled labor, are carefully built to give long service and can be furnished in a number of sizes and types.

Used in U. S. Arsenals and Navy Yards on gun parts and war work of many kinds. See Catalog for Details.

THE REYNOLDS
MACHINE CO.
Successors to
Reynolds Pattern & Machine Co.
Massillon, Ohio, U.S.A.

KELLY PRODUCTION TOOLS



FOR
CYLINDERS,
CRANKCASES,
CONNECTING
RODS, AUTO
PARTS, ETC.
They
"ADJUST"

KELLY
"Multiple"
7
Operations

We make **DELIVERIES** in 1 to 10 days

Write for the catalog G-3

THE KELLY REAMER CO.
CLEVELAND, OHIO, U. S. A.

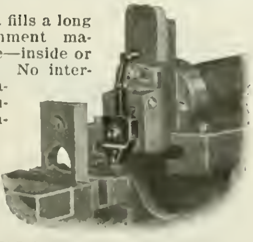
Burton, Griffiths & Co., Ltd., London, English Agents
Burton Fils, Paris, French Agents 40 Domestic Agencies

Bruno Slotting Attachment

It's new—it's good—and it fills a long felt want. This attachment machines any shaped surface—inside or out with equal accuracy. No interfering tool post—no vibration at any speed. A valuable addition to any planer or shaper.

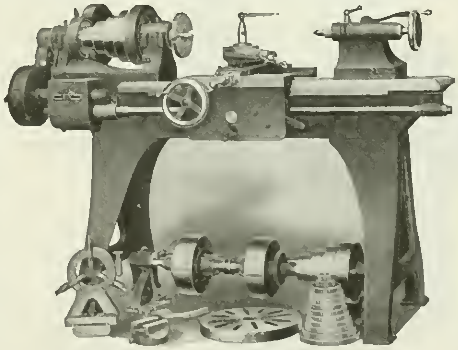
Send for details

Made in 3 sizes, ½ in., ⅝ in. and ¾ in. round shank tool capacity.



BRUNO MANUFACTURING CO.
61 Terrace Street BUFFALO, N. Y., U. S. A.

The Worcester "Thirteen"

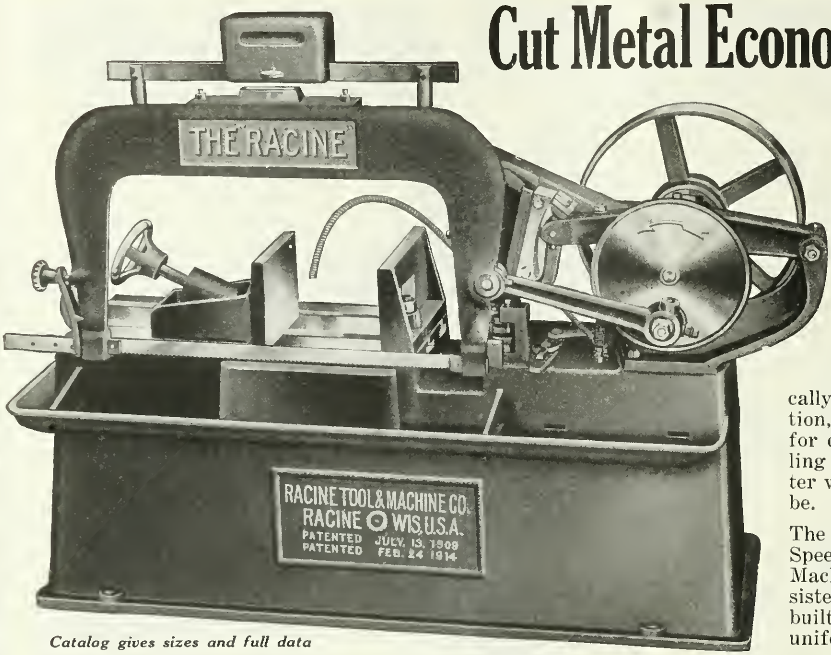


Worcester 13″ Manufacturer's Lathe has all the attributes of the Worcester line in general.

It is a compact, rigid machine, without complicated parts, and guaranteed to do accurately and quickly all the work that is within its range.

If you need a small Lathe it will be to your advantage to send for our Circulars.

WORCESTER LATHE COMPANY
68 Prescott Street WORCESTER, MASS.



Cut Metal Economically

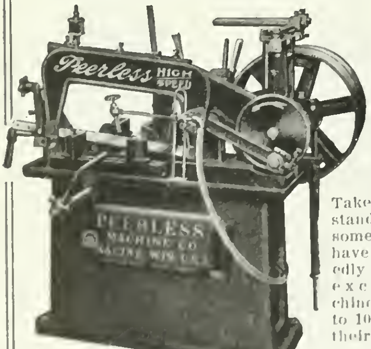
The special feature of the "Racine" High Speed Metal Cutting Machine — the Return Stroke Lifting Device — saves your saw blades and increases production. The saw frame is automatically held in any position, thus providing for convenient handling of stock no matter what its size may be.

The "Racine" High Speed Metal Cutting Machine is a consistent machine, built for speedy and uniform work.

Catalog gives sizes and full data

RACINE TOOL & MACHINE COMPANY, 250 Fifteenth St. **Racine, Wis., U. S. A.**

Peerless HIGH SPEED



A New Standard in Metal Cutting Increases Production 50% to 100%. Saves in Time, Labor and Material.

Take the older standard saws, some of which have been deservedly regarded as excellent machines and add 50 to 100 per cent to their output, and you will come pretty close to the productiveness of the Peerless High Speed. It has created a NEW standard of production which is all its own.

Repeat orders tell the story. Some of them come from manufacturers who have had to wait for Peerless machines when they could get others at once, paying heavy express charges to get them quickly.

The Peerless High Speed saves in time, labor, blades and material. It cuts faster, with a thinner blade, with less attendance and with a smaller consumption of saw blades than any other metal saw made.

Order a "Peerless" on 30 days' trial We pay freight BOTH WAYS if it fails to make good.

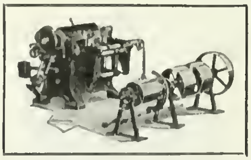
PEERLESS MACHINE COMPANY
1611 Racine Street RACINE, WISCONSIN

The
HIGLEY
COLD METAL SAW

Catalog furnished by

Vandyck Churchill Co.
New York Philadelphia New Haven

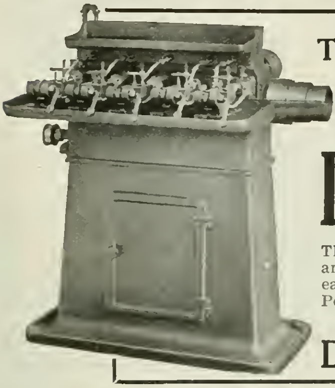
Crescent Wood Working Machinery



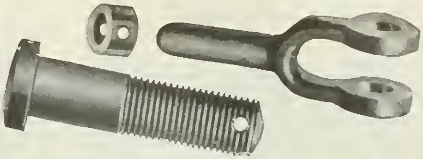
will largely compensate for shortage in labor at this time, and you owe it to yourself to investigate this splendid line of wood-working machinery right away.

Ask for free catalog of band saws, jointers, saw tables, planers, planers and matchers, disk grinders, swing saws, post borers, shapers, variety wood workers, hollow chisel mortiser, universal wood workers.

THE CRESCENT MACHINE CO.
56 MAIN STREET LEETONIA, OHIO



The Holes in These Parts Were Made on the



DETROIT Semi-Automatic Driller

The Detroit Semi-Automatic Driller can't be beaten for drilling small holes rapidly and accurately. All the operator is required to do is remove and insert stock at each of the five spindles in succession. Drill breakage is reduced to a minimum. Positive lubricating system insures quick, clean cutting.

Send for Complete Details

DETROIT TOOL CO., DETROIT, MICH.

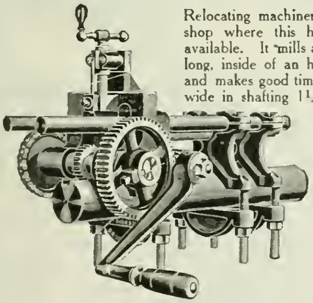
A Single Fact

is worth a ship-load of argument. The fact that well known manufacturers in many lines place reorders for Kelly Shapers as their business grows carries more conviction than a bookful of statistics, though these are also available in our catalog—a complete description of all seven sizes of

Kelly Crank Shapers

R. A. KELLY CO., Xenia, Ohio, U.S.A.

The Burr No. 1 Portable Shaft Keyseater



Relocating machinery is not a bugbear to the shop where this handy emergency tool is available. It mills a $\frac{3}{4}$" x $\frac{3}{8}$" keyseat, 12" long, inside of an hour—without resetting—and makes good time on any size up to $1\frac{1}{8}$" wide in shafting $1\frac{1}{4}$" x 5" diameter.

Well made, simple to operate and works in close quarters. Catalog for details.

John T. Burr & Son
429 KENT AVENUE
BROOKLYN, N. Y.

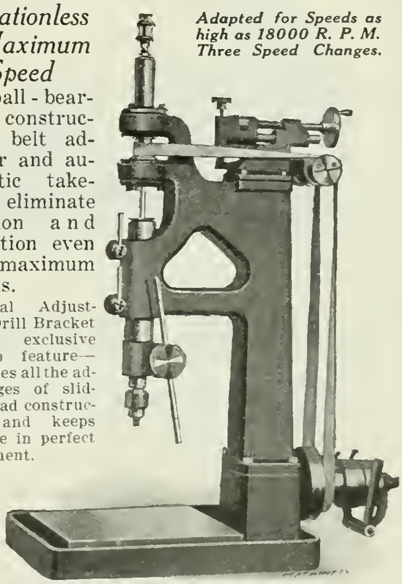
DEMCO BENCH TYPE HIGH SPEED DRILL

Vibrationless at Maximum Speed

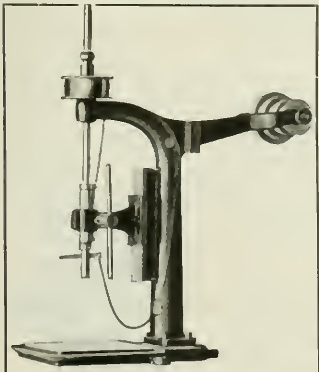
All ball-bearing construction, belt adjustor and automatic take-up eliminate friction and vibration even at maximum speeds.

Vertical Adjustable Drill Bracket—an exclusive Demco feature—provides all the advantages of sliding head construction and keeps spindle in perfect alignment.

Adapted for Speeds as high as 18000 R. P. M. Three Speed Changes.



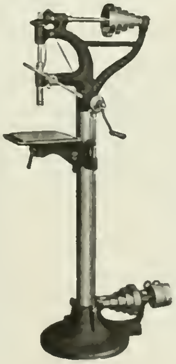
DEMCO MACHINE TOOL CO.
CLEVELAND, OHIO, U. S. A. Successors to The DeMooy Machine Co.



BENCH DRILLS

1-4 Spindles
½" Capacity
Lever and Power Feed
Powerful
Accurate
Durable

FRANCIS REED COMPANY
43 Hammond St.
Worcester Mass.



THE LINDGREN

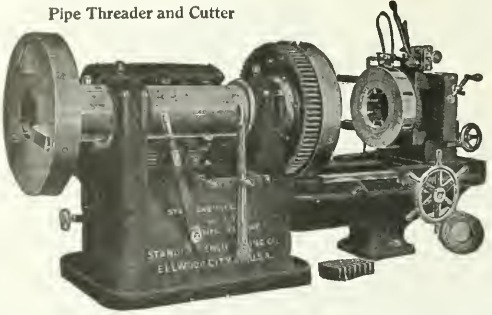
13-Inch High Speed Drill

All bearings are bronze bushed and provided with ring oilers. The spindle has ball thrust bearings. The sleeve is graduated in inches.

New lubrication features
No leakage of oil

F. W. LINDGREN CO.
ROCKFORD ILLINOIS, U. S. A.

Standard Wieland 6-inch
Pipe Threader and Cutter



Thread Pipe Do You? How?

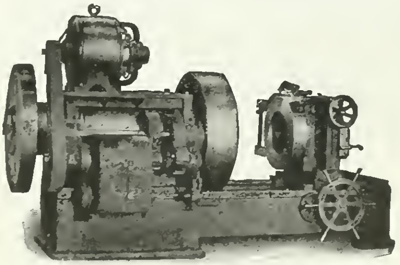
The modern, efficient way is the Standard Wieland way, with a heavy, sturdy, durable machine, simple and positive in operation, fast and accurate in production. This machine costs more and is worth it; character and quality of output prove it.

A few features: One-piece bed; single-speed pulleys; gear speed changes through semi-steel cut gears; deep chasers, cutting long taper threads in one cut perfectly, steel as well as iron pipe.

Send for the circular.

Standard Engineering Company
Ellwood City Pennsylvania
San Francisco Office: 1801 Claus Spreckels Bldg.

The Method of Drive is an Important Thing in a Pipe Machine



Because a lot of time is wasted if the speed is not just right for every size and material of pipe

The "Stoever" Pipe Machine

has a single-pulley drive with gear speed variation. This means that the **belt speed is constant,** not lowest when it should be highest. **The belt tension is always proportional to the power transmitted**—economy of power. **The belt contact is constant and always adequate.**

The "Stoever" has a friction countershaft which eliminates shifting belts and saves at least one-third in belting cost.

The gear speed variation affords a speed exactly right for every size of pipe, and for iron or steel. **This means maximum cutting and threading speed.**

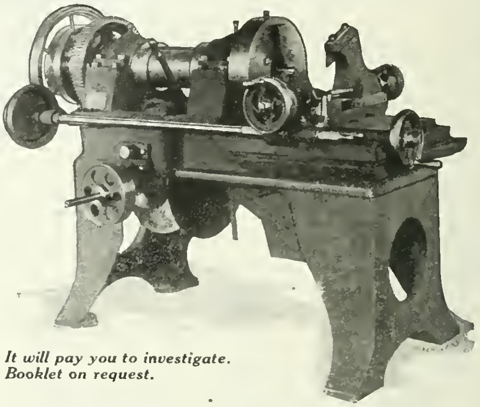
Write for the "Economy" Booklets.

TREADWELL ENGINEERING CO.
Sales Office: 140 Cedar Street, New York
Works: Easton, Pa.

TE 10

Quick!
Accurate!
Economical!

-HURLBUT-ROGERS



It will pay you to investigate.
Booklet on request.

THE two cutting tools of the Hurlbut-Rogers machine double the speed and halve the cost. In addition, one tool acts as a rest for the other and pressure being identical on both sides, the stock is held absolutely rigid and true. Capacity up to 10″.

The Hurlbut, Rogers Machinery Co.
South Sudbury, Mass.

MERRELL Pipe Threading and Cutting Machinery.

Hand or Power Operated

THE MERRELL MFG. CO.
15 CURTIS STREET TOLEDO, OHIO

Tuttle Tappers on Brass

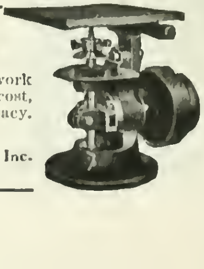
The Tuttle Tapper is tapping 10/32″ holes in brass guide arms for flush valves at the rate of *300 per hour* in a Trenton plant. If *you* would improve production, write us.

PARAGON GEAR WORKS, Taunton, Mass.
Evans Stamping & Plating Co.

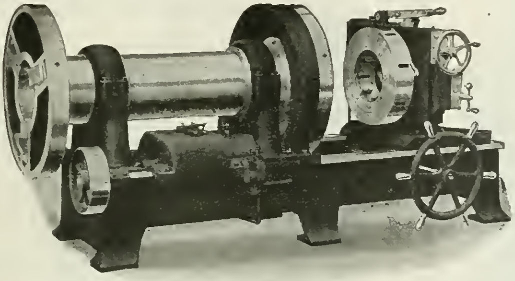
A "HARTFORD" Die Filing Machine

accomplishes many times more work than hand filing, at the same labor cost, and does it with greatest accuracy. More details on request.

THE ROBINSON TOOL WORKS, Inc.
Waterbury, Conn., U. S. A



PEERLESS B·&·K· DUPLEX P·D·O·C



No Waste Here

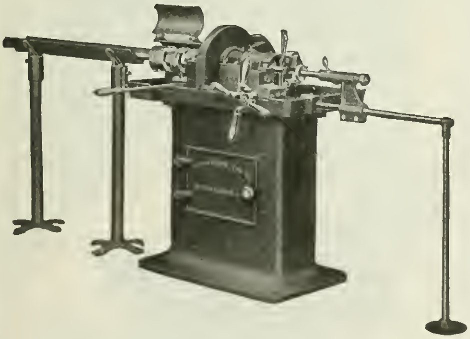
How much time do you spend *getting ready* to do the job? For instance—how long does it take to get ready to change the dies in your pipe machines? In the B & K machines no time is lost removing a lot of screws or the cover—then after the dies are removed you can clean the die slots so easily without more lost time.

The construction of the Peerless Die Head is such that all waste motion is eliminated. And the die head is backed by good chucks (three styles,) good gear-box and oiling system. All these go to make up a satisfactory pipe machine.

May we send you a catalog?

BIGNALL & KEELER MACHINE WORKS
EDWARDSVILLE ILLINOIS, U. S. A.

Cutting-Off Machines



THE MODERN CUTTING-OFF MACHINE

will cut Galvanized Pipe, Brazed Tubing, Welded Tubing, Butted Tubing, Seamless Tubing, any thickness of wall, quicker and cheaper than by any other method. Regular "Lathe Cut."

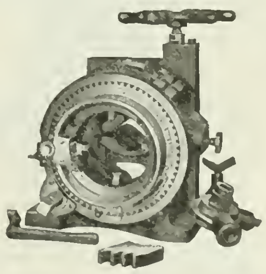
MODERN MACHINE TOOL CO.
JACKSON MICHIGAN, U. S. A.

FORBES
PIPE CUTTING THREADING MACHINES

Forbes Pipe Cutting and Threading Machines are highly developed, self-contained machines particularly adaptable for shops where speed and accuracy in pipe operations are desirable. Our 35 years' experience in pipe machine manufacture insures their correctness.

They are strong and simple, have few moving parts, are easily portable and require minimum floor space.

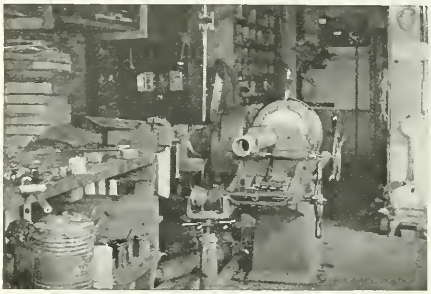
Capacity up to 15"



Write for catalog and prices

The Curtis & Curtis Co.
8 Garden Street Bridgeport, Conn.

Pipe Threading in close quarters



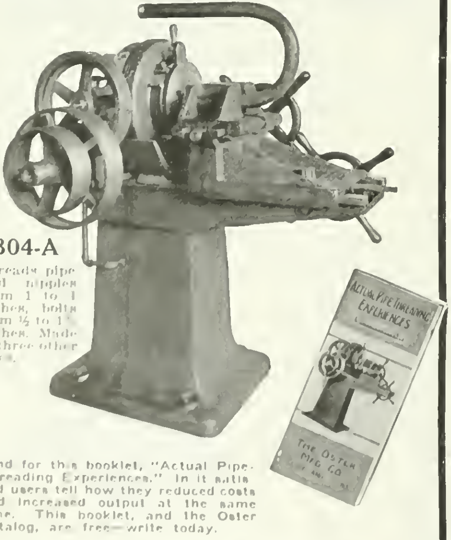
Many a concern has no space for a bulky machine, so they stick to hand-threading. It certainly doesn't take a large room to hold the Oster shown here.

OSTER

Combination
THREADING MACHINES

Thread straight pipe, bent pipe, bolts and nipples—even close nipples—they all come out of this machine easily and accurately threaded—ready for quick fitting into tight, accurate joints.

Besides that, it transforms a pile of scrap pipe into money by threading it into nipples in its spare time, and a boy can easily do the work.



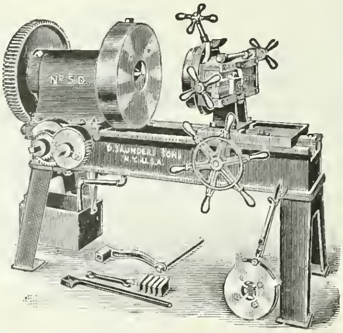
304-A

Threads pipe and nipples from 1 to 4 inches, bolts from ½ to 1½ inches. Made in three other sizes.

Send for this booklet, "Actual Pipe-Threading Experiences." In it satisfied users tell how they reduced costs and increased output at the same time. This booklet, and the Oster Catalog, are free—write today.

The OSTER Mfg. Co.
2107 E. 61st Street, Cleveland, Ohio, U.S.A.

SAUNDERS



No. 5D Pipe Threading and Cutting-Off Machine

Simple, compact and fully self-contained, this well constructed "Saunders" operates by hand or belt power—threads and cuts off pipe up to 6 inches diameter without stopping the machine. It is equipped with standard universal or three jawed Independent Gripping Chuck and adjustments for automatically centering and steadying the work.

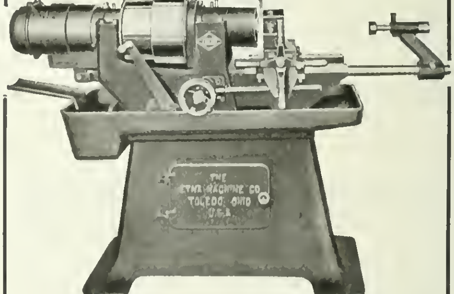
Catalog "P" gives all details, describes the whole line—capacity up to 18 inches—also our Patent Adjustable Expanding Die Heads with Interchangeable Chasers.

D. SAUNDERS' SONS
YONKERS NEW YORK, U. S. A.

The 3 Inch "Etna"

Capacity for continuous operation makes Etna Cutting-off Machines big producers—rigid construction insures their durability.

This 3 inch model has 10 and 12 inch cone diameters, two 11 inch friction pulleys and carries a 5 inch belt.



Capacity: 3" Round, 2" Square, 2½" Hexagon

Complete Description on Request

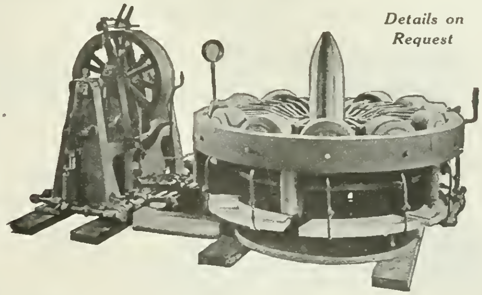
The Etna Machine Co.
Maplewood Avenue and Castle Boulevard
TOLEDO OHIO, U. S. A.

U. S. Government Requirements
and the Machine Which Meets Them
The Hydraulic Banding Machine

Goods manufactured for the U. S. Government must comply with regulations. For instance, the bands on shrapnel shells and other projectiles must enter the grooves without shearing.

The Hydraulic Banding Machine is designed with this requirement in mind and operates with unfailing accuracy in this respect. It is a rapid producer, economical and adapted to a wide range of general compressing operations.

All Sizes for Shells up to 16 Inches



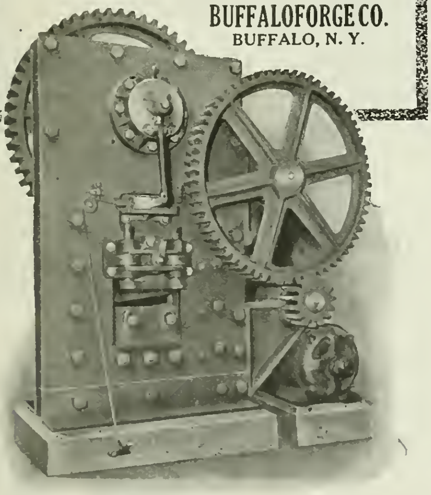
Details on Request

THE WEST TIRE SETTER COMPANY, Rochester, N. Y., U. S. A.

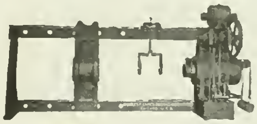
BUFFALO ARMOR PLATE

PUNCHES, SLITTING SHEARS, and BAR CUTTERS are dependable. They are built of "Armor Plate" steel - tensile strength 75000 lbs. per square inch 7½ times as strong as cast iron. That means a lighter and stronger machine—a machine built to take a lot of punishment. *Write for Catalog P/S-51.*

BUFFALO FORGE CO.
BUFFALO, N. Y.



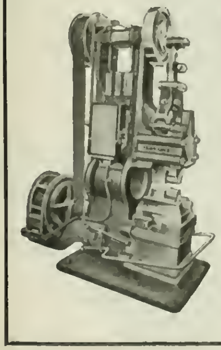
ELMES



Wheel Presses
Forcing Presses
Broaching, Bending
and
Straightening Presses

ESTABLISHED 1861

CHARLES F. ELMES
ENGINEERING WORKS
222 No. Morgan Street, Chicago, Ill.



FAIRBANKS HAMMERS

25 to 300 lbs.
BELT OR MOTOR DRIVE

These Hammers Embody a Design and Workmanship that are unsurpassed.

Send for Catalog

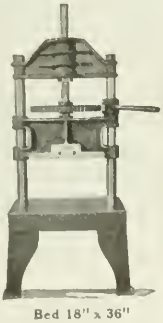
UNITED HAMMER CO.
OLIVER BLDG. BOSTON, MASS.

Toolmaker's Time Is Expensive
DON'T WASTE IT!
The Manhattan Screw Press

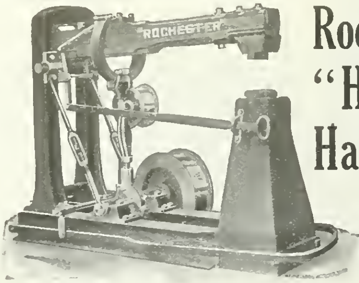
is a one-man machine with which to secure perfect alignment of punch and die; is sensitive and powerful in operation and a big time-saver. Note abundant room between bed and ram. *Convenient handling another feature.*

Circular gives particulars.

Manhattan Machine & Tool Works
Grand Rapids, Mich.



Bed 18" x 36"



Size B, dies crosswise

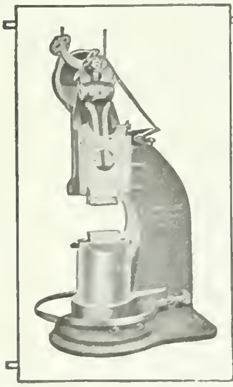
Rochester "Helve" Hammers

6 Sizes
8-30 Lbs.

Rochester Helve Hammers are adjustable for length of stroke while running, have non-crystallizable I-beam frames and separate, heavy weight anvils. Long stroke provides for handling larger work than other hammers of the same head sizes and the springy forging blows delivered by the solid hickory helves combine advantages of forging and drop hammers—do special die work which cannot be duplicated by hand.

Details of full line in Catalogue.
Investigate our Manufacturing "Special."

THE WEST TIRE SETTER CO.
ROCHESTER N. Y., U. S. A.



BEAUDRY HAMMERS

For General Forging

Save Fuel, Time and Labor. Cut Forging Costs in Two.

Belt or Motor Driven

BEAUDRY & CO.
Incorporated
141 Milk St., Boston, Mass.

20-Ton Forcing Press and Roller Jaw Drill Chucks

Manufactured by
WEAVER MANUFACTURING CO.
SPRINGFIELD, ILLINOIS

CHAMBERSBURG STEAM HAMMERS

"All Sizes for Every Class of Work"

Our hammers are double acting, have simple valve gear and give the operator perfect control

Write us for details

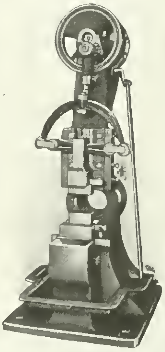
CHAMBERSBURG ENGINEERING COMPANY, Chambersburg, Pa.
HYDRAULIC MACHINERY

DROP PRESSES

for All Purposes Our Specialty

The Peck Drop Lifter can be readily applied to foot or hand drops.

MINER & PECK MFG. CO.
Proprietors of the PECK DROP PRESS WORKS
NEW HAVEN CONN., U. S. A.



"DEAD STROKE" POWERHAMMERS

Strike a square, true blow at all times and can be safely run at high speed.

The peculiar feature is the spring, to which the ram is attached by a flexible belt, permitting a far more effective blow than can be given by any other hammer of the same weight and stroke, and requiring less power.

Built in 7 sizes. Write for circulars.

MANUFACTURED BY
Dienelt & Eisenhardt, Inc.
1304 No. Howard Street
Philadelphia, Pa., U. S. A.

For Pointing, Tapering, or Otherwise Reducing Metal Rods and Tubes the

DAYTON SWAGING MACHINE

is more economical than rolling, grinding, milling, turning or drawing. It imparts strength and elasticity to the metal and gives a fine, smooth finish. All kinds of work—0 to 2 inches diameter.

NO. 3 MACHINE

Catalog tells the whole story

The Torrington Company Excelsior Plant
Successor to Excelsior Needle Co.
Torrington Conn.

LITTLE GIANT POWER HAMMERS

Powerful—
Versatile—
Durable—

MAYER BROTHERS COMPANY MANKATO MINN U S A LITTLE GIANT

Established
A. D. 1876

Little Giant Power Hammers are sturdy, powerful tools. They combine machine gun rapidity and precision with absolute rigidity.

They are made in five sizes—25- to 500-pound ram—each adapted for handling a great variety of work.

They are guaranteed *forever* against defective workmanship and materials.

Since the first Little Giant Power Hammer was built more than 25 years ago we have never heard of one going to the scrap heap. That is a pretty fair guarantee of lasting efficiency. There are more than 6000 Little Giant Power Hammers now in daily use.

Our repair sales for the last 25 years have averaged 48 cents per tool—less than two-fifths of one per cent of the original cost to purchaser.

Little Giant Power Hammers are safe, simple and compact. They occupy minimum floor space and are adapted for belt or motor drive.

Let us send details of our 30-day free trial offer. Write today.

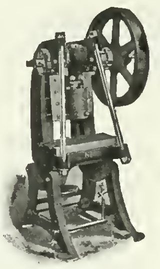
Special dies for any forging purpose. Prices quoted upon receipt of drawings or sample of work to be done.

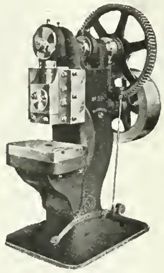
MAYER BROS. CO.
131 West Rock St.
MANKATO, MINN.
U. S. A.

P.S.—Prompt Delivery

NIAGARA
Power Presses

Niagara Power Presses are fast, accurate producers, perfectly balanced and easy to control. They will stand up under long, heavy usage in stamping, blanking, punching, drawing, trimming and drop forge work.


Inclinable Power Press.

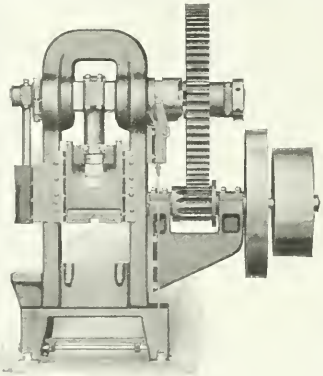

Geared Punching Press

NIAGARA Power Presses occupy comparatively little floor space, and obtain maximum results on a given amount of power.

There's a size and style for every purpose.

Send for descriptive booklet.

NIAGARA MACHINE AND TOOL WORKS
BUFFALO, N. Y. U. S. A.



Straight Sided Trimming Presses

Full line of Trimming and Power Presses as well as Bulldozers, Bolt and Forging Machines, Power Hammers, Punches and Shears, Gate Shears, Forging Rolls, Eye Benders—Multiple Punches, etc., included in our line.

Write for Catalog No. 10.

Williams, White & Co.
Moline, Ill.
U. S. A.

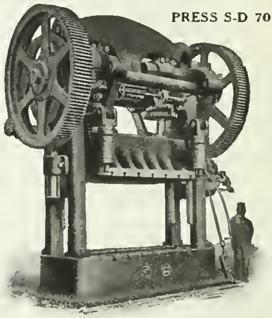
Pittsburgh Office
808 House Bldg.

Chicago Office
933 Monadnock Block

New York Office, C. H. Holbrook, 30 Church St.
Detroit Office, J. C. Austerberry, 924 Dime Bank Bldg.

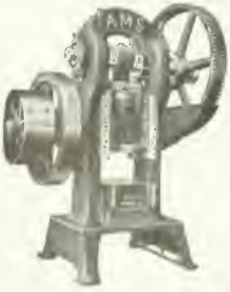
FERRACUTE
PRESSES

FOR CUTTING, FORMING AND DRAWING METAL



Double-action Toggle Drawing Presses, all widths, giving pressures of 100, 150, 200, 300, 400, 500, 700, 1000, 1500 and 2000 tons.
The press shown exerts 700 tons pressure and weighs 250,000 pounds. Ram stroke up to 18 inches and plunger stroke up to 36 inches. Distance between columns, 124 inches. Friction clutch. Unusually large safety factor.
Photographs and full information for the asking.

FERRACUTE MACHINE CO.
BRIDGETON NEW JERSEY


Press No. 570

PRESSES

LARGE OR SMALL
REGULAR OR SPECIAL

"AMS"

Let us quote you on your next press

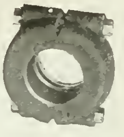
THE MAX AMS MACHINE CO.
BRIDGEPORT CONN.

AUTOMATIC BAIRD MACHINE CO. BRIDGEPORT, CONN. MACHINERY

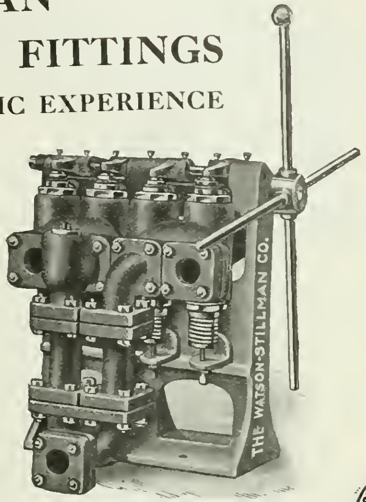
PRESSES—Foot and power.
WIRE FORMING MACHINES—Standard or special.
TUMBLERS—All kinds.
BALL BURNISHING EQUIPMENT.

BAIRD MACHINE CO.
BRIDGEPORT, CONN.

PRESSES and SHEARS
Sheet Metal Working Machinery
THE D. H. STOLL CO., Inc.
BUFFALO., N. Y.



WATSON-STILLMAN
HYDRAULIC VALVES AND FITTINGS
ARE BACKED BY 70 YEARS HYDRAULIC EXPERIENCE



Our line embraces an almost endless number of combinations designed to meet the varied demands of hydraulic equipment. Each and every valve and fitting is tested far beyond its listed strength before shipping. These tests insure you against accident, loss of time and production.

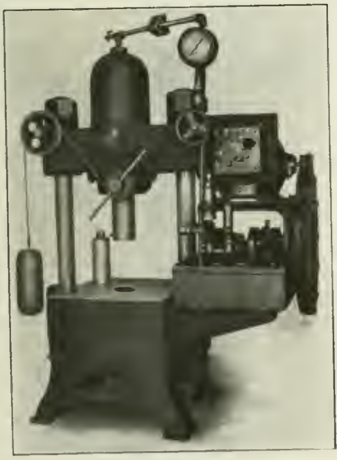
We build hydraulic machinery for every purpose where hydraulic pressure is a possibility—presses, shears, benders, straighteners, punches, etc., as well as a full line of accumulators, pumps, intensifiers, etc.

Write for Catalogs

The Watson-Stillman Co.
192 Fulton Street NEW YORK
CHICAGO: McCormick Building

417

HYDRAULIC Machinery of Quality



Hydraulic Presses may be compared to watches. A watch is a watch — but what about the grade of materials and skill represented and the degree of satisfactory service rendered?

We build the "Waltham" grade.

THE HYDRAULIC PRESS MFG. CO.
Engineer-Builders of Hydraulic Machinery Exclusively
84 Lincoln Avenue Mount Gilead, Ohio

BRANCH OFFICES: Room 1105-R, 39-41 Cortlandt St., New York City; 427-D Guardian Bldg., Cleveland, Ohio.

Reg. U. S. Pat. Office

TEST PRESSES

For applying Internal Pressure Physical Test to Shells

BANDING PRESSES

For Pressing in Copper Rotating Bands on Shells

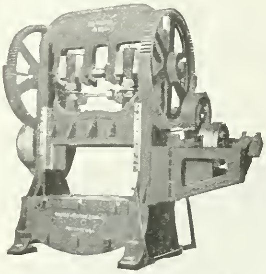
METALWOOD MANUFACTURING CO.
DETROIT, MICHIGAN

SALES REPRESENTATIVES

R. E. Ellis Engineering Co., 621 Washington Blvd., Chicago. Fairbanks-Morse Co., 30 Church St., New York City. Sherritt & Stoer Co., Finance Bldg., Philadelphia. Canadian Fairbanks-Morse Co., Ltd., Montreal and Toronto.

THE "TOLEDO"
PRESSES

Overcome, by their efficiency, the shortage of labor problem caused by our country's need for men.



These strong, durable, dependable double crank presses, with many advanced ideas and exclusive features, are adaptable for almost any sheet metal or drop forged work. They are built in over 250 sizes and styles ranging in weight from 4500 to over 400,000 lbs. There is no press or die requirement which we are not fitted by experience, knowledge and skill to fill ably, economically, promptly.

The Toledo Machine & Tool Co.
Toledo, Ohio

OVER-SEAS REPRESENTATIVE
ALMACOA ALLIED MACHINERY COMPANY OF AMERICA ALMACOA
120 BROADWAY, NEW YORK, U.S.A.

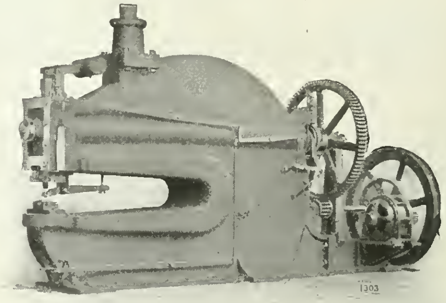
PARIS TURIN ZURICH BARCELONA

Established 1856 Incorporated 1878

The Quality Line

Punching, Shearing and Forging Machines and Machinery Equipment for Shipyards, Steel Car Plants, Rolling Mills, Bridge and Structural Iron Works

(See new cut in each issue)

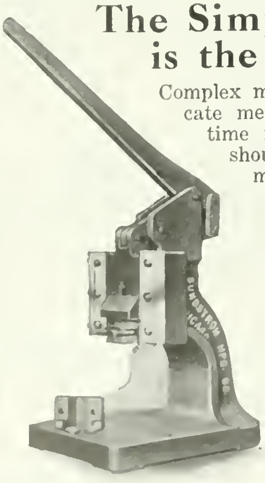


Single No. 1 Punch

All machines are built of the same high grade workmanship and material that has given The Long & Allstatter product a recognized standard of quality for over 50 years.

The Long & Allstatter Co.
Hamilton, Ohio, U. S. A.

The Simplest Way is the Best Way



Complex machines with intricate mechanism mean lost time in the shop which should be working every minute—and working to capacity. The Rex Testing Press needs no adjustment, is sensitive to accurate alignment; a one-man tool that saves space, time and energy. It tests dies, finds blanks, scrapes and stamps without injury to the work and is safe and easy to handle.

The Rex Die Testing Press

will pay for itself in a very short time. It will more than back up our claims for it.

Details on request

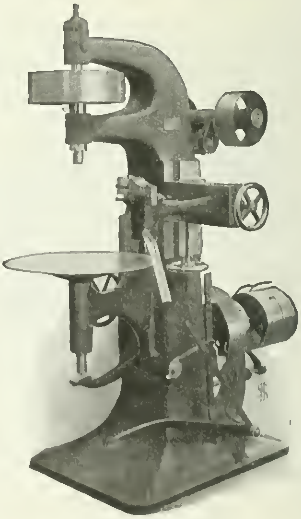
SUNDSTROM MFG. CO.
3201 SHIELDS AVENUE CHICAGO, ILL.

SWAINE

DOUBLE SEAMER No. 4

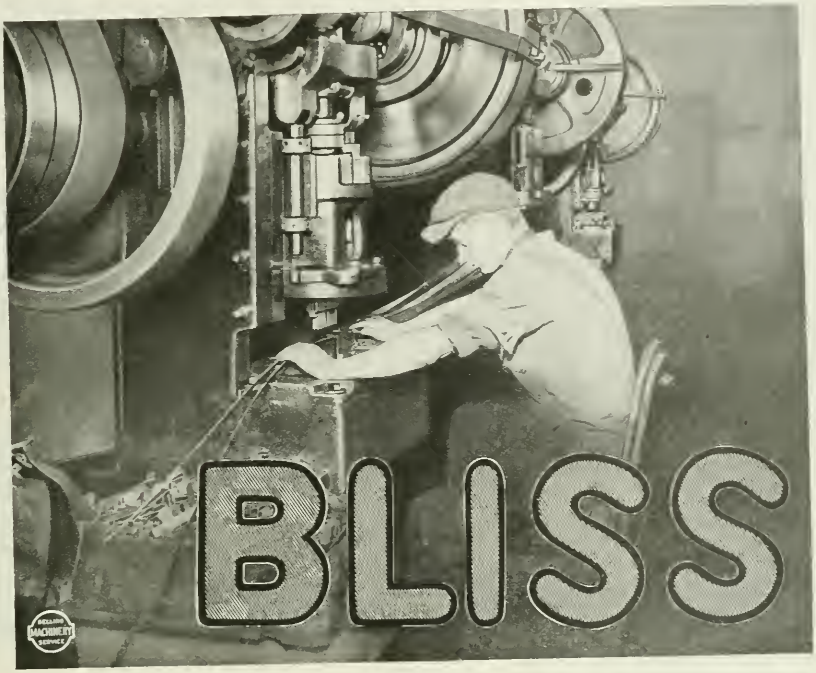
The precise alignment of the upper and lower spindle and the ease with which it is adjusted for work of different sizes are features which enable this machine to do the high class of work for which it is known.

Write us for catalog giving complete details.



Double Seamer No. 4

FRED J. SWAINE MFG. CO.
7th and O'Fallon Sts. ST. LOUIS, MO.
Largest Press Builders in the West



A Bliss Press Blanking and Forming 1000 Parts per Hour

BLISS 1857-1918 BLISS

E. W. BLISS CO.

Main Office & Works:
BROOKLYN NEW YORK

CHICAGO OFFICE
People's Gas Bldg.

DETROIT OFFICE
Dime Bank Bldg.

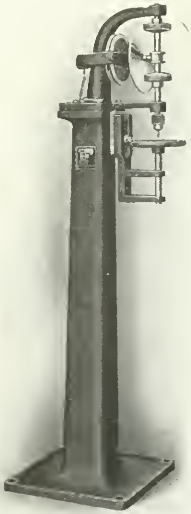
CLEVELAND OFFICE
Union Bank Bldg

LONDON, S.E., ENGLAND, Pocock Street, Blackfriars Road
PARIS, FRANCE 100 Boulevard Victor Hugo St. Ouen

ONE thousand parts per hour is this machine's record for blanking and forming lock strike rims from .072" stock. The Russell & Erwin Company, of New Britain, Conn., has used Bliss machines for 28 years, now has nine, and may be considered mighty sound authority on the kind of service they render (we happen to know the opinion is favorable.)

The operation illustrated is performed on one of four Bliss Double Acting Presses in this department. Two Bliss Inclinables and three other Bliss Presses are also used.

Bliss Power Presses for every purpose.



THE FENN TAPPER

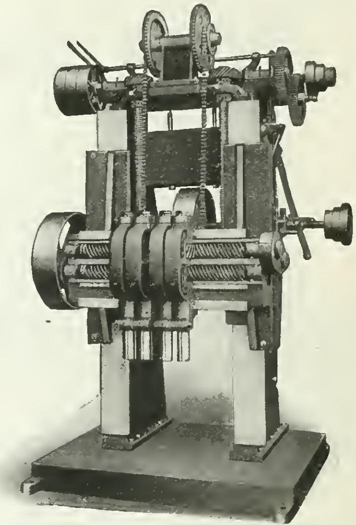
A mighty "big" little machine, with interesting special features.

It is rigid, well built, and practically free from vibration; it has friction drive and reverse, with control so sensitive as to eliminate broken taps even at top speed.

Especially suited to Fuse, Electrical and Gun Work. Circular.

FENN MANUFACTURING CO.
Hartford W. L. FENN & W. A. FENN **Conn., U.S.A.**
Cable Address: "Fenn"—Western Union Code

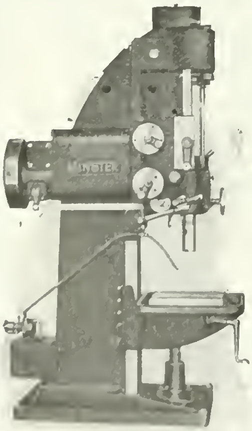
THE "HOLE HOG" LINE



No. 7D Cylinder Borer
Built for Rapid and Correct Production on Tractor, Truck and Aeroplane Motors.
Catalog Describes Others

MOLINE TOOL CO., Moline, Ill.
Multiple Drillers, Borers and Thread Hobbers.

Hi-Duty DRILLS



Special spindle construction and great variety of speeds and feeds make

THE MINSTER DRILL PRESS

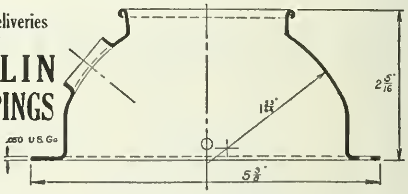
practically indispensable for a wide range of heavy drilling. Particularly well adapted for enlarging holes in steel and cast iron. Specifications call for durable quality in all working parts and correct balance insures smooth running.

Rigid, powerful, responsive, this machine will give you full service.
1-D 2" 2-D 2 [illegible] 3-D 3 [illegible]

THE MINSTER MACHINE CO.
MINSTER OHIO, U. S. A.

Prompt Deliveries
ON
ACKLIN STAMPINGS

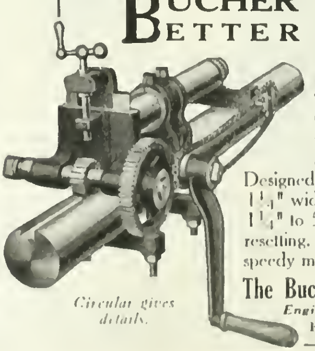
Let us Estimate



Many parts, such as this half casing for an automobile universal joint, are much more satisfactory stamped than cast—cheaper, stronger, far more durable and require no machining. *Let us talk it over.*

THE ACKLIN STAMPING CO.
1657 Dorr Street TOLEDO, OHIO, U. S. A.

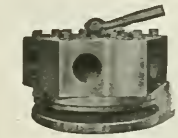
BUCHER SMITH
BETTER SERVICE
KEYSEATER

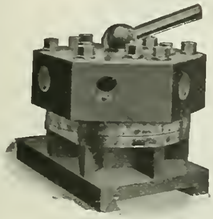


Compact, convenient, inexpensive, it operates accurately at low cost. Designed to cut keyways ¼" to 1¼" wide, 12" long in shafts 1¼" to 5" in diameter without resetting. A portable, rigid and speedy machine.

Circular gives details.

The Bucher-Smith Company
Engineers and Machinists
East Liverpool, Ohio





Make a Better Tool of Your Engine Lathe

With Phoenix Turret Attachments you can get maximum service from your engine lathes, save time for your turret lathes. Certain jobs cannot be handled profitably on either the engine or the turret lathe. Phoenix Turret Attachments are the solution. They will complete many jobs in the time it formerly took to set them up.

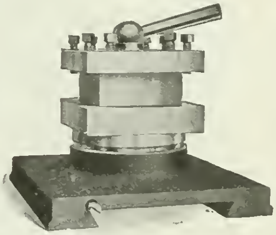
Will you not investigate further?

PHOENIX
MANUFACTURING CO.
EAU CLAIRE WISCONSIN
Cleveland Office: 913-15 Engineers Bldg.

THERE are now more than 3000 Phoenix Turret Attachments in use on all kinds of engine lathes.

PHOENIX
TURRET ATTACHMENTS

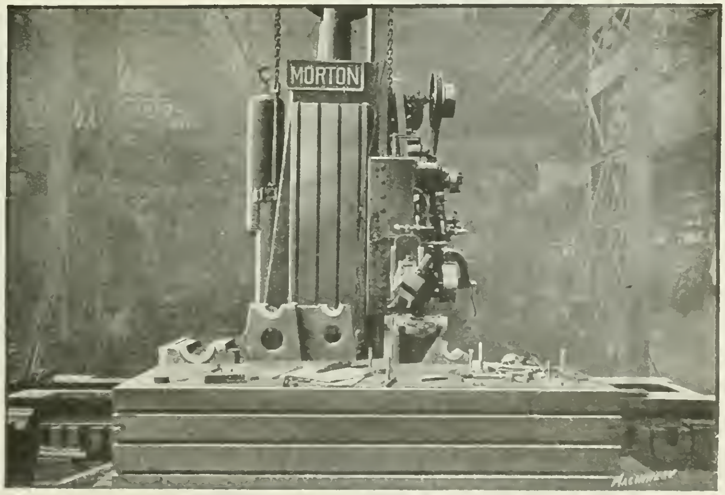
are strong, durable and easy to attach. They have improved locking devices to insure rigidity while in use and are quickly released by a three-quarter turn. Many styles and sizes meet all requirements.



MORTON Draw Cut Planers

Bulletin No. 8-D for full description.

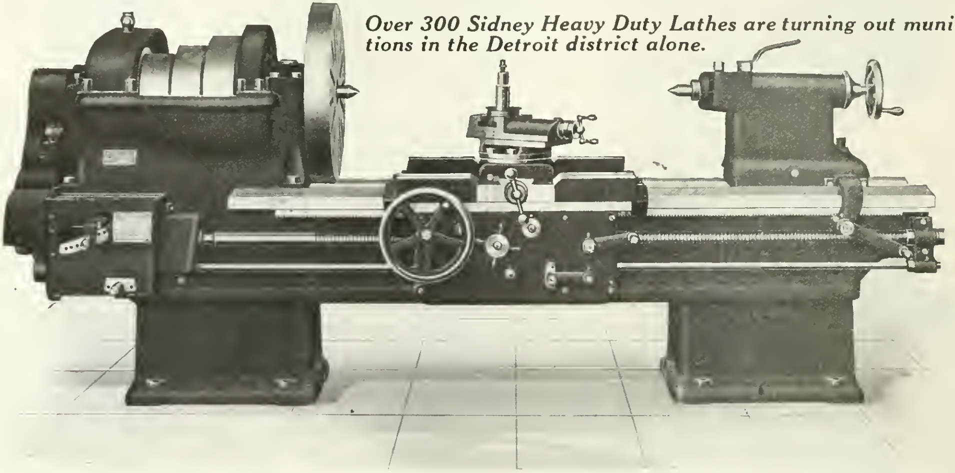
MORTON
MFG.
COMPANY
Muskegon Heights
MICHIGAN



POWERFUL, flexible, economical, the Morton Draw-Cut Traveling Head Planer, with Drilling and Boring Equipment, handles work accurately at all angles and can perform a number of operations at a single setting. Simply designed, easy to operate, it runs smoothly and with almost no vibration. The "Morton" occupies only half the floor space of a housed planer and takes only one-fourth the power. Capacity up to 100 tons. Let us tell you what it has done for others in the saving of time and money.

SIDNEY Heavy Duty Engine Lathes

Over 300 Sidney Heavy Duty Lathes are turning out munitions in the Detroit district alone.

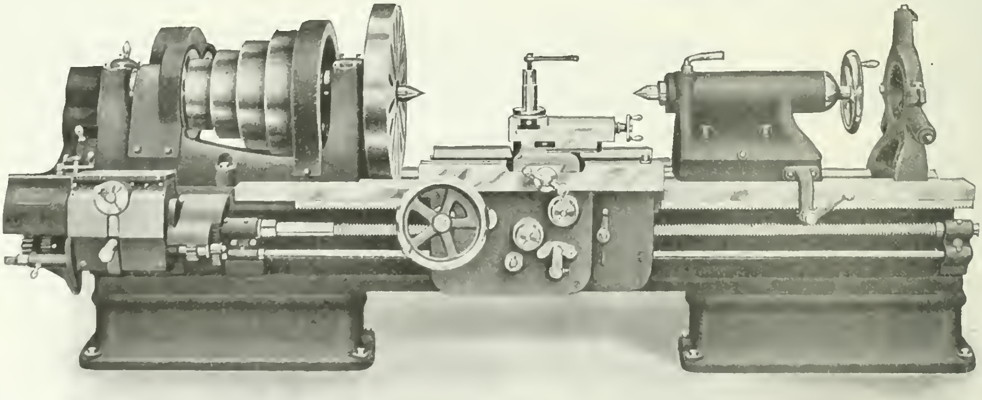


From the Sidney line of 15", 17", 19", 25" and 27" swings, built on beds from 6 feet to 20 feet, and fitted with any extra attachments required, you can equip a complete lathe department to your shop, whether it is for Government munition work or any other line of high production manufacture.

New Bulletins just issued on 25-Inch Machine. Write today!

THE SIDNEY TOOL CO., Sidney, Ohio, U. S. A.

AGENTS: Lynd-Farquhar Co., Boston, Mass.; J. J. McCabe Lathe & Machinery Corpn., New York City; Frank Toomey, Inc., Philadelphia, Pa.; Smith-Courtney Co., Richmond, Va.; McCoy-Brandt Machinery Co., Pittsburgh, Pa.; Simmons Machine Co., Inc., Albany, N. Y.; H. A. Smith Machinery Co., Syracuse, N. Y.; Homer Strong, Inc., Rochester, N. Y.; Strong, Carlisle & Hammond Co., Cleveland, Ohio; Vonnegut Machinery Co., Indianapolis, Ind.; The Chas. A. Strelinger Co., Detroit, Mich.; Wayne Machinery Co., Ft. Wayne, Ind.; Marshall & Huschart Mchy. Co., Chicago, Ill.; Bowman-Blackman Machine Tool Co., St. Louis; Young & Vann Supply Co., Birmingham, Ala.; Oliver H. Van Horn Co., Ltd., New Orleans, La.; Herberts Machinery & Supply Co., Los Angeles, Cal.; Fred Ward & Son San Francisco, Cal.; Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo.; The Salt Lake Hardware Co., Salt Lake City, Utah; The Portland Machinery Co., Portland, Ore.; Perine Machinery Co., Seattle, Wash.; F. E. Satterlee Co., Minneapolis, Minn.; H. W. Petrie, Ltd., Toronto, Canada; Geo. F. Foss Machinery & Supply Co., Montreal, Canada.



30-Inch Instantaneous Change Gear Engine Lathe

Double Back Geared Double Plate Apron

THE BOYE & EMMES MACHINE TOOL CO.

2245 to 2251 Spring Grove Avenue CINCINNATI, OHIO, U. S. A.

"WHITNEY"

HAND MILLING MACHINE

THOUSANDS IN USE

Note that the

"WHITNEY"

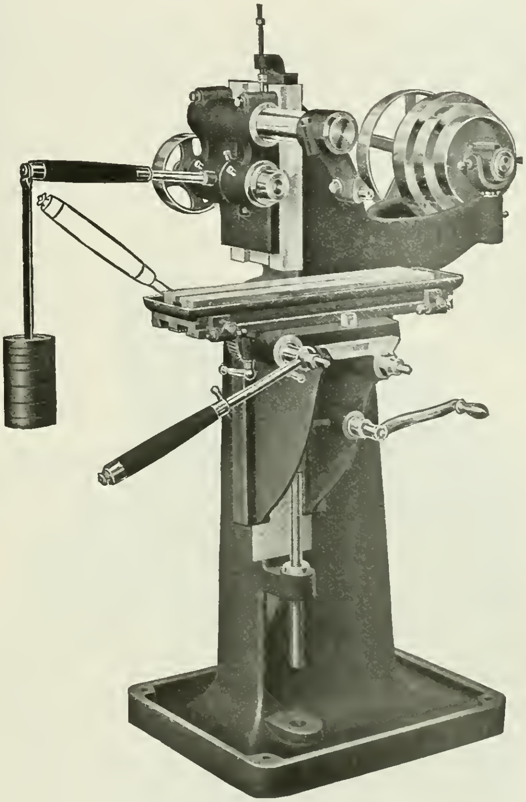
is different from the usual type of Hand Milling Machine.

The

Sliding Head

is its distinctive feature, thus giving advantages possessed by no other type of Hand Miller.

The spindle is driven by interchangeable side pulleys, giving six spindle speeds with three grade cone and four with two grade cone.



PROMPT DELIVERIES

THE WHITNEY MFG. COMPANY

HARTFORD, CONNECTICUT

CHAINS   KEYS AND CUTTERS   HAND MILLING MACHINES

"I'm Spending Too Much For Heat Treatment"

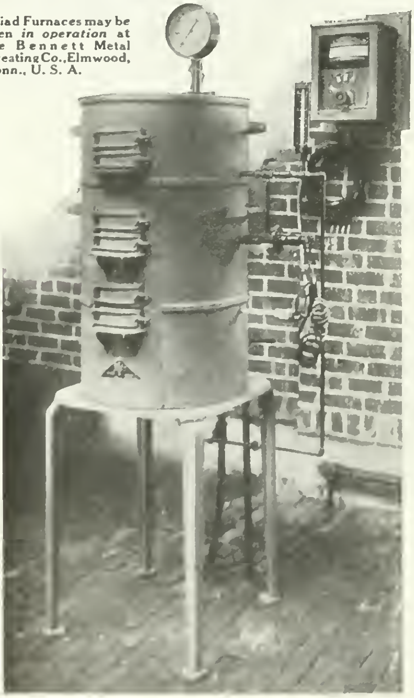
That's what everyone who sees the Triad Combination Furnace in operation says. Considering the saving the "Triad" effects in first cost, fuel, space, labor and installation, they have good cause to remark. It performs hardening, preheating and tempering operations at little more than the cost of any one of these.

The three processes may be carried on simultaneously. Proximity of chambers to each other eliminates danger of oxidation in products. Waste heat from high-speed chamber on bottom supplies other units.

You also may see Triad Furnaces in operation.
Meantime send for the circular

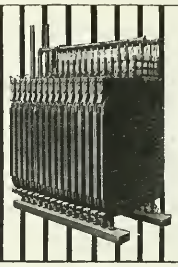
W. R. BENNETT, Elmwood, Conn.

Triad Furnaces may be seen *in operation* at the Bennett Metal Treating Co., Elmwood, Conn., U. S. A.



TRIAD

Combination Furnaces



SOME day—when failure to receive your supply of cylinder gas has interrupted your work and cost you heavy losses—you'll investigate the advantages of an I. O. C. Gas Generating Plant of your own.

But why wait for trouble? Why not prepare against it, now?

Send for Bulletin 20, about
"The Cell with Three Times the Capacity Per Unit of Space"

INTERNATIONAL OXYGEN COMPANY
115 Broadway New York

Standardized Apparatus

FUEL OIL

We respectfully solicit
your inquiries.

AMERICAN PETROLEUM PRODUCTS CO.
CLEVELAND OHIO, U. S. A.

Address
Dept. P

This book tells of the up to date Methods of Case Hardening. Copy sent free on request.

KASENIT

Non-Poisonous

Open-Fire Hardening Compound

Rapid and uniform surface hardening without poisonous smoke and fumes. Replaces dangerous materials heretofore used. *Ask your dealer or write us.*

"KASENIT No. 4"

Is the Perfect Carbonizer for oven work. Absolutely uniform and dependable results at low cost.

KASENIT COMPANY
11 Water Street New York

HOSKINS
ELECTRIC FURNACES

Annealing 240 Parts at a Time with Absolute Uniformity

In the making of high grade fishing reels, the Horton Manufacturing Company of Bristol, Conn., considers the matter of heat treatment a most important factor—so much so, that two years ago it brought this Hoskins Furnace all the way up from Kentucky to install in its Bristol plant. The photographed operation is annealing fishing-reel pinions. The furnace accommodates six boxes, each box containing 40 pinions. The 240 parts are annealed quickly, economically and *with absolute uniformity throughout.* Heat control does it. These furnaces are made in larger sizes for the heat-treatment of tools. Tools last longer when hardened in this way, because of the *heat-control* and lack of gases in the heating-chamber. All variables are eliminated and you are sure of good tools all the time.

Make your own thermo-couples with Hoskins Chromel Wire. Most any mechanic can do the job. No skill is necessary. The thermo-couple is the heart of your heat treating outfit. Make sure it's right. Protect your thermo-couples against gases and mechanical injury with Hoskins Chromel Protection Tubes.

Send for Bulletins No. 10 and No. 3

HOSKINS MFG. CO.
459 Lawton Avenue
Detroit, Mich.

Grand Central Terminal
New York City
Canadian Hoskins, Ltd.
Walkerville, Ont.
Otis Building, Chicago
Tremont Bldg., Boston
Oliver Bldg., Pittsburgh

COLTON-DETROIT

All Forged High Speed Drills

With Colton-Detroit All Forged High Speed Drills a greater number of holes are obtainable than with the average. They can be rotated faster—they last longer. Forging gives them a backbone which *insures* maximum service under all conditions.

And a Word About Grinding

The original grinding of Colton-Detroit All Forged High Speed Drills is guaranteed accurate. By keeping them correctly ground the best results are assured.

We will instruct at our plant mechanics employed by large users of drills in the correct method of grinding. *Your* men are invited.

USE COLTON-DETROIT DRILLS AND SAVE ON YOUR TOOL BILLS

Catalog of the complete line will be mailed upon request

ARTHUR COLTON CO.
785 Jefferson Avenue
DETROIT MICHIGAN, U. S. A.

STOP WASTED TIME

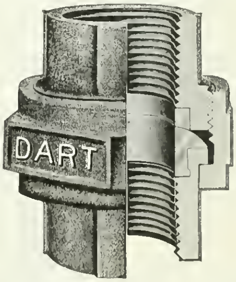
Make Your Machines Produce Every Minute of the Working Day.

One set of nine "Nicholsons" affords an instant fit for any size hole—round or square—from one to seven inches. Quick to insert; quick to remove.

NICHOLSON EXPANDING MANDRELS

Give you full value from your machinists' time. Increased production simply has to follow, with greater accuracy. "Nicholson" cannot distort—the jaws are always concentric. Put a Nicholson to the test in your factory. We will gladly loan you one for 30 days' trial. Send for our Mandrel booklet. It tells how and why "Nicholsons" stop wasted time.

W. H. NICHOLSON & CO.
112 Oregon St. WILKES BARRE, PA.



SPECIFY "DART" and your unions will out-last the rest of the pipe—two bronze seats prevent rust or corrosion—malleable iron pipe ends and nut insure strength.

Ask us about them or send for Sample Union.

E. M. DART MFG. CO. PROVIDENCE Rhode Island
The Fairbanks Co., Sales Agents. Canadian Factory: Dart Union Co., Ltd., Toronto

Is Good Tool Steel High and Hard to Get?

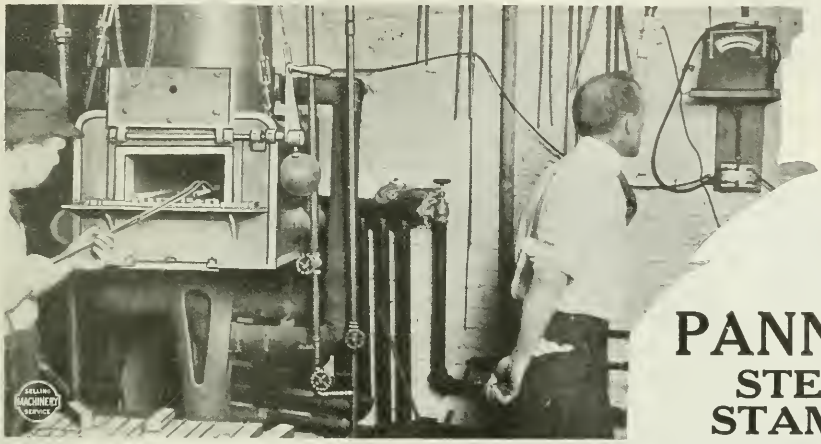
Then conserve the steel you have; don't scrap your worn out tools; send them to us, see what a high speed steel expert can do to reclaim them.

THE J. C. GLENZER CO., 3 14th St., cor. Fort, Detroit, Mich.

TAPS AND REAMERS

First-class Tools and Prompt Deliveries

REIFF & NESTOR CO., Lykens, Pa.



Three factors safeguard the temper of Pannier Steel Stamps:—
a good furnace, an accurate pyrometer and an experienced specialist on steel stamp treatment.

PANNIER
STEEL
STAMPS

How We Make It Easy For Our Salesmen

Sales "patter" frequently gives an inferior product a temporary hold on the market; a good article, once known, sells itself permanently. The age of our establishment proves we have been mindful of these facts. Pannier Steel Stamps are made of the best obtainable material, in a thoroughly modern plant, by genuine "old-timers" in this industry, to whom steel stamps represent more than mere intrinsic value. They make it easy for the Pannier salesman. He doesn't have to argue. He knows he can safely say—"Try them."

PANNIER BROTHERS STAMP COMPANY, Inc., Pittsburgh, Pa., U.S.A.

"Saws" All Over the World

In every line of work DISSTON SAWS for wood and metal, tools and tiles, play a large and important part.

TRADE MARK REG. U. S. PAT. OFF.

HENRY DISSTON & SONS, Inc.

KEYSTONE SAW, TOOL STEEL AND FILE WORKS

PHILADELPHIA, U. S. A.

TRADE MARK REG. U. S. PAT. OFF.

How do *you* handle *your* castings and forgings?

ONE at a time? Paying men to pick them up off the floor and load them on to trucks—moving them to the proper place—piling them off one at a time on the floor—then picking them up one at a time and loading them on to a truck again—and then on to the next operation—and so on?

If so you have a real opportunity to save a big item of expense—no matter how small your shop or how large. By installing the Barrett System you can eliminate four-fifths of the handling in your shop—and when you stop to figure it, one of the most costly items on your books is that of handling materials—getting things moved from one place to another. It's an expense that goes on every hour of the day—day in, day out—increasing your costs, eating into your profits.

What's more, the Barrett System can be started in your shop without upsetting your present methods in any way. No inconvenience of any kind—no cost unless you actually save enough money to cover your investment many times over in a very short time.

Write *at once* for free illustrated booklet showing exactly how you can put the Barrett System to work in your shop, immediately, *without cost and without obligation.*

BARRETT-CRAVENS COMPANY
713 Transportation Building, Chicago, Ill.

BARRETT MULTI-TRUCKS

THE HOLYOKE TRUCK

DETAILED INFORMATION ABOUT OUR PRODUCTS ON FILE AT ALL THE NATIONAL RED BOOK SERVICE STATIONS — ONE IS LOCATED NEAR YOUR OFFICE

Holyoke Transfer Trucks are designed for long service and are without unnecessary parts. Wheels are fitted with Hyatt Roller Bearings, axles heat treated chrome nickel alloy steel, wearing parts amply reinforced and material throughout is of the best. Operation is entirely by the handle.

Few Parts

Built to Last

Let us tell you how it works

HOLYOKE TRUCK CO.
112 RACE STREET HOLYOKE, MASS.

Distributors for Metropolitan District
YOUNG, COPLEY & DOLAN, Inc.
115 Broadway NEW YORK CITY

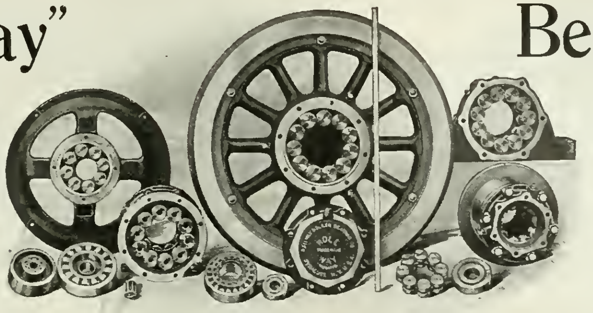
HIGH ON SPEED
Trade Mark

Let us Convert your High Speed Steel Scrap into Bars— Every Bar Guaranteed

ONONDAGA STEEL COMPANY INC.
SYRACUSE, N.Y.

"Rollway" Bearings

A
Three Year
Guarantee
With Every
Installation



All
Rollers
Midvale No. 6
Races 3½%
Nickel Steel

No load too heavy, no conditions too severe for "Rollway" Bearings. We back this statement with any amount of proof—actual cases where, after operating continuously for years under most severe and exacting conditions, in places where other bearings had been destroyed in as many months, "Rollways" showed no signs of wear.

ROLLER
BEARINGS
for RAILWAY and
INDUSTRIAL
PURPOSES

Beside being durable, "Rollways" save—80 per cent in lubrication, 4 per cent in power and all cost of rebabbitting. They require only infrequent inspection and are made to your design or designed to meet your requirements.

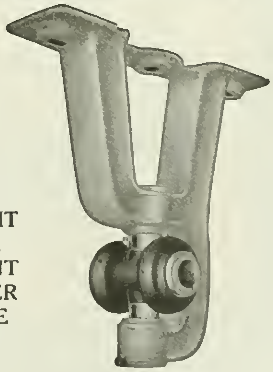
"Rollway" Bearings installed in old motors give them a new lease of life.

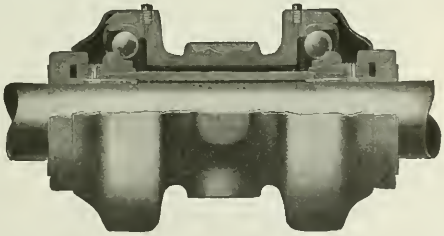
May we send you Descriptive Literature?

ROLL WAY TRADE MARK

Railway Roller Bearing Company
SYRACUSE N.Y., U.S.A.

You Can "Eat Your Cake and Have It Too" With
CHAPMAN TYPE BEARINGS





THEY
WILL FIT
YOUR
PRESENT
HANGER
FRAME

Chapman Bearings on Shafting Hangers, Pillow Blocks, Loose Pulleys and Friction Clutches, soon save enough power to pay for themselves and begin bearing interest. Ordinary bearings and self-oiling bushings waste enough to pay for this profitable equipment over and over again—without getting the benefit. We install Chapman Type Bearings to meet any transmission requirements, guarantee them to save 95 per cent on lubricant and attention and at least 15 to 20 per cent on power. Sixteen years on the market, Chapman Bearings are standard equipment in three or four thousand factories—some of the largest in Canada and U. S.—and reports on many of the first installations show them still doing full duty with no visible signs of depreciation.

Read what users say in "Results." Read what we claim in Catalog 3B. Both mailed promptly on request.

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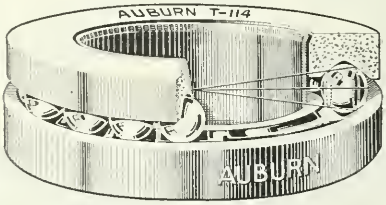
Chicago New York Cleveland 1050 Military Road, BUFFALO, N. Y. *Cambridge, Mass. Philadelphia*

CHAPMAN DOUBLE BALL BEARING CO., Ltd., 339-351 Sorauren Avenue, Toronto, Ont.

END THRUST FRICTION TROUBLE OVERCOME



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Trade Mark

State your difficulties, or ask for bulletins.

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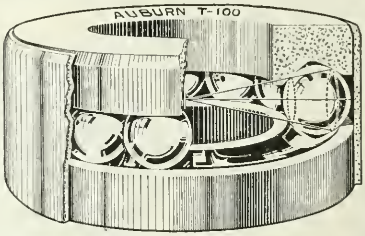

AUBURN BALL THRUST BEARINGS

AUBURN BALL BEARING COMPANY, 33 ELIZABETH STREET, ROCHESTER, N. Y.

Ball Thrust Bearings made to meet your requirements

Star Ball Retainers for Cup and Cone, Thrust and Magneto Type Bearings

The Bearings Company of America
Lancaster, Penna.

WESTERN SALES OFFICE:
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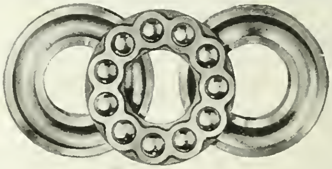
Roller Thrust
Steel Balls
Radax
Journal Roller
Taper Roller
Pressed Steel
Annular



BEARINGS
ALL TYPES — MANY SIZES — IN STOCK
THE GWILLIAM COMPANY
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ADJUSTABLE HANGER

FOR HIGH SPEED
FOR HEAVY DUTY

ESTABLISHED 1854
ENGINEERS FOUNDERS
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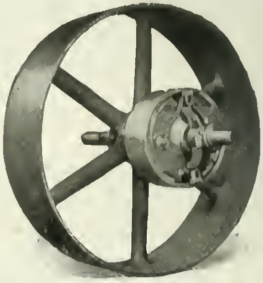
FOR MOTOR, MACHINE, MILL OR POWER PLANT
ROPE DRIVES A SPECIALTY

We lay out, make drawings, furnish the material and erect it. Special machinery built to drawings and specifications.



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WORKS: ELIZABETHPORT, N. J.

Factory resources and service go hand in hand with

STANDARD ROLLER BEARING PRODUCTS

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PRECISION BALL BEARINGS

(PATENTED)

Today, the measure of value is the capacity for service—in machines as in men. Not "what is the price," but "what will it do," is the decisive question. To be saleable today, a machine must above all else be serviceable—it must be capable of bearing its share of the national over-load. And serviceability commands a ready market and a good price.

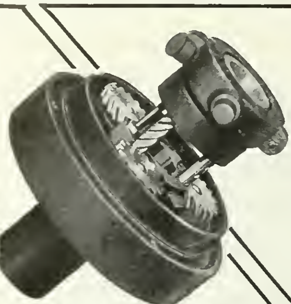
"NORMA" Precision Bearings are the standard bearings in hundreds of thousands of high-speed machines—simply and solely because the test of time has proved their preeminent service capacity. Their maximum-service qualities are recognized by machine builders who place performance above price.

BE SAFE. See That Your Machines Are "NORMA" Equipped.

THE NORMA COMPANY OF AMERICA

1790 BROADWAY NEW YORK

Ball, Roller, Thrust and Combination Bearings



No toggle joints, meaningless parts, or complicated attachments

Hilliard Clutches and Government Shops

Government shops can depend not only on the performance of Hilliard Clutches, but also on deliveries.

We promise to give priority at all times to plants doing government work.

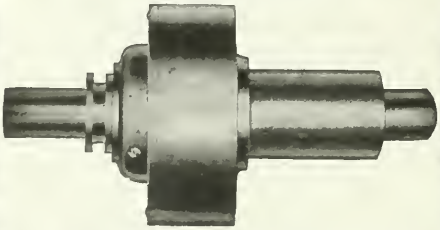
Practically any machine can be individually controlled through Hilliard Clutches.

Chapman Ball Bearing or Hyatt Roller Bearing Sleeves supplied for high speed work, and are recommended.

Ask for further details.

THE HILLIARD CLUTCH & MACHINERY CO.
ELMIRA NEW YORK, U. S. A.

CLEVELAND
The Dependable CLUTCH



SIMPLE-DEPENDABLE-ADAPTABLE

Engages gradually—releases instantly. No parts to burn out, work loose or damage—no exposed parts. Easily adjusted to a given load and may be modified to meet special requirements.

All parts are interchangeable—single oiling lasts months.

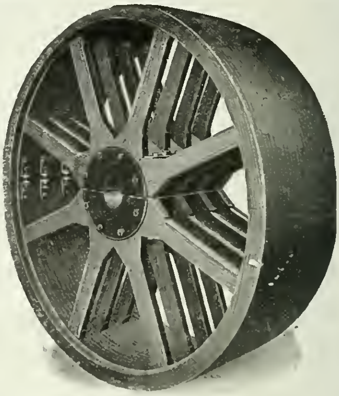
Write for Catalog "D"

THE RELIANCE GAUGE COLUMN CO.
6008 Carnegie Avenue
CLEVELAND, OHIO

Gilbert Wood Split Pulleys

Style "A"

For
Safety
Speed
and
Service



GILBERT WOOD PULLEYS are carefully made of seasoned wood, and can be safely run at very high speeds. The hard wood surface transmits more power than a steel pulley, weight is only half as much, cost is less, and wear is guaranteed. Various styles and sizes.

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Sales Agencies in All the Principal Cities in the World
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Cap Screw

ALLEN SAFETY (HOLLOW) SET SCREWS

Set Screw

U. S. Patent, June 7, 1910

Safe, strong, convenient and durable, Allen Safety Set Screws are manufactured by a special process which increases their strength 30 per cent. They're guaranteed. Carried in stock in U. S. Standard and V Threads—¼ to 1½ inch diameters. *Catalog and Samples Free.*

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COOPER
PATENTED UNIVERSAL JOINTS
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Shaft Sizes ⅛" to 2"
Double or Single
Carbonized
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Ample Oil Receptacle
Smooth Exterior
Five Parts No Screws
Compact

Carbonizing and Screw Machine Products

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4 MONTHS OR 5½ YEARS

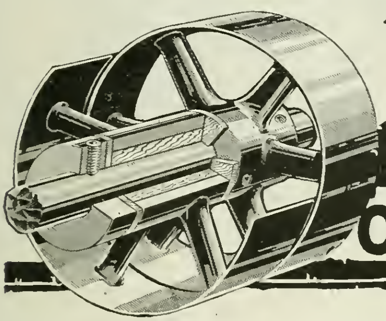
Did you ever have a metal bearing last more than four months at the most on a loose pulley or friction clutch? Here's an Arguto Oilless Bearing that showed no signs of wear after 5½ years "on the job."

Consider the saving the user made on this bearing alone:

Cost of metal bearing	**$9.73**	**Arguto**	**$2.86**
Metal bearings used yearly	**3**		
Metal bearings cost yearly	**$29.19**		
	5½ yrs.		
	$160.55		**$2.86**

One Arguto saved $157.69

With the entire plant equipped with Arguto Oilless Bearings, the saving in first cost alone is a big item. Add to it, oilers' services that can be dispensed with, and the saving to belting and product, through the elimination of dripping oil, and you can readily see why so many manufacturers specify Arguto for their bearings. Try two or three on some of your troublesome bearings, and check up the figures for yourself. *Full particulars on request.*



ARGUTO OILLESS BEARING COMPANY
145 Berkley Street Wayne Junction
PHILADELPHIA, PA.

ARGUTO
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NON-METALLIC

Ball and Roller Bearings

Quality Bearings for Every Bearing Need

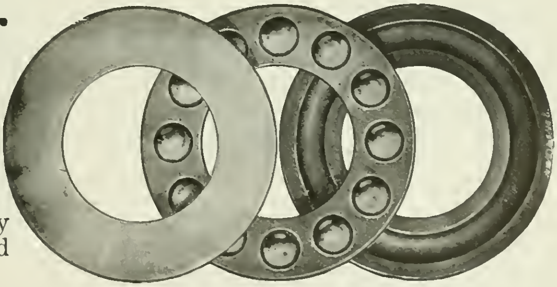
Our line is complete and of uniformly high quality, design, material and workmanship.

We manufacture: Radial Roller Bearings, Journal Roller Bearings, Roller Thrust Bearings, Ball End Thrust Bearings (in both inch and millimeter sizes), Cylindrical Rollers.

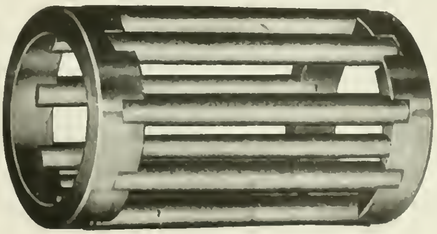
We have unusual facilities for the manufacture of cylindrical rollers.

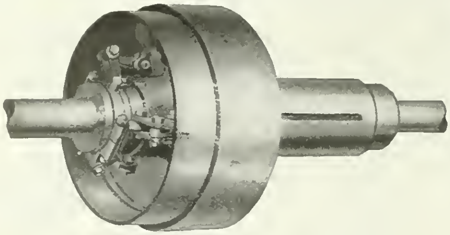
We specialize in anti-friction service. Can we help you?

THE BALL & ROLLER BEARING COMPANY
Danbury Connecticut, U. S. A.



New Catalog No. 9 gives all the details





Longer Life
Less Upkeep Expense
Greater Durability
Better Satisfaction

FOUR STERLING QUALITIES POSSESSED BY

MOORE & WHITE FRICTION CLUTCHES

Their wearing qualities are guaranteed by the first-class workmanship and materials that enter into the construction of all Moore & White Friction Clutches that leave our plant. The upkeep is reduced to a minimum by the small number of repair parts needed, and unless the Clutches are subjected to some extraordinarily terrific strain or sudden jerk they will run a long time without needing repairs.

Moore & White Friction Clutches are extremely simple in design and require but little adjustment. Not at all necessary to be an expert mechanician to understand their make-up.

Cannot throw oil or become accidentally engaged. Will transmit the full power at all times. Allow instantaneous stopping of one or all machines.

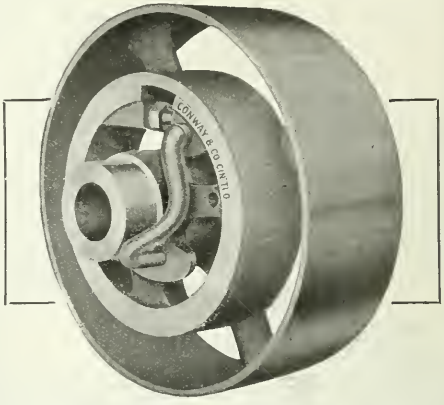
In fact, Moore & White Friction Clutches will give you the service, in the best manner possible, that Friction Clutches were designed for. They're made to last a lifetime and satisfy the user.

Booklet "M" FREE Upon Request. A complete treatise upon Friction Clutches. No mill owner, superintendent, buyer or man in the shop should be without it. Send for it today. Yours for the asking.

THE MOORE & WHITE CO.
2707 to 2737 N. 15th St. PHILADELPHIA, U. S. A.

SOLD BY ALL GOOD DEALERS

The
C-M-T



For Countershafts

CONWAY & COMPANY
Fairmount Cincinnati
Manufacturers of Friction Clutches since 1895

CRESSON-MORRIS CO.

Power Transmitting Machinery

We make a specialty of equipping plants completely with Power Transmitting Machinery, including Shafting, Rope Transmission, Machine-Cut and Moulded Iron and Steel Gears for heavy service.

Almost sixty years' experience and competent engineering advice is at your disposal.

CRESSON-MORRIS COMPANY
Engineers—Founders—Machinists
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"THE CHAIN OF DOUBLE LIFE"
Fits cut and Standard C. L. Sprockets 1 to 12 in. pitch.

Union Steel Rivetless Chains

High Carbon Links (STRENGTH), Large Glass-hard Reversible Bearings (DURABILITY), One-piece Rivetless Construction (PERMANENCY) insure TROUBLE-PROOF, MONEY SAVING SERVICE. Bushing Chains, Roller Chains, Sprockets, Buckets, Elevators, Conveyors, etc.

The Union Chain & Manufacturing Company, Seville, Ohio
30 Church Street, New York Telephone, Cortlandt 892

FLEXIBLE STEEL TUBING

For Supplying Lubricant to Machine Tool Cutters

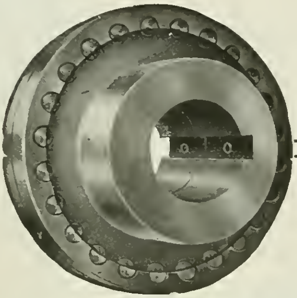
Strong, durable and warranted tight. No packing. All steel construction. Made in sizes ⅛ to ¾".

We are supplying many big machine tool builders—why not you? Write for details and samples.

WHEELOCK MFG. CO., Wheelock, Vt.

REAL FLEXIBILITY

in connecting the shafts of any two close coupled machines eliminates the expense of extremely careful alignment and provides for misalignments, which cause trouble and expense.



FRANCKE

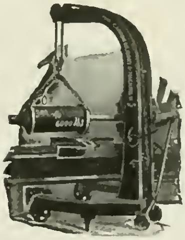
FLEXIBLE COUPLINGS

for any size and type of direct power drive, are flexible in three directions in addition to providing a cushion for the driving shocks.

New Bulletin No. 26 lists sizes for all usual drives.

Smith-Serrell Co., Inc.
General Sales Agent for the Francke Co.
144 Cedar St., New York City

Are Working Conditions a Factor?



The Canton Portable Floor Crane takes the place of a half dozen men in lifting and hauling heavy objects to any part of the shop. Goes where an overhead cannot.

Powerful — reliable — easy to operate — the Canton is strictly a one-man machine. Moderate prices.

Catalog E-10 for details

CANTON FOUNDRY & MACHINE CO., Canton, Ohio

"TOLEDO CRANES"

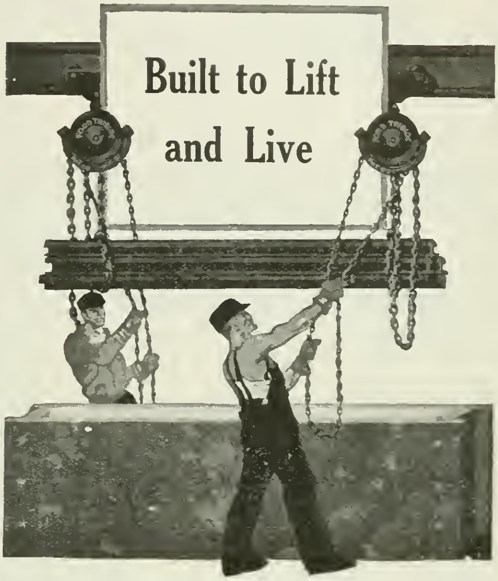
FOR EVERY SERVICE

They are quite Reliable

The Toledo Bridge & Crane Co.
2950 Dorr St. TOLEDO, OHIO

FORD TRIBLOC

CHAIN HOIST


Built to Lift and Live

THE spur gear operating mechanism, with steel gears, makes the Ford Tribloc the most highly efficient type of Chain Hoist marketed. Eighty per cent of the power applied to the hand chain is converted into lifting energy—a mere 82-pound pull of one man on the hand chain lifts a ton.

The important part about the efficiency of the Ford Tribloc is that its original high efficiency is maintained longer than in any hoist, due to the patented **LOOP Hand Chain GUIDE.** This Loop Guide prevents "gagging" of the hand chain at all speeds and angles and protects the blocks.

For long, strong service specify the Ford Tribloc. We back our claims with a 5-year guarantee. Have you our Catalog?

FORD CHAIN BLOCK & MFG. CO.
Second and Diamond Sts. Philadelphia, Pa.

OVER SEAS REPRESENTATIVE
ALMACOA ALLIED MACHINERY COMPANY OF AMERICA ALMACOA
120 BROADWAY NEW YORK U S A

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THE SHAW ELECTRIC CRANE COMPANY
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SALES OFFICES IN ALL PRINCIPAL CITIES
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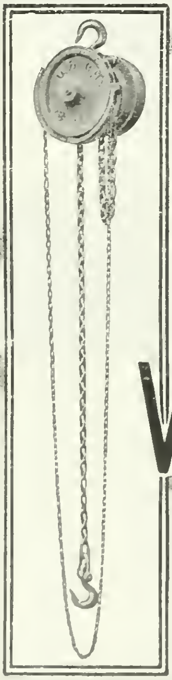
PRINCIPAL OFFICE - 119 WEST 40TH. ST., NEW YORK.



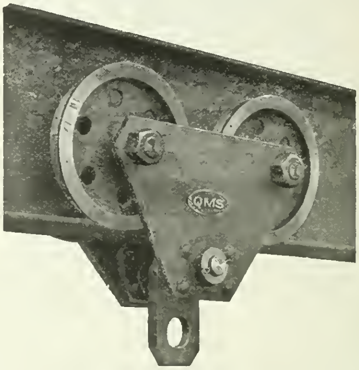
Let the Wright High Speed Steel Hoists Lift the Loads

150% more efficient than any other Hand Hoist. High speed steel and malleable iron parts—special design and construction—make for longer life and better service.

Catalogue ?

WRIGHT HOISTS

Manufactured by
WRIGHT MFG. COMPANY
LISBON OHIO



QMS TROLLEYS

Strong, Durable, Efficient

Built in both plain and geared styles. Capacities ranging from one quarter to seven tons. In making inquiry state I-Beam size and style of trolley desired.

Write or wire now

VULCAN ENGINEERING SALES COMPANY
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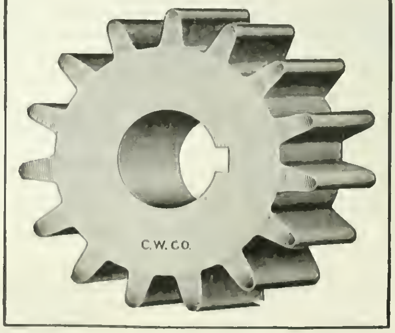
Sales Agent for
Hanna Engineering Works Mumford Molding Machine Company
The QMS Co. J. C. Busch Company

Cullman Sprockets

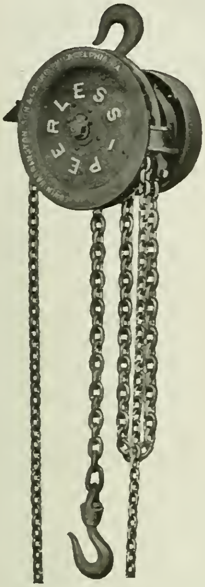
in stock and to order

For Block, Roller and High Speed Silent Chains. New Catalogue.

CULLMAN WHEEL CO., 1339 Altgeld St., Chicago



Use The Same Judgment



when buying a hoist that you would use in employing a man for a big job. Search its reputation for reliability and record of past performances. You will find in applying this test to

Peerless Hoists

that the enviable and unparalleled reputation they have controlled for many years past is due solely to the merit of design, material and workmanship.

No cast or malleable iron used to carry the load.

Suppose you let us demonstrate this hoist to prove to your satisfaction our claim is fully warranted.

Edwin Harrington, Son & Co.
Incorporated
Philadelphia Pa., U. S. A.

Cranes and Hoists

- Electric Traveling Cranes.
- Hand Power Traveling Cranes.
- Bucket Cranes.
- Jib Cranes.
- Monorail Cranes.
- Electric Hoists.
- I-beam Trolleys.
- Track Systems.
- High Speed Chain Hoists.

Alfred Box & Co., Inc.
PHILADELPHIA, PA.

Quick Work!

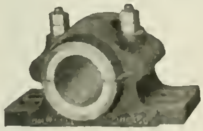
Quick and Easy. Lift with Cyclone Hoists—save time and labor.

CYCLONE HOISTS
HIGH SPEED

Sizes ¼ to 40 tons. Distributors in all cities. Catalog M gladly mailed on request.

The Chisholm-Moore Mfg. Co.
CLEVELAND, O.
Hoists Cranes Trolleys

Power Transmitting Machinery


Heavy Pillow Block

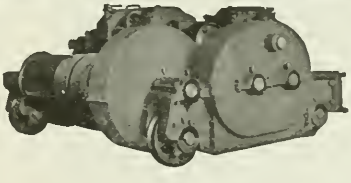
Heavy bearings, drop hangers and post hangers.

Machine moulded gears and pulleys.

Friction clutches, rope drives and chain drives.

H. W. CALDWELL & SON CO.
Elevating, Conveying and Power Transmitting Machinery
17th Street & Western Avenue, Chicago, Ill.
50 Church St., New York 709 Main St., Dallas, Texas

NORTHERN CRANES



Has your crane a modern ship-shape safety trolley like this? This is our

"Type E" Crane Trolley

Made along up-to-the-present lines with all features of safety and efficiency demanded by good engineering practice. Learn more—get our catalogs. We also make

ELECTRIC HOISTS
Air Hoists, Foundry Equipment, etc.

Northern Engineering Works
6 Chene Street Detroit, Mich.

CHICAGO RECORDING SCALE CO. CRESCO WAUKEGAN-ILL.

CRESCO CHUCK

The Quickest—The Simplest

Ground All Over

Perfectly Balanced

Entirely self contained. No screws in the whole construction.

Superlatives are usually unconvincing. We want you to *try* the new Cresco Chuck. We'll give you your money back if it isn't the simplest and quickest drill chuck you have ever seen.

Tools are immediately released by simply raising the loose collar, thus permitting the hardened steel balls, which hold the collet in cross grooves, to fall back into it. The grip, as quickly effected, is positively secure.

Perfect balance insures absolute freedom from vibration at maximum speeds

Wire for price. Order a Cresco Chuck *today* on our money-back guarantee.

CHICAGO RECORDING SCALE COMPANY

Waukegan, Illinois, U. S. A.

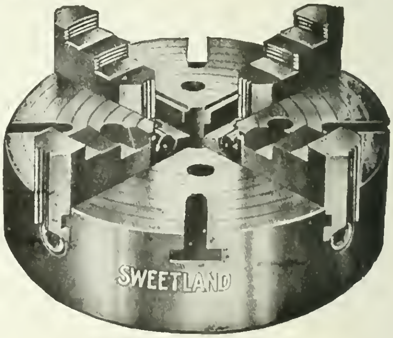
A Grip on Production

STANDARDIZATION is a milestone in mechanical progress. Standard machines and standard parts have made predetermined production standards possible. Take a grip on *your* production. Find the best equipment and make it universal in your plant. For lathe chucks, of course, you'll want Sweetland. They're standard in high production shops everywhere.

Convenience, adaptability and reliability are the marks by which the Sweetland Lathe Chuck is known. Do *you* profit by these features?

HOGGSON & PETTIS MFG. COMPANY

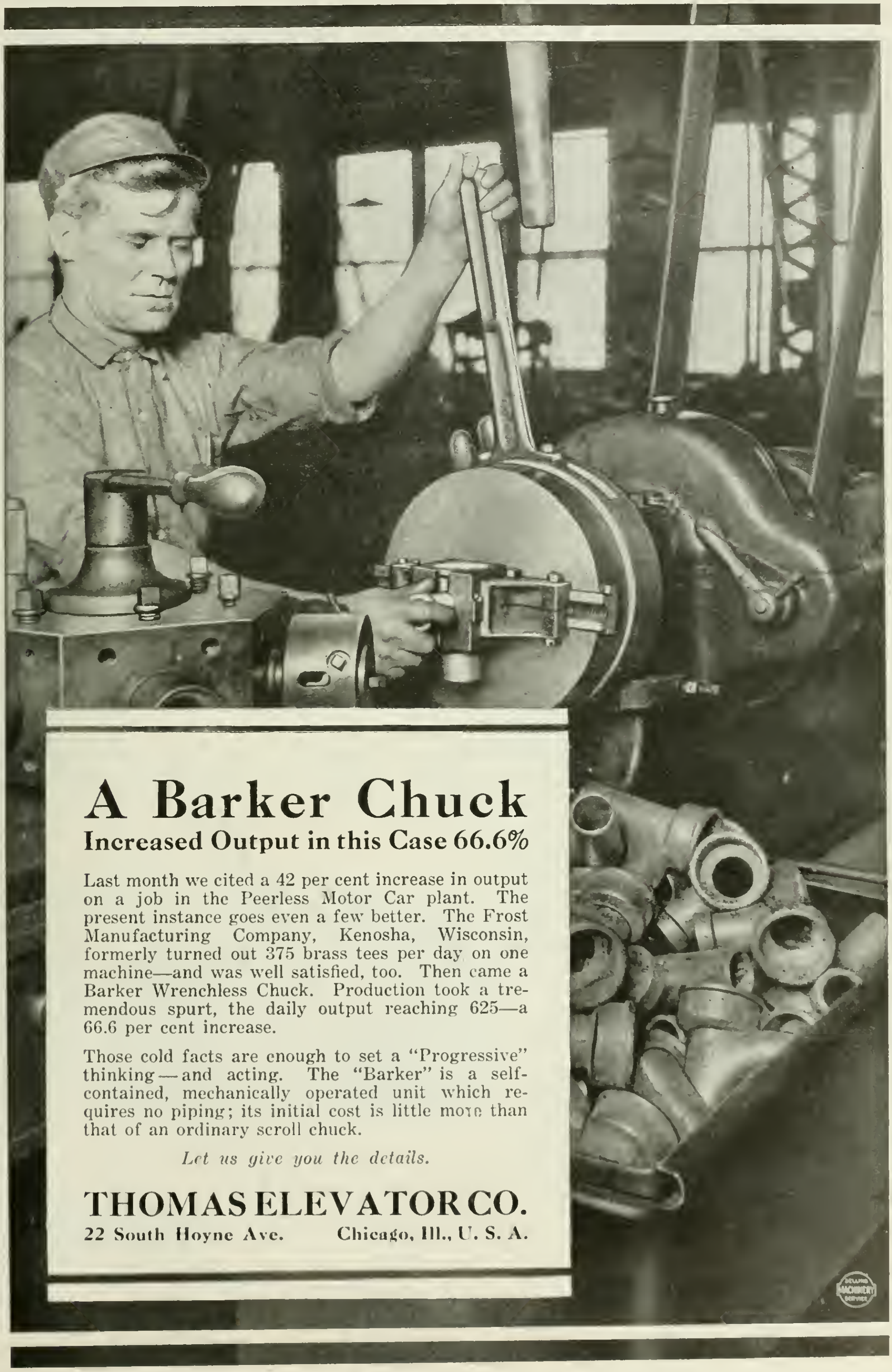
NEW HAVEN CONNECTICUT, U. S. A.



"Chucking for Profit" will interest you if you're interested in maximum efficiency.

Send for it today and get some helpful chucking data straight from headquarters.

SWEETLAND LATHE CHUCKS



A Barker Chuck

Increased Output in this Case 66.6%

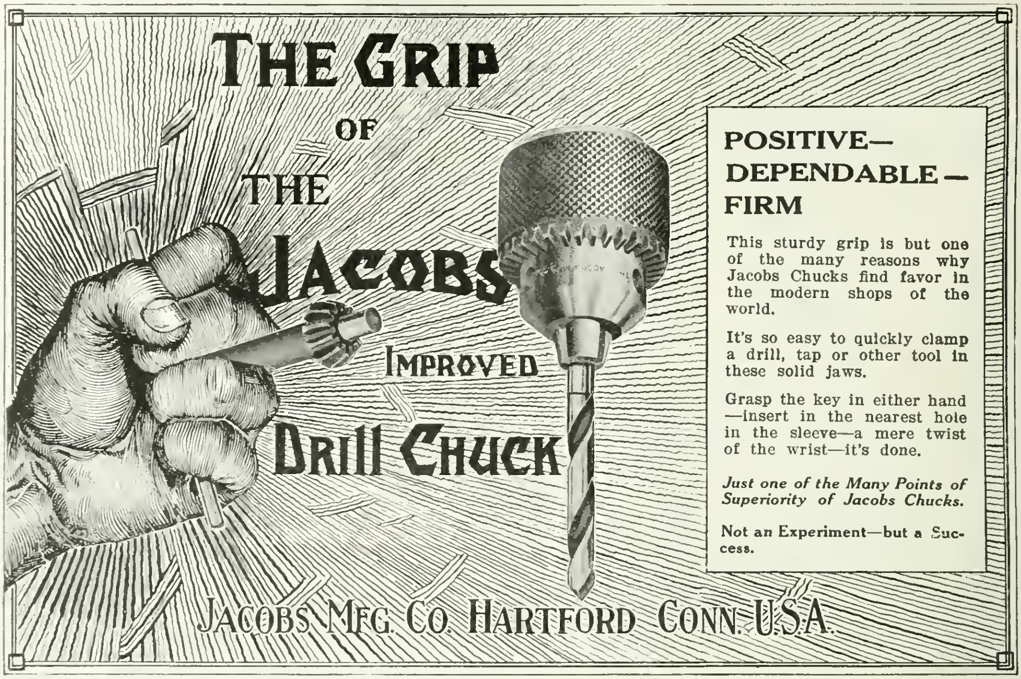
Last month we cited a 42 per cent increase in output on a job in the Peerless Motor Car plant. The present instance goes even a few better. The Frost Manufacturing Company, Kenosha, Wisconsin, formerly turned out 375 brass tees per day on one machine—and was well satisfied, too. Then came a Barker Wrenchless Chuck. Production took a tremendous spurt, the daily output reaching 625—a 66.6 per cent increase.

Those cold facts are enough to set a "Progressive" thinking—and acting. The "Barker" is a self-contained, mechanically operated unit which requires no piping; its initial cost is little more than that of an ordinary scroll chuck.

Let us give you the details.

THOMAS ELEVATOR CO.

22 South Hoyne Ave. Chicago, Ill., U. S. A.



**POSITIVE—
DEPENDABLE—
FIRM**

This sturdy grip is but one of the many reasons why Jacobs Chucks find favor in the modern shops of the world.

It's so easy to quickly clamp a drill, tap or other tool in these solid jaws.

Grasp the key in either hand—insert in the nearest hole in the sleeve—a mere twist of the wrist—it's done.

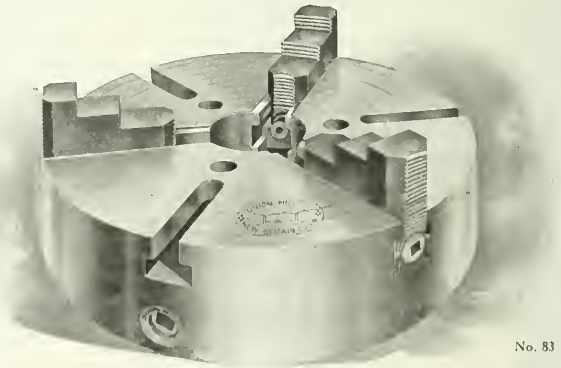
Just one of the Many Points of Superiority of Jacobs Chucks.

Not an Experiment—but a Success.

IF IT'S A CHUCK WE MAKE IT!

Chucks of every description, standard or special; chucks of any size.

We make chucks, have been making them for years and are equipped to furnish a "Union" Chuck that will fill your needs to the letter—and allow a margin for futures.


No. 83

Accurate, strong, durable and adaptable — "Union" Chucks never fail to make good.

Catalog lists full line.

The Geared Scroll Chuck illustrated combines the features of the Universal Chuck and the "Independent" and has, in addition, the special convenience characteristic of all Union Chucks. No. 83 with 3 jaws—No. 84, 4 jaws.

**UNION MANUFACTURING COMPANY
NEW BRITAIN CONN., U. S. A.**
NEW YORK OFFICE: 26 Cortlandt Street

GRADUATED ADJUSTABLE FRICTION SELF-CENTERING TAP HOLDER FOR TURRET LATHE

ERRINGTON

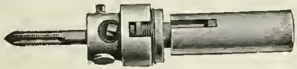
MECHANICAL LABORATORY

39 CORTLANDT STREET, NEW YORK
136 West Lake Street, Chicago
New England Branch: 829-A Old South Bldg., Boston Mass.

Double-Clutch Sleeve

TAPS STEEL as Safely as Cast Iron

Regulates the Whole Power of Machine to Just Drive, but Cannot Break Tap. When Tap Sticks (or Strikes Bottom) the FRICTION SLIPS, and Tap can thus be Run In and Out until the Toughest Metal is Quickly Tapped.



Interchangeable Spring Shank for Rough and Finish Taps occupying One Turret Hole

Especially Good for Roughing and Finishing Taps, Running Solid Dies Up Against a Shoulder, etc.

Hit the Bottom with Your Tap. Use the Bottom of the Hole for a Stop.

The "Double Gripp" Safety Tapping Attachment

WON'T LET IT BREAK

One of our records is 90,000 holes without breaking a tap.

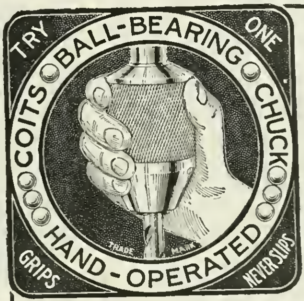
Saves the tap, the cost of removing same and ofttimes the material.

Also made for a Reversible Drill Press or Tapping Machine.

WILLIAM L. PROCUNIER

549 W. Washington Blvd., CHICAGO

In stock and for sale by Young, Corley & Dolan, Inc., 115 Broadway, Manhattan district representatives; Barnes Saw and Equipment Co., Detroit, Mich.; M. Jaeger, Cleveland, Ohio; McKeen Machinery Co., Pittsburgh, Pa.

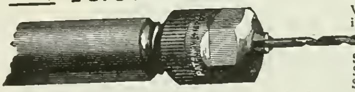


The Chuck That Never Slips.

The More You Crowd it, The Tighter It Grips.

NARRAGANSETT MACHINE CO.
PROVIDENCE, R. I., U. S. A.

1874 TRUMP DRILL CHUCK 1918

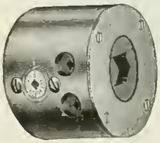


We have been making it for 44 years; it is still the BIG Chuck at the SMALL price; for Straight or Taper Shank Drills.

Three Sizes	No. 1	No. 2	No. 3
	0 to ⅛"	0 to ¼"	0 to ⅜"

Write for prices and particulars

TRUMP BROS. MACHINE CO. Wilmington, Del.

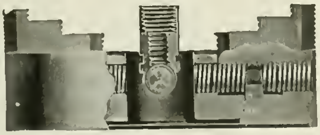


Flynn Offset Boring Heads

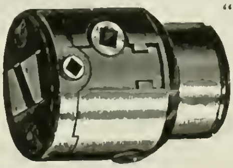
This chuck, which has a micrometer adjustment and large range, is strong, durable and easily operated.

Write for free circular

J. M. WATERSTON, 77 Woodward Ave., DETROIT, MICH.



Solid Steel Rings Reinforce these Independent Lathe Chucks making them strong where other chucks are weak, providing for tensile stresses and screw thrusts, insuring greater durability and better service.



"National" Round Body Drill Chuck

Made with three distinct grips which can be applied at the same time when neccessary—a positive gripping chuck—all sizes up to 2 inches. *Catalog?*

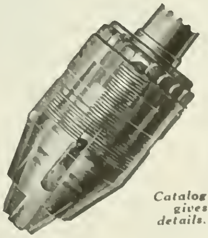
Oneida National Chuck Co.
ONEIDA N. Y., U. S. A.

Don't Lose Time With Keys and Wrenches

Eclipse Roller Bearing Drill Chucks

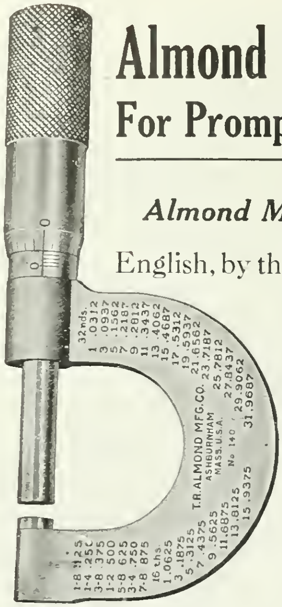
are quickly tightened or released by simply using the thumb and forefinger. Speed and convenience of the tightening operation do not lessen the security of the grip.

GROUND ARBORS FOR ALL KINDS OF CHUCKS



Catalog gives details.

Nielsen-Barton Chuck Co.
106 South Jefferson Street
CHICAGO ILLINOIS



Almond Specials
For Prompt Delivery

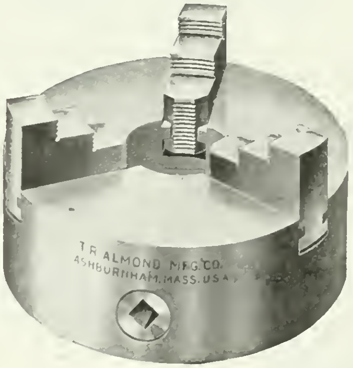
Almond Micrometers

English, by thousandths and ten-thousandths, 1, 2 and 3 inch.

Metric, by 1/100 mm.—25, 50 and 75 mm.

With or without Ratchet Stop.

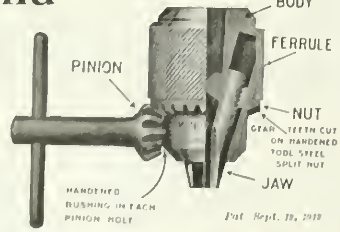
Almond Universal
Scroll Lathe Chucks



5, 6, 7½ and 9 inch sizes

Almond
Geared Nut Drill Chucks

Powerful
Accurate
Durable and
Economical
to Maintain
Try One


BODY
FERRULE
PINION
NUT
GEAR TEETH CUT ON HARDENED TOOL STEEL SPLIT NUT
JAW
HARDENED BUSHING IN EACH PINION HOLE
Pat. Sept. 18, 1917

Details of Whole Almond Line on Request

T. R. ALMOND MFG. CO.
2 Maple Ave. Ashburnham, Mass., U. S. A.

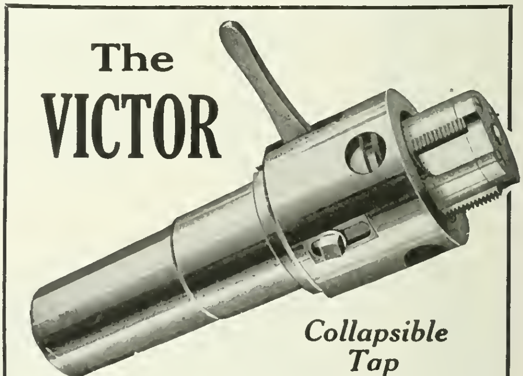
Drill Chucks
Lathe Chucks
Portable Face Plate Jaws

**Many Styles and Sizes.
All Designed for Hard
and Exacting Service.**

Catalog Free

THE CUSHMAN CHUCK CO.
HARTFORD CONN., U. S. A.

The VICTOR



Collapsible Tap

The Victor Collapsible Tap is a sure remedy for most tapping troubles. Like other good taps, it cuts a clean, sharp thread—but there is *not a chance* of it then ruining that thread, as solid taps often do in backing out. The other big reason for using Victor Collapsible Taps is the time they save. They eliminate the "return trip" time on every operation.

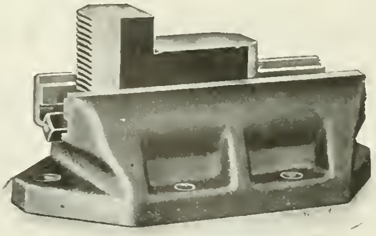
Just take a pencil, if you please, and figure out what this would save you a day in your tapping operations. You will then see why the Victor Collapsible Tap pays for itself.

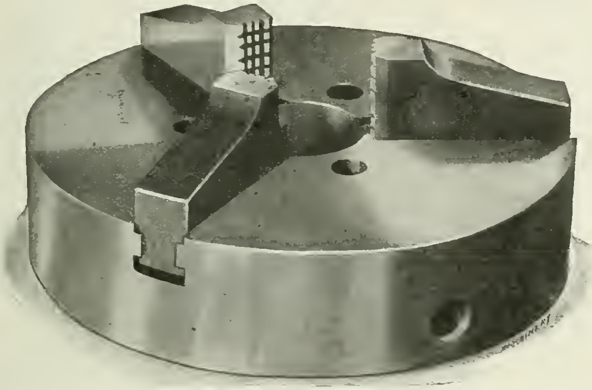
The Catalog tells you more. Write for it.

VICTOR TOOL COMPANY
Waynesboro Pa., U. S. A.

A HORTON Chuck for Every Purpose

All have distinctive "Horton" features—strength, convenience and durability—adapted to the requirements of each specific class of work. In this heavy duty chuck, the scrolls and pinions are heat treated and oil hardened to give the extra strong grip necessary for bar and forging work.





HORTON
Face Plate Jaws

have helped solve a lot of chucking problems. They have extra provision for clamping and strapping, are pointed—to permit holding small diameter work—and can be used interchangeably on different faceplates.

Catalog of full Horton line on request.

THE E. HORTON & SON CO., Windsor Locks, Conn., U. S. A.

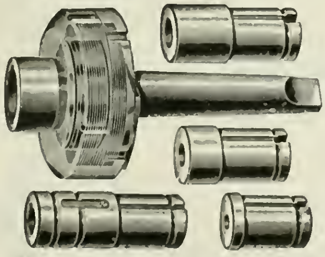
PRATT CHUCKS
Drill Without Waste or Worry

The Pratt Positive Drive Drill Chuck is especially adapted for high speed drilling. It grips securely, drives without vibrating—without danger to work or tool—and leaves drill shank clean and free from scar. It saves time, too.

Make your next chuck order read "Pratt"

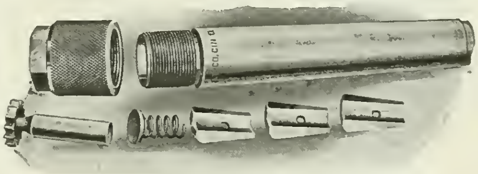
THE PRATT CHUCK CO., FRANKFORT, N. Y., U. S. A.
Sales Representatives: Surpless Dunn & Co., Chicago, New York
EUROPEAN AGENTS: Selson Engineering Co., Ltd., 85 Queen Victoria Street, London, England.

The Safety Drill and Tap Holder



is the only attachment for the purpose that gives universal satisfaction and is unequaled in efficiency, convenience, rapidity, accuracy and simplicity. Nothing to break or get out of order. Made in 4 sizes, covering from 0 to 2½ inches diameter.

The Beaman & Smith Co. PROVIDENCE Rhode Island



How Do You Hold Your Woodruff Keyseat Cutters and Other Tools with ½" Straight Shanks?

LOOK

This chuck is made with a taper shank either B & S or Morse to fit the spindle of your machine. The design is such that the jaws do not fall together, but allow free entrance of the shank at all times.

Send for our Catalogue and get acquainted with our tools

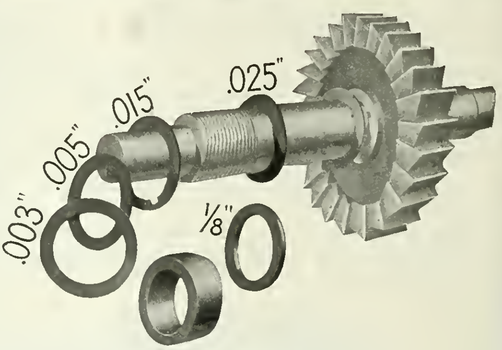
THE ADVANCE TOOL CO.
Canal & Jackson Sts., Cincinnati, Ohio
Agents wanted in all principal cities

Don't Make Washers—Buy Them

You'll find it a whole lot quicker, cheaper and less trouble to buy your spacing washers than to have them made in your own shop.

Stock Sizes—with or without standard keyways—for arbors of the following diameters: 3/8, 1/2, 5/8, 3/4, 7/8, 1, 1 1/8, 1 1/4, 1 3/8, 1 1/2, 1 5/8, 1 3/4, 1 7/8, 2, 2 1/4, 2 1/2, 3 and 3 1/2 inches. Stock thicknesses: .003, .005, .015 and .025 inches. To order, .0015 to 3.000 inches.

DETROIT STAMPING CO.
951-957 West Fort Street DETROIT, MICH., U. S. A.



JUST a single piece of hardened metal—nothing to adjust, nothing to get out of order or wear. Any ordinary mechanic can quickly change taps with the

"WEAR-EVER" Tap Chuck

It drives true, every time—regardless of shank variation—is equally well adapted for taper reamers and other straight shank tools, reduces tool breakage to a minimum and is always ready for work.

9 Sizes - Morse Taper
Low Price—Investigate

SCULLY-JONES & COMPANY
647 Railway Exchange Bldg.
CHICAGO, ILLINOIS, U. S. A.

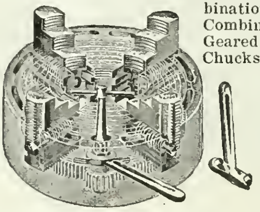
Electric Blue Printing Machines

Write for Catalogue B-2

Buckeye Engine Co.
Salem, Ohio

If You want the best Lathe or Drill Chucks—buy Westcott's

Little Giant Auxiliary Screw Drill Chucks, Little Giant Double Grip Drill Chucks, Little Giant Improved Drill Chucks, Oneida Drill Chucks, Spur Geared Scroll Combination Lathe Chucks, Scroll Combination Lathe Chucks, Spur Geared Scroll Universal Lathe Chucks, IXL Independent Lathe Chucks, Cutting-off Chucks.


Spur Geared Scroll Combination Lathe Chuck

Strongest Grip, Greatest Capacity Great Durability and Accuracy

WESTCOTT CHUCK CO.
ONEIDA, N. Y., U. S. A.

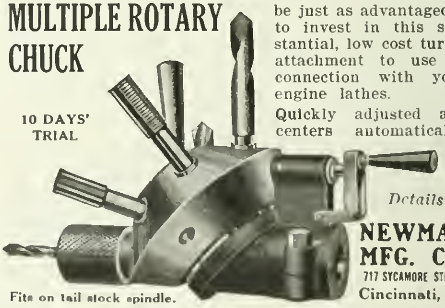
Ask for Catalogue

THE NEWMAN MULTIPLE ROTARY CHUCK

10 DAYS' TRIAL

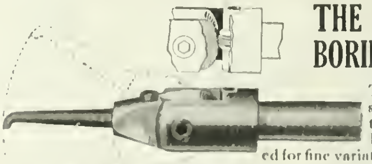
Think twice before installing another expensive turret lathe. It may be just as advantageous to invest in this substantial, low cost turret attachment to use in connection with your engine lathes.

Quickly adjusted and centers automatically.


Fits on tail stock spindle.

Details?

NEWMAN MFG. CO.
717 SYCAMORE STREET
Cincinnati, O.



THE E-Z SET BORING TOOL

Three sizes—straight or taper shank. Easily adjusted for fine variations. *Details?*

Spacing Washers

Accurately cut 1, 1¼, 1½ and 1¾ inches diameter; 3, 4, 5 and 6 thousandths thick $3.00 per 100, 25 of each thickness.

The Maxwell-Hutchcroft Company
1227 W. 9th St., Cleveland, Ohio, U. S. A.

The "WOODSTOCK"

For Cylinder Tapping

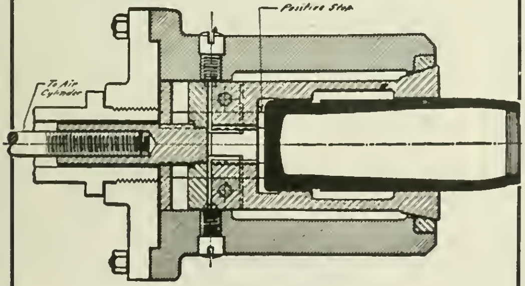
"No more broken taps since we use the Woodstock Tapping Chuck." This comes officially from the Loew Victor Engine Company, apropos of cylinder tapping.

Requirements were 66 holes of three sizes and a high percentage on tap breakage made it an expensive operation until "Woodstock Tapping" proved the solution, as it invariably does, whether threading cored holes in castings—subject to "soft and hard spots"—or those troublesome shallow holes where an automatic stop on the machine is utterly useless.

Try a "Woodstock" 30 days "on us" and put it at your most expensive tapping job. Write for details.

PETER BROS. MFG. CO.
135 Railroad Avenue
ALGONQUIN ILLINOIS

Save Time—Chuck Instantaneously



Shell manufacturers and others to whom time is precious, but accuracy even more so, have found that

M. E. C. Air Operated Collet Chucks and Short Expanding Mandrels

save one and insure the other. They are quick-acting, positive, and adapted for all classes of work; save 90 per cent of chucking time and increase production accordingly.

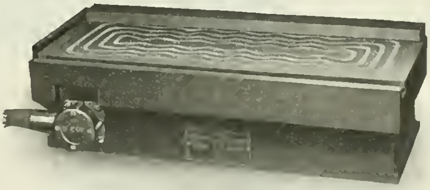
We're getting repeat orders from all quarters of the earth—that's the ultimate proof of efficiency.

Full details on request

MANUFACTURERS EQUIPMENT CO.
200 N. Jefferson St. CHICAGO, ILL.

AGENTS FOR EASTERN STATES AND CANADA: J. R. Stone Tool & Supply Co., Goebel Bldg., Detroit, Mich.; also 30 Church St., New York.

Increased Production Is the Big Idea Today



"D & W" Magnetic Chucks dispense with the needless delay of adjusting clamps and bolts. They have solved many a problem of rush work in shops throughout the country. They can help you in your shop.

If you want to save time, increase production and grind more accurately you will find that "D & W" Magnetic Chucks will do the same for you as they have for others, viz.: speed production, and they are proof against adverse shop conditions, heat, moisture, oil, etc.

Write for Circular No. 206-M, describing them

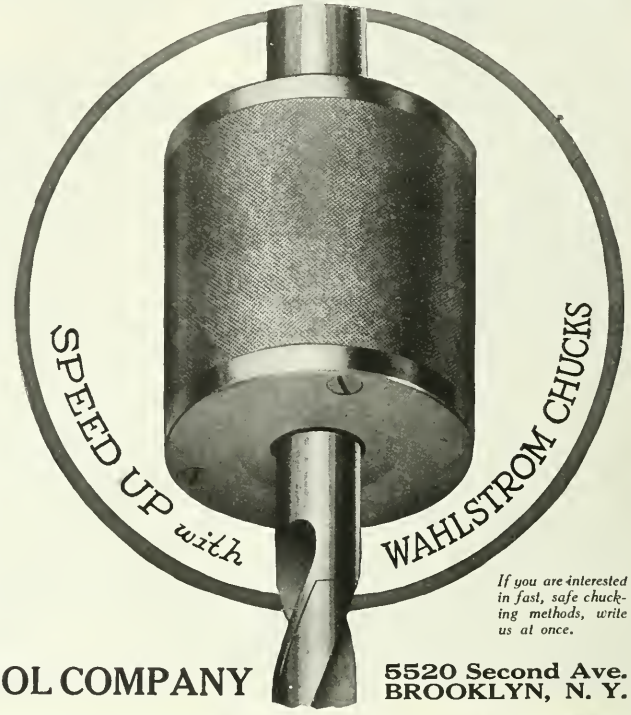
D & W FUSE COMPANY
PROVIDENCE RHODE ISLAND

Buy The

Wahlstrom Drill Chuck

You Can't Buy Time, But You Can Buy Production

Wahlstrom Automatic Drill Chucks increase production. They grip and release tools while the spindle is running. They employ no keys, collets or sockets, are entirely self-contained and can be used wherever drill chucks are needed. Tools are automatically centered. All parts are interchangeable.

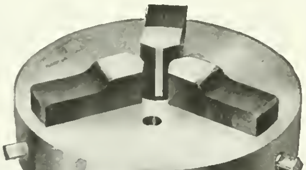


If you are interested in fast, safe chucking methods, write us at once.

WAHLSTROM TOOL COMPANY

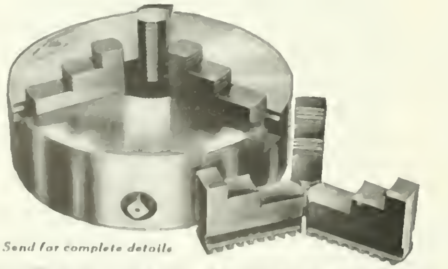
5520 Second Ave.
BROOKLYN, N. Y.

T & W



Chucks That Are Right

Best material and workmanship throughout. Thousands now in use. Sizes 2½ to 15 inches.



Send for complete details

TERKELSEN & WENNBERG
BOSTON, MASSACHUSETTS

Don't Let Rust Eat Up Your Profits

Which are they doing? Those machines and tools of yours—wearing out or rusting out? Our Sherardizing process prevents needless rust. Let us demonstrate on samples of your work.

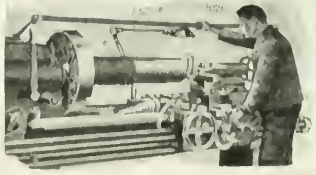
WISE ELECTRO SHERARDIZING CO.
120 Eighth Street DETROIT, MICH.

Better Light *for* Half the Price

is the claim we are prepared to substantiate by a trial offer

THE NEWMAN SPOTLIGHT

concentrates the light just where it is required, does not shine in the operator's eyes, is readily attached to any light plug and cuts your light bills 50 per cent.



Ask for details

We make bench brackets also.

NEWMAN MFG. CO.
717 Sycamore Street
CINCINNATI, OHIO

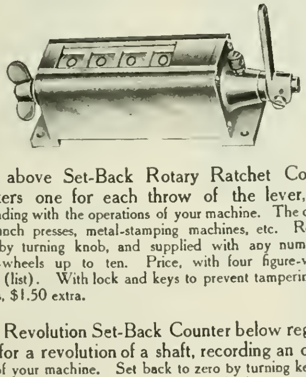
Making More of Your Man-Power

The amount of work your machine operator will do depends on the amount of incentive you can furnish him, and the amount of money he can see coming to him.

Let him see his wages go up before his eyes—let him watch his production run up on a Veeder Counter—and the incentive is there because the *assured reward* is there.

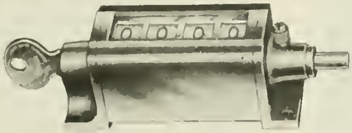
You satisfy your operative that he's paid for all he does—and in satisfying the operative you make more of your man-power. The worker acquires new value as a producer when his machine acquires a

Veeder
COUNTER



The above Set-Back Rotary Ratchet Counter registers one for each throw of the lever, corresponding with the operations of your machine. The counter for punch presses, metal-stamping machines, etc. Reset to zero by turning knob, and supplied with any number of figure-wheels up to ten. Price, with four figure-wheels, $9.50 (list). With lock and keys to prevent tampering with figures, $1.50 extra.

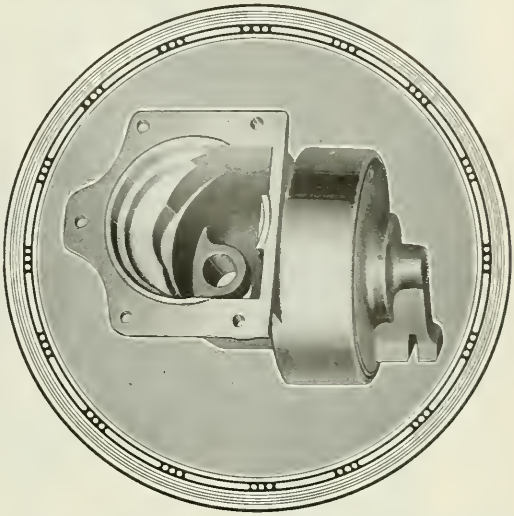
The Revolution Set-Back Counter below registers one for a revolution of a shaft, recording an operation of your machine. Set back to zero by turning key, and supplied with from four to ten figure-wheels, as required. The price, with four figure-wheels, lock and keys, is $9.50 (list). Without lock and keys, the price is $8.00.



The exact counter you'd want for this or that machine can be readily found in the Veeder booklet; like a copy?

THE VEEDER MFG. CO.
39 Sargeant Street, Hartford, Conn.

Pacific Coast Distributor: F. Somers Peterson Company,
60 Pine Street, San Francisco, Cal.



Stewart Process Die-Castings

The qualities essential to perfect die-casting are assured by the Stewart Process — accuracy — uniformity — strength —finish.

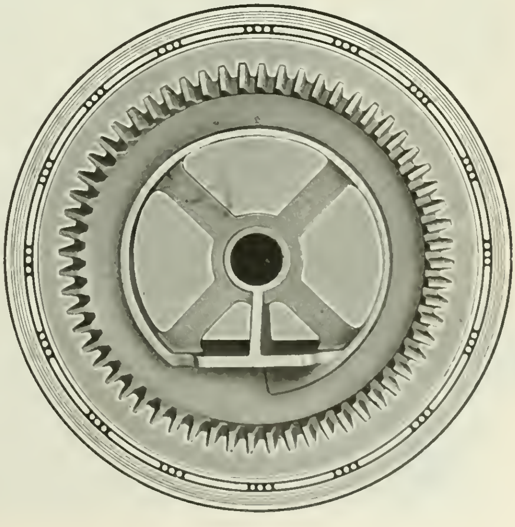
To be a source of economy, die-castings must combine all these qualities. They must be delivered in a perfect, finished state.

Stewart-made die-castings are cast automatically—every one alike—100% perfect.

Unlimited facilities—rapid production—superior methods guarantee quick deliveries on large outputs.

Stewart Manufacturing Co.
Wells Street Bridge Chicago, U. S. A.

Stewart



High Speed Twist Drills, Reamers, Countersinks, Flue Cutters, Etc.

One Grinding a Day Is Enough

It takes these drills only one and three quarter minutes to penetrate the solid two inch flange on this Triplex Plunger Pump — Goulds Manufacturing Company, makers—and only one grinding per day is required.

Of course the Drills are

CELFOR

High Speed Twist Drills

The Goulds Company uses them exclusively for holes ½″ and over.

Clark Equipment Company

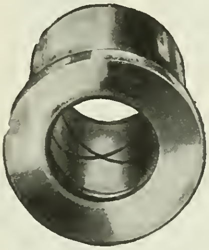
Buchanan Michigan

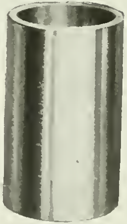
Successor to Celfor Tool Company

WHERE CELFOR TOOLS ARE SOLD

Manning, Maxwell & Moore, Inc., New York, Boston and Philadelphia; Machinists Supply Company, Pittsburgh; Clark-Witbeck Company, Schenectady; H. D. Taylor Company, Buffalo; Rudel-Belnap Machinery Co., Montreal and Toronto; Stirling-Warfel Mill Supply Co., Erie; The W. M. Pattison Supply Co., Cleveland; National Supply Company, Toledo; Everett Moses Company, Birmingham; The E. A. Kinsey Company, Cincinnati and Indianapolis; Geller, Ward & Hasner Hardware Company, St. Louis; Oliver H. Van Horn Company, New Orleans; Robinson, Cary & Sands Co., St. Paul and Duluth; J. C. Dolan, Denver, Seattle Hardware Company, Seattle; Pacific Tool & Supply Co., San Francisco and Los Angeles.

The more they are used, the less it is necessary to say about them; for pre-eminence in men or products needs no lengthy eulogy.





BUNTING

Finished Bronze
Bushings and Bearings
Patented

The Bunting Brass & Bronze Co.
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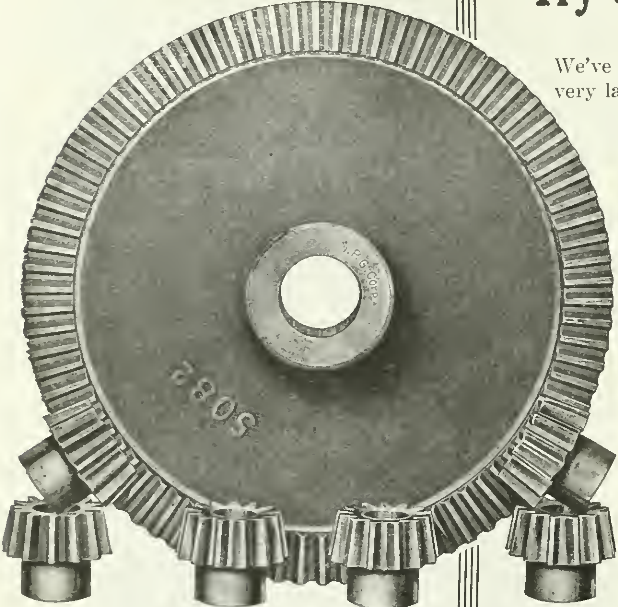

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We've specialized on bevel gears. Our very large capacity and the fact that hundreds of thousands of our bevels are standard parts on leading automobiles, machine tools and other machinery, places us in a peculiarly advantageous position to fill your requirements.

Our equipment provides for generating the correct shape of tooth which assures the highest quality of workmanship and for a rapidity of production which makes our prices attractive. Give us at least a chance to figure on any quantity, size, pitch and finish.

NEW PROCESS GEAR CORPORATION
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Because:

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2. We employ skilled workmen.
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4. We have concentrated on this product for years and *you* get the benefit of our experience.
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Complete drives with housing ready for power

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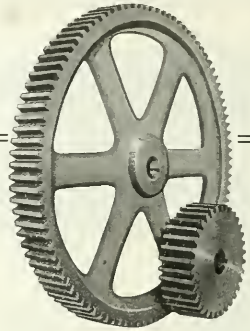

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For all-round satisfactory gear service —accurate, long wearing gears of any desired metal or best commercial rawhide—prompt deliveries and reasonable rates, send your specifications to

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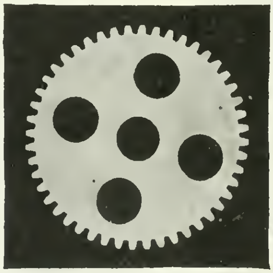

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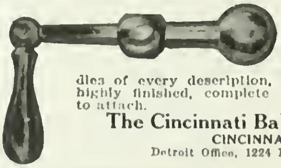

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We guarantee satisfaction
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Screw Machine Products Up to 5½"

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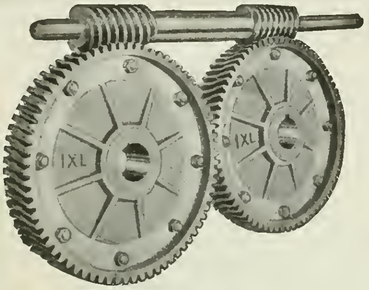

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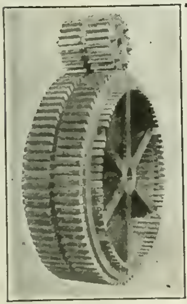

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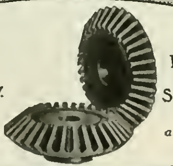

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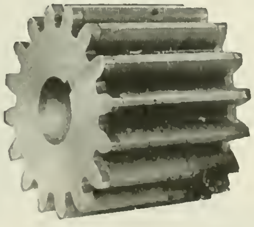

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We're doing our bit to keep things humming in the home shops—making *prompt deliveries* on all kinds, styles and sizes of gears.

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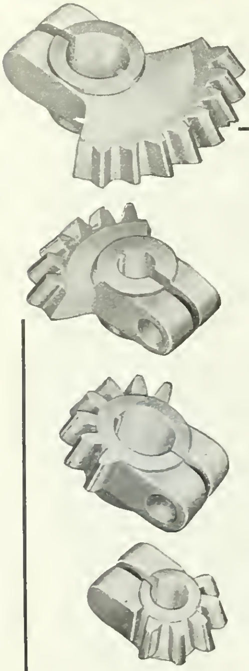

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There are few parts of machines as difficult to produce as gears. This group of sprocket gears shown here is no exception.

They must be accurate. Every tooth is exact in depth and pitch. Every projection and depression is true and smooth. The old method of machining such parts is too slow and uncertain. Progressive manufacturers now use the

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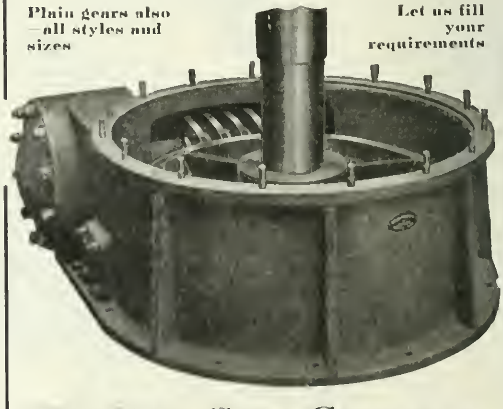
Hindley Gears are being used in the most important services of the day—in airplanes, submarines, army trucks, etc.

Their dependability is a known quantity. That's why.

Plain gears also—all styles and sizes

Let us fill your requirements



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A sudden break in one of the gears and a machine or part of your plant is shut down until the gear can be replaced. Such delay reduces production. If a similar gear is not in stock, you are dependent upon the output of another plant and upon the uncertain transportation of the present day. Renewals of worn-out gears are equally expensive.

Gears made from

Carnegie Rolled Steel Blanks

wear three to seven times as long as cast steel gears, and if properly heat treated, never break. Good business policy dictates their use at all times.

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immediate
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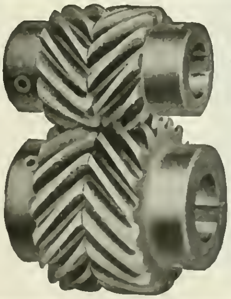

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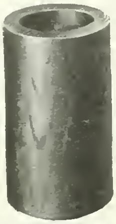

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IN this war—essentially a war of mechanics—we are staking the outcome against the fidelity of machinery. Airplanes, motor trucks, despatch cars, ambulances, tanks, tractors, cranes, hoists, battleships, cruisers, destroyers, submarines, each is playing a vital part.

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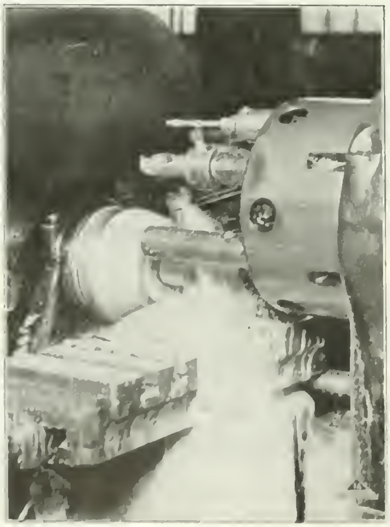
All Genuine Graphited Oil-less Bushings have always been made at Bound Brook, U. S. A.



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Cutting Compound

has proved its worth as a speed promoter and a tool saver. Mystic increases output and lowers cost.

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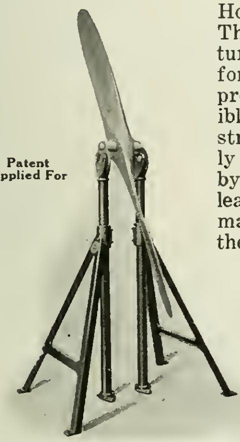

BALANCE—important in any machine, MORE important the finer its adjustments and MOST important when the machine in question is an airplane.

How to achieve it? The Twentieth Century Balancing Tool, for balancing airplane propellers, is infallible. Durably constructed and extremely sensitive, it is used by Curtiss and the leading manufacturers making airplanes for the U. S. Government.

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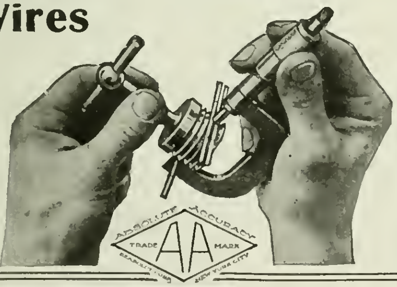

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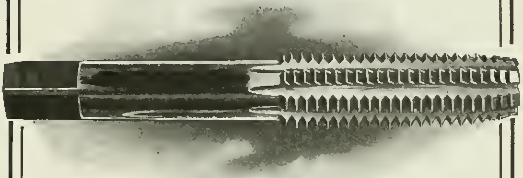

PUT to the test, our fighting forces in France have justified the nation's faith in them. Backed by the necessary production forces at home, they are exceeding expectations in meeting the demands imposed upon them, and in this general efficiency

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BRUBAKER TOOLS ARE GUARANTEED

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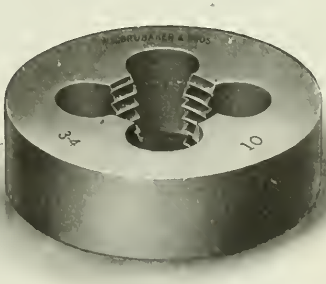

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MORSE DRIVES PROVIDE MAXIMUM DURABILITY AND EFFICIENCY

Positive as Gears **Flexible as a Belt**

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Aims by careful analysis and tests of your power service to determine the weak points and losses, submit reports designating changes to increase production with lower costs and maintenance and greater durability. Installing without interrupting work. Always glad to receive inquiries and furnish information or reports. All assistance free, without obligation.

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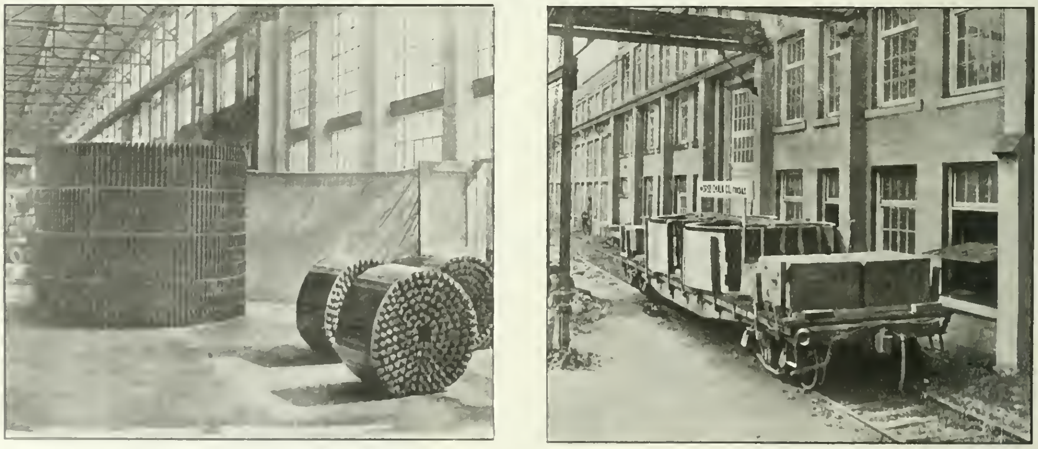
Morse Drives have great mechanical strength. Made of the best material available, assuring 100 per cent overloads.

SLIPPING BELTS MEAN HIGHER PRODUCTION COSTS, SHUT DOWNS ARE EXPENSIVE.



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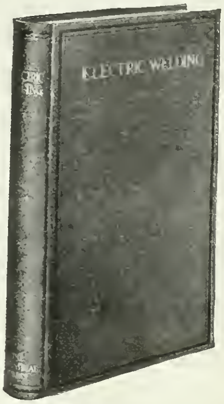
MACHINERY'S New Book on Electric Welding

A treatise that thousands of mechanical men have been waiting for

A comprehensive review of the whole subject clearly and practically written, well illustrated.



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Few processes in the mechanical field are more important today than Electric Welding. Yet this highly interesting welding method is hardly more than a name to thousands of men in the mechanical field who should be perfectly familiar with the process and its extraordinary results. The rapid development of this important process during the last few years means that a constantly increasing amount of welding will be done by the electric process in the future.

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For that reason, MACHINERY has published its latest book on this subject

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283 PAGES OF DEFINITE, PRACTICAL INFORMATION ON THIS IMPORTANT PROCESS

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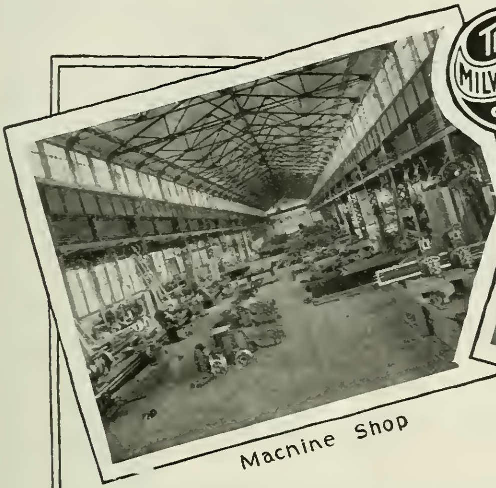
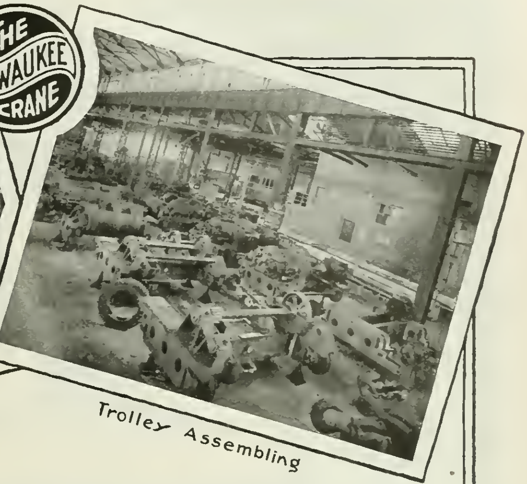
Address .... Works ....

THE MILWAUKEE CRANE

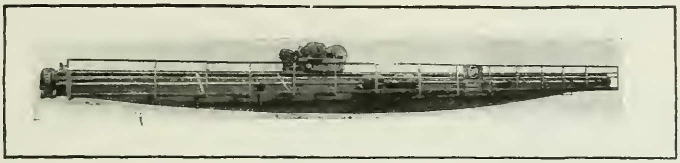


Macnine Shop



Trolley Assembling

-THE MILWAUKEE CRANE-



MILWAUKEE ELECTRIC CRANE & MFG. CO.

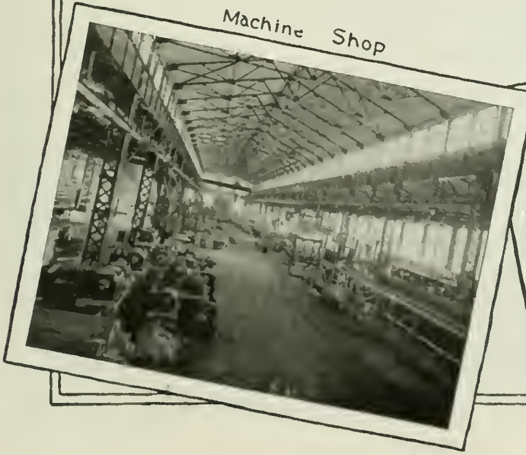
INCORPORATED

Milwaukee, Wisconsin

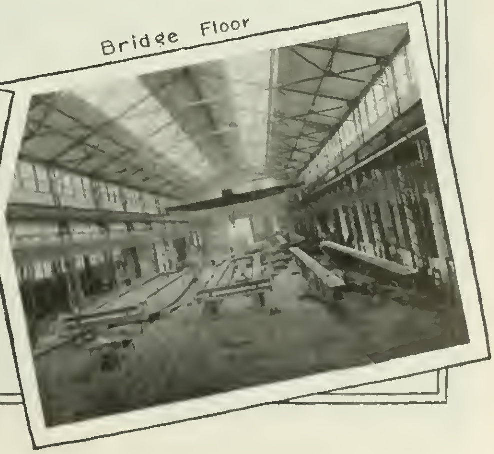
NEW YORK
50 CHURCH ST.

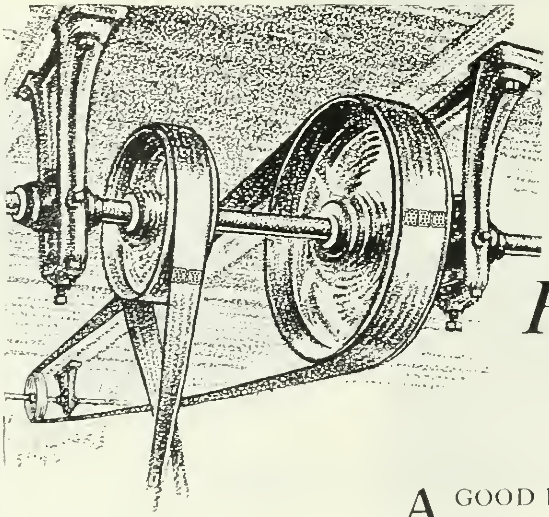
PITTSBURGH
704 EMPIRE BLDG.

Machine Shop



Bridge Floor





There is a Crescent Fastener adapted to every kind of belt, of every length, width and thickness.

Get Full Measure Belt Service

A GOOD belt can give the service its quality and cost warrant only if the joint is as good as the belt. The mechanic on the job can take 25% to 50% out of the life and strength of the best belt made by inefficient fastening methods.

Crescent Fasteners make a uniform, high-strength joint that holds until it is *taken* apart. The Crescent is a solution of the belt-joint problem worked out in accordance with the best modern engineering practice.

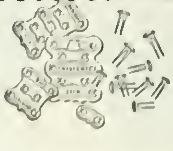
The largest plants in the country have standardized on Crescents throughout as a measure of belt service insurance.

Ask your dealer to supply you with Crescents. "They answer one of the little—*but most important*—problems in the whole plant."

CRESCENT BELT FASTENER CO.
381 Fourth Avenue, New York City
Branches and distributors throughout the world.

"GONE AGAIN" is a moving picture of belting problems—a serious subject treated with a sense of humor. It is interesting in itself and gives a lot of important facts about belt performance. Send today for as many copies as you can use to advantage.

CRESCENT BELT FASTENERS
"For Continuous Production"



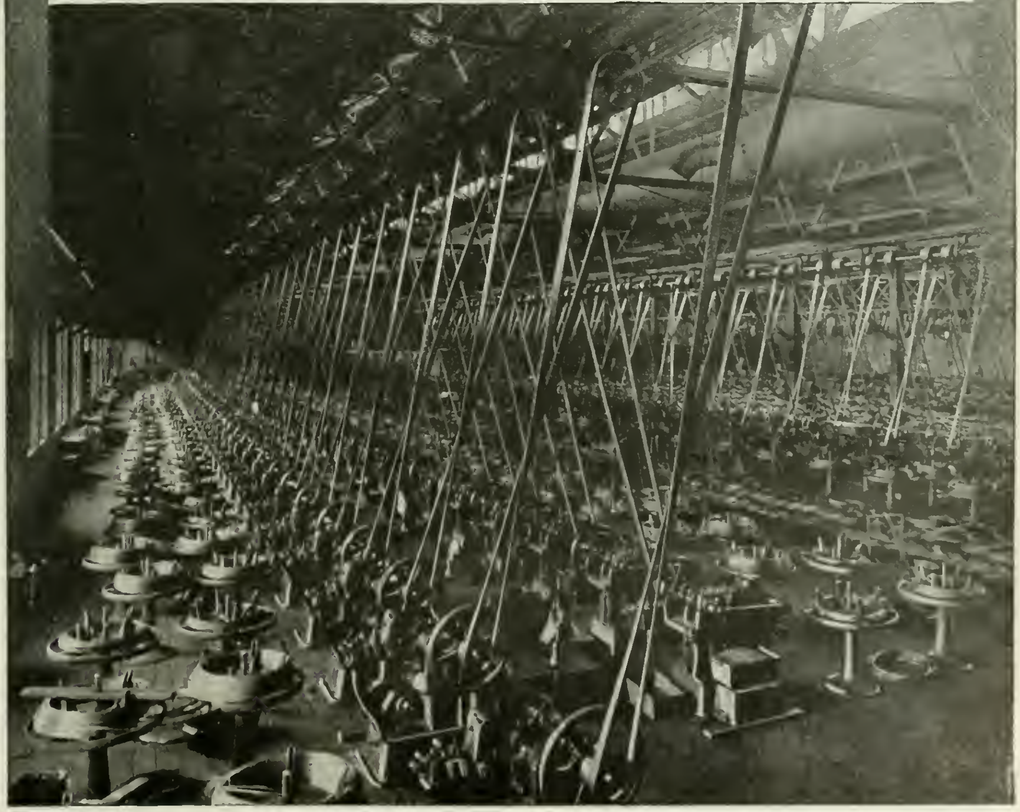
Crescent Belt Fasteners distribute the strain evenly across the entire width of the belt—form a permanent joint for the life of the belt, permitting easy, quick adjustment for take-up of stretch—do not injure belt fibre, require no punching—"hold without holes." They are the time-proven, belt joining device, the standard by which all methods are judged—adapted to all kinds and makes of belting of every length, width and thickness.

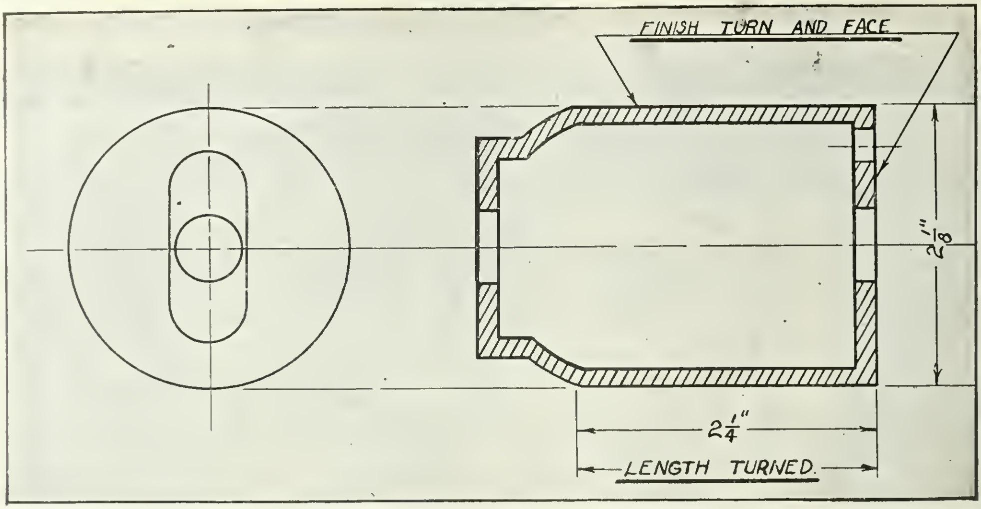
BELTING
Edw. R. LADEW Co. Inc.
GLEN COVE, NEW YORK, U.S.A.

Every Belt In This Huge Plant Is a "Flintstone" Leather Belt

Wire nails is the product—automatic machines the equipment—swift and uninterrupted operation the key to profitable production. Belting troubles—resultant delays and loss of output—could not be tolerated. Therefore, **"Flintstone"** Belts carry the load—with an unsurpassed record for dependable service.

"LADEW"—"DEPENDABILITY"—Synonyms





Test Made on Rifle Grenades

MACHINE USED	Brown & Sharpe, No. 1-½ Full Auto. Screw Mch.
WORK	Rifle Grenades, Malleable Iron.
SURFACE SPEED	275 Feet per Minute.
FEED	.024" per revolution.
OPERATION	Rough Turn & Rough Face
METAL REMOVED	On Rough Turn 1-16 to 3-32. On Rough Face 1-16.
TOOLS USED	On Rough Turn One 5-16 No. 3 Stellite Bit in overhanging arm attached to Turrett. On Rough Face One 3-8 sq. No. 2 Stellite Bit held in tool post on Automatic cross slide.
ACTUAL CUTTING TIME	With Stellite 20 seconds. With High-speed Steel 36 seconds.

Stellite tools are ground twice an hour High-speed Steel six times an hour.

Make your machine shop larger—without adding floor space or extra machines—with STELLITE *tools.*

STELLITE tools are *cast* metal, supreme hardness being induced by the method of mixing. They are harder than high-speed steel, and immune to heat up to 1800°F. The hotter they get up to this heat, the tougher they get, the better the cut and the longer they last under cutting. Further details sent gladly.

Patentees and Sole Manufacturers

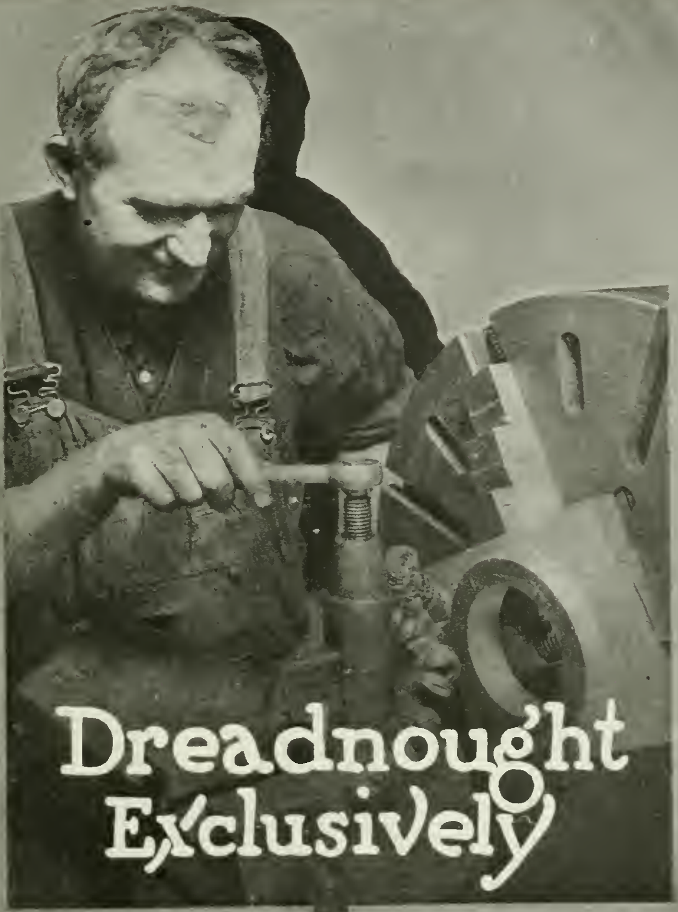
THE HAYNES STELLITE CO.

HOME OFFICE & PLANT
KOKOMO, IND.

BRANCHES: NEW YORK 120 Broadway DETROIT 1370 Penobscot Bldg. CHICAGO 1829 Lytton Bldg. ST. LOUIS 324 International Life Bldg. LOS ANGELES 231 Marsh Strong Bldg.

Stellite

MASTER METAL



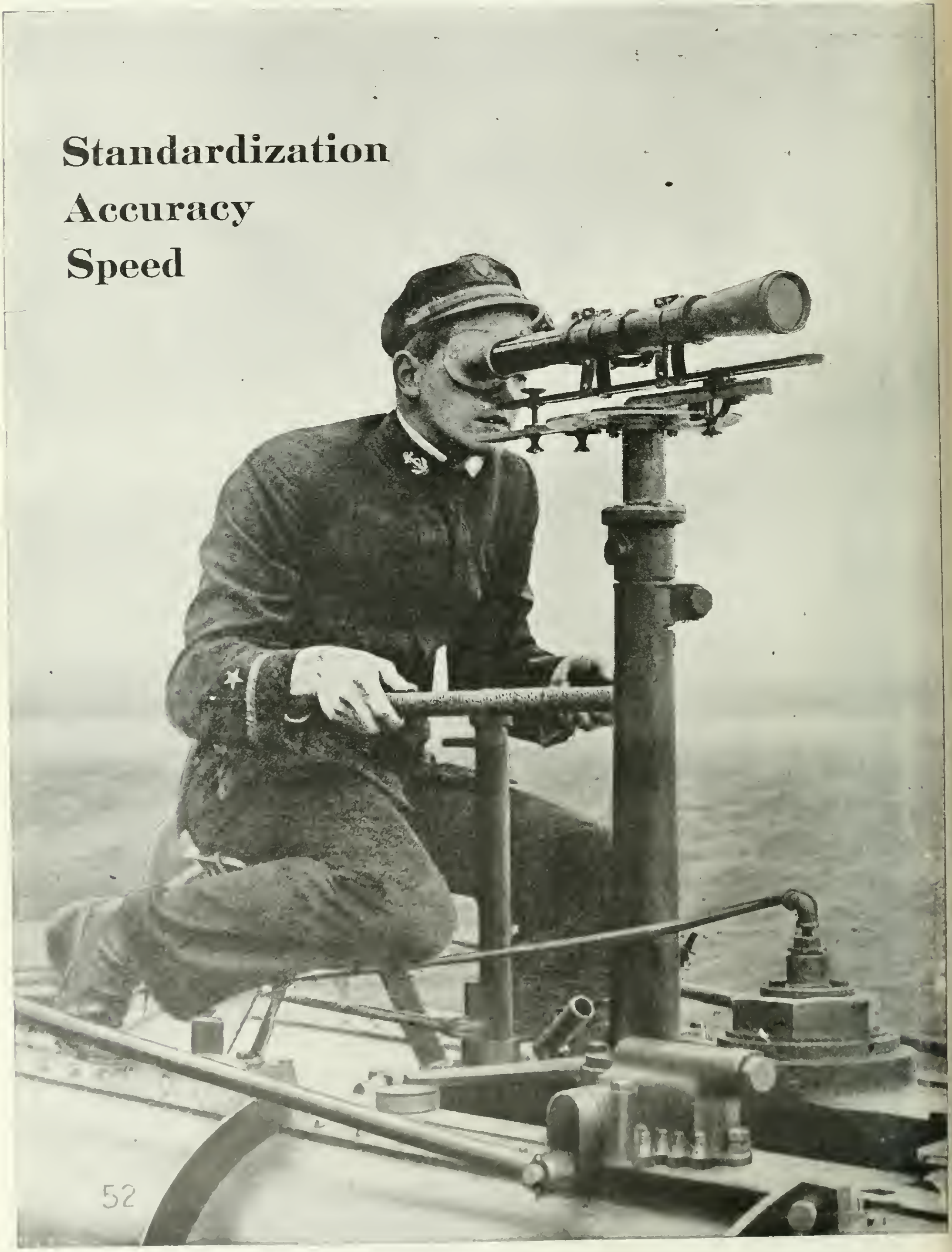
AFTER all, the biggest boosters of Dreadnought are not our salesmen, but the men who use it. In the plant where the accompanying photograph was taken, Dreadnought is used exclusively, and what the operators say about it would make a pretty convincing argument for the prospective purchaser.

Incidentally, this firm is making jigs and fixtures for government work, and we don't have to tell you what this means as far as speed and accuracy are concerned.

We won't ask you to try Dreadnought
—use it—now—with confidence.

HALCOMB STEEL COMPANY
SYRACUSE NEW YORK

Branches: Chicago, Philadelphia, Cleveland, Boston, New York


Standardization
Accuracy
Speed
52

Critical Moments

When the torpedo tube or gun is sighted and the signal to "Fire" is given, the success of the shot depends upon the accuracy of hundreds of co-ordinating parts of the mechanism.

Accuracy is a critical factor in industry, too. It is measured within carefully set limits, quickly and efficiently, by the use of GTD Limit Gages. They are standard for instruments of war and peace.

Let us send you information about these and GTD standard screw cutting tools.

GTD Gages have the confidence of the United States Government

Greenfield Tap and Die Corp'n
Greenfield, Massachusetts
New York: 28 Warren St. Chicago: 13 So. Clinton St.
Canadian Plant: Wells Brothers Company of Canada, Limited, Galt, Ontario.

This is an accurate drawing of a club in the possession of a member of the Liberty Loan Committee.

"The Modern Huns of Europe," is what the Kaiser told his people they must be in this war and, true to the name, they have used clubs like this to "finish off" Allied soldiers who have been wounded or overcome by poison-gas on the battlefield.

The ancient Huns of Attila, whose faithful descendants are in the German trenches now, had no worse weapon than this, and were guilty of no more fiendish savagery—and yet the name *Hun* has been the symbol of barbarity and cruelty for forty-five generations.

Our boys are over there now to risk their all in a gallant fight to end the barbarian. Are you sure you're doing your part? Are you *sure?* The one best thing you certainly can do to save him from German savagery is to lend your money to buy him rifle and ammunition, steel helmet and gas mask. Are you doing that?

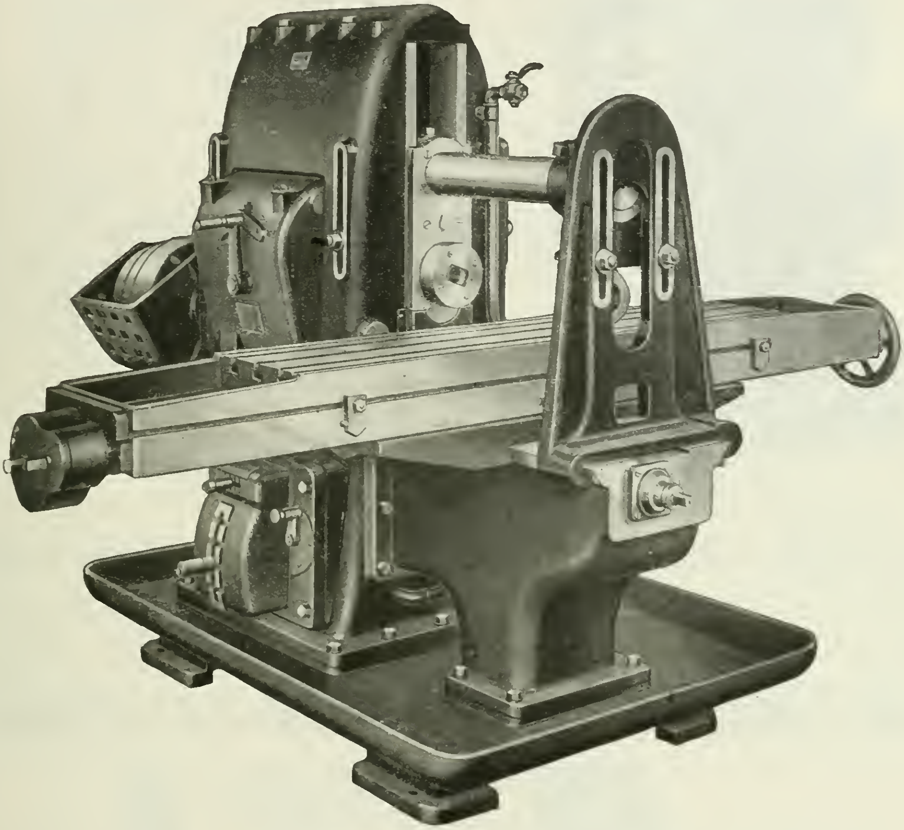
Buy War Savings Stamps

W.S.S.
WAR SAVINGS STAMPS
ISSUED BY THE
UNITED STATES GOVERNMENT

National War Savings Committee
Treasury Dept., Washington, D.C.

Designed and published by MACHINERY without cost to the Government.

Heavy Plain Milling Machine



NATIONAL TRANSIT No. 6

Designed and intended primarily for manufacturing work, and combines certain features of the Lincoln type and the knee type of milling machines, giving greater general stability, more permanent alignment, increased capacity for a given weight, longer life under heavy cuts and slower depreciation.

A well designed and strongly built machine

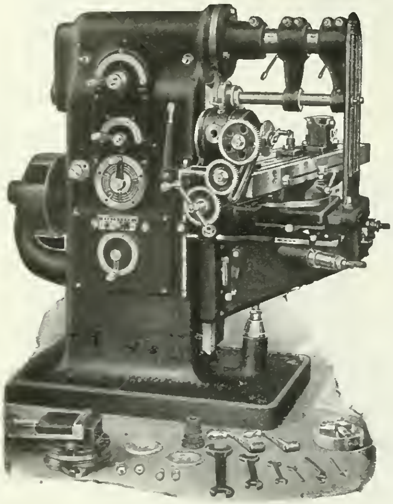
MANNING, MAXWELL & MOORE, Inc.

119 West Fortieth Street NEW YORK

BRANCHES:

CHICAGO PHILADELPHIA BOSTON ST. LOUIS PITTSBURGH CLEVELAND NEW HAVEN
CINCINNATI BUFFALO DETROIT MILWAUKEE SAN FRANCISCO SEATTLE, WASH.
MEXICO CITY, MEXICO YOKOHAMA, JAPAN HONG KONG, CHINA

Seeing is Believing with Rockford Millers



INVESTIGATE some installations of Rockford Universal Milling Machines in munition plants and other close limit shops where rigid inspections prevail. Examine the wide range of work they are doing; study production records and see for yourself what they are worth.

The four inch overhanging arm is of solid steel. Reinforced with our patented flanged support, it has power and rigidity to take cuts, in many instances, twice as heavy as other machines of like dimensions. Inside are centrally located, cut steel gears, accurately grooved, bronze bushed shafting—all but the main spindle shaft running in High Duty Hyatt Roller Bearings—and other "quality" features which recommend these machines for a wide range of work.

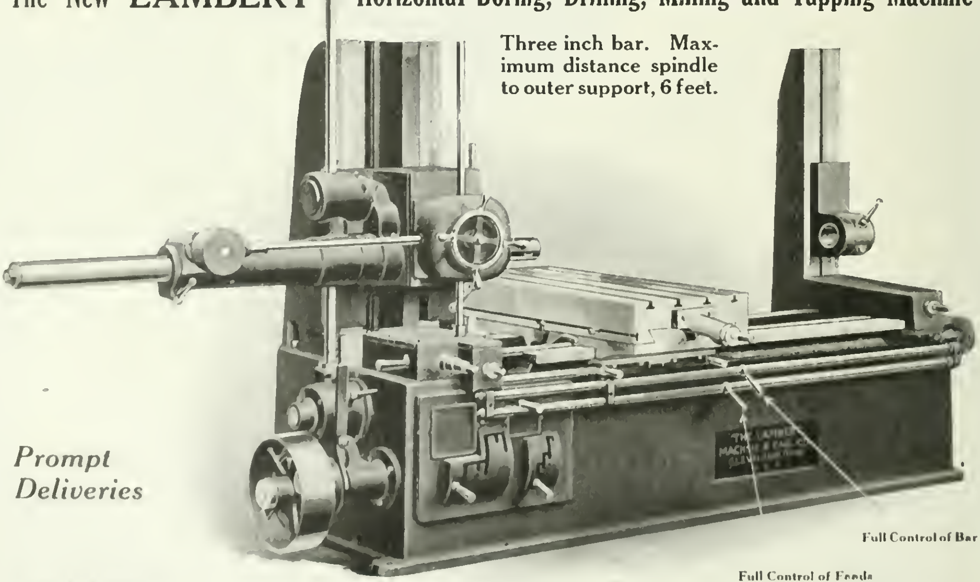
ROCKFORD No. 2 FOR HEAVY DUTY
ROCKFORD No. 2½ FOR EXTRA HEAVY DUTY

Details on Request.

ROCKFORD MILLING MACHINE CO., Rockford, Illinois, U.S.A.

ANNOUNCING

The New LAMBERT Horizontal Boring, Drilling, Milling and Tapping Machine



Three inch bar. Maximum distance spindle to outer support, 6 feet.

Prompt Deliveries

BUILT BY

THE LAMBERT MACHINE & ENGINEERING CO., CLEVELAND, OHIO

THE GRAY THREAD MILLER, arranged for taper threading, will do the job, giving you perfect threads, at a rate of production which will please you. Massive proportions and high grade workmanship make these machines stand up for years of hard service.

THREADING GAS SHELLS

Is a Tough Proposition—
Unless You Mill the Threads

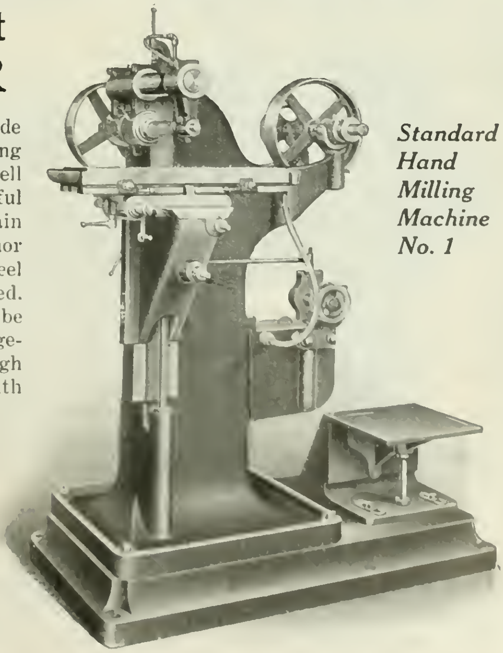
We also manufacture Shot Blasts, Washers Waving Attachments, Grooving Lathes, Knurling Machines. Prompt Delivery. Every machine guaranteed.

THE GRAY MACHINE TOOL CO.
2651 Main St. Incorporated Buffalo, N. Y.

STANDARD HAND MILLING MACHINE NO. 1

An Accurate and Convenient HAND MILLER

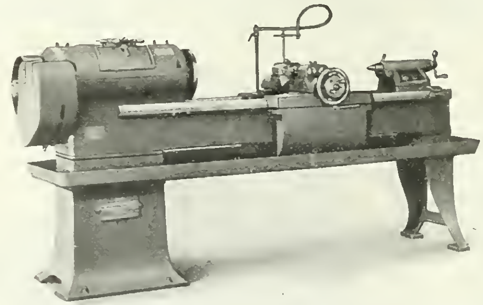
Designed to facilitate rapid milling on a wide variety of small parts, the Standard Hand Milling Machine has hand feed for the headstock as well as the table, and accuracy is assured by careful construction throughout; box type knee, main spindle bearing and adjustment nuts of phosphor bronze, 50 point carbon crucible analysis steel spindle—accurately ground to size and tapered. For further convenience the machine may be equipped with "Standard" Motor Drive arrangement, as illustrated—a sub-base, 5 inches high with bracket to carry the motor—provided with slots to accommodate motors of various makes and sizes and to facilitate proper alignment of motor and pulley.



Standard Hand Milling Machine No. 1

Details of this versatile machine in catalog

STANDARD ENGINEERING WORKS
PAWTUCKET Rhode Island, U. S. A.



The Automatic Threading Lathe

The John Steptoe Company's Choice for Threading After Nearly Three Quarters of a Century's Experience

Manufacturing High Class Millers and Shapers for seventy-four years has made the John Steptoe Company experienced judges of tools and machinery.

These people exercise great discrimination in selecting equipment and we are proud to state—on their authority—that all screws in their machines are cut on the Automatic Threading Lathe.

The Automatic Threading Lathe combines the accuracy of an engine lathe with the speed of a thread cutting machine and one man can handle a battery. Details?

Automatic Machine Co., BRIDGEPORT CONN, U. S. A.

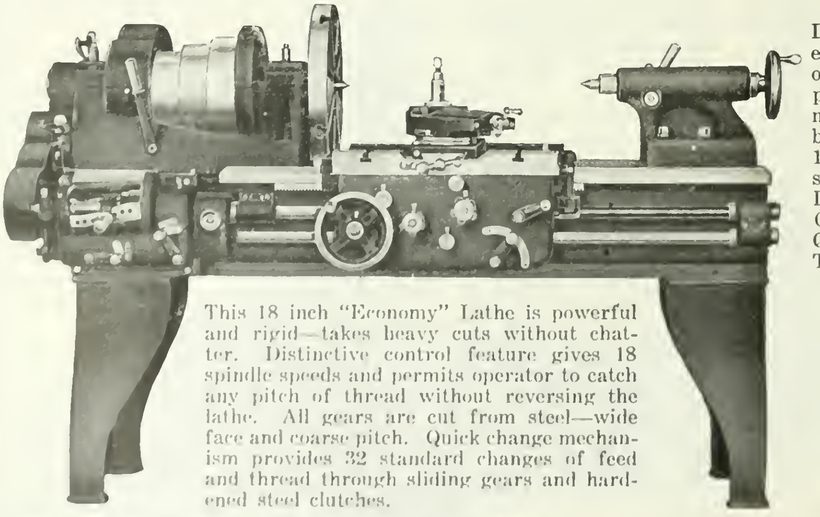
AGENTS: Burton, Griffiths & Co., Ltd., of London, England. Marshall & Huschart Machinery Co. of Chicago, Ill. Motch & Merryweather Machinery Co. of Cleveland, O., and Vandyck Churchill Co. of New York.

OVER-SEAS REPRESENTATIVE

ALMACOA ALLIED MACHINERY COMPANY OF AMERICA ALMACOA
120 BROADWAY, NEW YORK, U.S.A.

PARIS TURIN ZURICH BARCELONA

Rockford "Economy" Lathes



Designed to cover a wide range of modern shop practice, these machines are built with 14, 16 and 18 inch swing, in Plain, Double Back Geared and Quick Change Types.

This 18 inch "Economy" Lathe is powerful and rigid—takes heavy cuts without chatter. Distinctive control feature gives 18 spindle speeds and permits operator to catch any pitch of thread without reversing the lathe. All gears are cut from steel—wide face and coarse pitch. Quick change mechanism provides 32 standard changes of feed and thread through sliding gears and hardened steel clutches.

Complete Description on request

ROCKFORD LATHE & DRILL CO., Rockford, Illinois

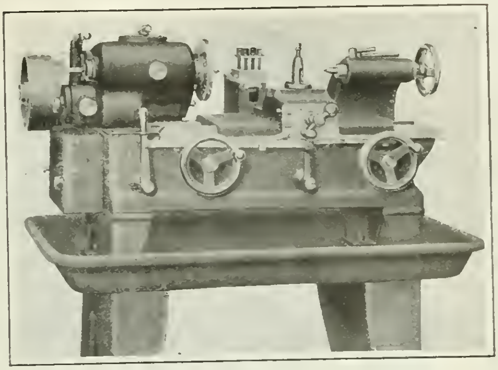
DOMESTIC DISTRIBUTORS: Stocker Rumley Wachs Co., Chicago, Ill.; J. S. Miller Machinery Co., Pittsburgh, Pa.; The C. H. Wood Co., Syracuse, N. Y.; The Garvin Machine Co., New York, N. Y.; Patterson Tool & Supply Co., Dayton, Ohio; The Cleveland Tool and Supply Co., Cleveland, Ohio; Homer Strong, Rochester, N. Y.; Niles-Bement-Pond Co., Detroit, Mich.; E. L. Fraser, Philadelphia, Pa.; Brownell Machinery Co., Providence, R. I.; McMullen Machinery Co., Grand Rapids, Mich.; Pratt & Whitney Co., San Francisco, Cal.

"SUNDSTRAND Jr."

A Nine-Inch Precision Lathe For Manufacturing Purposes

The constantly increasing demand for large quantities of small duplicate parts makes it imperative to provide equipment specially adapted to handle this class of work on an economical manufacturing basis.

The new nine inch "Sundstrand" is designed for this very purpose. Stockily built, it maintains uniform accuracy at high speeds, saves 50 per cent of floor space—without in any way sacrificing efficiency—and is so simple to operate that the shortage of skilled labor need not reduce production.



Principal specifications include: distance between centers 12″; diameter of spindle hole $1\frac{3}{8}''$; cutter size $\frac{5}{8}''$ by $1\frac{3}{8}''$; 12 spindle speeds; 4 feed changes; length of carriage on bed 18″, etc. Fully described in bulletin.

ROCKFORD TOOL COMPANY
Harrison Avenue and Eleventh Street
ROCKFORD ILLINOIS, U. S. A.

SPECIALIZE ON YOUR PULLEYS

ENGINE LATHES ARE SCARCE

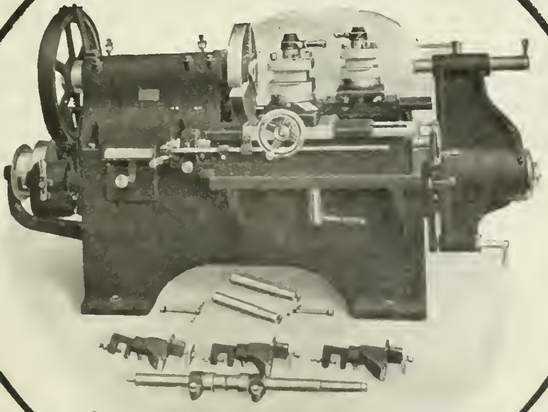
PRICES HIGH DELIVERIES BAD

PULLEYS ARE A CONTINUAL NECESSITY

Why not get them at **BOTTOM COST** and thus have a **CONTINUOUS SAVING?**

Our Pulley Lathe is specially built for pulley work and every feature is particularly adapted to save time on this class of work.

OUR CATALOG COSTS YOU NOTHING



Why do Pulley Work on Engine Lathes?

Get the Right Machine FOR YOUR WORK

ONE PULLEY LATHE does as much pulley work as two engine lathes, thus you can

SAVE FLOOR SPACE
Cut Your Labor Cost in Two
SAVE COST of EQUIPMENT

You will be surprised to find how reasonable the prices of these machines are. ASK US

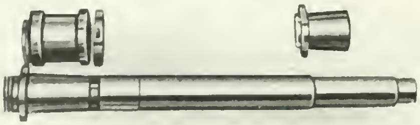
THE CINCINNATI PULLEY MACHINERY CO., Cincinnati

Building the OHIO Miller—

The Spindle

If there is one part more important than another in building a milling machine, it is the spindle. It carries the taper into which the cutter arbor fits, takes all the thrust of cutting tools and bears the brunt of any abuse to which the machine may be subjected. Its bearings are the first to chatter, heat or sweat if not properly made and adjusted.

MILLERS
OHIO
GRINDERS



In the Ohio Miller, the spindle is extra large, forged of chrome nickel spindle steel, provided with ample means for taking up wear and runs in carefully fitted phosphor bronze bearings. An abundance of lubricant is available at all times, from oil wells in the column.

A recess in the front end of the "Ohio" spindle provides a positive drive for cutting arbors—a very important point which eliminates the possibility of tools slipping. Assembling and adjusting the spindle is always the work of specialists—in the "Ohio" plant—men whom long experience has made so familiar with every detail that no smallest defect escapes their attention. This specialized assembling puts the seal to your guarantee of satisfaction in the Ohio Miller.

Let us describe the whole machine.

THE OESTERLEIN MACHINE CO.
CINCINNATI OHIO, U. S. A.

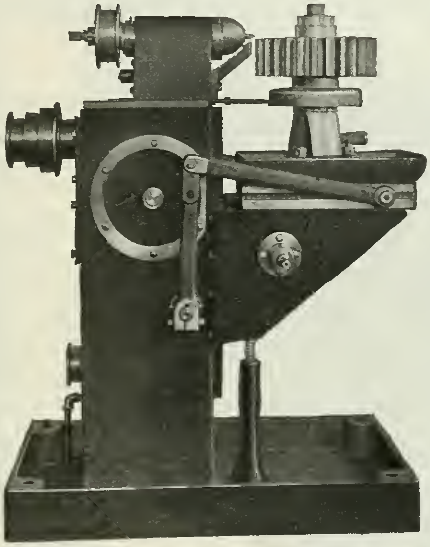
The "Cross" Gear Tooth Rounding Machine

Specially designed to round the ends of sliding meshing gears.

The only machine that will successfully round tank and tractor gears *on a production basis.*

It is guaranteed to round 24 gear teeth a minute, of any pitch, 6—8 or finer. Every tooth is a perfect half round from tip to root.

Manufactured and sold exclusively by Cross Gear & Engine Co. from Cross Patents allowed and pending.



The Cross Gear Tooth Rounder is the original machine which allows the gear to be *held rigid* during the cutting operation, and where the cutter spindle *oscillates about an axis eccentric* to its own axis of revolution.

All other machines having this principle are direct infringements, and all manufacturers, sellers or purchasers of the same will be considered infringers and will be liable to the full extent of the law.

Do you wish details?

CROSS GEAR & ENGINE COMPANY

809 BELLEVUE AVENUE DETROIT, MICH.

MACHINERY'S Handbook

Not a big book if measured in cubic inches—but the biggest book in the mechanical field if measured either in *value* or in total sales. MACHINERY'S Handbook contains the whole mass of essential data, tables and formulas needed daily and hourly in machine shop and drafting-room —the facts and figures that are part of the equipment of the machinist, the machine designer, the foreman, superintendent and engineer.

No single advertisement can adequately describe MACHINERY'S Handbook, but some idea of the way in which innumerable subjects are handled in this comprehensive work may be gotten from the description of a single one of thousands. Take, for example, the section on:—

SPEEDS AND FEEDS

This section of MACHINERY'S Handbook contains the most complete collection of tables of cutting speeds and feeds for the various machine tools and the raw materials used that has ever been gathered together and published in any book.

Cutting speeds and feeds for the Lathe are fully covered, each being treated separately. Milling speeds and feeds are given in a remarkably clear and complete way, including not only descriptive paragraphs and very full tables, but also many specific examples of cuts from practice, with diagrams and full information in regard to material, depth of cut, etc., all arranged in tabular form. Drilling is adequately dealt with, both in regard to ordinary speeds and high speed work. Planing speeds and feeds are considered and a table of Actual Cutting Speeds of Planers is given. Gear Cutting is fully presented, and under this head Feeds for Hobbing are covered. Speeds and feeds for Cold Sawing receives adequate attention and there are paragraphs on Speeds for Turning Unusual Materials such as Slate, Rubber, Gutta Percha, Copper, Lime-stone and Marble. All of these data are based on the assumption of proper TOOL GRINDING which is given very clear treatment in the section of the HANDBOOK following the one on Speeds and Feeds.

The important subject of CUTTING LUBRICANTS is treated in the HANDBOOK in a separate section, lubricants for various operations and materials being discussed by competent, practical mechanics and engineers.

The whole book (1400 pages) is conveniently arranged and thoroughly indexed. It is easy to find what you want, and what you want is there.

Finely printed on carefully selected bible paper to keep the size convenient, and handsomely and durably bound in full flexible black leather, MACHINERY'S Handbook will give long, satisfying service.

Have You Got Your Copy?

"The Most Complete Collection of Practical Mechanical Data Ever Published."

☞ LET US SEND YOU A COPY FOR EXAMINATION ☜

Date..

MACHINERY, 140-148 Lafayette Street, New York City.

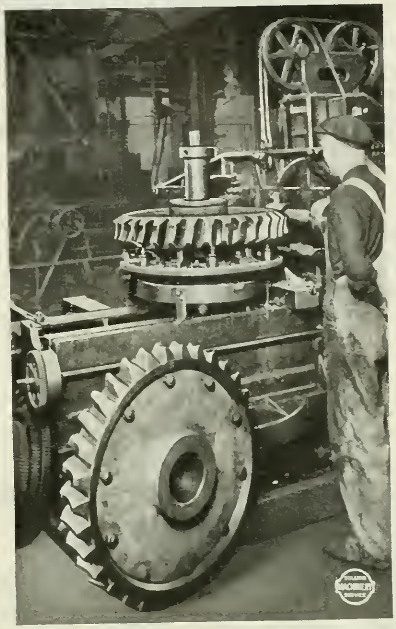
You may send me a copy of MACHINERY'S HANDBOOK for ten days' free examination. I enclose $2.00, and if I am not satisfied with the HANDBOOK, I have the privilege of returning it, and you will refund me the $2.00. If I keep the HANDBOOK, I will send you the balance, $3.00, at the rate of $1.50 a month.

Name ....

Address .... City ....

Occupation .... Works ....

Newark Gear Cutting Machines



Newark Gear Cutting Machines if you use gears in quantities sufficient to keep them busy.

Newark Contract Service if you buy your gears in the market. Write for more details.

Contract Gear Cutting

This end of our business is large and growing. Our equipment fortifies us against unusual demands—we don't believe you can spring anything on us that we can't handle with profit to all concerned.

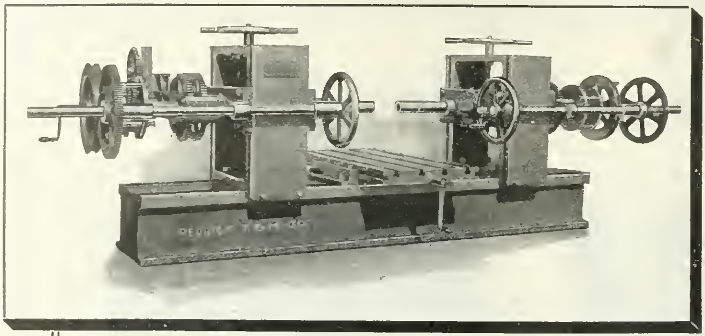
Some Things Some Shops Do Better Than Others

And one of the things we do well out here in Newark is to cut large worm gears. There is a continuous flow of them through our Gear Cutting Department—and the variety in size and materials is quite remarkable.

The large worm gears shown are part of a war machine for your Uncle Sam—more than this it is not wise to say. A shipment of them makes as fine a picture of top-notch gear manufacture as you ever saw.

Newark Gear Cutting Machine Company

NEWARK HENRY E. EBERHARDT, President NEW JERSEY



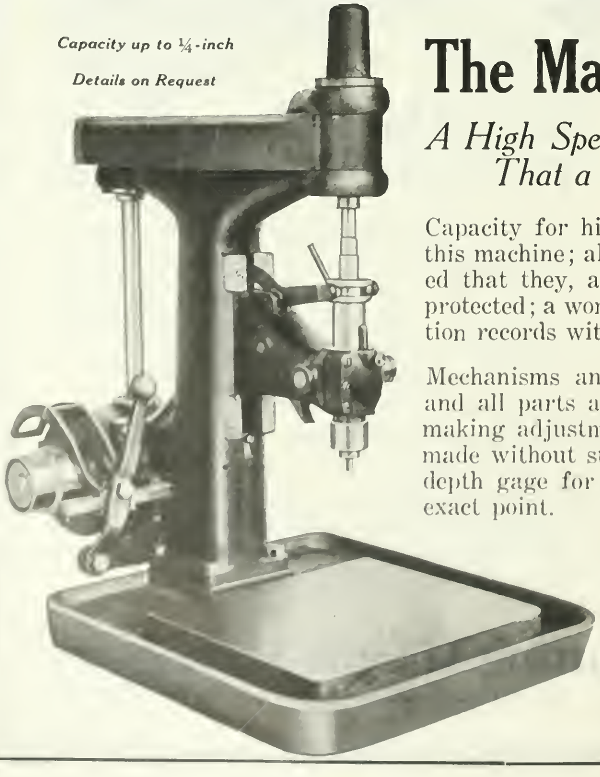
In Ordnance Plants

The Pedrick Duplex Horizontal Boring Machine is being used for turning trunnions, also for boring the bearings in gun carriages. The boring bars operate independently, but two of them are working at once on both trunnions or both bearings. Two sizes of the machine are made—3 inch or 6 inch bars, motor driven. *Circular?*

PEDRICK TOOL & MACHINE COMPANY
3639 N. LAWRENCE STREET PHILADELPHIA, PA., U. S. A.

Capacity up to ¼-inch

Details on Request



The Mason Bench Drill

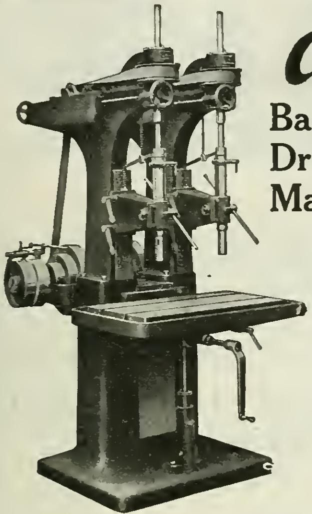
A High Speed Quick Change Machine That a Woman Can Operate

Capacity for high speeds is a strong feature of this machine; all moving parts are so well guarded that they, as well as the operator, are fully protected; a woman can duplicate a man's production records with perfect safety.

Mechanisms and controls are extremely simple and all parts are readily accessible to facilitate making adjustments. Changes of speed may be made without stopping the machine, and positive depth gage for spindle facilitates drilling to an exact point.

The "Mason" is equipped with ball bearings throughout.

ARTHUR C. MASON, Inc.
River and Putnam Streets
PATERSON NEW JERSEY



Avey

Ball-Bearing Drilling Machines

It is one thing to issue orders to your foreman to speed up work, but it is quite another thing to expect a speeding up without the aid of the right kind of a drilling machine.

Our No. 2½ Avey is being used in the largest plants for heavy duty work, and when orders are given to "speed up" the Avey does its share.

No. 2½ Avey—With 1 to 6 spindles, capacity 29/32″ speeds up to 3500 r.p.m. Overhang 7½″, 12″, 15″. Drills to center of 15″, 24″ and 30″ circle.

The Cincinnati Pulley Machinery Co.

Cincinnati, Ohio

CARLTON RADIALS

No gears used in driving this speedy, high power radial—even the tapping attachment is belt driven.

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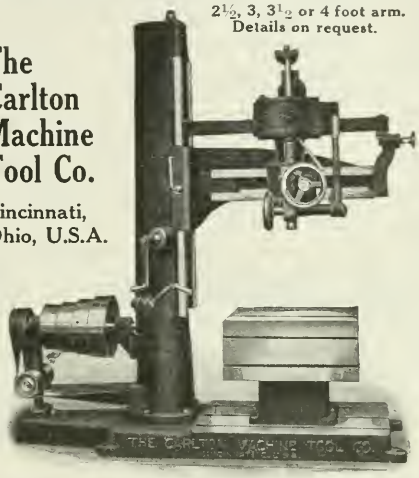

The Carlton Machine Tool Co.

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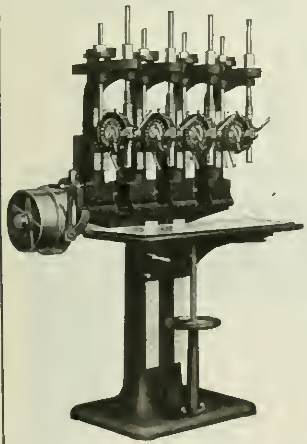
A Line of Drilling Machines That Help to Push Production



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Type C, as shown, has independent automatic power feed with quick return for each spindle.

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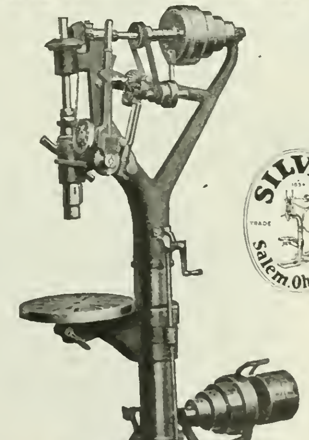

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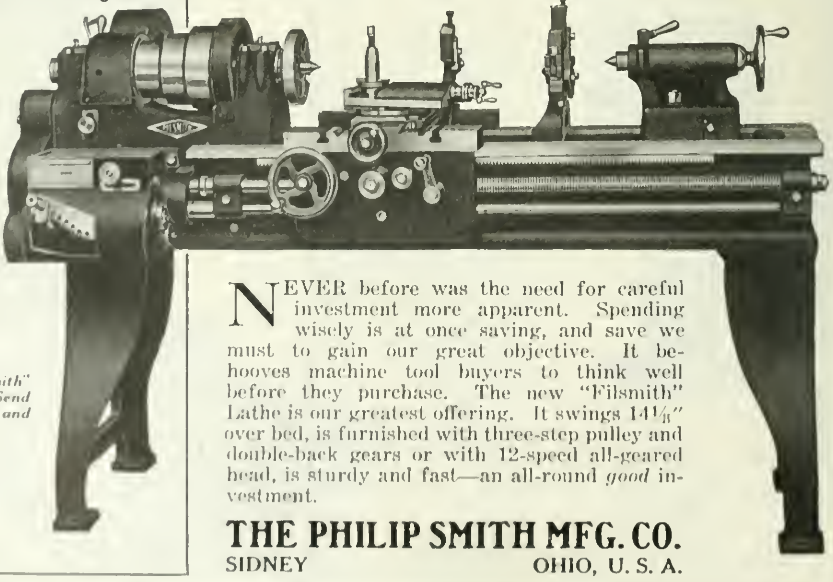

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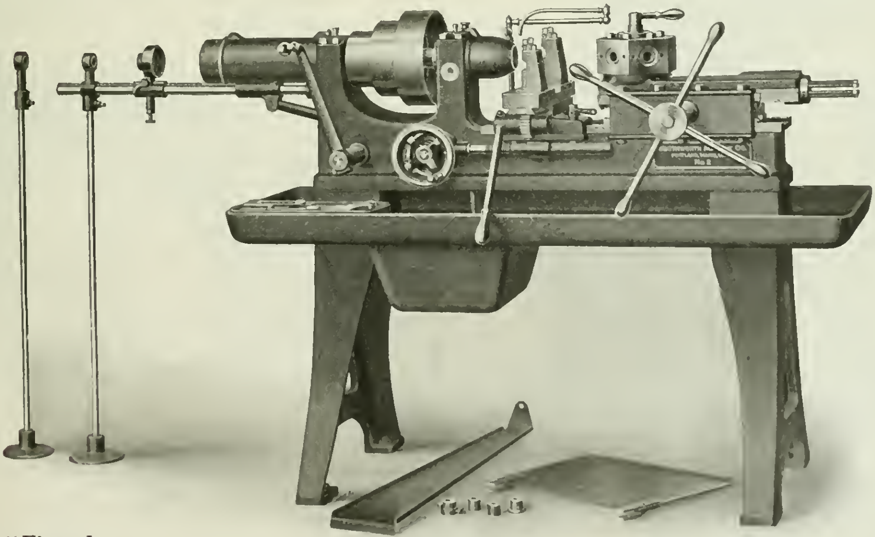

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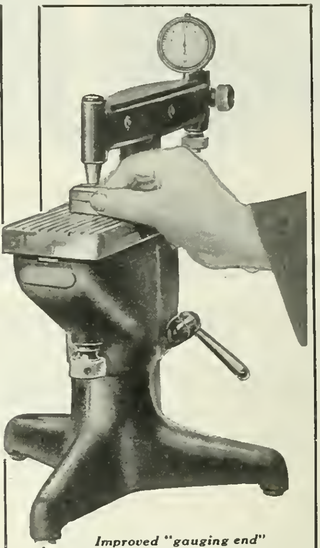

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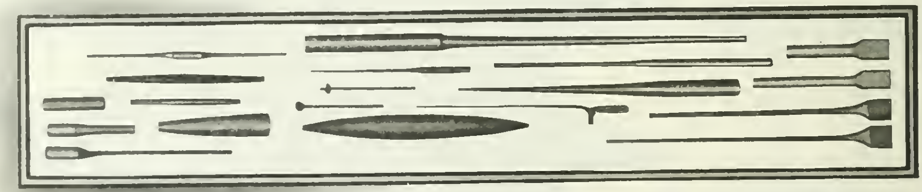

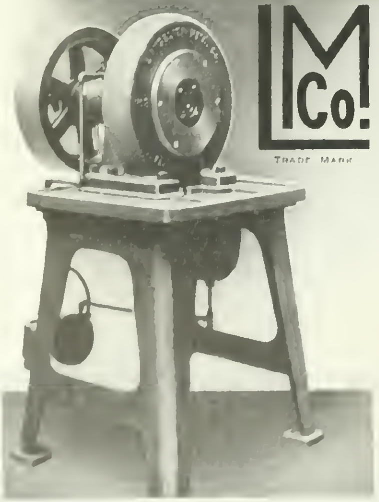

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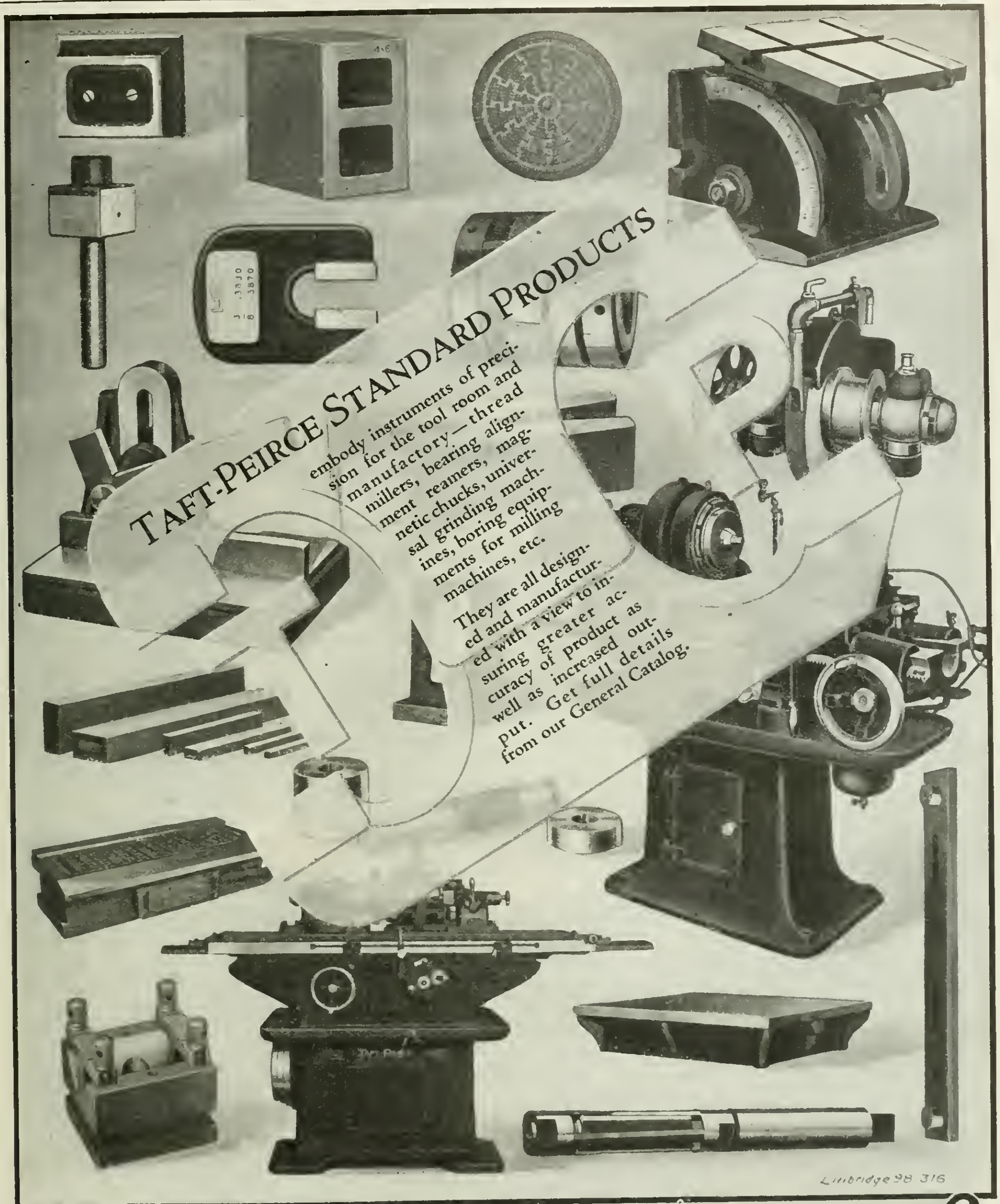

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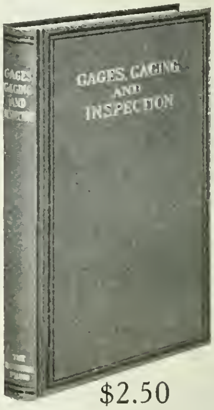

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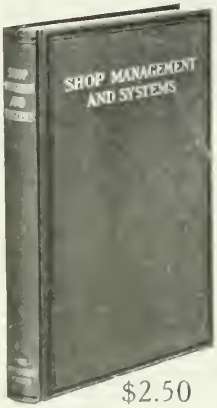

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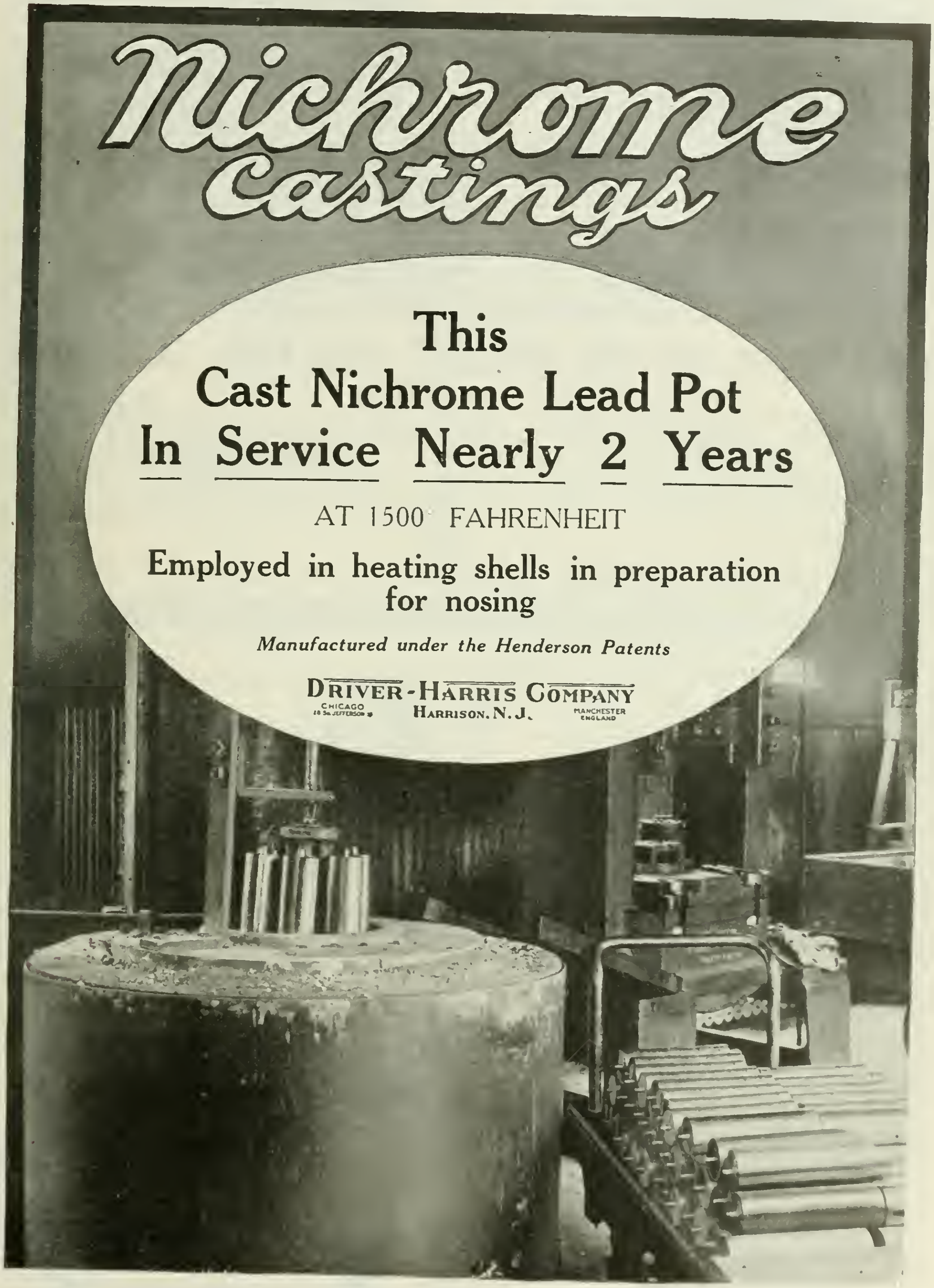

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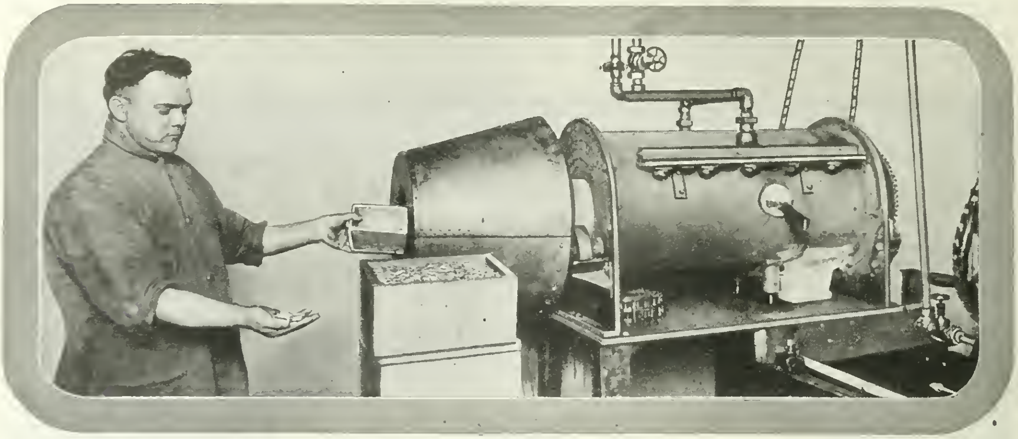

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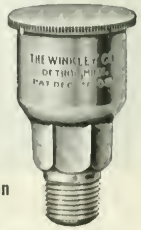

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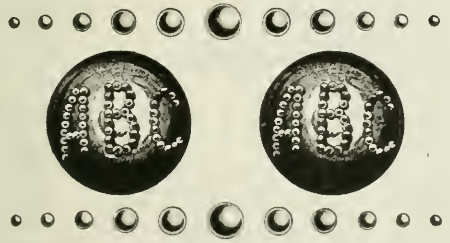

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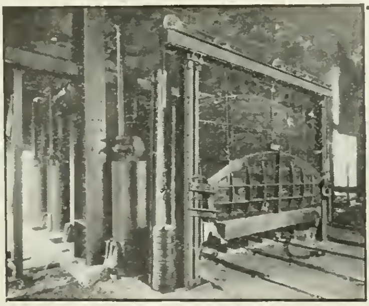

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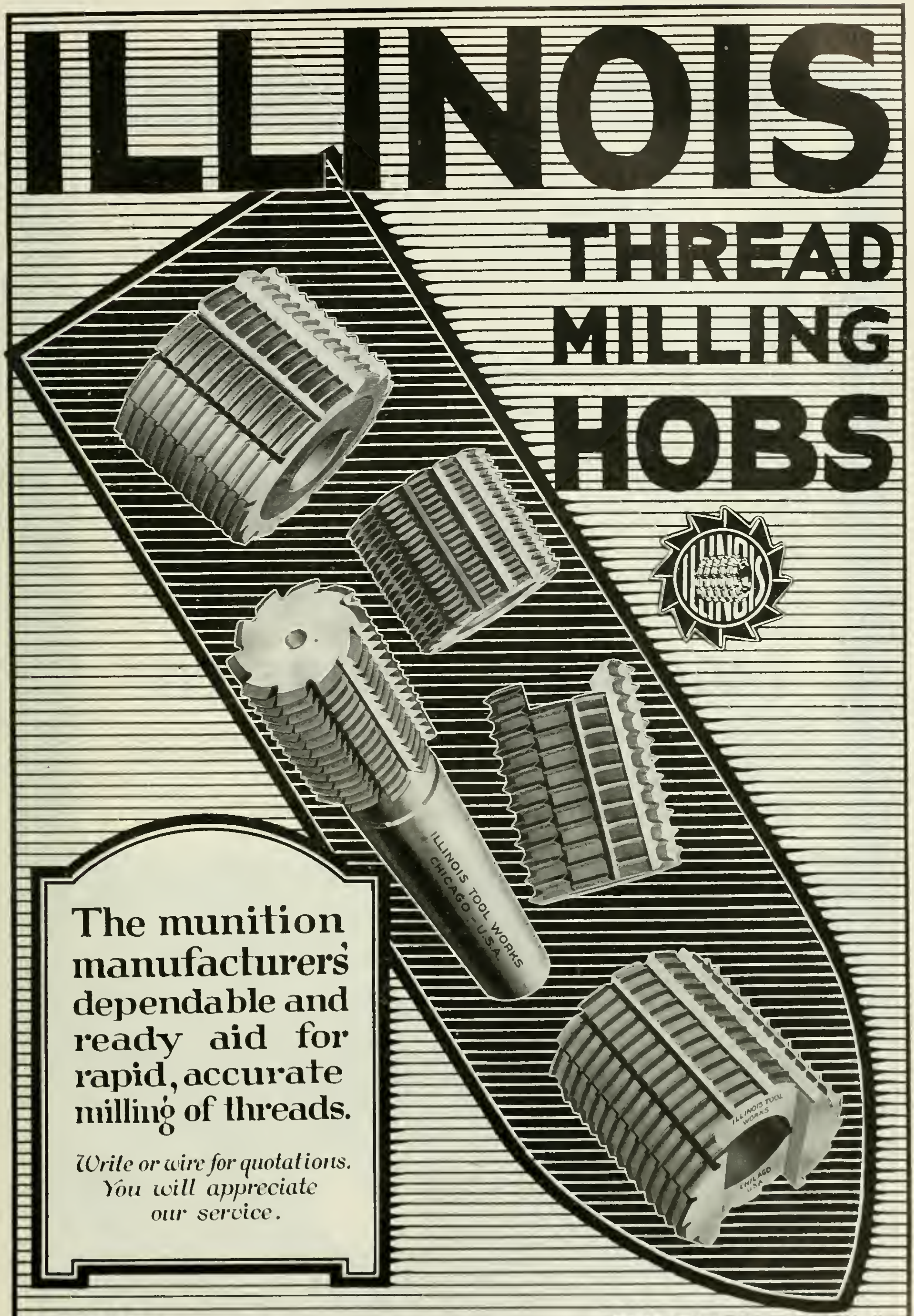

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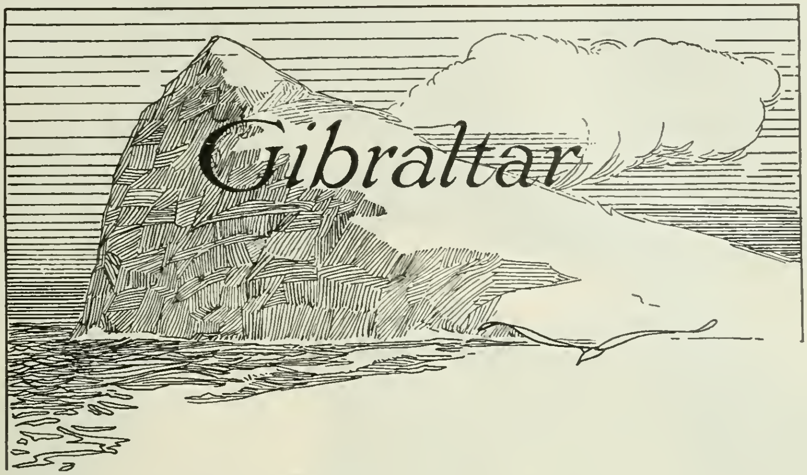

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The steel without an equal.

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The standard in high-speed steel.

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The tool steel without a risk.

Gibraltar Steel survives the continuous heavy driving required by present day industrial conditions—holds its cutting edge for long periods, while other well-known steels make repeated trips to the grinding room.

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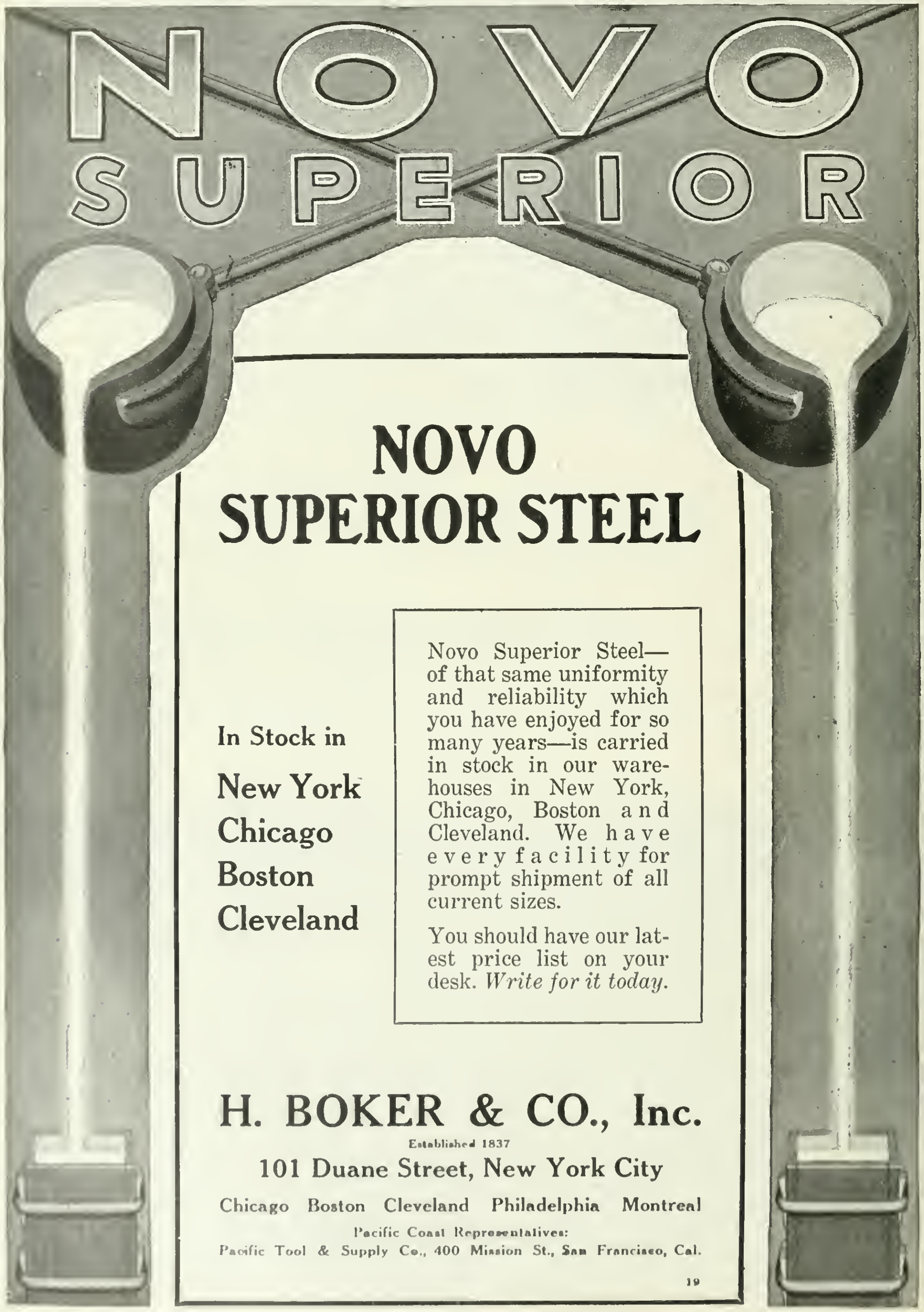

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19

Oxy-Acetylene Welding for "Higher Grade Products"—with Davis-Bournonville Apparatus

David Lupton's Sons Company, Philadelphia, advertise that "Similar rigidity and permanency are regularly secured by the same means in all the higher-grade Lupton sash products." They advertise that their higher-grade products are oxy-acetylene welded. They have employed the oxy-acetylene method of welding for many years, with the highest efficiency. They have an extensive acetylene pressure generating system, piped throughout the plant, and a very large number of welding units—*all Davis-Bournonville apparatus.*

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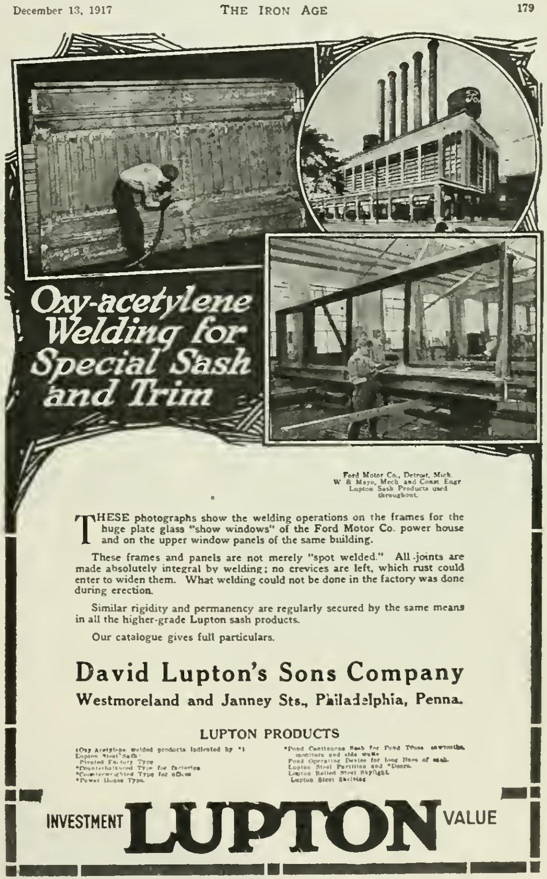
"Davis Apparatus" is used in manufacturing, reclamation and repair work by the leading foundries, steel mills, ship-building yards, navy yards, locomotive and car builders, auto and truck makers, sheet metal workers, general repair shops, *and by the U. S. Army and Navy at home and abroad.*



December 13, 1917 THE IRON AGE 179

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Ford Motor Co., Detroit, Mich.
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THESE photographs show the welding operations on the frames for the huge plate glass "show windows" of the Ford Motor Co. power house and on the upper window panels of the same building.

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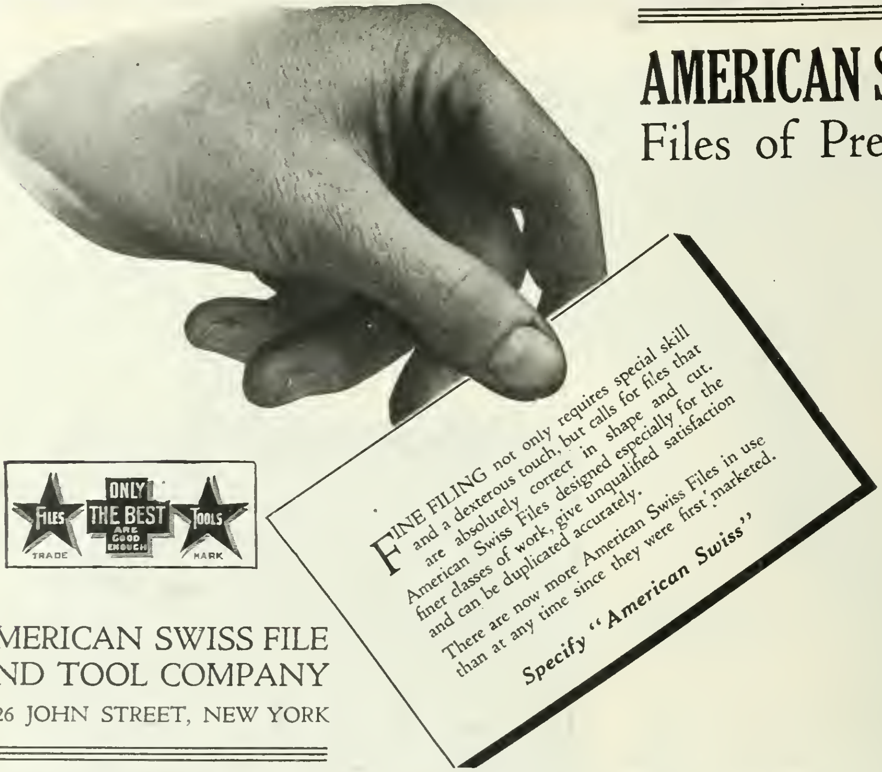

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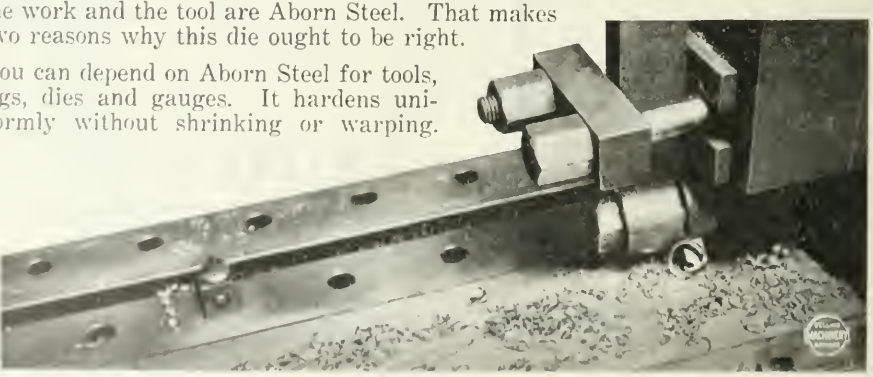

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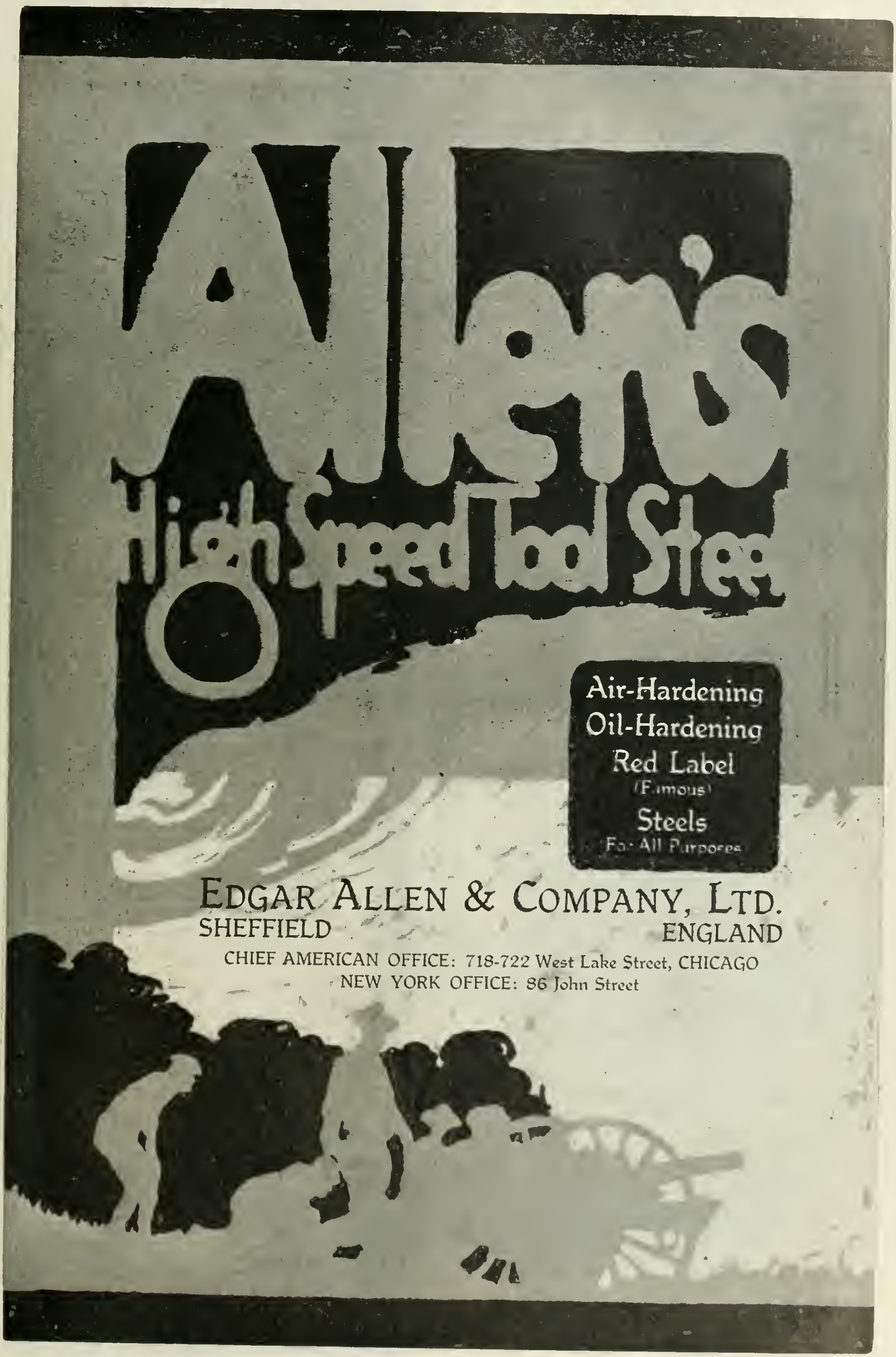

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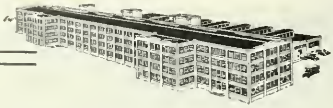

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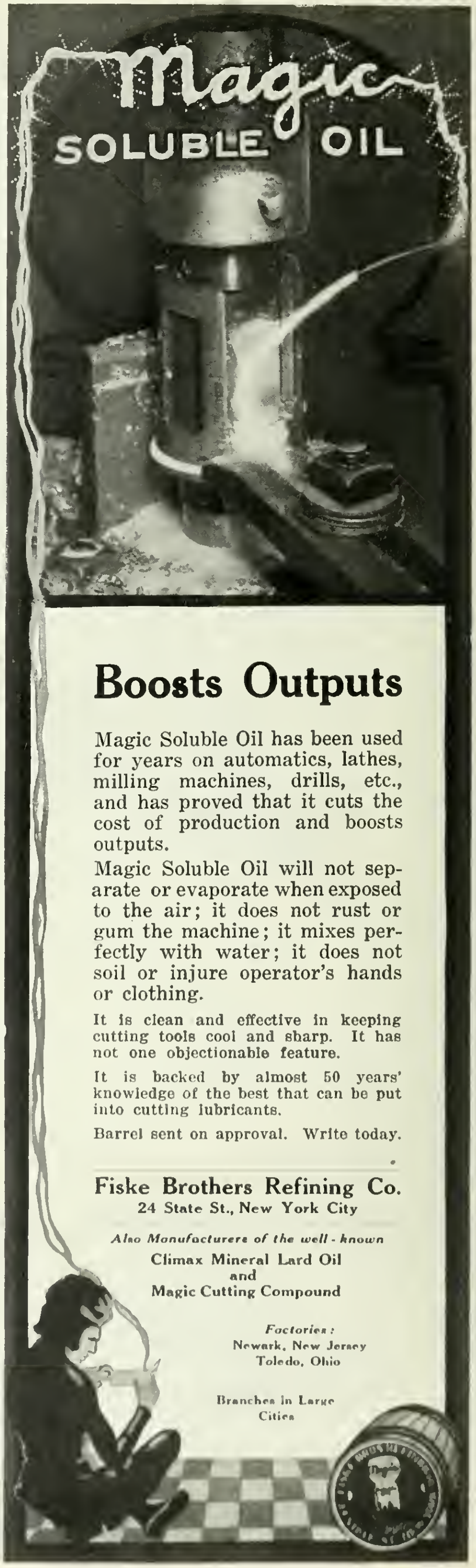

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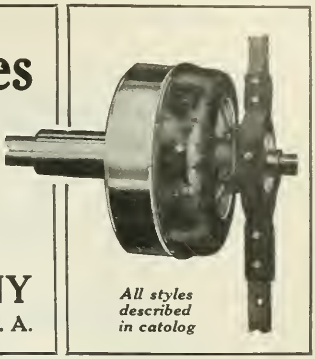

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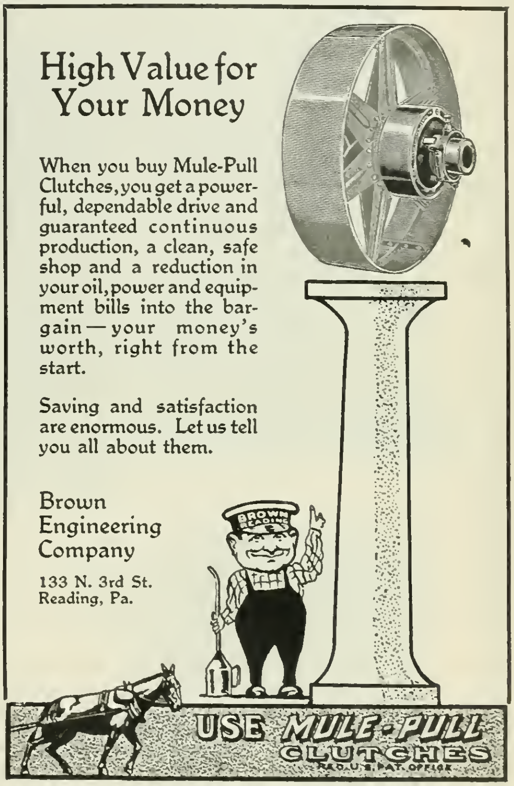

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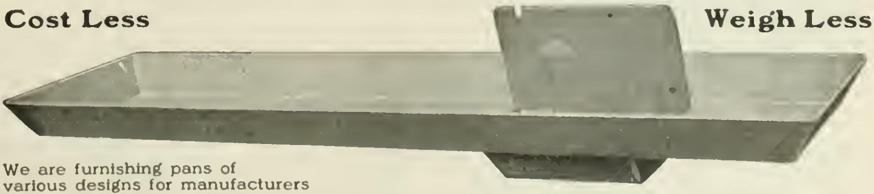

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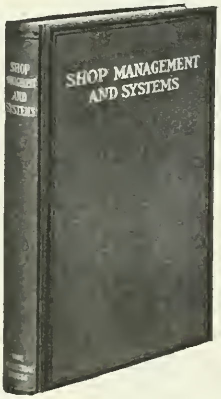

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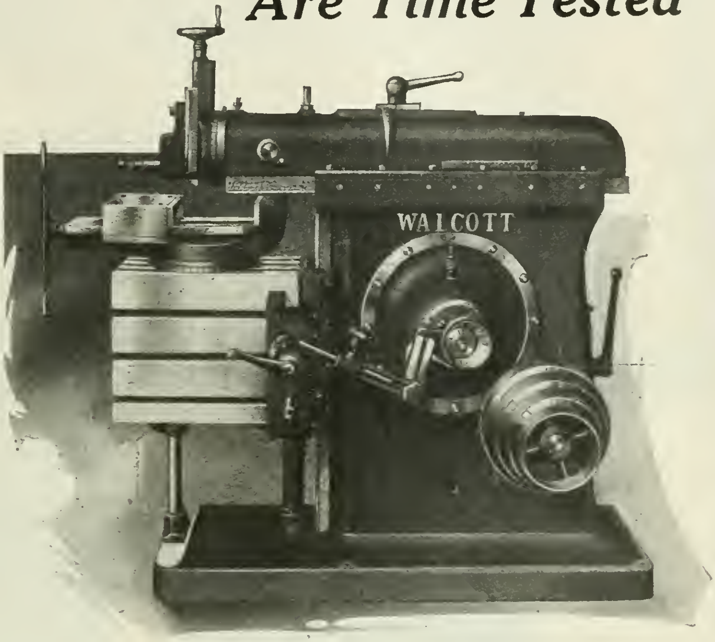

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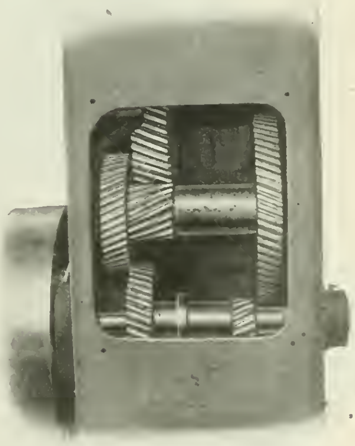

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This machine makes any die with one or more semi-circular impressions in 1/2 to 1/10 the time of other known methods. Of course the delay in getting dies out of the shop is shortened proportionately.

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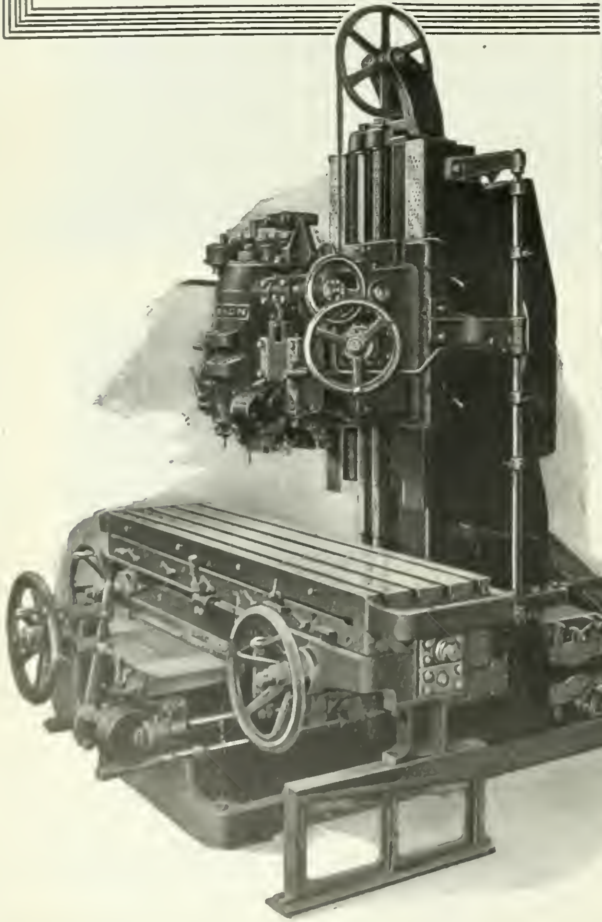

This complete book fully describing the No. 10 Jackson Duplex Typeless Die Sinker, giving floor plans, view of head and vital parts of the machine, will be sent upon request to anyone interested in a machine of this type.

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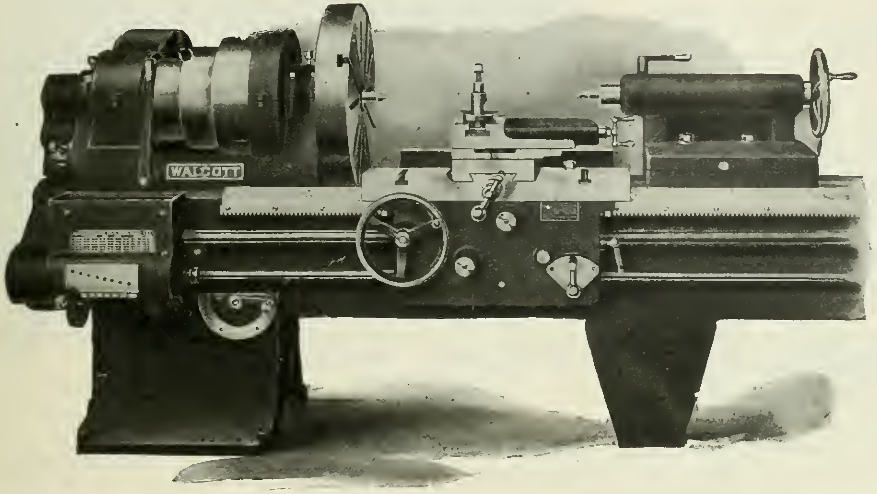

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Every improvement which will facilitate production without the sacrifice of safety has been embodied in this lathe, and its sturdy construction insures a life of usefulness far in excess of what you usually expect.

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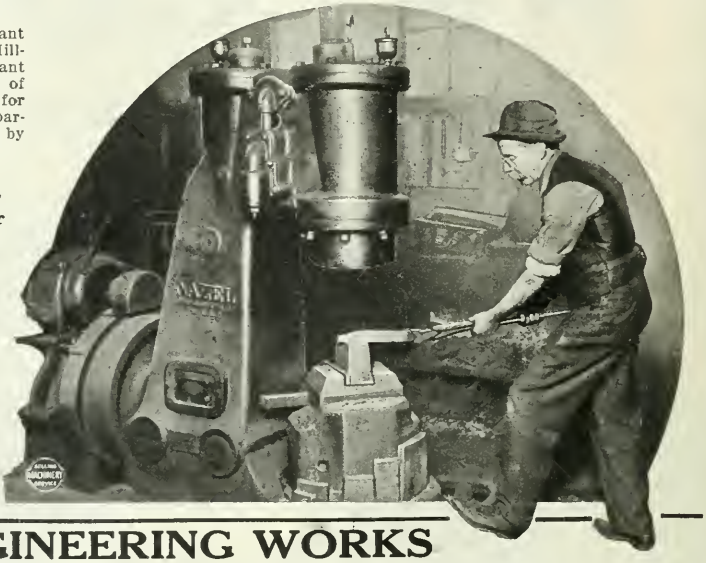

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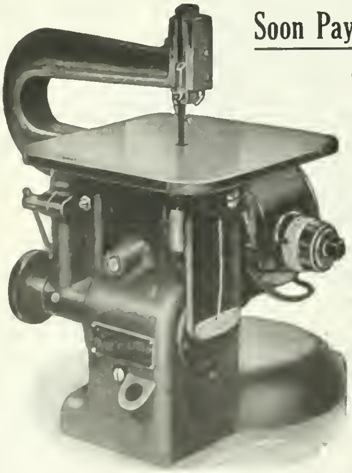

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is a real machine tool — durably constructed and fully self contained — specially designed for die making, but adapted to much of the miscellaneous work put up to the modern tool room.

It saws close to the outline—leaving a proper angle of clearance, files accurately and laps to a fine, true finish; can be used to advantage by any good mechanic—leaving the skilled diemaker free to design and lay out work. The "Oliver" saves an average of 30 to 60 per cent on production costs and soon pays for itself. *Details in circular*

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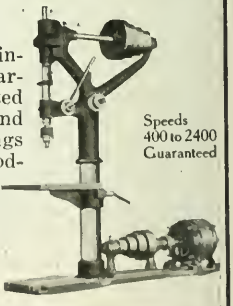

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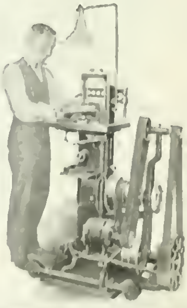
Get That Iron Tool Maker Called

THE REARWIN Die Filing Machine



with 400 lbs. of filing efficiency to help you with your war orders on dies and tools. You can turn out more good work with less experienced help in less time than the old way with skilled toolmakers. Others are doing it, why not you?

The new catalogue and price list is interesting and yours for the asking.

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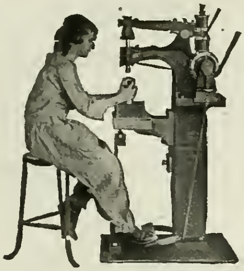
HEADS RIVETS COLD



Heads 'em tight or loose, flush, countersunk, or finishes heads any shape desired, and at the rate of:

A rivet a second, sizes up to 3/16"
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A rivet in three seconds, size 7/16" to 5/8"

and on special order we build machines to handle rivets up to 1½" with proportionate rapidity.

Built in eight sizes.

Besides riveting

The High Speed Riveting Hammer

does all kinds of peening, swaging, upsetting, etc.

Send us sample assembly parts with rivets or sketch of your work and let us shoulder your riveting problems. Send for The High Speed Hammer Book.

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10" Universal Index Centers of the highest quality. Many new improvements; over 5" worm wheel; new two-side head clamps; new steel crank and sector; new spindle lock. Accuracy is *guaranteed.*

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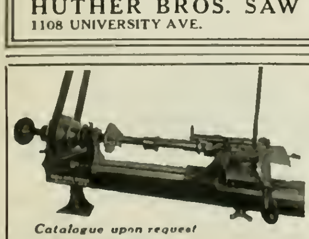

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Built to the highest standards of precision and accuracy. With their many attachments will be found adaptable to a wide range of uses.

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ELGIN ILLINOIS

See Where You're Going!

NO more working in the dark on your trimmer plates. No more machining "fairly close" to the impression line. Your work is in full sight when you use

The Billings & Spencer Improved TRIMMER MILLER

You can see where you're going with this perfected machine, cut clean to the line, and do your job like a good workman. The cutter is always in plain sight.

Here's another new point. No more trouble with chips. They can't get in the way of your work or come in contact with bearing surfaces.

The efficient lubrication of the vertical spindle bearings is a feature.

We developed this machine first in our own shop under most rigorous tests and when it had made good for us we put it on the market for you.

It is peculiarly well adapted for milling the irregular outlines, and at the same time the necessary draft or clearance of trimming press dies, used for cutting the flash from drop forgings. Also adapted to milling cutting dies of all kinds for press work.

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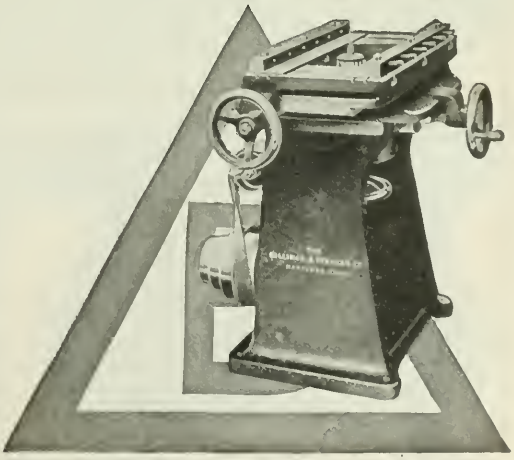

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GRANT

If you could watch the Grant Riveter on these parts—

"Zip"—another rivet set with a Grant Riveter! The blow is so quick and decisive, you scarcely realize it has fallen. Production is limited only by the operator's dexterity in feeding the work to the spindle—"GRANT" speed must be seen to be appreciated.

Grant Riveters are well constructed production tools—design, material and workmanship being adapted to hard service in both standard and noiseless "spinner" type machines.

Adjustment in these machines is quickly made for different heads and sizes, and "Grant" production records have set new standards in assembling departments all over the country.

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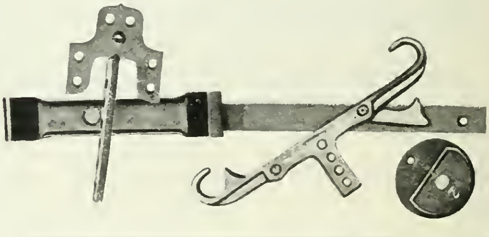
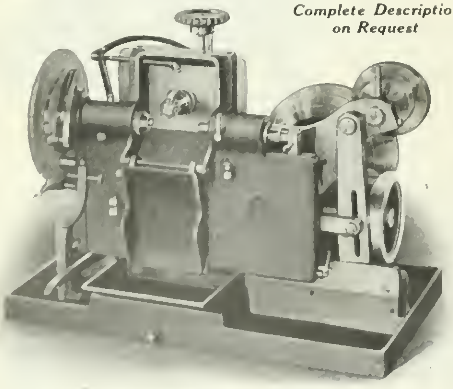
Bridgeport Connecticut, U. S. A.



THE WALTHAM 4" GEAR CUTTER

Distinctive features for increasing output and securing close accuracy in cutting small gears and fine pitch pinions have been developed in this automatic production machine. For example—the cutter slide, when in position for cutting, is tightly clamped while the cut is in progress but is released during the return stroke so the slide may be lifted for indexing.

Complete Description on Request



Waltham Machine Works

Newton Street, Waltham, Mass.

Small Thread Millers, Gear Cutters, and other small Automatic Machines

---

IF you are interested in Rivet and Screw Machinery there is valuable information for you in this new catalogue. There is 60 years' manufacturing experience back of the Cook line of machines — experience that may help you.

Let us send the book today

THE ASA S. COOK CO., Hartford, Conn.

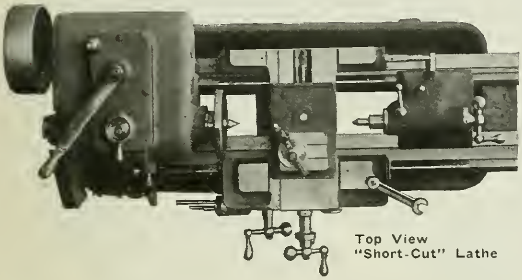
The Townsend Taper Attachment

Is adapted for the rapid manufacture of tapers, reamers, twist drills, end mills, arbors, punches, etc., in quantities. Turning becomes as easy as straight work and parts may be duplicated exactly.

Send for circular

The H. P. Townsend Mfg. Co., Hartford, Conn.

READY!—
The Adams "SHORT-CUT" Lathe



Top View
"Short-Cut" Lathe

HOW much of your lathe work consists of short length pieces of medium diameter? Do you employ a standard sized lathe providing greater swing and longer bed than are necessary, with consequent excess costs? Or do you use a small lathe with the handicap of insufficient power?

We've designed a new lathe to handle this class of work most advantageously.

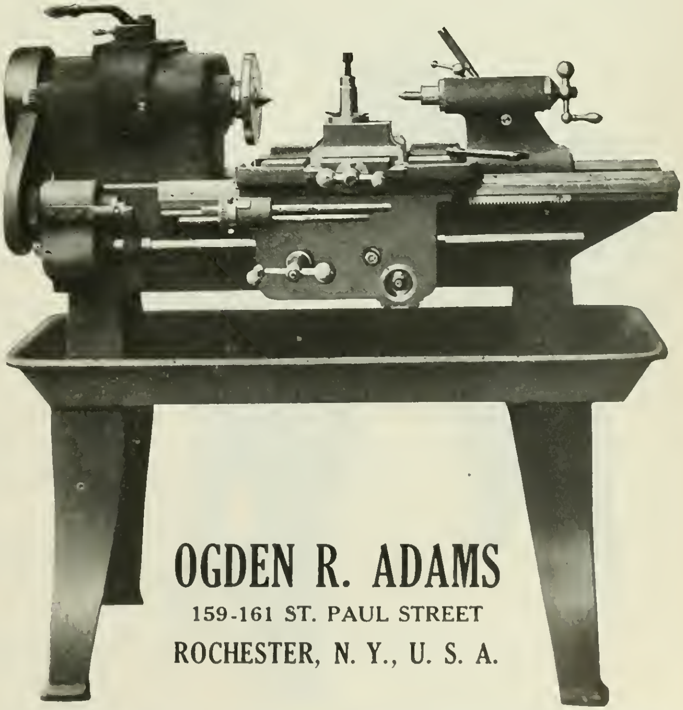
The Adams "Short-Cut" Lathe performs equally well for roughing and in extremely accurate finishing, costs less than larger tools, conserves fuel and labor, and shows many "short-cuts" from raw stock to finished pieces. It is exceptionally well built.

Geared head provides six speed changes through one operating lever and a sliding clutch. Headstock gears run in an oil bath, insuring perfect lubrication and a long life. Spindle is of crucible steel scraped to perfect bearing fit with hole capacity for 1" bar stock. Three positive feeds from 0.007 to 0.020 are instantly obtainable; three others with a two gear change.

DIMENSIONS

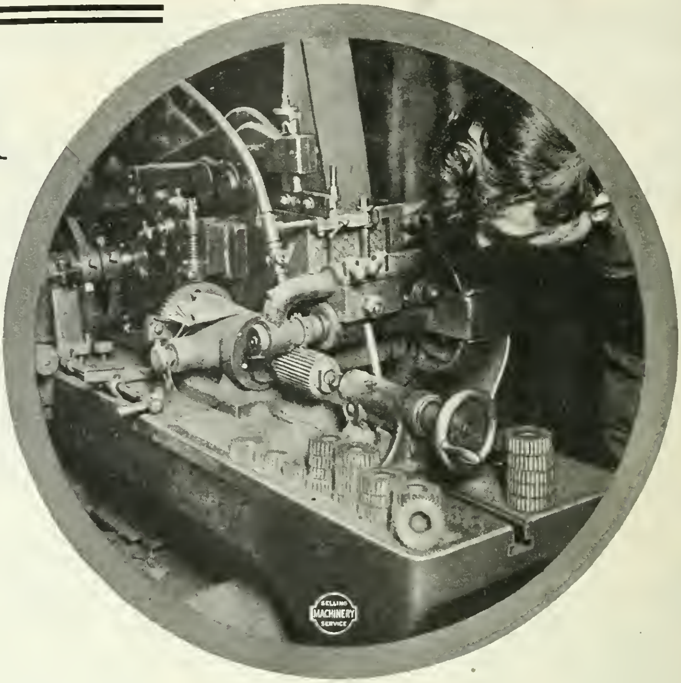
Swing over bed—$12\frac{1}{2}''$.
Space between centers—19″.
Length of bed—48″.
Width of belt—2″.
Dia. hole in spindle—1 1/16″.
Max. cap. wire chuck—$\frac{5}{8}''$.
Length of carriage—$18\frac{1}{2}''$.
Width of cross-slide—$7\frac{1}{4}''$.
Spindle speeds (pulley running at 200 r.p.m.)—23 to 374 r.p.m.
Weight—1350 pounds.

Write for further information and advice on deliveries.



OGDEN R. ADAMS
159-161 ST. PAUL STREET
ROCHESTER, N. Y., U. S. A.

Bilton
Cut Gears
For Washing Machines

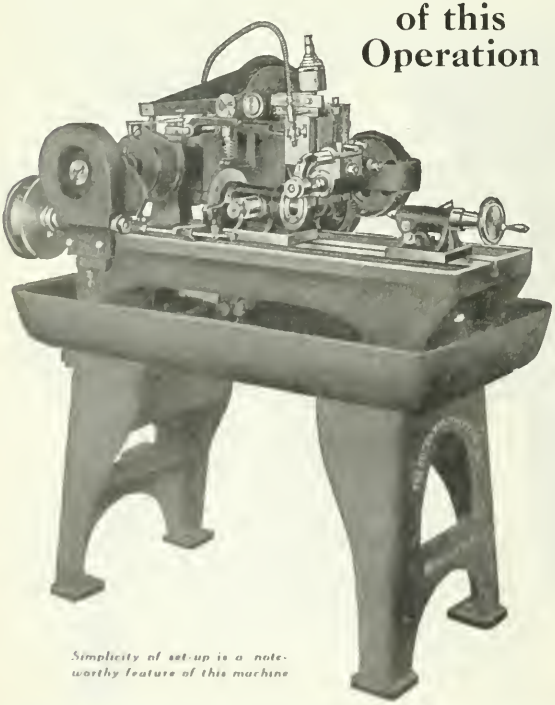


The accompanying photograph was secured at a Pittsburgh plant where washing machines are made. For nearly two years two Bilton Gear Millers have helped save labor in the manufacture of these labor-saving machines. They have also saved time and money. Take this illustration for an example of true economy.

Economy is the Object of this Operation

The Bilton Gear Miller is machining 32 teeth, 16 pitch, on gears of ⅝″ face. Five gears are mounted on the arbor at one time, and it takes just 25 seconds for the cutter to make one cut through the lot. One gang of blanks will be cut in 8 minutes, which makes a production of 38 gears per hour.

One operator tends both Bilton machines and three other tools besides.



Simplicity of set-up is a noteworthy feature of this machine

Catalog No. 20M gives the reasons for Bilton supremacy. Send for it to-day and be convinced.

The Bilton Machine Tool Co.

BRIDGEPORT CONNECTICUT

FOREIGN AGENTS: Chas. Churchill & Co., M. Mett Engineering Co., Alfred Herbert, Ltd.

MACHINERY'S
GREEN SECTION

Comprising the latest lists of Second-hand and Rebuilt
metal-working machines, tools and accessories,
now available. The merchants represented
in the GREEN SECTION are well known to

MACHINERY

The GREEN SECTION is MACHINERY'S Second-hand Tool Department. Use it for Used Machinery.

MACHINERY
140-148 Lafayette Street, New York City

More Tools Wanted

Can you help on this?

Machinery is indebted to readers and advertisers for the quick response to our appeal made here last month for a number of tools that were badly wanted. Nothing could more effectively demonstrate the extraordinary circulation and the close attention the Green Section receives. The answers began to start as soon as the first copies of July Machinery were delivered and they came in all through the month; and they came from all over the country. The Green Section has arrived.

TOOLS WANTED

Cutting off machine of the Williams or Vandervoort type to handle 9.2″ and 9.5″ shell forgings. Immediate delivery necessary.

Power Punch and Shear 24″ to 36″ throat. Capacity about 1″ x 1″.

50,000 pounds used testing machine. Machine to be complete and in first class condition.

Small shaper—second hand, but in good condition.

3 ft. Sensitive Radial Drill.

Machinery's Green Section

140-148 Lafayette Street, New York City

The Bread That Was Cast Upon The Waters

Truly it has been found after many days! How wonderful to imagine the ardent, liberty-loving spirit of Lafayette, who fought so bravely and devotedly for American liberty, gazing now upon the eager lads going forward with the stars and stripes and the tri-color to save and secure forever the liberty of his immortal France. These are the children of that freedom he fought for and the soldiers of freedom always win at last!

"For freedom's battle, once begun,
Bequeath'd by bleeding sire to son,
Though baffled oft, is ever won."

USED and REBUILT SHOP EQUIPMENT

USED MACHINERY

DRILLS

One-spindle 24″ Henry & Wright.
One-spindle 30″ Henry & Wright.
Two-spindle Fox Sensitive.
Four-spindle Slate Sensitive.
5½′ Baush post radial.
2-spindle Moline Cylinder Borer.
3—10″ Barnes friction.
23″ Barnes sliding head.
2—25″ Blaisdell sliding head, back gears, power feed, auto. stop, new table.
No. 0 2-spindle Garvin Horizontal.
4-spindle 14″ Foote-Burt power feed.
48″ Dreses cone driven radial.
No. 2½—2-spindle Avey.
Two No. 2½—4-spindle Avey, with automatic feed.

GRINDERS

12 x 60 Landis Universal.
6 x 48 Pratt & Whitney Plain.
18—30 x 96 Norton Plain.
5—10 x 36 Nortons.
No. 60 Heald Cylinder.
No. 6 Bryant Internal.
20″ Whitney Water Tool.
⅝″ Yankee Twist Drill.
No. 4 Van Norman internal.
48 x 6 Springfield Double Head Planer Type.
No. 2 Walker, with outfit "J" gear cutter grinding attachment and center rest and 6″ 4 jaw chuck.
No. 70 Heald internal with Type "F" wheel head.
No. 12—26″ Besly disc grinder.

LATHES

10 x 4 Davis, C.R., P.C.F.
11 x 4 Mann R. & F.
14 x 8 Flather, C.R., P.C.F. Chuck.
18 x 10 Schumacher & Boye, C.R., P.C.F. Chuck.
44 x 16 Niles, C.R., P.C.F.
56 x 24 Wood & Light, C.R., P.C.F.
84 x 30 Putnam Plain Turning.
16 x 6 Automatic Threading.
3—16 x 6 Hendey geared head, 4 way tool blocks.
20 x 12 Hendey Norton screw cutting.
20 x 12 Fifield comp. rest power cross feed.
20 x 12 Putnam Pl.R., P.C.F. solid spindle.
28 x 14 L. W. Pond C.R.
21 x 8 Lodge & Davis C.R., P.C.F.

MILLERS

Nos. 1 and 2 Pratt & Whitney Hand.
F. E. Reed Lincoln Type.
No. 2 Owen, plain.
No. 3 Van Norman Duplex.
No. 9 Garvin Lincoln.
No. 2 Milwaukee back gears vert. and rack cutting att.
No. 32 Kempsmith Lincoln.
No. 0 Steptoe plain driving head and tailstock.

TURRET LATHES AND SCREW MACHINES

No. 2½ P. & W.
24″ Gisholt, 6¼″ hole.
2 x 24 Jones & Lamson Flat Turret.
No. 1, ⅝″ Pratt & Whitney Wire Feed.
20″ x 7′ Fay & Scott Universal Turret.
24″ x 10′ Lodge & Davis Heavy Turret.
2″ Garvin.
18 x 6 American.

PLANERS

20 x 20 x 4 Pease, one head.
26 x 26 x 6 Lodge & Davis, one head.
25 x 25 x 10 Sellers, one head.
36 x 36 x 14 Lodge & Davis, one head.

AUTOMATIC SCREW MACHINES

½″ 4-spindle National Acme.
1⅜″ 4-spindle National Acme.
1¼″ Style B Cleveland.
2″ Style A Cleveland.
4¼″ Style A Cleveland.
3¼″ Gridley Single Spindle.

MISCELLANEOUS

2—26 x 10 Automatic Gear Cutters.
No. 1 Slate Automatic Pinion Gear Cutter.
No. 2 36″ Whiton Automatic Spur Gear Cutter.
150-lb. Plain Drop Hammer.
50-lb. Beaudry Power Hammer.
675-lb. Pratt & Whitney Board Drop Hammer.
6″ Hurlbut & Rogers Cutting-off Machine.
7 No. 2 Stiles Power Punch Presses.
36″ Stoll Power Squaring Shear.
No. 15 Lea-Simplex Cold Saw.
18″ Newton Cold Saw with facing head.
No. 6 Fellows Gear Shaper.
No. 13 P. & W. Profiler.
No. 14 Cochrane-Bly Die Slotter.

HENRY PRENTISS & COMPANY, Inc.

Formerly PRENTISS TOOL & SUPPLY CO.

Singer Building, 149 Broadway NEW YORK

BOSTON, MASS BUFFALO, N. Y. ROCHESTER, N. Y. SYRACUSE, N. Y. SCRANTON, PA.

ReMANUFACTURED -(ORIGINATED BY US)- MACHINE TOOLS

TRADE MARK

In the business of Remanufacturing we start with the assumption that the only difference between a new machine and a worn machine is the condition of the moving parts and bearing surfaces. In other words, the material has not deteriorated by use, but rather, if anything, improved. Therefore, if the moving parts and bearing surfaces of all parts are renewed you have, to all intents and purposes, a new machine with seasoned material. Users of the present ten-day-out-of-the-sand machines will appreciate what "seasoned" material means.

RADIAL DRILLS

1—3' American, single pulley drive.
1—4' Niles Full Universal.
1—5' Fosdick Plain.
1—5' Universal.
1—5' Niles Full Universal.
1—6' Putnam Plain.

MILLING MACHINES

2—No. 14 Garvin Mfg. Plain.
2—No. 14 Garvin Plain.
1—No. 18 Kempsmith Plain.
1—No. 32 Kempsmith Lincoln.
1—No. 4 Newton Duplex.
1—Hilles & Jones.
1—No. 2 Beaman & Smith Vertical.

GEAR CUTTERS

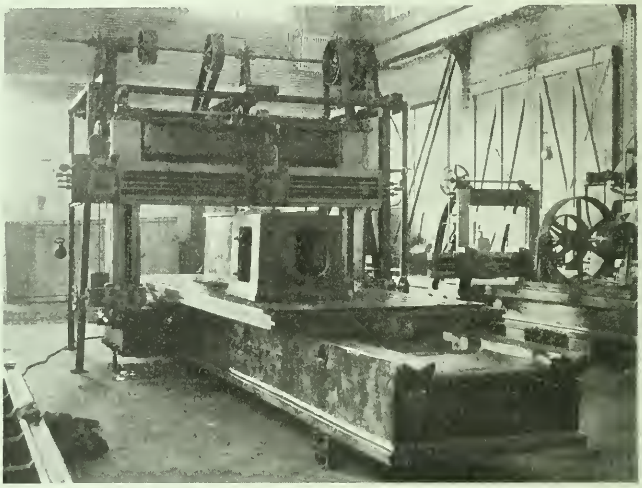
2—No. 11 Gleason Bevel Gear Generators.
1—24" Fellows Gear Shaper.
1—36" Fellows Gear Shaper.

PLANERS

1—22" x 22" x 6' Gray.
1—22" x 22" x 6' American.
1—24" x 24" x 6' American.
1—26" x 26" x 6' American.
1—26" x 26" x 8' Gray.
1—30" x 30" x 12' Gray.
1—36" x 36" x 8' Flather, 2 hds.
1—36" x 36" x 10' Whitcomb, 2 hds.
1—36" x 36" x 13' Sellers, 2 hds.
1—48" x 38" x 12' Pond, 1 hd.

ENGINE LATHES

1—15" x 6' Von Wyck, taper.
1—16" x 6' Walcott & Wood.
1—18" x 6' American, Full Q.C.G.
1—20" x 8' Whitcomb-Blaisdell, Gd. Hd.
1—24" x 10' Walcott & Wood.
1—24" x 10' American.
1—36" x 16' Johnson Triple Geared, motor drive.
1—36" x 20' New Haven.
1—50" x 14' Fitchburg.
1—60" x 16' Fifield.
1—No. 3 Niles-Bement-Pond Double Axle.
1—Niles Cylinder, 41" swing.



Replaning the bed of a large horizontal boring mill which was out of alignment.

TURRET AND SCREW MACHINES

1—12" Foster-Kimball.
4—16" Pratt & Whitney.
1—20" Pratt & Whitney Geared Head.
2—22" Steinle.
1—24" Foster.
1—1¾" American Screw.
2—2" x 24" Jones & Lamson.

GRINDERS

2—No. 200 Heald Piston Ring.
2—18" Gorton Disc.
1—No. 11 26" Besly Disc.
1—No. 23 Landis Plain.
1—1½ Landis Internal.
1—No. 2½ Bath Universal.
1—12" x 72" Norton Plain.
24—12" x 24" Modern Plain.

PUNCHES AND SHEARS

1—96" Robinson Power Brake.
1—No. 2 Bethlehem Slitting Shear.
1—No. 1 Wm. Frech Punch.
1—No. 3 Robinson Inclinable.
1—No. 1-B New Doty Geared Punch.

MISCELLANEOUS

1—38" Colburn Vertical Boring Mill.
1—Gould & Eberhardt Draw Bench.
1—1½" Morton Keyseater.
1—4" Bignall & Keeler Pipe Machine.
1—36" Morton Draw Cut Shaper.
1—No. 2 Lapointe Broaching Machine.
1—No. 104 Consolidated Press.

OUR GUARANTEE: YOUR MONEY BACK IF YOU RETURN MACHINE WITHIN THIRTY DAYS OF DATE OF SHIPMENT. FREIGHT PREPAID. **NO EXCUSES NECESSARY!**

HILL, CLARKE & CO. OF CHICAGO

625 Washington Blvd., Chicago, Ill.

MACHINES WE OWN—For Immediate Delivery

6—New Cleveland, 2 spindle, high speed, ball bearing Sensitive Drills.
2—New Cleveland, 4 spindle, high speed, ball bearing Sensitive Drills.
4—No. 5—20" Buffalo Stationary Head, back geared Drills.
1—New 21" Cleveland Upright Back Geared, power feed Drill.
3—New Cleveland 25" Sliding Head, back geared, power feed drills.
1—New 28" Cleveland High Speed Upright Drill, with tapping attachment.
1—New 32" Cleveland, Upright Sliding Head.
24—New 20th Century Filing Machines.
1—New Cleveland Profile Grinder, motor driven.
4—New Greenfield Universal Tool & Cutter Grinders.
2—New No. 190 Wells Universal Tool & Cutter Grinders.
1—No. 60 Heald Cylinder Grinder.
4—New No. 1 La Salle Plain Surface Grinders, micrometer adjustment.
1—Used 36" Fellows Gear Shaper.
1—Used No. 2 Knowles Keyseater.
2—New 12" x 5' Cleveland Tool Room Precision Lathes, complete equipment.
3—New 16" x 6' Cleveland Tool Room Lathes, complete equipment.
2—New 16" x 6' Cleveland Quick Change Engine Lathes, regular equipment.
1—Used 24" Libby Turret Lathe.
1—New No. 2 Garvin Universal Milling Machine.
1—Used No. 5 Cincinnati Plain Milling Machine, geared head, single pulley drive, in A-1 condition.
1—New No. 2 Marvel Draw Cut Hack Saw with swivel vise.
1—New No. 1 Chicago Automatic.
1—New Grand Rapids Universal Tool & Cutter Grinder.
1—Used 6' Bickford Radial Drill, gear box drive, very good condition.
1—New No. 2 Garvin Universal Milling Machine.
1—New No. 2½ Rockford Universal Milling Machine.
4—New Adams Farwell No. 1 Gear Hobbers.
1—Used 1¼" Gridley Multiple Spindle Automatic, arranged for motor drive, but without motor.
1—Used No. 2 Le Blond Universal Milling Machine, fine condition.
1—New 20" Canedy-Otto Drill Press.
2—New Cleveland Single Spindle Sensitive Drills.
4—New Cleveland Three Spindle Sensitive Drills.
1—24" x 24" x 5' Morse Planer, one head.
1—No. 13 Garvin Plain Miller.
1—No. 6 Becker-Lincoln Type Miller.
1—No. 1½ Cincinnati Universal Miller.
1—No. 1½ Landis Internal Grinder.
1—16" x 8' Lodge & Shipley Patent Head Engine Lathe, including Universal Chuck.
1—24" x 12" Schumacher & Boye Engine Lathe.
1—3½" x 84" Fitchburg Lo-swing Lathe, all geared heads, single pulley drive, quick change feed.
1—New 24" Walcott, back geared, high duty Shaper.

PARTIAL LIST OF MACHINES LISTED WITH US FOR SALE

BORING MACHINES—VERTICAL

1—New Bullard 24" New Era, with 4 jaw chuck.
1—36" Bausch & Harris, 2 swivel heads.
1—40" King—2 swivel heads.
1—42" Bullard—2 swivel heads, quick change feed.
1—60" Bickford—2 swivel heads.
1—62" King, 2 swivel heads.
1—8' Bickford, 2 swivel heads, equal to new.
1—96" Vertical Cylinder Boring Machine, good as new.
1—10' Niles—2 swivel heads.
1—New 14' Niles Pattern, two swivel heads.

BORING MACHINES—HORIZONTAL

1—No. 2 Rockford, with special large table, good as new.
1—No. 0 Detrich & Harvey, floor type, all geared feeds, universal table, 3½" bar.
1—Niles Knee Type, all geared feeds, 4" bar.
1—No. 33 Lucas Latest Type, 4" bar. Excellent condition.

BULLDOZERS

1—No. 2 Williams & White 16" stroke.
1—No. 5 Williams & White, 13" stroke.
1—No. 23 Williams & White, Belt Driven.
1—Williams & White, 18" stroke.

CRANES—TRAVELING

1—10 ton Whiting, 37'—3" span, 2 motors.
1—New 10 ton 3 motor type, Case—40' span, 220 volt D.C.
1—20 ton Niles—75' span.
1—25 ton Case—28' span.
1—Single Leg, 4 motor, Grantry Crane.

CRANES—LOCOMOTIVE

1—15 ton McMyler, 8 wheel 42' boom.
1—20 ton Brown Hoist 8 wheel 40' boom bucket.

DRILLING MACHINES—RADIAL

1—3' Dreses Plain Single Pulley Drive.
1—4' American Plain, latest type, single pulley drive.
1—New 5' Dreses Plain, July delivery.
1—5' Bickford Plain, arranged for variable speed motor.
1—5' American Full Universal, single pulley drive, practically new.
5—6' Reed Prentice Heavy Duty Ball Bearing.

DRILLING MACHINES—HEAVY DUTY

4—No. 310 Baker.
1—No. 23 Foote-Burt.
1—New No. 416 Baker, high speed, 4" capacity.
2—Style P-3 Baker High Duty. Good as new.

DRILLING MACHINES—SLIDING HEAD

1—26" Barnes Sliding Head, Gang Drill, with 4 spindles. Weight about 6000 lbs.
1—28" J. F. Barnes, good as new.
1—32" Hamilton.

GEAR CUTTING MACHINES

4—New No. 1 Adams Farwell Gear Hobbers.
1—No. 2-A Newark—24" x 8" capacity.
1—36" Fellows Gear Shaper.
1—No. 4 Brown & Sharpe, capacity 48" latest type, equal to new.
1—New No. 4-A Cincinnati, capacity 48" x 12".
1—New No. 5 Lees Bradner, gear Generator, 14" swing, full universal.
1—New 40" Flather Gear Cutter. Immediate delivery.

GRINDERS—CYLINDRICAL—PLAIN

2—New Modern 8 x 30 Self-Contained.
2—New 12 x 24 Modern Self-Contained.
4—New Modern Self-Contained; capacity 12" x 48".
1—14" x 66" Landis.
1—No. 21 Landis, capacity 10 x 30.

GRINDERS — CYLINDRICAL — UNIVERSAL

1—New No. 1—10" x 30" Webster & Perks.
1—New No. 3 Modern, Capacity 13" x 40".
1—New Landis No. 3, Capacity 12" x 42".
1—No. 5 Brown & Sharpe, capacity 22" x 72".

GRINDERS—INTERNAL

1—No. 1½ Landis—good as new.
1—No. 70 Heald, very good condition.

GRINDERS—SURFACE

2—Walker Single Stroke. Good as new.
2—Reed-Prentice Vertical, table capacity 12" x 78", including Magnetic Chuck.
2—13' Pratt & Whitney Vertical.
1—Blanchard—16" wheel, 24" Magnetic Chuck.
1—No. 2½ Walker, including Magnetic Chuck.

HAMMERS—POWER

1—New Williams & White 40 lb., Yeakley.
2—New Williams & White 650 lb., Yeakley.
2—800 lb. Bliss, Board Drop.
1—1200 lb. Billings & Spencer, Board Drop.
1—75 lb. Beaudry.
1—100 lb. Bradley Strap.

HAMMERS—STEAM

1—400 lb. Sellers Single Frame.
1—1100 lb. Pittsburgh Single Frame.
1—3000 lb. Morgan Double Frame.
1—New 6500 lb. Massillon.
1—7 ton Morgan Double Frame—1st class condition.

KEYSEATERS

4—New No. 0 Mitts & Merrill.
1—No. 1 Baker.
1—New No. 3 Mitts & Merrill.
1—New No. 4 Mitts & Merrill.
1—No. 5 Colburn 43" stroke.

LATHES—ENGINE

10—New 16 x 8—Cincinnati Quick Change Double Back Geared, Engine Lathe, immediate delivery.
1—18" x 18' Lodge & Shipley Quick Change. Good as new.
1—27" x 40' Bridgeford, geared head, motor driven, arranged for turning only.
1—New 32" x 18' Bridgeford.
1—32" x 24' Fay & Scott.
1—42" x 20' New Haven Triple Geared, face plate drive.
1—50" x 20' New Haven, triple geared, raising blocks to swing up to 72".
1—51" x 18' Fifield triple geared, face plate drive.
1—60" x 28' New Haven, triple geared. Fine condition.
1—90" x 20' Pond, face plate drive.

LATHES—TURRET

2—21" Gisholt 18" Chuck, quick traverse, taper attachment.
2—2 x 24 Jones & Lamson.
1—3 x 36 Jones & Lamson, single pulley drive.
18—6-A Potter & Johnston.
1—3-A Warner & Swasey hollow hex. bar and chucking equipment.

MILLING MACHINES—KNEE TYPE, UNIVERSAL

1—New No. 1 Cincinnati.
1—No. 2 Milwaukee all geared head, single pulley drive, as good as new.
2—New No. 3 Becker Universal Milling Machines. Immediate delivery.
2 New No. 3 Kempsmiths.
1—New No. 3-A Garvin.
1—New No. 4 Le Blond.

MILLING MACHINES—KNEE TYPE, PLAIN

5—New Gooley & Edlund Type A Briggs.
6—New No. 1½ American.
1—New No. 2 Kempsmith.
1—No. 3 Le Blond, with vertical attachment, Modern Tool.
1—No. 5 Cincinnati, geared head, single pulley drive.
2—New No. 15 Garvin.

MILLING MACHINES—VERTICAL

1—No. 2 Cincinnati, single pulley drive.
1—New No. 4-B Becker.
1—No. 5 Becker-Brainard, with rotary table.
2—New Garvin No. 15, table feed 60".

PLANERS

2—24 x 24 x 6' American late type, one head.
1—New 27" x 27" x 10' Woodward & Powell, 2 heads.
1—28" x 28" x 8' Cincinnati 2 speed latest type, 2 heads on rail.
1—30" x 30" x 16' Hamilton, 2 heads on rail. Good as new.
1—36" x 36" x 8' Gray, 2 heads.
1—36 x 36 x 12' Cincinnati, 2 heads on rail, good as new.
1—40" x 40" x 8' Pond, one heavy swivel head.
1—43" x 33' Detrick & Harvey, frog and switch, 2 swivel heads, motor driven, excellent condition.
1—48" x 48" x 12' Niles, 2 heads on rail.
1—60" x 46" x 15' Patch, 4 heads. Excellent condition.
1—16' Hilles & Jones plate planer.
1—18" Hilles & Jones plate planer.

PUNCHES & SHEARS

1—Alligator Shear, capacity 5" in soft steel.
1—No. 5 Canton Foundry Alligator Shear, capacity 3" square steel, motor driven.
1—5' Loy & Nawarth Squaring Shear, capacity 10 gauge.
1—Bertch Boiler Makers, punches 14" stroke, capacity 1" through 1". Geared Type. Good as new.
1—New Beatty 25" throat, capacity 1" through 1". Delivery 30 days.
1—New Kling, 36" throat, capacity 1¼ through 1". 90 days delivery.
1—New Beatty Single End Punch & Shear, 42" throat, capacity 1¼" through 1". 90 days delivery.
1—New Beatty Single End Punch & Shear. 48" throat. Capacity 1" through 1". 30 days delivery.
1—66" Queen City, capacity 4" through 1" or 2" through 2", weight 53,000 lb. Immediate delivery.

ROLLS

1—Set Stacy 8' Bending Roll, ¾" plate cap.
1—Set 10' Niles, capacity ⅜ to ½".
1—Set 14' Hilles & Jones, capacity ½" plate.
1—Set 20' Niles, pyramid type, capacity 1" to 1¼" plate. Drop and housings. Immediate delivery.

SCREW MACHINES—AUTOMATIC

7—¾" Gridley Multiple Spindle, arranged for motor drive.
1—1¾" Gridley, Multiple Spindle, good as new.
20—3¼" Gridley Single Spindle.
1—No. 0 Brown & Sharpe.
1—No. 2 Brown & Sharpe Turret Forming.

SHAPERS

3—New 18" Hollingsworth.
2—New 20" Steptoe, improved single geared crank.
6—New 24" Hollingsworth Triple Back Geared.
1—New 28" Smith & Mills. Crank.
1—30" x 96" Cincinnati Heavy Duty Openside Shaper. Excellent condition.
1—36" Morton Draw Cut.

SLOTTERS

1—New Garvin Die Slotter.
1—10" Newton. Good as new.
1—20" Craven. Good condition.

WM. F. DAVIS MACHINE TOOL COMPANY, Inc.

CHICAGO, ILL.
549 W. Washington Boulevard

CLEVELAND, OHIO
508 Leader-News Building

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945 Pennsylvania Avenue

NEW YORK CITY
85 Liberty Street

WIRE OR WRITE OUR NEAREST OFFICE FOR QUOTATIONS

"BAIRD"-"DETROIT"

IN STOCK
FOR IMMEDIATE DELIVERY

LATHES

2—No. 1 Ideal Precision Bench Lathes.
18—6" x 30" Dalton Precision Bench Lathes.
10—6" x 36" Dalton Precision Bench Lathes.
1—11" x 5' Worcester Semi Q.C.
2—14" x 5' Carroll & Jamieson Q.C.
4—14" x 6' Carroll Jamieson Q.C.
2—16" x 6' Cincinnati Q.C., D.B.G.
2—18" x 8' Cincinnati Q.C., D.B.G.
2—18" x 8' Bradford Q.C., D.B.G.
1—18" x 10' Bradford Q.C., D.B.G.
1—20" x 10' Bradford Q.C., D.B.G.
1—20" x 12' Lodge & Shipley Q.C.
1—24" x 12' Porter Standard.
1—26" x 14' Rahn-Mayer-Carpenter.
1—32" x 16' New Haven.
1—38" x 16' Fifield Triple Geared.
1—42" x 16' Niles D.B.G.
1—48" x 20' New Haven.
1—60" x 25' Fifield Triple Geared.
1—4½" x 84" Lo-Swing (new).

GEAR CUTTERS

2—No. 3 26" Brown & Sharpe Automatic.
1—No. 4 48" Brown & Sharpe Automatic.
1—No. 4 36" Brown & Sharpe Automatic.
2—36" Fellows Gear Shapers.
1—No. 6 Fellows Gear Shaper.
1—No. 1 Farwell Automatic Gear Hobber.

GRINDERS

2—No. 1 Fraser Universal.
1—No. 2 Fraser Universal.
2—No. 1 Wilmarth & Morman Universal.
1—No. 2 Bath Universal.
1—6" x 32" Norton Plain.
1—10" x 24" Landis Plain.
1—10" x 36" Landis Plain.
3—No. 1 Wilmarth & Morman Surface.
2—No. 2 Wilmarth & Morman Surface.
2—No. 3 Wilmarth & Morman Surface.
1—No. 6 Bryant Internal.
1—No. 6A Bryant Internal.
1—No. 1 Capital Internal.
1—No. 34 Van Norman Internal.
1—14" x 72" Norton Plain.

BORING MILLS

1—39" Rogers Vertical.
1—30" Bullard Vertical.
1—42" King Vertical.
1—72" Niles Vertical.
1—8' Bickford Vertical.
1—10' Niles Vertical.
1—No. 0 Fosdick Horizontal 3⅛" Bar (new).

MILLING MACHINES

5—No. 1 U. S. Hand Millers.
1—No. 1 Standard Hand Miller.
1—No. 3 Rockford Hand Miller.
1—No. 2B Rockford Universal (Used).
1—No. 34 Oesterlein Plain (Used).
1—No. 5 Cincinnati Plain (Used).
1—No. 4 Cincinnati Plain (Used).
1—No. 3 Cincinnati Plain (Used).
1—No. 3 LeBlond Plain (Used).
2—No. 2 Brown & Sharpe Plain (Used).
1—No. 32 Kempsmith Lincoln Type (Used).
1—No. 2 Brown & Sharpe Universal (Used).

SHAPERS AND PLANERS

2—16" Hollingworth Crank Shapers.
1—18" Hollingworth Crank Shaper.
1—24" Hollingworth Crank Shaper.
1—16" Milwaukee Crank Shaper.
1—20" Milwaukee Crank Shaper.
1—16" Smith & Mills Crank Shaper (Used).
1—24" Queen City Crank Shaper.
1—24" Bement Traveling Head Crank Shaper (Used).
1—24" x 24" x 8' Lodge & Davis Planer.
1—26" x 26" x 6' Gray Planer.
1—36" x 30" x 10' Cincinnati Planer, 2 Heads.
1—36" x 36" x 8' Niles 1- Rail Head 1- Side Head.
1—42" x 42" x 10' Davis & Egan Planer, 2 Heads.
1—42" x 42" x 10' Detrick & Harvey Open Side Planer; 3- Heads.
1—42" x 42" x 14' Niles Planer, 2 Heads.
1—60" x 38" x 12' Patch Planer, 4 Heads.
1—52" x 52" x 24' Betts Planer, 1 Head.
1—72" x 72" x 16' Pond Planer, 2 Heads.

SCREW MACHINES

1—No. 3A Warner & Swasey Universal Hollow Hex.
1—No. 3 Warner & Swasey Hollow Hex.
1—No. 7 B.&S. Hand Screw Machine, 2" Cap.
1—16" Oliver Hand Screw Machine, 2¼" Cap.
2—⅝ x ⅞ 5-Hole Cleveland Automatic.
1—1¼" 5-Hole Cleveland Automatic.
1—2" 5-Hole Cleveland Automatic.
2—2" x 2¼ Cleveland Automatic.
1—4¼" Gridley Single Spindle Automatic.
1—No. 54 National Acme 4-Spindle Automatic.
3—No. 75 National Acme 4-Spindle Automatic.

MISCELLANEOUS

1—50 lb. Dayton Helve Hammer.
1—75 lb. Bradley Compact Hammer.
1—1200 lb. Williams & White Drop Hammer.
1—Leighton & Hathaway Single End Punch, 40" Throat, Cap. ¾ in ¾.
1—Set Hills & Joes Pyramid Type Bending Roll 9½' between housings, Cap. ½" plate.

Honest Prices---Good Service

W. J. BAIRD MACHINERY COMPANY

265 JEFFERSON AVENUE
DETROIT, MICH.

MACHINE TOOLS

RELIABUILT

A FEW OF OUR GOOD ONES—MANY OTHERS IN STOCK ALL GUARANTEED

MILLERS

New No. 3 Becker Universal.
New No. 4 LeBlond Universal.
Used No. 33 Becker-Brainard Miller.
Used No. 15 Garvin Plain Miller.

PLANERS

1—New, 36 x 36 x 12′ Openside Planer, two heads.
5—New, 48 x 48 x 14, 4 heads, spiral drive, Government specifications.
1—New, Model "A" 42 x 42 x 12 Openside Planer.
3—New, Model "B" 42 x 42 x 12 Openside Planers.
3—Used, 42 x 42 x 14′ Openside Planers.
1—Used, 52 x 48 x 10′ Pond Planer.
1—Used, 52 x 74 x 52 x 24′ Betts, two heads.
1—Used, 54 x 44 x 13′6 Reliabuilt, two heads.
1—Used, 54 x 50 x 12′6 Reliabuilt, two side heads, two rail heads.
1—Used, 66 x 52 x 13′6 Reliabuilt, two heads.
1—Used, 74 x 52 x 14′ Reliabuilt, two heads.
1—Used, 78 x 62 x 14′ Reliabuilt, two heads.
1—Used, 16′ Hilles-Jones Plate Planer.

RADIAL DRILLS

1—Used, 3′ Reed-Prentice Plain Radial, single pulley, tapping attachment.
1—New, 4′ Dreses Plain Radial.
1—Used, 8′ Warren Semi-Universal.
1—Used, No. 17 Foote-Burt four spindle.
1—Used, No. 15 Harrington four spindle.
1—Used, Rockford Six spindle Drill.

GRINDERS

New Premier Tool and Cutter Grinders.
1—Used, No. 5 Brown & Sharpe Universal.
1—Used, 12″ x 72″ Landis Plain.
1—20″ Cylindrical Grinder.
10—New, Dumore Electric Grinders.

LATHES

3—Used, 16″ x 8′ Greaves-Klusman Lathes.
1—Used, 16″ x 8′ Schellenbeck Lathe.
1—Used, 16″ x 8′ Davis Lathe.
1—Used, 18″ x 6′ American Lathe.
1—Used, 18″ x 8′ Cisco Lathe.
1—Used, 20″ x 10′ Lodge & Shipley Lathe.
1—Used, 24″ x 10′ Harrington Lathe.
1—Used, 28″ x 8′ Pond Lathe.
1—Used, 30″ x 10′ Harrington Lathe.
1—Used, 38″ x 16′ D. W. Pond Lathe.
2—Used, 2½ x 36 Marvel Geared Head Lathes.

BORING MILLS

1—Used, Special Bement No. 7 Horizontal Boring Mill.
1—Used, Bement Horizontal Boring Mill, Knee type, 2½″ bar.
1—Used, 7′ Bickford Vertical Boring Mill.
1—Used, Beaman & Smith Floor Type Boring Mill.
1—New, No. 1 Cleveland Horizontal Boring Mill.

AUTOMATICS

1—Used, No. 52 National Acme.
3—Used, 2″ Cleveland Model "A."
1—Used, 2¼″ Gridley Automatic.
1—Used, 2¼″ Cleveland Automatic.

SHAPERS AND SCREW MACHINES

3—Used, No. 32½ Garvin Turret Lathes, wire feed, friction head, back geared, power feed to turret, 2⅛″ capacity.
15—Used, 20″ x 8′ Roulsted Turret Lathes.
1—Used, Conradson Turret Lathe, 24″ swing, thirteen turret holes.
1—Used, 2″ x 24″ Jones & Lamson Cone Type Turret.

MISCELLANEOUS

1—Used, 42″ Niles Car Wheel Borer.
1—3″ Curtiss Cutting-off Machine.
1—Ten Ton Bedford Crane, two Motor Type, 40′ span.
1—Used, No. 2 Whiton Gear Cutter.

WRITE FOR ILLUSTRATED STOCK LIST

FOR IMMEDIATE DELIVERY

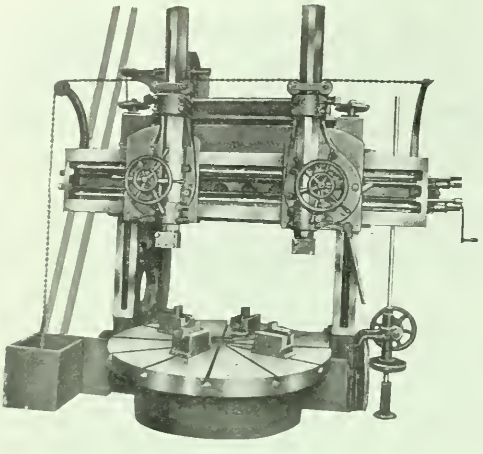
SIMMONS 10-INCH UNIVERSAL DIVIDING HEADS BUILT BY US, PRECISION GUARANTEED, BUY ONE BEFORE THE NEXT ADVANCE

SIMMONS MACHINE COMPANY, INC.,

Main Office and Warehouse
ALBANY, N. Y.

BRANCHES

801 Singer Building, New York
358 Ellicott Square, Buffalo
316 Rialto Building, San Francisco
804 Dime Bank Building, Detroit



Used 72″ Niles Vertical Boring and Turning Mill with two swivel heads. Table 68″ diameter. Takes 45″ under tool. Friction feeds. Driven by six step cone for 4″ belt. Complete with four chuck jaws and countershaft. In excellent condition and can be inspected under power.

DAY MACHINERY CO.

651 ELLICOTT BLDG. BUFFALO, N. Y.

A. D. WHITE MACHINERY CO.

108-114 N. Jefferson Street CHICAGO, ILL.

No. 3 Kempsmith Plain Miller; like new.
No. 1½ Valley City Plain Millers (2); new.
No. 1½ Valley City Univ. Miller; new.
10 x 30″ Landis Plain Grinder.
No. 1 Farwell Gear Hobbing Machine.
No. 2 Mitts & Merrill Keyseater.
No. 6 Long & Allstatter S. E. Punches, 4″ throat, cap. ½″.
Style "G" Rock River S. E. Punch, 12″ throat, cap. ¾″.
No. 1 Rockford O. B. I. Press.
26″ x 25′ Blaisdell Engine Lathe.
28″ x 12′ Fifield Engine Lathe.
32″ x 14′ Pond Engine Lathe.
36″ x 20′ American Triple Geared Lathe.
20″ Cincinnati Pulley Turning Machine.
3/16″ Grant Rivet Spinner.
3/16″ Adt Riveter.
8 Spindle Valley City Mult. Drill, No. 1 taper.
4′ Gang Plain Radial, Gear Box.
34″ W. F. & J. Barnes Slid. Hd. Drill.
42″ W. F. & J. Barnes Sliding Head Drill.

Desirable Used Machinery For Sale

2—H.D. Bliss Milling Machines arranged for cutting steel pinions to 3 pitch.
1—No. 2 Spindle Pratt & Whitney Profiling Machine.
1—42″ x 12′ Engine Lathe with Raising Blocks, to swing 58″, C R. S.B.G., 4 step cone.
1—Williamson Metal Band Saw.
1—42″ King Boring Mill arranged for grinding.
2—42″ King Boring Mills arranged for grinding.
1—12″ x 6′ American Screw Cutting S.B.G. Engine Lathe.
10—No. 3 Potter & Johnston Mfrs. Lathes with pumps.
1—Cleveland Automatic Screw Machine, 2¼″ Bar capacity.
1—Cleveland Automatic Screw Machine, 2″ Bar capacity.
1—No. 8 Lapointe Broaching Machine.
1—3 ft. Dresses Plain Radial Drill.
1—14 x 48 Q.C. Plain Grinder.

The E. A. Kinsey Company

CINCINNATI — INDIANAPOLIS

MACHINERY FOR SALE

Bought New in 1915-16

Used less than twelve months. Low Prices. Immediate Shipment.

LATHES

5—2¾″ Mod. C. Cleveland Auto. Lathes.
6—No. 11 Amalgamated Lathes.
5—Warren Automatic Nosing Lathes.
3—18″ Reed Grooving and Undercutting Lathes.

MISCELLANEOUS

3—Holden-Morgan Mechanical Wrenches.
8—Fairbanks Scales.
2—Sullivan Shell Grinding Machines.
1—12″ Belt Lacing Machine.
1—No. 22 Frankfort Lead Pot Furnace.
1 Pair Ajax Rolls, Size No. 1, 22″ x 11″, new.

Tools for many of the foregoing machines.
Will be sold subject to previous sale, and inspection, before shipment.
Descriptive circulars and price on application.

THE UNION SWITCH & SIGNAL COMPANY, Swissvale, Pa.

FOR SALE

HYDRAULIC HORIZONTAL PRESSES—Two of them—total ram capacity 125 ton and 300 ton. New and complete in every respect. Manufactured by R. D. Wood & Co. Immediate delivery.

EVERLASTING VALVE COMPANY
2 Rector Street New York City

Following used machines for sale, immediate delivery, subject to prior sale. Machines in good running condition and can be inspected in our plant.

One Lincoln Type Milling Machine.
One Cincinnati, Plain No. 4 Miller.
One Hand Miller.
One Mitts & Merrill Key Seater.
One 18″ x 8′ Engine Lathe.
Two—Two-spindle Sensitive Drills.
One 16″ Kelly Shaper.
Two B. & S. Gear Cutters.

THE GRAMM-BERNSTEIN MOTOR TRUCK COMPANY
LIMA OHIO, U. S. A.

First Class Rebuilt Tools

Immediate Delivery

BORING MILLS

2—American 37″ double head vert. boring and turning mills, plain tables.
1—42″ Bullard vert. boring and turning mill, 2 swivel hds., plain table.
1—84″ Pond vert. boring and turning mill, 2 swivel heads, plain table.

DRILLS

20″ Silver w. and l. feed.
20″ Silver b.g., p.f.
24″ Hoefer sliding head, b.g., p.f.
42″ New Haven sliding head, b.g., p.f.
4′ Bickford plain radial drill, gear box drive.

GEAR CUTTERS

24″ Fellows gear shaper.
36″ Fellows gear shaper.

GRINDERS

No. 1 Fraser universal cylindrical grinder.
No. 1 Cincinnati universal cutter grinder.
Landis 10″ x 30″ universal grinder.
Queen City 14″ x 48″ plain grinder, practically new.
Saxon surface grinder, table 36″ x 12″.

LATHES

11″ x 6′ Flather, c.r., h.s.
16″ x 10′ Pratt & Whitney, c.r., h.s.
18″ x 8′ Muller, c.r., h.s.
22″ x 12′ New Haven, c.r., h.s.
24″ x 14′ Putnam, solid spindle, c.r.
28″ x 10′ New Haven, solid spindle, c.r.
30″ x 18′ Draper, q.c.g., c.r., h.s.

MILLING MACHINES

No. 1 Brown & Sharpe universal.
No. 1½ Cincinnati plain, geared feed.
No. 2 Cincinnati plain, geared feed.
No. 2 Cincinnati universal, geared feed.
No. 3 Cincinnati plain.
No. 4 Cincinnati plain.

PLANERS

30″ x 30″ x 6′ Enterprise, one head.

POWER PRESSES

C-3 Ferracute o.b.i. press.
C-4 Ferracute f.b.i. press.
P-2 Ferracute upright press.
P-3 Ferracute upright press.

SHAPERS

18″ Steptoe geared shifting belt.
20″ Walcott geared shifting belt.

SCREW MACHINES AND TURRET LATHES

1/4″ Hartford automatic screw machine.
5/8″ Bardons & Oliver hand screw machine.
2 1/4″ Warner & Swasey screw machine, geared friction head, p.f.

MISCELLANEOUS

4″ Victor pipe machine.
30″ and 36″ Peck, Stow & Wilcox foot power squaring shear.

Send for Complete Purple List

FEDERAL MACHINERY SALES CO.

14 N JEFFERSON ST., CHICAGO

HAVE YOU TRIED US FOR YOUR USED EQUIPMENT?

Here Are Some Good Starters:

Bickford 8′ Vertical Boring Mill, Two Swivel Heads.
W. E. Gang 2½ ft. Radial Drill, Cone Drive.
Prentice 21″ Sliding Head Upright Drill.
Barnes 25″ Stationary Head Upright Drill.
Potter & Johnston 24″ Crank Shaper.
Root No. 4 High Pressure Exhaust Blower.

LYND-FARQUHAR COMPANY
Machine Tool Values BOSTON, MASS.

Planers and Radials

60 x 60 x 18 Betts 3 heads.
36 x 36 x 18 Pond 1 head.
36 x 36 x 16 Sellers 1 head.
32 x 32 x 10 Niles 1 head.
26 x 26 x 8 Niles 1 head.
24 x 24 x 8 American 1 head.
22 x 22 x 6 Gray 1 head.

4½′ Semi Universal.
4′ Bickford Single Pulley Drive.
4′ Baush Plain.
2½′ Bickford Plain.
5 Sliding Head Drills 24 to 46″.
3 x 36 J. & L. Single Pulley Drive.
2 x 24 J. & L. Single Pulley Drive.

2 BULLDOZERS, Nos. 25 and 26, Williams, White & Co.

No. 6 W. & S. Screw Machine.
32 Baush Boring Mill.
No. 2 B. & S. Heavy Miller.
Press 10′ 6″ Bet. Housings.
Press Bliss Drawing 42,000 lbs.
Press Perkins 16 x 24 Bolster.
No. 25 Becker Brainard Miller.

16, 18 and 24 Bk. Grd. Shapers.
No. 7 Bliss Double Crank Press.
36″ x 12′ Slab Miller.
Landis 20″ x 96″ Universal Grinder.
25″ x 24′ Fifield Lathe.
24″ x 14′ LeBlond Lathe.

THE OSBORNE & SEXTON MACHINERY CO.
COLUMBUS, OHIO

M. J. Walsh Machinery Co.

141 Sycamore Street MILWAUKEE, WIS.

USED MACHINE TOOLS FOR IMMEDIATE DELIVERY

One 24″ Fellows Gear Shaper.
Two 36″ Fellows Gear Shapers.
One No. 3—26″ B. & S. Auto. Gear Cutter.
One No. 400 1/4A Toledo Power Squaring Shears.
One No. 2 Brown & Sharpe Auto. Turret Forming Machine.
One No. 3 Bardons & Oliver Turret Lathe.
Two No. 12 Modern Plain Grinders.
One No. 1 Garvin Universal Milling Machine.
Two 30″ Bullard Boring Mills.

---

2 No. 12 Pratt & Whitney GUN BARREL and TUBE DRILLING MACHINES

Immediate Delivery

THE NEW BRITAIN MACHINE CO., New Britain, Conn.

---

1 Type C-3 Straight Side Double Crank Stamping Press

E. W. Bliss manufacture. Practically new. weight 9000. lbs. Size of bolster plate 16 x 41½″. A bargain. Can make immediate shipment. Will advise price if interested.

HOOSIER MANUFACTURING CO. New Castle, Ind.

Here You Are

One PUTNAM 48″ x 48″ x 18′ Planer, two heads on cross rail. As good as new.

Three POTTER & JOHNSTON No. 6A Automatic Chucking Lathes. Excellent condition.

Twenty GRANT Spinning Machines about ¼″ capacity. Excellent condition.

Lathes, Milling Machines, Power Presses, Upright Drills, Screw Machines and others, both new and second-hand in stock.

HILL, CLARKE & CO., Inc.
156 Oliver Street
Boston, Mass.

136 Cedar Street
New York City

MACHINERY

5—New No. 1½ Plain Milling Machines.
8—No. 3 Federal 1 5/16 Screw Machines.
26—No. 1½ Pratt & Wright 13/16 Screw Machines.
5—14″ Pierce Turret Lathes.
5—1″ x 8″ Pierce Screw Machines.
5—4′ Plain Radial Drills.
10—No. 1 Pratt & Wright Bench Millers.
3—Hardinge Cataract Bench Precision Lathes.
20—18″ x 8′ Heavy Duty Wright Lathes.
18—24″ x 10′ Milwaukee Engine Lathes.
34″ to 96″ Swing Fifield Triple Geared Engine Lathes.

Large stock of New and Used Machinery of all kinds

DAVID A. WRIGHT, Chicago, Ill.

Girard Machine & Tool Co.

491-493 N. Third St. Philadelphia, Pa.

ENGINE LATHES

25" x 16' Blaisdell, 12' centers.
24" x 12' Pratt & Whitney.
20" x 10' Hendey.
20" x 8' Reed with taper attachment.
18" x 8' Hendey.
18" x 8' and 10' bed engine lathes with double back gear (12).
16" x 6' new engine lathes with double back gear (10).

TURRET LATHES

2 x 24 Jones & Lamson geared head (5).
2 x 26 Pratt & Whitney all feeds, bar equipment, back geared and friction head.
No. 3 Smurr & Kamen automatic chuck (10).
No. 6 Brown & Sharpe, roller feed (2).
No. 4 Brown & Sharpe, roller feed (2).

Also a large assortment of other makes.

Complete list No. 93, covering big stock, just off the press.

All machines for immediate delivery.

DAY MACHINERY CO.

651 Ellicott Square Buffalo, N. Y.

LATHES

26" x 12' Newark C.R., P.C.F.
36" x 16' Putman C.R., P.C.F.
38" x 16' Fifield Triple Geared.
42" x 16' Niles C.R., P.C.F., D.B.G.
48" x 20' New Haven C.R., P.C.F., Q.C.G.
102" x 32' Triple Geared Screw Cutting.

PLANERS

42" x 42" x 10' Detrick & Harvey Openside. Two heads on cross rail, one side head.
60" x 38" x 12' with Sellers Spiral drive to table. Two heads on cross rail, two side heads.
72" x 48" x 14' Gray. Two heads.
82" x 56" x 10' Woodward & Powell. Two heads.

BORING MACHINES

36" Brown & Sharpe Vertical with one turret head.
42" King Vertical. Two swivel heads.
72" Niles Vertical. Two swivel heads.
10' Niles Vertical. Two swivel heads.
Betts Horizontal with 4" bar.
Bement Horizontal Floor Type with 5" bar.
2—New Gray Horizontal with 6" bar. Immediate delivery.

DRILLING MACHINES

2—No. 12 Pratt & Whitney Gun Barrel or Tube Drilling Machines. Capacity 3" drill 51" long.
Four Spindle Moline Drilling and Boring with special size adjustable table
Ten Moline "Hole Hog" Single Spindle 3" capacity
Two Spindle Foote-Burt Heavy Duty Drilling and Boring Machine
Four Spindle Niles Heavy Duty Rail Type, Working Surface of Table 24" x 10' 4"

MISCELLANEOUS

8" Heald Ring Grinder Magnetic Chuck, 220 V., D.C.
No. 60 Heald Cylinder Grinder
7 ton Morgan Steam Forging Hammer
24" Bement Heavy Duty Shaper
4—No. 2 Brown & Sharpe Automatic Screw Machines Old style 5/8" capacity
No. 2 Lapointe Broaching Machine
2—No. 12 Pratt & Whitney Gun Barrel Tube Drilling Machines, capacity 3" x 51"

What Have You For Sale?

E. B. Stickley Machinery Co.

GOEBEL BLDG. DETROIT, MICH.

1—64" BETTS HORIZONTAL BORING MILL, 4" BAR.
1—24" GISHOLT TURRET LATHE.
2—3 x 36" JONES & LAMSON, BAR EQUIPMENT.
1—3/4" WARNER & SWASEY SCREW MACHINE.
1—24" KELLY BACK GEARED SHAPER.
1—NO. 3 WILMARTH & MORMAN SURFACE GRINDER WITH MAGNETIC CHUCK.
1—22 x 10 HAMILTON LATHE.
1—NO. 59 TOLEDO DOUBLE GEARED STRAIGHT COLUMN PRESS.
2—NO. 59 1/4 TOLEDO DOUBLE GEARED STRAIGHT COLUMN PRESSES.
3—NO. 666 TOLEDO KNUCKLE JOINT GEARED EMBOSSING PRESSES.
1—D.G. NO. 55 FERRACUTE PRESSES.

TELL US WHAT YOU WANT.
WHAT HAVE YOU FOR SALE?

USED MACHINE TOOLS

LATHES

1—26 x 16 Bridgeford.
1—26 x 22 New Haven.

DRILLS

1—20" Barnes, all geared.
4—No. ½, 3 Spindle Avey High Speed, Bench Type.
2—5 ft. Baush Radial.
1—6 ft. Baush Radial.

GRINDERS

2—No. 23 Brown & Sharpe Cylinder.
1—No. 170 Wells Universal Tool & Cutter.
1—No. 6-16" Besly Double Spindle, Ring Wheel.

MILLING MACHINES

1—No. 0 Bickett Vertical Miller & Profiler.
1—No. 2-A Becker Vertical.

PRESSES

6—Straight Sided Inclined Gang, 1½" stroke.
2—Straight Sided Inclined Gang, 2½" stroke.
1—No. 2½ Consolidated Plain Inclinable.

MISCELLANEOUS

1—No. 2 Smurr & Kamen Hand Screw Machine.
1—24 x 24 x 6 ft. Hamilton Planer.
1—No. 2 Bilton Automatic Gear Cutter.
1—No. 3 Canton Portable Crane & Hoist.
1—No. 7 Bellvue Industrial Furnace for gas.
1—No. 40 Connersville Pressure Blower.
1—No. 2 Davis Key Seater.
1—No. 1 Racine High Speed Hack Saw.

VONNEGUT MACHINERY CO.
INDIANAPOLIS, IND.

New Planers—

Immediate Delivery

3-24" x 24" x 6' Powell Standard Planers. Now in New York storehouse, boxed for export.

Full information on application

Powell Machine Co.
243 Stafford St., Worcester, Mass.

Ship Yard Tools

AVAILABLE FOR IMMEDIATE DELIVERY

One Fitchburg Engine Lathe, 52" x 20' bed, geared face plate drive, compound rest; excellent shape.
One Pair Niles Bending Rolls No. 2, 8' x 10" dia., pyramid type, good as new.
One Pair of 4' Light Bending Rolls.
One Pair 3' Light Bending Rolls.
One Horizontal Punching and Bending Machine.
One Oster 6" Pipe Machine.
One Heavy Steel Body Armor Plate Punch.
One 6' Cornice Brake.
One 8 x 8 Air Compressor with Receiver and Tools.
One American Tenoning Machine.
One American Mortising Machine.
One 36" Band Saw.
One Iron Saw Table.

Factory & Mill Supply Co.
137 Oliver St. BOSTON, MASS.

FOR SALE

30" Fosdick Radial Drill, Gear Box..	$ 350
11" x 5' Rockford Lathe and Chuck..	225
12" x 5' Star Lathe, draw Collets....	300
13" x 5' Barnes Lathe and Chuck....	175
18" x 10' Bradford Lathe with Chuck..	750
16" x 6' American Q. C. G..........	950
21" x 16' Fifield Lathe.............	600
4" Armstrong Auto. Pipe Machine....	175
Steptoe No. 2 Pl. Miller..............	600
8 Potter & J. 6-A Automatics........	1300
⅝" Warner & S. Screw Machine......	275
Shaper, Niles-Bement-Pond 16".......	575
20 Sp. Fox Multiple Drill, 1"........	3200
No. 1 Shinn Metal Band Saw, new....	165
Case Hardening Furnace.............	75

B. C. ALLEN MACHINERY CO.
1000 Randolph St. CHICAGO

FOR SALE

1—Brown & Sharpe No. 4 Plain Screw Machine.
2—Brown & Sharpe No. 2 Plain Screw Machines.
4—3 x 18 Norton Grinders.
2—No. 74 National Acme Automatic Machines.
2—No. 54 National Acme Automatic Machines.
3 South Bend Lathes, 12" swing.
1—Peter Garloch Boring Machine (wood).
1—Peter Garloch Wood Turning Machine.

Box A332, care Machinery
148 Lafayette St. New York

Hydraulic Presses

200 ton H. P. Manufacturing Co.
200 ton Chambersburg Eng. Co.
225 ton Niles-Bement-Pond Co.
170 ton Watson-Stillman Co.
90 ton Chambersburg Eng. Co.
350 ton Southwark Fdry. & Mch. Co.
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Cincinnati Ohio, U. S. A.

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1—⅝ Cleveland Automatic Screw Machine.
4—⅝ Automatic Screw Machines.
6—¾ Hartford Automatic.
6—1⅜ Hartford Automatic.
5—2" Cleveland Automatic.
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1—22 x 22 x 5 S. H. Ames Planer.
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34" Bullard Boring Mill.
36" Bullard Boring Mill.
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8" Stover Pipe Machine.
36" Aurora Sliding Head Drill.
1 Spindle H. & W. High Speed Drill.
20" Barnes All Geared Drill.
5' Prentice Plain Radial.
2½' American Plain Radial.
No. 1 Adams Gear Hobber.
No. 12 B. & S. Auto. Gear Cutter.
36" Flather Gear Cutter.
No. 1 Norton Univ. Grinder.
No. 2 Bath Univ. Grinder.
No. 1 Gardner Disc Grinder.
25 lb. Bradley Helve Hammer.
No. 3 Baker Keyseater.
12" x 6' Seneca Falls Lathe.
14" x 6' Flather Lathe.
14" x 6' Hendey, Q.C.G.
16" x 6' Reed Lathe.
16" x 6' Advance Lathe, Q.C.G.
18" x 8' LeBlond.
16" x 10' Prentice Lathe, Q.C.G.
24" x 12' Prentice Lathe.
38" x 14' Fifield Lathe.
No. 1-B K. & T. Univ. Miller.
No. 1 Cinc. Plain Miller.
36" x 36" x 16' Ohio Planer.
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24" x 30'-0" second hand Reed Engine Lathe with compound rest, complete with all regular attachments, including chain drive and 8 horse power, 240 D.C. motor. Excellent condition. Can be seen in operation.

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1—No. 3-A Cincinnati Automatic Gear Cutter, new.
1—No. 11 Atlas Plain Grinder, 10 x 30.
2—Landis Plain Grinders, 10 x 30.
1—No. 1 Norton Universal Tool and Cutter Grinder, new.
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19—Garvin No. 22 Monitor Turret Lathes, with air chucks.
10—Southworth No. 2 Turret Lathes, with air chucks.
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2—"Rockford" No. 5 Geared Presses.
2—"Rockford" No. 6 Straight Side Fly Wheel Presses.
10—"Rockford" 20" Back Geared Drills.
10—"Rockford" 20" Plain Drills.
12—"Rockford" 23" Plain Drills, Geared Feed.
9—"Rockford" 24" Sliding Head Drills.
4—"Rockford" 26" Sliding Head Drills.
3—"Rockford" 26" Sliding Head Drills; Tapping Attachment.
1—"Rockford" No. 2 Double Back Geared Universal Miller; Vertical Attachment; Sleeve and Intermediate Gear; Oil Pump.
1—"Rockford" No. 2 ALL GEARED Universal Miller; same equipment as above.
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C-1, with bolster, bushing and elevator, 1½" stroke, ram knockout.
C-3, with bolster, bushing and elevator, 2" stroke, ram knockout.
C-5, with bolster, bushing and elevator, ram knockout.
P-4 with 2" stroke.

SECOND HAND

Pratt & Whitney five spindle multiple drill.
14" x 6' Rockford lathe, three step cone.
16" x 6' Seneca Falls "Star" lathe, compound rest, quick change gears, taper attachment, pan bed.
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60" x 26' Thayer-Houghton lathe, compound rest, triple geared face plate.
36" x 36" x 6' Niles planer, one rail head, one side head.
36" x 36" x 10' Whitcomb planer, one head.
1" Landis bolt-cutter.
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1⅝" Pearson back geared screw machine, power feed turret.

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2" x 24" Jones & Lamson Turret Lathe, cone type.
30" x 30" x 10' Putnam Planer, 1 head, fine condition.
72" x 45" x 16' 6" Pond Planer, 2 heads.
24" x 72" Bement Massive Shaper, single head, rebuilt.
5" Hurlbut-Rogers Cutting-Off Machine, accelerated feed, motor drive, good as new.
5' 6" Niles Plain Radial Drill, belt drive.
18" x 8' Springfield Double Back Gear Engine Lathe, quick change gear attachment.
12" Sellers Slotter, motor driven.
No. 4 Cincinnati Plain Milling Machine, motor driven.
No. 5 Used Cincinnati Milling Machine.
40" King Boring Mill, latest model.
36" x 6' Fellows Gear Shaper, excellent condition.
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Blanchard Floor Type Grinder, motor drive, good as new.

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3—New 16 x 6 Springfield Ideal Engine Lathes.
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1—16 x 8 Porter Lathe.
1—16 x 8 Reed Lathe.
1—14 x 8 Barnes Lathe.
1—13 x 8 Barnes Lathe.

TURRET AND SCREW MACHINES

1—3 x 36 Jones & Lamson Turret Lathe.
1—4½" Gridley single spindle Automatic Screw Machine.
3—No. 2 Smurr & Kamen Hand Screw Machines.
3—No. 2 Smurr & Kamen Power Feed Hand Screw Machines.
3—14" Pierce Turret Lathes, New.
3—1 x 8 Pierce Hand Screw Machines, New.
3—16" Warner & Swasey P.H. Turret Lathes with air chucks.
4—No. 107 Wells Hand Screw Machines.
2—2" Cleveland Automatic Screw Machines.
1—⅝-¾" Cleveland Automatic Screw Machine.
8—No. 52 National Acme 4 spindle Automatics.
1—No. 53 National Acme 4 spindle Automatic.
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1—No. 60 Heald Cylinder Grinder.
1—No. 6 Bryant Internal Grinder.
1—New No. 2½ Woods Cylindrical Grinder.
1—New No. 2 Woods Cylindrical Grinder.
3—No. 1 Thompson Cutter and Reamer Grinders, New.
3—No. 1½ American Plain Milling Machines, New.
1—No. 0 Brown & Sharpe Plain Milling Machine.
1—No. 13 Garvin Plain Milling Machine.
4—New Burke Hand Milling Machines.

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6—No. 3-36 Brown & Sharpe Automatic Spur Gear Cutters.
2—No. 3-26 Brown & Sharpe Automatic Spur Gear Cutters.
2—No. 13 Brown & Sharpe Automatic Spur and Bevel Gear Cutters.

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1—60 x 48 x 18' Patch four head Planer.
1—36 x 36 x 12' New Haven Planer, S.H.
1—30 x 30 x 7' New Haven Planer, S.H.
2—24" Milwaukee Shapers, New.
2—16" Milwaukee Shapers, New.
3—20" Milwaukee Shapers, New.
3—20" Columbia Shapers, New.
1—20" Hendey Geared Shaper.
1—26" Davis & Egan Geared Shaper.
1—18" Hendey Geared Shaper.
1—60" Bickford Boring Mill.
1—No. 3 Lucas Horizontal Boring Mill.

DRILL PRESSES

2—24" Milwaukee Drill Presses, New.
1—2 spindle Baker H.D. Drill.
1—16 spindle Natco Drill.
1—12 spindle Pratt & Whitney Drill.
3—20" Buffalo B.G., P.F. Drill Presses, New.
3—20" Buffalo Drill Presses, New.
1—38" New Haven P.G. Drill Press.
1—14" Henry & Wright H.S. Drill Press.
3—8" Langelier H.S. Drill Presses.
1—Hammond Flexible Arm Radial Drill, T.A.
1—3½' Canedy-Otto Plain Floor Radial Drill.
2—14" U. S. Plain Drill Presses, New.
3—20" Excelsior Plain Drill Presses, New.

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1—Waterbury Farrell B.G. Heavy G.B.I. Press.
1—No. 2-W Bliss Wiring Press.
1—No. 21 Consolidated Horning Press.
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1—No. 2 Sidney O.B.I. Press, New.
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Rockford, Flywheel, 1⅓ H.P. Motor, 3 phase, 60 cycle, 220 volts, A.C.

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2—10" Burke Bench.
12", 4-spindle Pratt & Whitney Sensitive.
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8" Fairbanks Emery.
No. 60 Heald Belt Driven Cylinder.
No. 70 Heald, Pump, Gear Box, C/S & (1) Extra Whl. Hd.
No. 1 Cincinnati Plain Cutter & Tool.
No. 12 Gardner Duplex Disc, 18" Discs, without Wheel Press.
2—10 x 30" Landis.
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30" x 9 Gould & Eberhardt Horiz. Type Auto. with Regular Equipment.
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Speed Lathe, Countershaft and compound rests.
16 x 6 Lodge & Shipley Patent Head.
16 x 6 Lodge & Shipley Patent Head, with Turret on Carriage.
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12" Curtis & Curtis.

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No. 2 Consolidated Plain Inclinable.

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No. 2 Hoefer Hack.
3½" Burr Cold.
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High Duty Paragon Saw, complete with new Blade.

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1½" Cap, Bardons & Oliver Plain, Round, Hand Feed Turret, Cut-Off and Pan. No Pump, tubing or wire feed. (With Automatic Chuck.)
2" Cleveland Automatic, with Countershaft.
No. 22 New Britain Chucking Machine.
2—No. 23 New Britain Chucking Machines.
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40" Peck, Stow & Wilcox Brake.
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Fay & Scott Turret Shears with hand feed, Hex. Turret.
Fay & Scott Turret Shears with hand feed, Hex. Turret.

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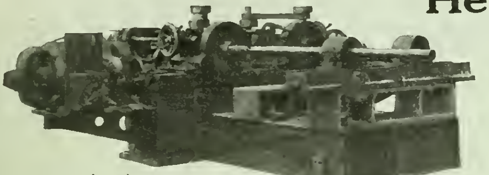

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Two New 6" Horizontal Boring Mills Table Type

Diameter of bar	6"
Faceplate to tail support	78"
Platen	40" x 54"
Travel of Bar, by power	42"
Vertical Movement of Head, by hand	36"
Cross Travel of Platen, by hand	30"
Spindle Speeds, eight	6 to 50 R.P.M.
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- 10 x 30 Landis Cylindrical Grinder; first-class shape.
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- 18" x 6' Hendey Q.C. Lathe, Compound Taper Attachment and Chucks.

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- No. 4½ Bardons & Oliver Hand Screw Machines.
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- 16" Queen City Shaper, cone drive.
- 20" Queen City Shaper, cone drive.
- 2—20" Qneen City Crank Shapers, gear box drive.
- 2—24" Queen City Shapers, cone pulley drive.
- No. 23 Demco Floor Drill.
- No. 32-B Demco Floor Drill, two-spindle.
- No. 32-B Demco Floor Drill, three spindle.
- 3—No. 22 Demco Bench Drills.
- 2—6 x 6 Peerless Metal Saws.
- 3—No. 1 Toledo Hand Milling Machines.
- No. 2 Two-Spindle Washburn Ball Bearing Drills.
- No. 2-B Single-Spindle Washburn Ball Bearing Drill.
- 23" Stationary Head Upright Drill.
- 25" Sliding Head Upright Drill.
- No. 20 Bliss Inclinable Press.
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17" x 8' New Sidney Quick Change D.B.G., Swing 19".
16" x 8' Schumacher Boye.
18" x 6' New Sidney Quick Change D.B.G., Swing 21".
20" x 6' Reed.
24" x 20' Reed.
25" x 14' New Sidney Quick Change C.B.G., Swing 27".
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2" x 24" Jones & Lamson Geared Head.
2" x 24" Jones & Lamson Cone Head.
2—24" Davis Chucking Lathes.
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2½" Bar Warner & Swasey.
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10" Newton.

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36" x 36" x 8' Gray, Two Heads.
30" x 30" 10' Fitchburg, One Head.
24" x 24" x 6' Gray.
16" x 18" x 3' Blaisdell.

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4—14" New Steptoe.
4—16" New Steptoe B. G.
16" Bement Traveling Head Shaper.
2—24" New Steptoe B. G.

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12" x 30" B. & S. Universal.
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10" x 20" Bath Universal.
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14" New Excelsior Sensitive.
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30" G. & E. Sliding Head with compound table.
32" New Superior Sliding Head.
36" New Superior Sliding Head.
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42" Radial Niles.

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350 lb. Sellers Steam.
250 lb. Little Giant Belt—New.
100 lb. Little Giant Belt—New.
50 lb. Little Giant Belt—New.
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60 ton P. & W. Coining Press.
300 ton P. & W. Coining Press.
1000 ton P. & W. Coining Press.
20" Throat Single and Ridgeway Punch, Cap. 1½", 1".
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No. 54 New Beloit Punch and Shear.
No. 53 New Beloit Punch and Shear.
No. 52 New Beloit Punch and Shear.
2—No. 2 Stiles Presses.
2—No. 1 Stiles Presses.
2—No. 130 New Max Ams Inclinable Presses.
3—No. 126 A New Max Ams Inclinable Presses.
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13" x 16" New Peerless High Speed.
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¼" to ⅜" National Six Spindle Nut Tapper.
3/16" to ½" National Five Spindle Nut Tapper.
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16" x 10' Automatic Threading Machine.
7' Swing Pitt Lathe.
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LATHES

"PUTNAM" screw cutting, 22 in. x 10 ft., heavy duty double back gears, semi-quick change face plates, tool post, c-s, etc. In excellent condition; $1250.

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SCREW MACHINES

"BROWN & SHARPE" No. 6, with 7-hole hexagon turret and power feed, friction head, oil pan and pump, wire feed, cut-off rest and tool posts, friction c-s. In excellent condition. Bargain; $950.

"GARVIN" No. 32¼ with 6-hole hexagon turret and power feed, back geared, friction head, tool posts, wire feed and c-s. Like new; $515. Without wire feed, $375.

"WARNER & SWASEY" No. 2 hexagon turret, power feed, oil pan and pump, about 25 collets, cut-off rest, wire feed and c-s. Good condition; $500.

"NATIONAL-ACME" Automatic, 4-spindle, 2½-in. capacity. Not a new machine, but includes an abundance of parts and is in very good condition. Bargain; $900.

GRINDERS

"LANDIS" No. 1 Full Universal, single pulley drive, all complete. In good condition. Extra parts; $1050.

"CINCINNATI" No. 4 Full Universal, 18 x 78 in. Like new, all complete; $4150.

REMEMBER WE PAY FREIGHT TO ALL POINTS!

Send for Complete List.

TERMINAL MACHINE CO., 404-408 Broome St., New York City

Guaranteed Machinery

All Owned By Us—Immediate Delivery

LATHES

2—13 x 6 Carroll-Jamieson semi-quick change (new).
1—14 x 8 Lodge & Shipley quick change, taper attachment.
1—14 x 6 Prentiss quick change, complete.
2—15 x 6 Sebastian gap (new), complete.
2—15 x 6 Maydrite, brand new, complete.
1—16 x 32 x 12′ Fay & Scott gap, with chuck.
1—18 x 8 Mueller quick change (new), double back geared.
2—16 x 8 Greaves & Klusman, complete.
1—21 x 36 x 16 LeBlond gap, heavy duty, quick change, double back geared (new).
2—26 x 14 Schumacker & Boye, double back geared, quick change, complete.
1—28 x 14 Pittsburgh double back geared, complete.
1—24 x 48 x 10 Rahn-Larmon, extension bed, quick change, taper attachment (new).
1—90 x 20′ face plate drive Pond, complete.
1—26″ blocked to 32″ x 16′ Lodge & Shipley quick change double back gear engine lathe.

MILLERS

1—No. 24 Ohio Universal (new).
1—No. 34 Ohio Universal (new).
1—No. 4 LeBlond Universal (new).
1—No. 2 Kempsmith Universal (new).
1—No. 2 Cincinnati Universal (new).
1—No. ½ Valley City Universal (new).
1—No. 1 Kempsmith Universal (new).
1—No. 1 Cincinnati Universal (new).
1—No. 2 Kempsmith Plain (new).
1—No. 3 LeBlond Plain, with vertical attachment.
3—No. 25 Becker Plain.
2—No. 4-B Becker, with rotary table.
1—No. 5 Becker Vertical, with rotary, complete.
1—No. 6 Becker Vertical, with rotary, complete (new).
1—Becker-Brainard Slab Miller, working surface of table 84 x 20, distance between housings 42″, slightly used, good as new.
1—Brown & Sharpe Plain Miller, equivalent to No. 5.

TURRET LATHES

1—2 x 24 J. & L. cone drive, bar equipment.
1—3 x 36 J. & L. geared head, chuck equipment.
1—3 x 36 J. & L. geared head, bar equipment.
1—2½ x 26 Pratt & Whitney, flat turret, chuck equipment.

SHAPERS

1—14″ Steptoe, brand new.
1—14″ Smith & Mills (new).
1—16″ Smith & Mills (new).
1—24″ Potter & Johnston Universal (new).
1—28″ Smith & Mills triple geared (new).
1—14″ Walcott Geared Shaper with countershaft.
1—16″ Ohio Crank Shaper, with countershaft.
1—26″ Davis & Egan Geared Shaper, with countershaft.
3—7″ Rhodes Horizontal Shapers.
2—No. 1 Rhodes Vertical Shapers, brand new, complete.

BORING MILLS

1—Newton-Duplex Horizontal, 2½″ bar.
1—Binsse Horizontal, 2½″ bar.
1—No. 3A Fosdick Horizontal, 3⅛″ bar (new).
1—24″ Bullard Vertical Turret Lathe, turret and side head.
1—36″ Bertram Vertical, single turret head (new).

GRINDERS

1—No. 1½ Cincinnati Cutter and Reamer (new).
1—8 x 30 Norton Plain (new).
1—10 x 72 Brown & Sharpe Plain, complete.
1—No. 3 Modern Universal (new).
1—No. 3 Landis Universal (new).
1—No. 6 Duplex Internal and External.
1—No. 60 Heald Cylinder.
1—No. 75 Heald Internal.
1—Pratt & Whitney Vertical Surface Grinder, will grind wet and dry, with magnetic chuck, complete, good condition, guaranteed A1.
1—No. 3 Brown & Sharpe Universal Grinder, in good condition, equipped only with tail and head stock.
1—No. 21 Landis Plain Grinder, used, complete.

PLANERS

1—26 x 26 x 7 Pond heavy duty, single head.
1—36 x 36 x 8 Flather, two heads on cross rail (new).
1—30 x 30 x 8 Harrington, single head.
1—36 x 36 x 10′ Woodward & Powell, two heads on cross rail (new).
1 48 x 48 x 16′ Detrick & Harvey open side planer, two rail heads, one side head.
1—30 x 30 x 6 Heavy Duty Putnam Single Head Planer, condition like new.

AUTOMATIC SCREW MACHINES

1—No. 2 National Acme, four spindle.
2—4½ Gridley.
1—⅝″ Cleveland, single spindle (new).
1—¾″ Cleveland, single spindle, complete.

RADIAL DRILLS

1—3′ Morris plain (new).
1—3½′ Cincinnati-Bickford, single pulley drive (new), plain.
1—4′ Prentiss, single pulley drive, plain.
1—5′ Prentiss, plain.
1—6′ C & C portable radial girder drill, complete with motor and carriage on wheel.
1—4′ Cincinnati-Bickford Single Pulley Drive Universal Radial Drill, used, condition like new.
1—4′ Bickford Plain Radial Drill, complete.
1—5′6″ Niles Plain Radial Drill, complete.
1—3′ Prentiss Plain Radial Drill.

CRANES

1—5-ton Locomotive, standard gauge.
1—20-ton McMyler, boom 45 ft., 8 wheel, completely overhauled.
2—3 ton P. & H. Cranes, new 22′2″ Span, lift 25′, having 3 motor cage control, 220 D.C.
3—3 ton P. & H. Cranes, new 21′6″ Span, 45′ lift, having 3 motor cage control, 220 D.C.

MISCELLANEOUS

2—14″ Nutter & Barnes Cold Saws.
1—No. 2 Royersford Double End Punch and Shear, capacity ½″, 12″ throat.
1—Large Weis & Coes Punch and Shear, capacity ¾″, 18″ throat.
1—Newbold Circular Shear, 14″ blade, 22″ throat.
2—48″ Throat Beatty Heavy Duty Single End Punch, brand new, angle jaws and shearing attachment.
1—3½O Bliss Toggle Press, practically new.
5—No. 5 Langelier Swaging Machines.
1—2½″ Detrick & Harvey Bolt Cutter, no dies, in good condition.
1—500 lb. Kirkwood Steam Hammer.
1—1000 lb. Billings & Spencer Board Drop Hammer.
1—300 lb. Beaudry Hammer.
1—500 lb. Kirkwood Steam Hammer.
1—300 lb. Billings & Spencer Board Drop Hammer.

Also Engines, Boilers, Cranes, Air Compressors, Presses, Drop Hammers, Blowers, Motors, etc. We will look up for you any machine you want.

SPECIALS—SPECIALLY PRICED

3—No. 4 Manville Double Stroke Headers, and

7—No. 4 Manville Single Stroke Headers, capable of taking material up to ¾″—cold.

19—No. 4 Manville Thread Rollers. Largest diameter of screw, ¾. Greatest length of threads, 3⅜.

13—Bolt Trimmers, manufactured by Manville. Largest blanks handled, ⅜. Longest, 4½. Shortest, ¾. Stroke of punch, 5″.

10—Ferracute Presses.

5—American Gas Furnace Co.'s Carbonizing Tempering Furnaces, including electric heat control. All in first-class condition.

We have in our warehouse for immediate delivery about 500 modern machine tools.
Are always equipped to fill any demand. All machines guaranteed. Try us.

MODERN MACHINERY EXCHANGE

NEW YORK CITY

Office: 25 Church Street
Warehouse: 52 Walker Street

Practically New Equipment

16-in. x 8-ft. LeBlond Tool Room Lathe, quick-change gear, taper attachment, relieving attachment.

18-in. x 8-ft. Oliver Double Back Geared Lathe, quick-change gear.

18-in. x 8-ft. Oliver Lathe, Double Back Gear, quick-change gear, taper attachment and oil pan.

19-in. x 10-ft. LeBlond Heavy Duty Manufacturing Lathe, double back geared, semi-change feed, cross and longitudinal stops, taper attachment.

21-in. x 12-ft. LeBlond Heavy Duty Manufacturing Lathe, double back geared, semi-change feed, cross and longitudinal stops, taper attachment.

No. 2 Cincinnati Cone Type Universal Milling Machine.

No. 3 Cincinnati Single Pulley Drive Universal Milling Machine.

3¼ Gridley Automatic Screw Machine.

No. 56, Four-Spindle, 2¼-in. National-Acme Automatic Screw Machine.

2—3¼ x 36 Cincinnati Acme Flat Turret Lathes, chucking equipment.

No. 2 Woods Universal Cutter and Tool Grinder.

Gisholt Machine Tool Co.'s Universal Tool Grinder.

Style "E" Point Wilmarth & Morman 3-phase, 60-cycle, 220-volt A.C. Drill Grinder.

No. 2 Gardner Machine Co.'s Disc Grinder, with two 14-in. ring wheel chucks; equipped with 3-phase, 220-volt, 60-cycle A.C. motor.

10 x 24 Landis Plain Self-Contained Grinder.

22 x 72 Pratt & Whitney Vertical Surface Grinder, with magnetic chuck, 45-hp., 3-phase, 60-cycle, 220-volt A.C. motor.

2—14-in. Allen High-Speed Ball Bearing Drills.

26-in. Barnes All Geared Sliding Head Drill, with tapping attachment.

2½-ft. Arm American Radial Drill, with speed box drive and round table.

Fox Multiple Spindle Drill, with 14 x 32 rectangular head, bored for 20 spindles and equipped with 16.

36-in. Bullard Vertical Turret Lathe, with cutting lubricant system.

14-in. Gould & Eberhardt Crank Shaper.

No. 3 Lapointe Machine Tool Co.'s Broaching Machine.

150-ton, 36-in. Lourie Hydraulic Tire Wheel Press.

2-C, 6 x 6 Racine High-Speed Metal Cutting Machine, with three-speed attachment, 220-volt, 3-phase, 60-cycle motor.

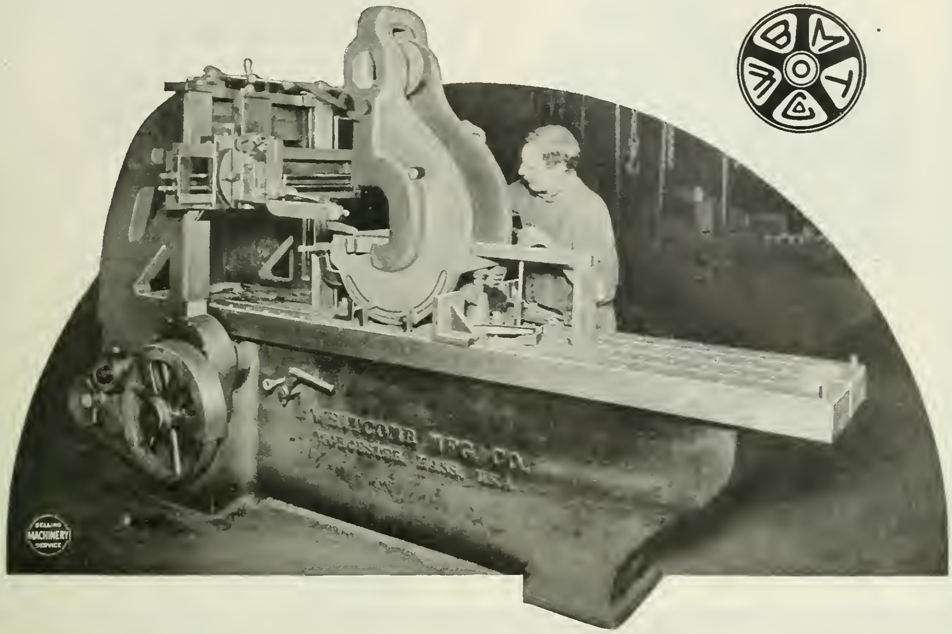
National Brake & Electric Co.'s 300-cu. ft. Air Compressor, with 54-hp., Allis-Chalmers, 3-phase, 60-cycle, 220-volt motor, with 4 x 12 tank.

46-ft. 10½-in. Span Case Three-Motor Crane, 20-ft. lift; equipped with two 15-hp. and one 3-hp. General Electric motors, 3-phase, 60-cycle, 220-volt, and operator's cage.

MACHINERY DEPARTMENT

THE W. M. PATTISON SUPPLY CO.

CLEVELAND OHIO, U. S. A.



A Mean Job—

Planing the bed of a power press frame allows not the slightest variation in the cutting stroke. That's why it's put up to the Whitcomb-Blaisdell Second Belt Planer in the Standard Machinery Company's plant at Providence.

They make all kinds of machinery in this shop, and the mean job—the special piece of machining—always goes to their Whitcomb-Blaisdell, because, in spite of its twelve years' service, it is a machine they can depend on for A-1 results.

Noiseless operation is a characteristic of this well-designed machine, and distinctive control features facilitate handling the wide range of work to which it is adapted; self-locking dogs, that can be adjusted by hand, and patented cross rail binder, instantly adjustable from a central point.

These and other interesting construction details are fully described in our Planer Catalogue. Write for it.

Whitcomb-Blaisdell Machine Tool Co.

Worcester Mass., U. S. A.

You Can Depend Upon A TRAHERN Pump

TRAHERN Pumps are simple in construction, efficient, economical and CAN BE DEPENDED UPON to get any lubricant to the cutting tool in copious streams free from pulsations. They are provided with an automatic relief valve which enables you to cut off the supply at discharge without stopping the pump, eliminating expense of an independent relief valve.

Let us furnish you with complete details and illustrations showing the use of a TRAHERN Pump on various machines.

TRAHERN PUMP COMPANY
DEPT. 10
ROCKFORD, ILL. 1328 BROADWAY, NEW YORK CITY

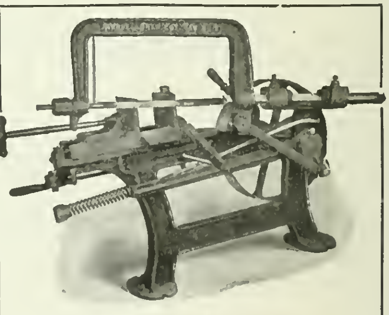
Two High Grade Hack Saws

Marvel Hack Saw No. 1

Marvel Hack Saw No. 1 has capacity for stock 4″ x 4″, is adapted for general shop use. Pressure on saw blade is adjustable. Stops automatically when work is cut off.

The Marvel Draw Cut Hack Saw Machines live up to their name in every particular. They are clean-cut, hard working, built for strain and endurance.

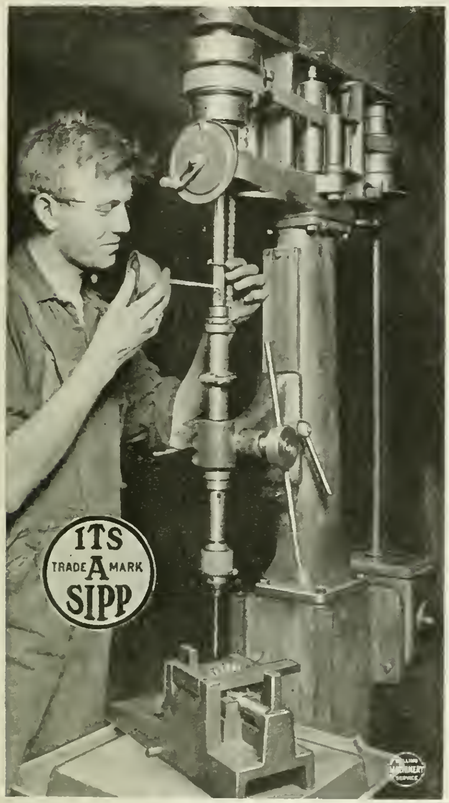
Both machines combine accuracy with durability. Write for details.



Marvel Hack Saw No. 2

Marvel Hack Saw No. 2 is a twin brother to No. 1 but has capacity up to 6″ x 6″ on the long stroke and 8″ x 8″ on the short stroke. Automatic stop and heavy vise swivelling in either direction are features of this machine.

ARMSTRONG-BLUM MANUFACTURING CO.
343 North Francisco Avenue CHICAGO, ILLINOIS, U. S. A.



The SIPP *PRIMER*

Lesson No. 2—Oiling

What is this man doing?

He is oiling the spindle of the Sipp Drilling Machine.

Why, are not all drilling machine spindles oiled in that way?

Hardly!

You see the oil groove sealing-shim he is holding clear in his left hand?

Yes, what is that for?

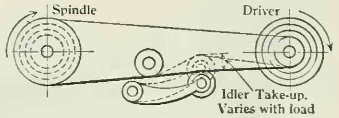
It is to seal the oil grooves after oiling against the entrance of dirt and foreign matter into grooves and bearing.

Does the Sipp need any other lubrication attention?

All the transmission gears, its ball bearings, etc., turn in oil baths, which once filled, last almost a year.

So you see, the Sipp is more independent of the personal factor than any other drilling machine in the world. It is fool-proof.

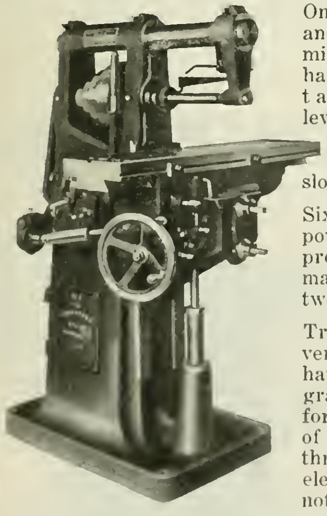
THE SIPP PRINCIPLE



THE SIPP MACHINE CO.

PATERSON NEW JERSEY

The New DAVENPORT
No. 2 Milling Machine



On this new hand and power feed milling machine, hand feed is obtained through lever, for rapid feed, or wheel, for slow feed.

Six changes of power feed are provided by the manipulation of two levers.

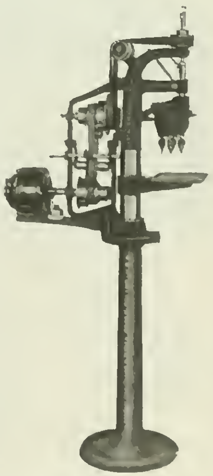
Transverse and vertical screws have adjustable graduated dials for gaging depth of cut. Hole through floor for elevating screw not necessary.

Send for full particulars.

THE DAVENPORT MFG. CO.

MEADVILLE PENNSYLVANIA

Landau 4 in 1 Drill Press

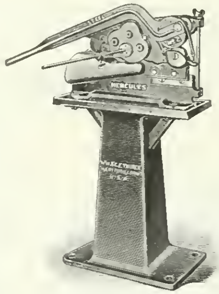


The Landau is four machines embodied in one. Each spindle is a separate machine. One spindle drills, one counterbores, one countersinks, one taps. While one operates, the others remain idle. Only enough power required to operate one spindle. Only 12 x 28-in. floor space required. Runs by motor or countershaft. The r.p.m. is changed quickly by simple lever shift to suit the job in hand. Similar in operation to the turret lathe. We also have a bench style machine.

Send for details

Landau Machine & Drill Press Company, Inc.

19 W. 44th Street New York City


Nos. 1, 2 and 5

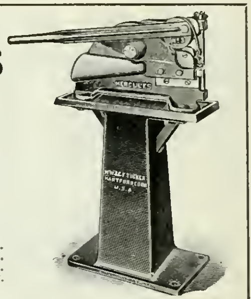
Hercules Shears and Rod Cutters

In Six Sizes

Are preparedness tools in that they are always ready to do that job of sheet, bar and iron or soft steel rod cutting. No tools to adjust, belts to break, no drag on the power plant. Feed the material to the machine and work the lever with low cost labor. Rods can be cut with ends ready to thread, or spin over forming rivet head without additional machining.

No. 0 cuts 1/16" flats and under.
No. 1 cuts 3/16" flats and under
No. 2 and 3 cuts 1/4" flats and under.
No. 4 and 5 cuts 5/16" flats and under.

No. 0 cuts rods 1/8", 3/16", 1/4" and under.
No. 1 cuts rods 1/4", 3/8", 1/2" and under.
No. 2 cuts rods 3/8", 1/2", 5/8" and under.
No. 5 cuts rods 1/2", 5/8", 3/4" and under.

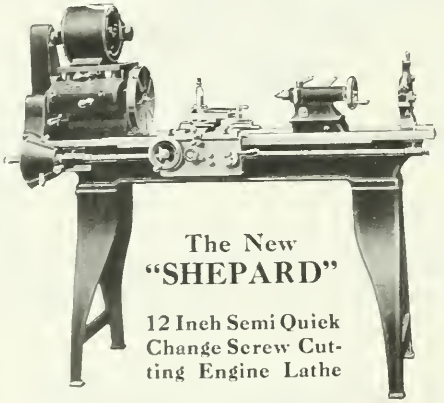

Plain Shears—3 and 4

Send for Shear Catalog

Manufactured and for sale by **W. M. & C. F. TUCKER** HARTFORD, CONN., U. S. A.

ADDITIONAL IMPROVEMENTS IN

SHEPARD LATHES

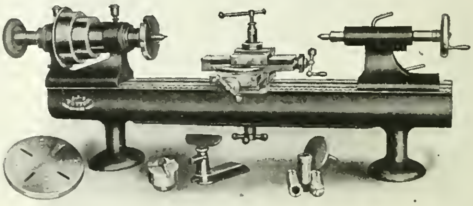

The New "SHEPARD"

12 Inch Semi Quick Change Screw Cutting Engine Lathe

Several new machines have been added to the New Shepard Line, among them this all geared head model, with individual motor drive mounted on the headstock. This machine has all the distinctive New Shepard features—the reversing lever in the headstock, which obviates stopping the machine to reverse, being one of the more important. Complete description and full line on request.

SHEPARD LATHE COMPANY
Canal and Jackson Sts. Cincinnati, Ohio

S·A·POTTER *Precision Bench Lathe*



Rigid yet not Cumbersome

Bed is sufficiently wide to insure rigidity without the addition of undue weight. Head and tail stocks are carefully fitted to master plates. Bearings are adjustable for wear. Large dials on compound rest are instantly adjustable. Swings 7". Collet capacity ¾". Three speed grinding countershaft.

Ask for circular.

S. A. POTTER TOOL & MACHINE WORKS
79 EAST 130th STREET, NEW YORK CITY

SWIND SAWS SAVE SPACE

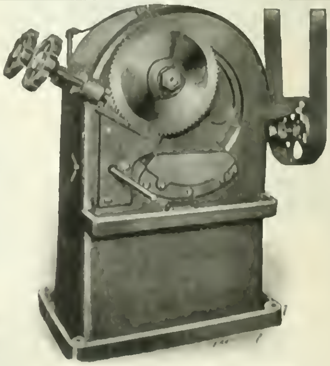
The Swind Cold Saw is designed for use where every foot of floor space counts. You can put it in any corner of your stock room.

THE Swind Cold Saw has an improved automatic device for correctly feeding the saw to the work.

The Swind Cold Saw is unusually rigid and powerful for its size, and there is ready access to all working parts. Capacity $3\frac{1}{4}''$.

Send for a complete description.

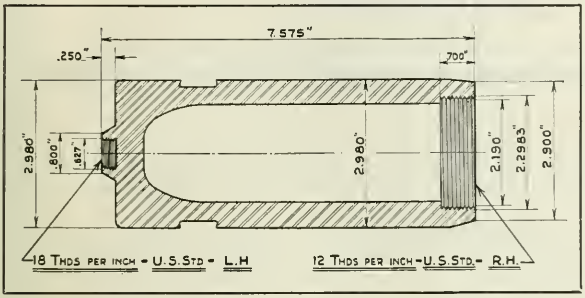
Swind Machinery Co.
Widener Building Philadelphia, Pa.



Read This Letter About

SMALLEY-GENERAL THREAD MILLERS

The following is part of a letter from the Spencer Engineering Company, Toledo, Ohio:—


7.575"
.250"
.700"
2.980"
.800"
.627"
2.980"
2.190"
2.2983"
2.900"
18 THDS PER INCH - U.S.STD - L.H
12 THDS PER INCH - U.S.STD. - R.H.

"We had these machines working on a contract for the United States Government for 3" steel shells. We maintained a production of 54 shells per machine hour, cutting a 2¼" thread, 12 pitch, U. S. Standard; also 84 shells per machine hour, cutting a ⅝" thread, 18 pitch, U. S. Standard. Scrap was practically nil, owing to the accuracy with which your machines perform. Upkeep of hobs was very small. We have cut as many as 5000 threads with one hob. This would be impossible to do with taps. These machines are still running in our plant, and have not given us one minute's trouble. It does not take experienced men to run them."

What better recommendation could a machine receive? Specifiations upon request.

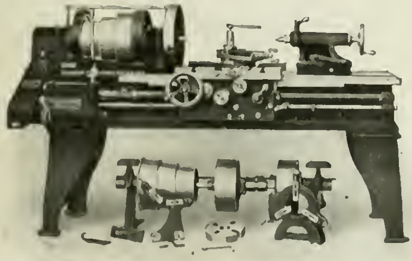
SMALLEY-GENERAL COMPANY, Inc.
BAY CITY MICHIGAN

CHAMPION

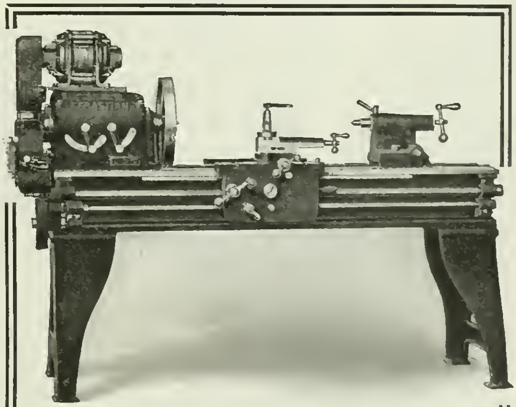
Developed *since* the introduction of high speed steel, the Champion is fully prepared to handle the hardest jobs of modern practise. It has no "spotty" reinforcement—it is strong *all over.*

Four sizes—12" to 18". Complete details on request.

LATHES



CHAMPION TOOL WORKS CO.
4955 Spring Grove Avenue CINCINNATI, OHIO



SEBASTIAN LATHES

The experience of thirty years of exclusive lathe building stands back of our lathes. Built in three sizes—13-, 14-, 15-inch Swing, with Geared Head, Cone Head, Plain or Quick Change.

Write for complete catalog

THE SEBASTIAN LATHE CO.
154 Culvert Street CINCINNATI, OHIO

Machinery Manufacturers are Invited To Co-operate

Does the idea of a *permanent* exhibit in the very heart of New York, with its sales possibilities, and in co-operation with other manufacturers in the same field, appeal to your sound judgment? Many machine tool builders are of the opinion that this project will give a distinct advantage to the concerns taking part in it.

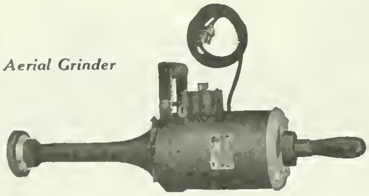
The plan does not contemplate a brief exhibit of any one product or class of products; but is to provide for the continuous display, in action if advisable, of machines and tools of all kinds. It is to provide for a permanent installation of machine tools, with demonstrators, etc. It is a big plan, developed by men who have made successes of similar plans, and is bound to succeed with the proper co-operation.

The place—Grand Central Palace. Space—50,000 square feet. Power, light, heat, etc. Ideal location—for the development of exports as well as domestic sales.

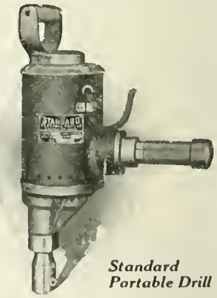
Send for prospectus. Address

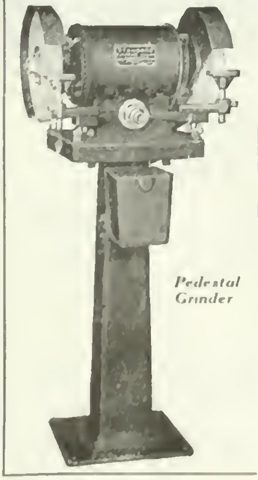
MACHINERY SALES DEPARTMENT

GRAND CENTRAL PALACE NEW YORK CITY


Aerial Grinder

Bench Grinder


Standard Portable Drill


Pedestal Grinder

For economy's sake use Electric Portable Tools; for the sake of the job see that your tools are the best to be had.

Standard Electric Drills and Grinders

are made to fill practically every need and are *built for wear*. Let us send our catalogue—if you've used electric portables you'll appreciate "Standard" values; if not, it will help you realize the labor saving possibilities still before you.

THE STANDARD ELECTRIC TOOL CO.

New York Office:
Marbridge Bldg., 1328 B'way

CINCINNATI, OHIO

Chicago Office:
10 So. La Salle Street

For Grinding Those Heavy Castings—

Think of the time, labor and money you would save if you equipped your plant with Haskins Flexible Shaft Machines. It would no longer be necessary to carry the work to the grinder—simply attach the Haskins to a convenient light socket near the work and grind away.

Haskins Flexible Shaft Machines are 20th Century equipment. They enable you to conserve time and labor, both important factors in these times of shortage of help. They will pay for themselves time and again in your plant.

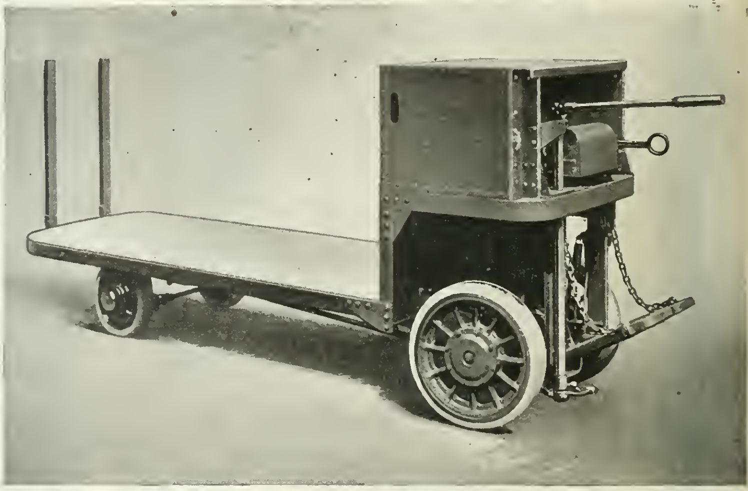
Haskins Flexible Shaft Machines are made to stand hard use and give long service. Flexible shaft troubles amount to practically nil in the **Haskins**, because of the accuracy and precision with which they are constructed. You'll like Haskins Flexible Shaft Equipment, and the three-speed countershaft which gives low speed for heavy grinding and high speed for light grinding is a feature exclusively found in Haskins Machines.

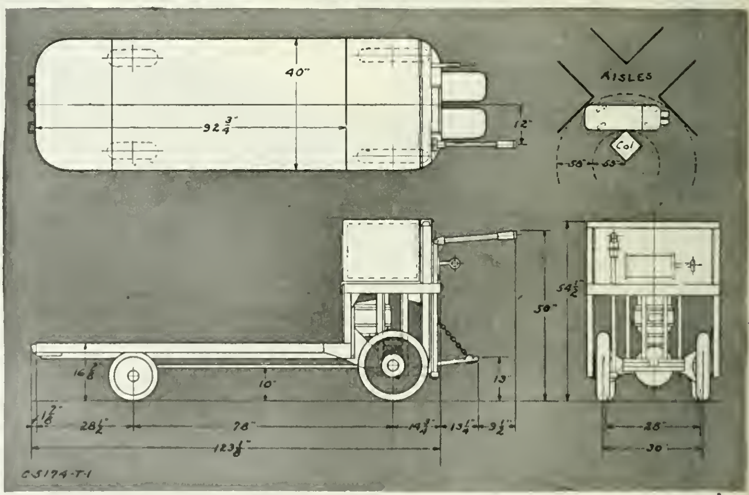
Write for our catalog

R. G. HASKINS
541 W. Washington Blvd., CHICAGO

QUICK DELIVERY

Of materials is assured between factory departments at least expense where Elwell-Parker trucks or tractors are used. Built to fit the job and withstand hard usage.





TYPE WB TRUCK—SPECIFICATIONS

Four-Wheel Steer, Two-Wheel Drive. Motor Direct Connected to Worm on Full Floating Axle. Brake Between Motor and Four-Pinion Bevel Differential. Battery over Drive Wheels Fully Assembled and Wired in One Removable Box.

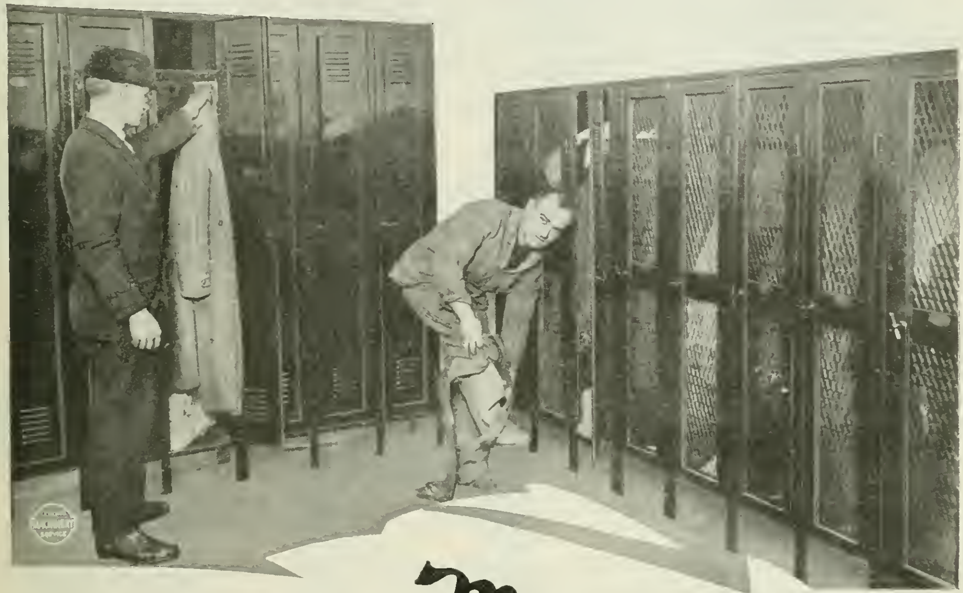
Motor—Elwell-Parker Heavy Duty, Enclosed
Controller—Elwell-Parker Self-Returning Drum Type
Circuit Breaker—Patented, Independently Foot Operated.
Speeds—Three in Either Direction
Brake—Independently Foot Operated, External Contracting.
Drive—Single Reduction Worm, Steel to Bronze
Axles—Both Support Frame on Springs.
Wheels—Drive, Spoked, Extra Large, Demountable
Steering Levers and Knuckles—Cast Steel or Forged; Bushed.
Steering Pins—Hardened and Ground, Rigid in Yokes.
Frame—Hot Riveted Heavy Steel with Malleable Castings.
Platform—Maple and Cast Iron with End Stakes and Coupler.
Signal—Electric or Mechanical Horn.
Tires—Solid Rubber, Press-on Type, Drive 21½ x 3½ Inches. Rear—15 x 3½ Inches.
Carrying Capacity—4000 Pounds.
Speed—375 to 525 Feet per Minute, i.e., 4¼ to 5¾ M.P.H. Outer Corner of Platform Swings on 9-Foot 3-Inch Radius. Inner Edge of Platform Swings on 4-Foot 5-Inch Radius. Lead or Edison Battery Equipment.

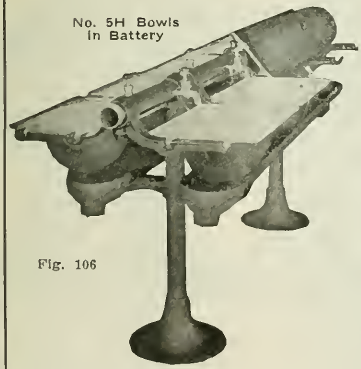
THE ELWELL-PARKER ELECTRIC CO.
Pioneer Builder of Electric Industrial Trucks
CLEVELAND, O.

Boston, Worcester, New Haven, New York, Philadelphia, Baltimore, Washington, Atlanta, Pittsburgh, Buffalo, Youngstown, Detroit, Cincinnati, Chicago, Milwaukee, Indianapolis, St. Paul, St. Louis, Kansas City, San Francisco, Portland, Seattle, Denver, Montreal.

TIMES HAVE CHANGED

"Cleaning Up" Means Something in This Shop





No. 5H Bowls in Battery

Fig. 106

Made in double and single batteries—arranged for hot and cold or one temperature water. Our line also includes: Metal Stock and Pattern Storage Racks, Metal Shelving, Metal Cabinets, Vault Fixtures, Soda Kettles (40 and 60 gallons), Metal Stools and Chairs, Water Mixers, Work Benches, Bench Legs, Full line of Plumbing Fixtures, etc. Send for complete catalog.

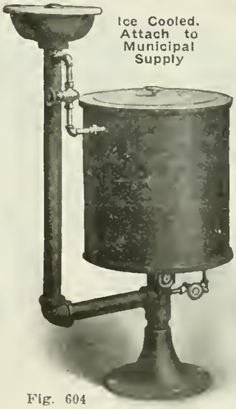
MEECO

Metal Equipment For Shop And Factory

An old time machinist will tell you that in his 'prentice days, provision for "cleaning up" was a bucket half full of cold water kept under his machine—that he stored his overalls on his stool and hung his coat on a hook in the shop.

How times have changed—individual enamel basins, an abundance of hot water and separate fire-proof lockers give "cleaning up" a real significance in the shop where this picture was taken. Ice cooled, bubbling drinking fountains replace the pail and dipper of by-gone days and sanitary metal furniture the dirt grimed bench and rack.

Sanitary, up-to-date shop equipment is our specialty. Send for circulars.



Ice Cooled. Attach to Municipal Supply

Fig. 604

Supplies 150 people; holds 75 pounds of ice. 15½ coils ½ inch seamless brass tubing. Attaches to municipal water supply.

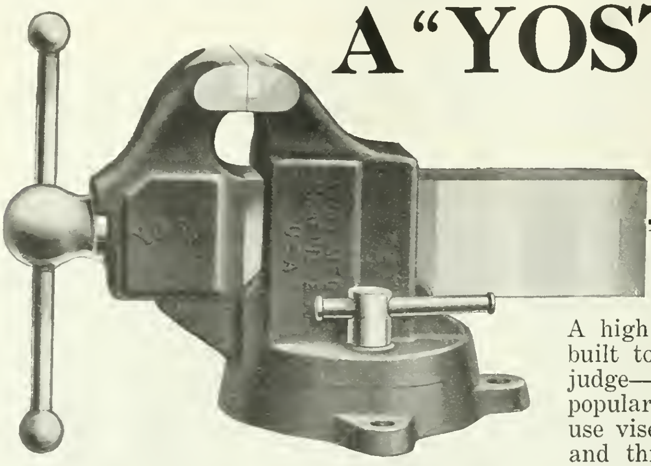
Manufacturing Equipment & Engineering Co.

Office and Show Rooms Boston, Massachusetts

Works and Mail Address, Framingham, Mass.

A "YOST" VISE

Solid Jaw
Swivel Base



A high grade machinists' vise, built to suit that most critical judge—the skilled mechanic. A popular vise with the men who use vises in their daily work—and this we consider the best recommendation that any tool can earn.

There's a big family of Yost Vises—vises for every purpose—every one designed and built with the proper distribution of carefully selected metal — every vise guaranteed to give satisfactory service under all working conditions.

Buy Yost Vises and you'll make a good investment.

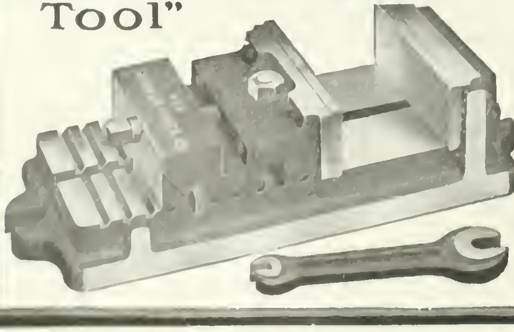
Catalog No. 8 lists full line—send for a copy.

YOST MANUFACTURING CO., Meadville, Pa.

SKINNER DRILL PRESS VISES

"The Handy Tool"

This Vise is designed for holding work on a drill table. It is similar in construction to the Skinner Planer Chuck, but more portable and convenient for use on a drill. It can also be used to advantage on Planers, Shapers, Milling Machines, etc.



BODY—Carefully machined and highly finished casting, provided with lugs on side so vise may be used at right angles.

JAWS—Of good proportion with steel faces. "V" grooves can be cut in these jaws for holding round work. Instant adjustment of jaws can be made from 0 to greatest capacity. Either straight or taper work can be held.

SCREWS—Set screw and holding strip of crucible steel, and set screws and nuts hardened.

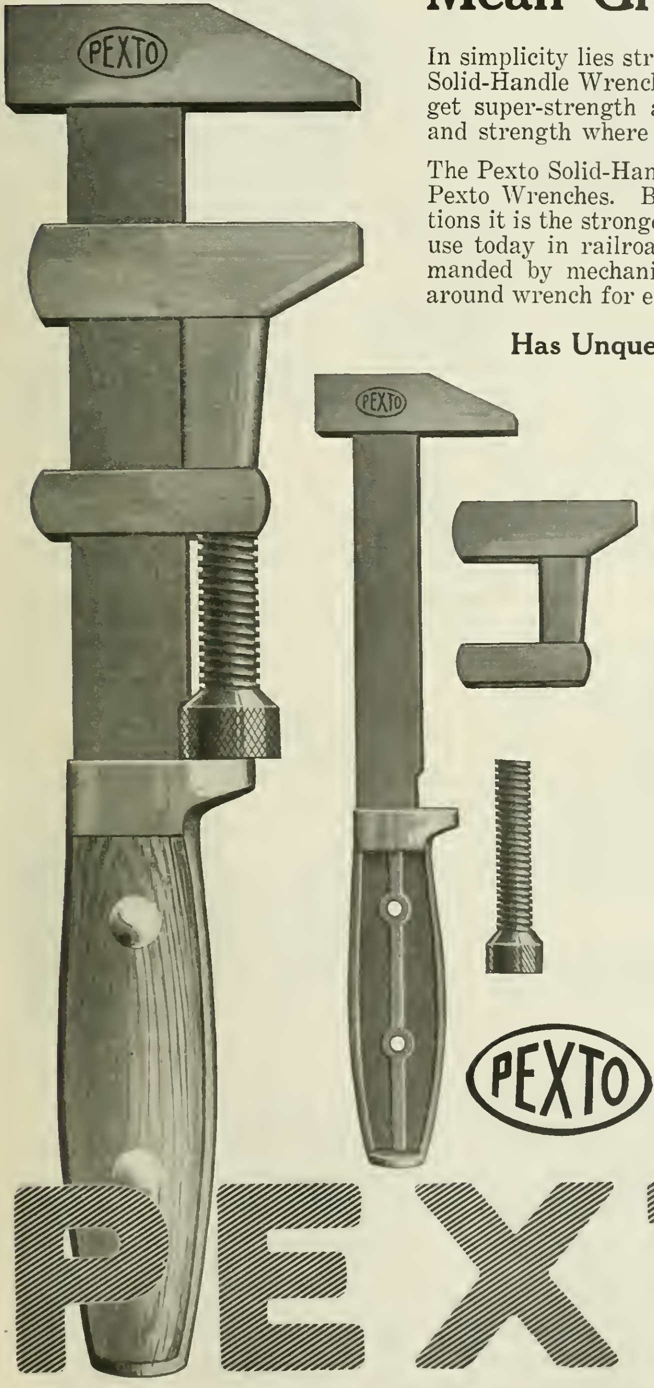
WRENCH—A case hardened forged steel wrench is furnished with each vise.

FITTING—Bolted to drill, planer, miller or shaper by ears at both ends of vise. Vise also has flange on all sides for clamping.

We will be glad to send a Catalog illustrating our entire line of Lathe, Drill and Planer Chucks, upon request.

THE SKINNER CHUCK CO.
FACTORY AND MAIN OFFICE NEW BRITAIN, CONN., U.S.A.

Three Simple Parts Mean Greatest Strength



In simplicity lies strength. And in the popular Pexto Solid-Handle Wrench, with its three simple parts, you get super-strength at all points—with extra weight and strength where most needed.

The Pexto Solid-Handle Wrench heads the long line of Pexto Wrenches. By actual tests in various institutions it is the strongest wrench made. It is in general use today in railroad and machine shops, and is demanded by mechanics in every field. It is the all-around wrench for every-day or special work.

Has Unquestioned Lasting-Power

The head, bar shoulder, and handle-frame are forged solid of one piece, then case-hardened to insure uniform strength and to overcome the weak point found in ordinary screw wrenches, namely, the likelihood of breaking at a point on the bar opposite the knurled thumb-screw.

The sliding jaw fits, with just enough play to work without binding. The screw is extra heavy, and the thread carefully machined.

The method of fastening the sliding jaw over the bar is covered by patents. This feature, instead of proving a weakness as in other styles, adds even more to the strength of this good wrench—strength which cannot be gained in any other way.

There is a need for the Pexto Solid-Handle Wrench in the tool-kit of the mechanic in every field.

If your dealer cannot supply you, write us direct.

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"Matthews Marked"

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Foreman: "B—'s tools are all right, but it takes too long to pick them out—especially after they're worn. A—'s tools are "Matthews Marked"—you can read the serial numbers at a glance till they're scrapped. They save time—that's the reason."

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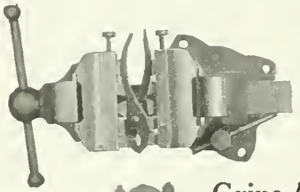

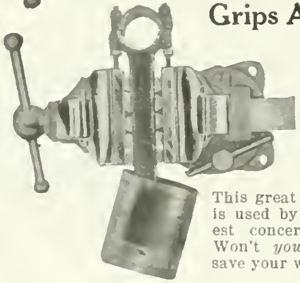

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Fits Any Vise
Needs No Adjustment

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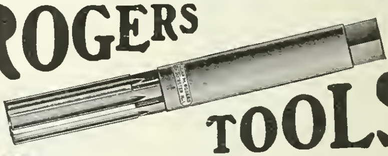

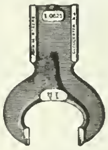

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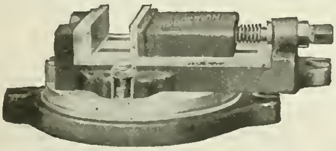

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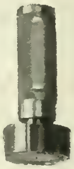

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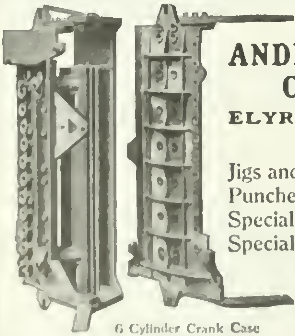

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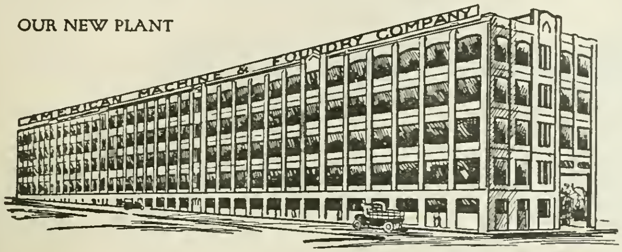

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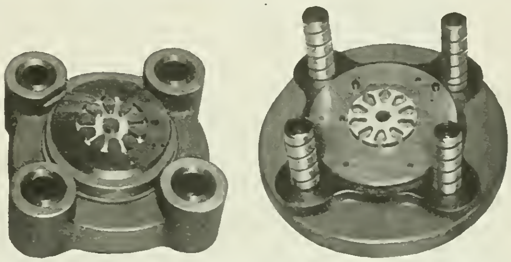

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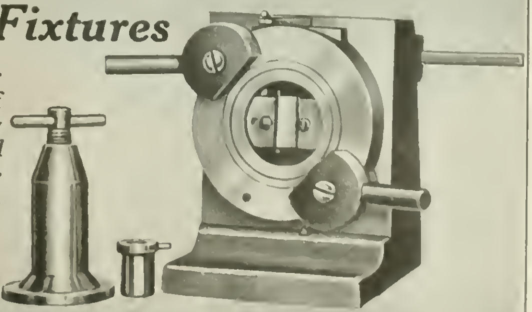

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Columbus Die, Tool & Machine men are hired for their particular skill, and are specialists in their respective callings. They are taught the Columbus Die, Tool & Machine organization system—the value of co-operation—the importance of attention to detail. The fact that they remain and become important parts of the organization proves they like their work—which is *your* work. The result is

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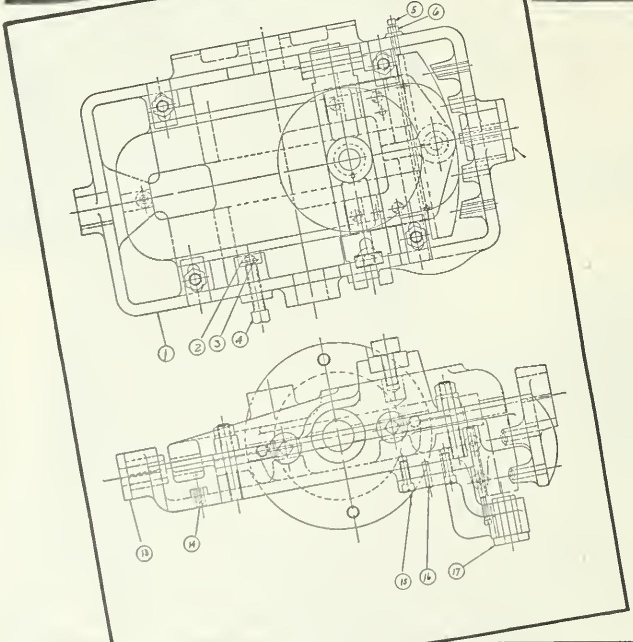

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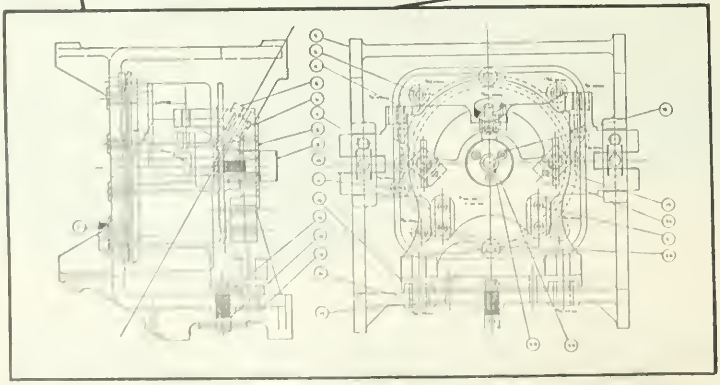

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Urbana Tools—Dies, Gages, Jigs, Fixtures —Quality Known

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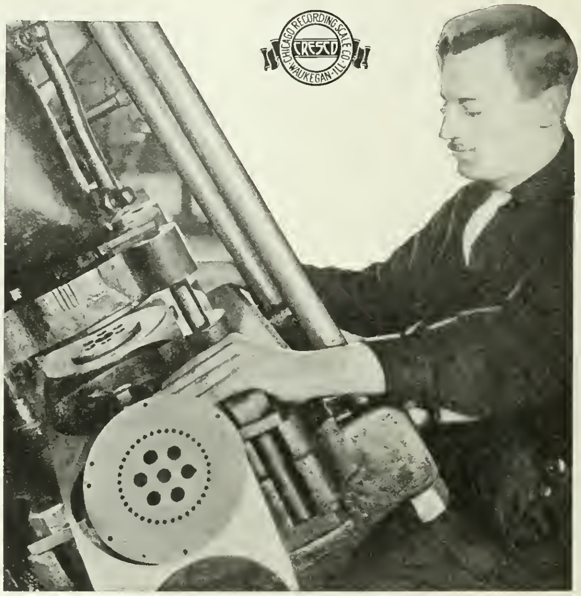

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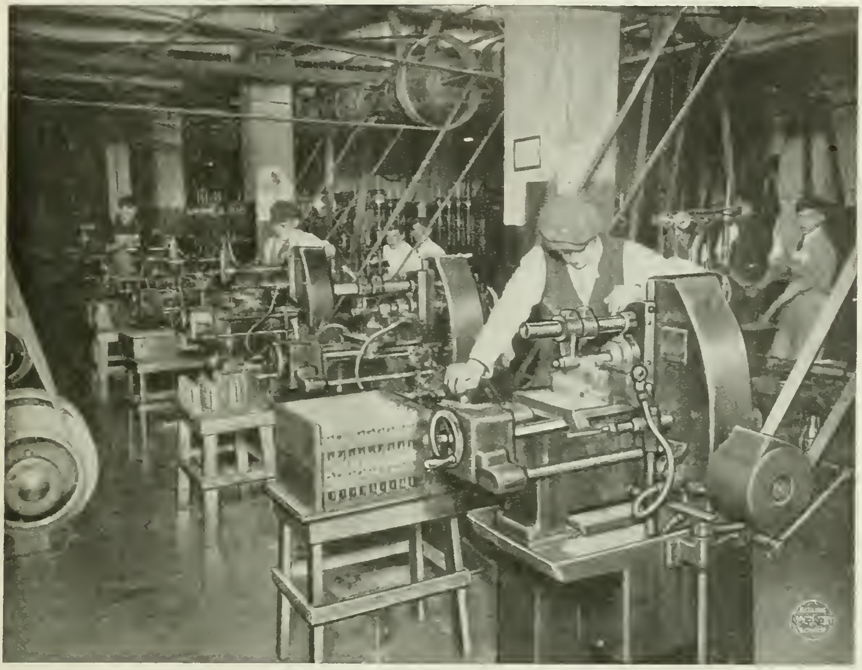

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This is by way of showing the completeness of Krasberg equipment. Every part a product calls for, large or small, can be made at the Krasberg plant, which accounts in great measure for the promptness of Krasberg Service.

Who is Your Toolmaker?

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MARVIN GAUGES
rank with the best on the
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WHY?

Because they are designed right, made from the best materials by skilled workmen, checked by the Johansson Block system and each order is given the individual attention that insures satisfaction.

Give us a chance to convince you that concentrated efficiency pays.

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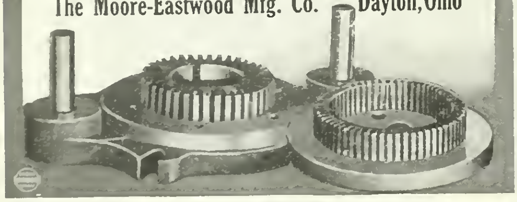

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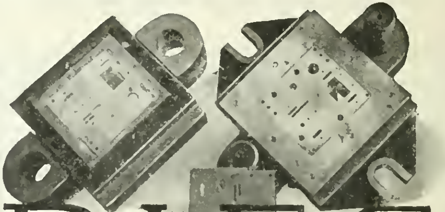

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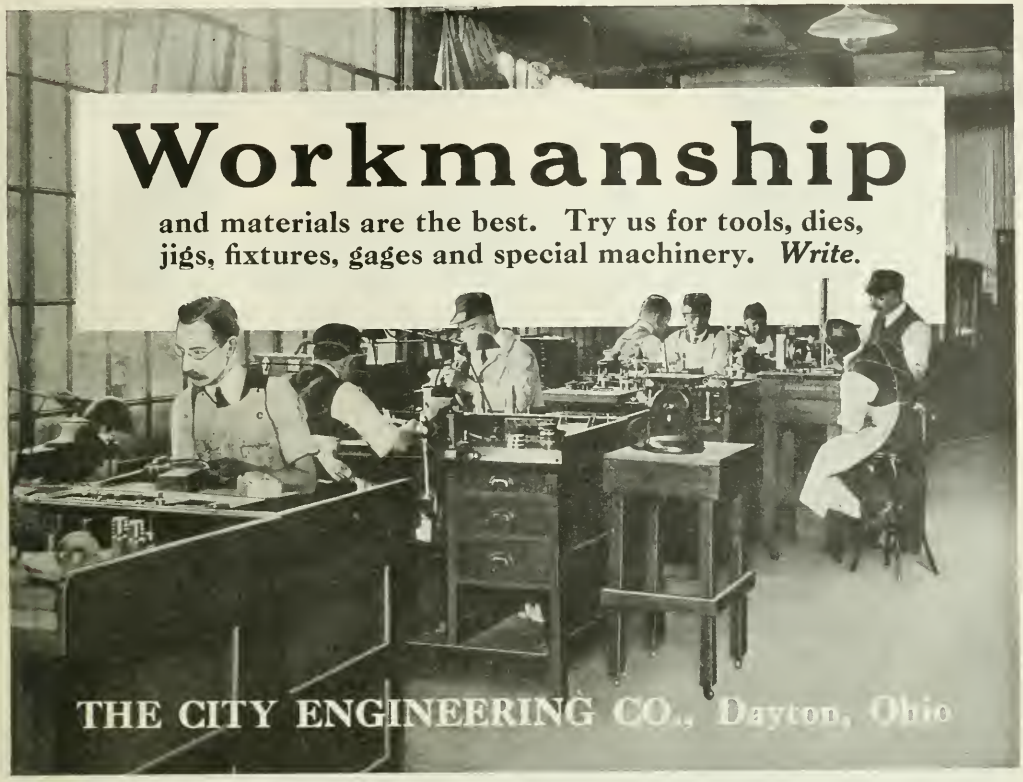

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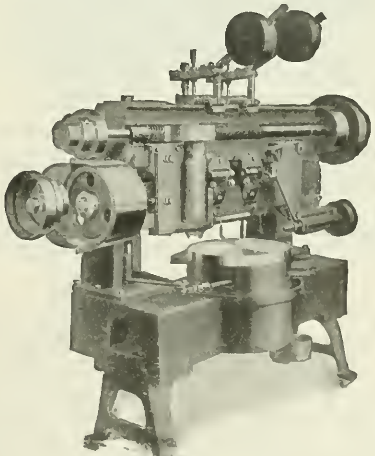

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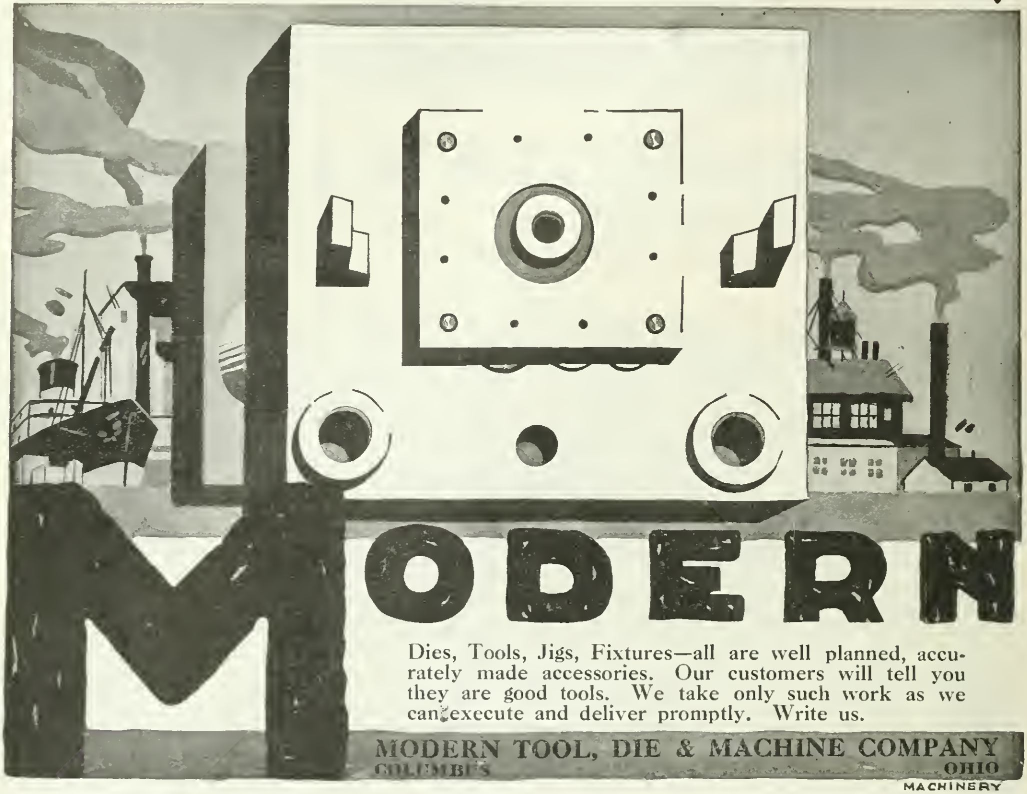

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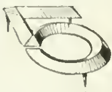

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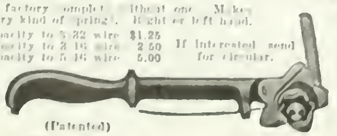

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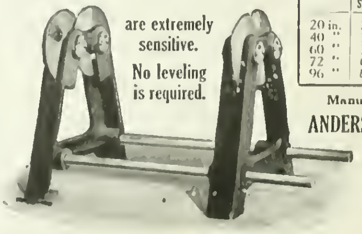

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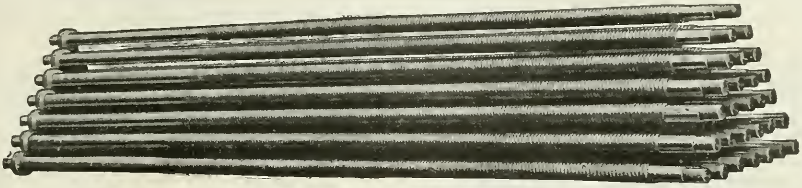

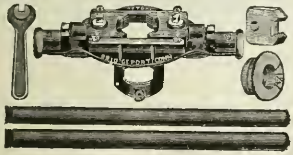

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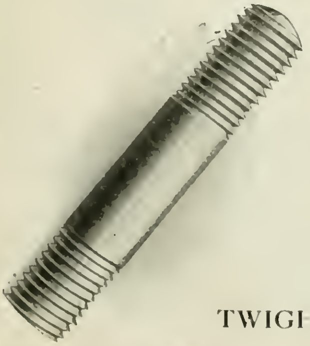

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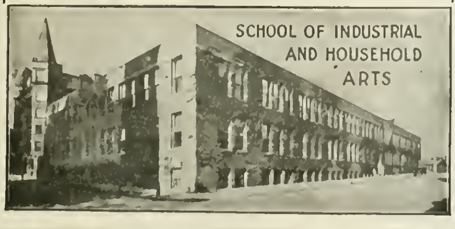

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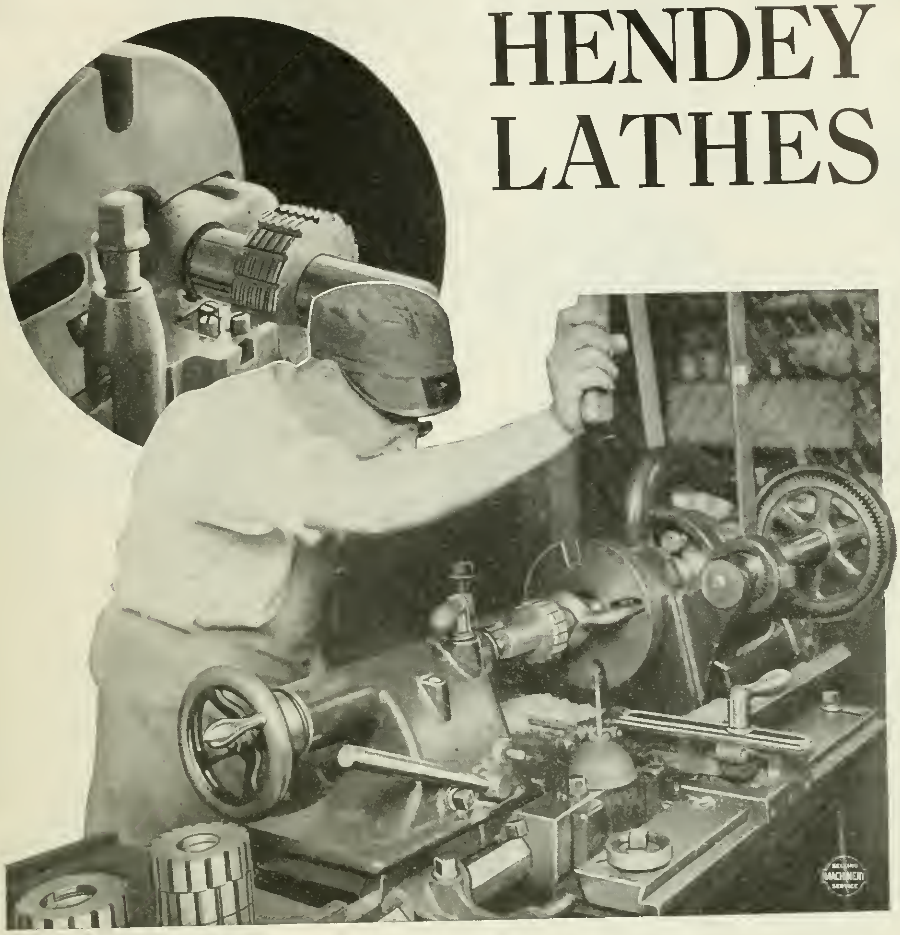

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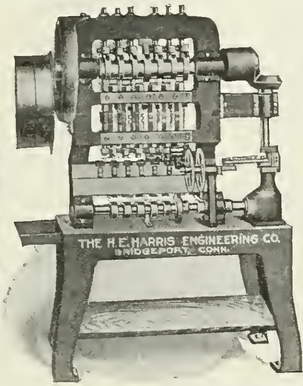

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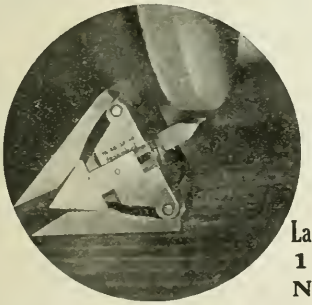

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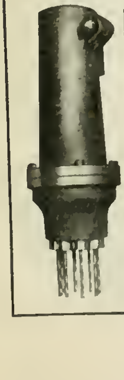

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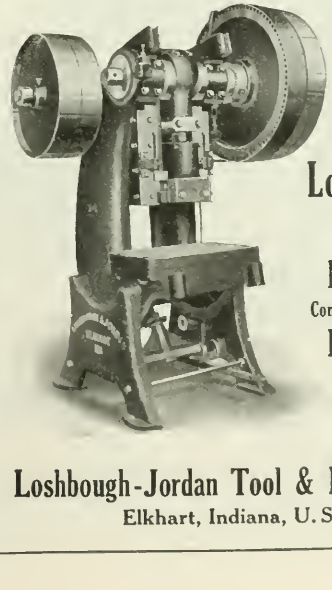

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Precision Casting Co., Inc., Syracuse, N. Y.
Stewart Mfg. Co., Wells St. Bridge, Chicago, Ill.
Veeder Mfg. Co., 20 Sargeant St., Hartford, Conn.

Castings, Iron and Steel
Cresson-Morris Co., Philadelphia, Pa.
Steger & Sons Industrial Works, Steger, Ill.

Castings, Nichrome
Driver-Harris Co., Harrison, N. J.

Centering Machines
Greenfield Tap & Die Corp., Greenfield, Mass.
Hendey Mch. Co., Torrington, Conn.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
Niles-Bement-Pond Co., 111 Broadway, New York.
Porter-Cable Mch. Co., Syracuse, N. Y.
Pratt & Whitney Co., Hartford, Conn.
Whiton Mch. Co., D. E., New London, Conn.

Centers, Planer and Miller
Cincinnati Planer Co., Cincinnati, O.
Greenfield Tap & Die Corp., Greenfield, Mass.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.

Centers, Test
American Gauge Co., Dayton, O.

Chain Blocks
See Hoists, Chain, etc.

Chains, Driving, Etc.
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Frasse & Co., Inc., Peter A., 417 Canal St., New York.
Link-Belt Company, Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.
Union Chain & Mfg. Co., Seville, O.
Whitney Mfg. Co., Hartford, Conn.

Checks, Time, Tool and Pay
Matthews & Co., Jas. H., 3946 Forbes Field, Pittsburgh, Pa.
Noble & Westbrook Mfg. Co., Hartford, Conn.
Schwerdtle Stamp Co., Bridgeport, Conn.

Chucking Machines, Automatic
Gisholt Machine Co., Madison, Wis.
Potter & Johnston Mch. Co., Pawtucket, R. I.

Chucking Machines, Semi-Automatic
National Acme Co., Cleveland, O.
New Britain Mch. Co., New Britain, Conn.
Wood Turret Mch. Co., Brazil, Ind.

Chucking Machines, Multiple Spindle, Automatic
New Britain Mch. Co., New Britain, Conn.

Chucks, Air
Bardons & Oliver, Cleveland, O.
Garvin Mch. Co., Spring and Varick Sts., New York.
Manufacturers Equipment Co., 200 N. Jefferson St., Chicago, Ill.

Chucks, Drill
Almond Mfg. Co., T. R., 2 Maple Ave., Ashburnham, Mass.
Chicago Recording Scale Co., Waukegan, Ill.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Detroit Twist Drill Co., Detroit, Mich.
Goodell-Pratt Co., Greenfield, Mass.
Greenfield Tap & Die Corp., Greenfield, Mass.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
McCrosky Reamer Co., Meadville, Pa.
Modern Tool Co., 2nd and State Sts., Erie, Pa.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Narragansett Mch. Co., Providence, R. I.
National Twist Drill & Tool Co., Detroit, Mich.
Newman Mfg. Co., Cincinnati, O.
Nielsen-Barton Chuck Co., 106 So. Jefferson St., Chicago, Ill.
Oneida National Chuck Co., Oneida, N. Y.
Parker Mfg. Co., Ann Arbor, Mich.
Pratt Chuck Co., Frankfort, N. Y.
Rich Tool Co., 513A Railway Exchange, Chicago, Ill.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Swedish Gage Co., Inc., 245 W. 55th St., New York.
Trump Bros. Mch. Co., Wilmington, Del.
Union Mfg. Co., New Britain, Conn.
Wahlstrom Tool Co., 5520 Second Ave., Brooklyn, N. Y.
Waterston, J. M., Detroit, Mich.
Weaver Mfg. Co., Springfield, Ill.
Westcott Chuck Co., Oneida, N. Y.
Whiton Mch. Co., D. E., New London, Conn.

Chucks, Lathe, Etc.
Advance Tool Co., Cincinnati, O.
Cushman Chuck Co., Hartford, Conn.
Gisholt Mch. Co., Madison, Wis.
Hardinge Bros., Inc., Berteau & Ravenswood Ave., Chicago, Ill.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
McCrosky Reamer Co., Meadville, Pa.
Newman Mfg. Co., Cincinnati, O.
Oneida National Chuck Co., Oneida, N. Y.
Pratt Chuck Co., Frankfort, N. Y.
Rivett Lathe & Grinder Co., Brighton District, Boston, Mass.
Skinner Chuck Co., New Britain, Conn.
Terkelsen & Wennberg, Boston, Mass.
Thomas Elevator Co., 22 S. Hoyne Ave., Chicago, Ill.
Union Mfg. Co., New Britain, Conn.
Westcott Chuck Co., Oneida, N. Y.
Whiton Mch. Co., D. E., New London, Conn.

Chucks, Magnetic
D & W Fuse Co., Providence, R. I.
Heald Mch. Co., Worcester, Mass.
Persons-Arter Mch. Co., Worcester, Mass.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Walker Co., O. S., Worcester, Mass.

Chucks, Planer
Cincinnati Planer Co., Cincinnati, O.
Cushman Chuck Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Conn.

Chucks, Tapping
Beaman & Smith Co., Providence, R. I.
Bicknell-Thomas Co., Greenfield, Mass.
Errington Mechanical Laboratory, 39 Cortlandt St., New York.
Greenfield Tap & Die Corp., Greenfield, Mass.
McCrosky Reamer Co., Meadville, Pa.
Newman Mfg. Co., Cincinnati, O.
Peter Bros. Mfg. Co., 135 Railroad Ave., Algonquin, Ill.
Procunier, Wm. L., 549 Washington Blvd., Chicago, Ill.
Scully-Jones & Co., 647 Railway Exchange, Chicago, Ill.
Wahlstrom Tool Co., 5520 Second Ave., Brooklyn, N. Y.

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D & W Fuse Co., Providence, R. I.
General Electric Co., Schenectady, N. Y.
Wahlstrom Tool Co., 5520 Second Ave., Brooklyn, N. Y.

Clamps
Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill.
Besly & Co., Chas. H., 120-B N. Clinton St., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Goodell-Pratt Co., Greenfield, Mass.
Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York
Starrett Co., L. S., Athol, Mass.
Western Tool & Mfg. Co., Springfield, O.
Williams & Co., J. H., 61 Richards St., Brooklyn, N. Y.

Clocks, Watchmen's
Hardinge Bros., Inc., Berteau & Ravenswood Aves., Chicago, Ill.

Clutches, Friction, Etc.
Bicknell-Thomas Co., Greenfield, Mass.
Blevney Mch. Co., Greenfield, Mass.
Brown Co., A. & F., 79 Barclay St., N. Y.
Brown Engineering Co., 133 N. 3rd St., Reading, Pa.
Caldwell & Son Co., H. W., 17th St. and Western Ave., Chicago, Ill.
Conway & Co., Cincinnati, O.
Cresson-Morris Co., Philadelphia, Pa.
Edgemont Mch. Co., 2700 National Ave., Dayton, O.
Hilliard Clutch & Mchy. Co., Elmira, N. Y.
Johnson Mch. Co., Carlyle, Manchester, Conn.
Link-Belt Company, Chicago, Ill.
Moore & White Co., 2707-2737 N. 15th St., Philadelphia, Pa.
Reliance Gauge Column Co., 6008 Carnegie Ave., Cleveland, O.
Wood Sons Co., T. B., Chambersburg, Pa.

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Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Brown Co., A. & F., 79 Barclay St., N. Y.
Link-Belt Company, Chicago, Ill.
National Grinding Wheel Co., Inc., Buffalo, N. Y.
Standard Pressed Steel Co., Philadelphia, Pa.

Collars, Spacing, Etc.
Detroit Stamping Co., Detroit, Mich.
Maxwell-Hutchcroft Co., Cleveland, O.
Scully-Jones & Co., 617 Railway Exchange, Chicago, Ill.

Collets
Cleveland Twist Drill Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.

Collets, Spring
See Chucks, etc.
Ames Co., B. C., Waltham, Mass.
Hardinge Bros., Inc., Berteau & Ravenswood Aves., Chicago, Ill.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass.

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Wagner Electric Mfg. Co., St. Louis, Mo.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Compound, Cleaning
Oakley Chemical Co., 26 Thames St., New York.

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American Petroleum Products Co., 1031 Williamson Bldg., Chicago, Ill.
Cataract Refining & Mfg. Co., Buffalo, N. Y.
Fiske Bros. Refining Co., 24 State St., New York.
Haws, Inc., Geo. A., 135 Front St., New York.
Oakley Chemical Co., 26 Thames St., New York.

Compressors, Air and Gas
Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill.
Curtis Pneumatic Mchy. Co., 1568 Kienlen Ave., St. Louis, Mo.
General Electric Co., Schenectady, N. Y.
Ingersoll-Rand Co., 11 Broadway, New York
Taylor Instrument Companies, Rochester, N. Y.
Worthington Pump & Mchy. Co., 115 Broadway, New York.

Conduits
General Electric Co., Schenectady, N. Y.

Connectors, Frankel Solderless
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Contract Work
American Mch. Tool Engineering Works, 4854 W. Kinzie St., Chicago, Ill.
American Tool & Mfg. Co., Urbana, O.
Bruno Mfg. Co., Buffalo, N. Y.
Chicago Recording Scale Co., Waukegan, Ill.
City Engineering Co., Dayton, O.
Colburn Gear & Mfg. Co., Boston, Mass.
Columbus Die Tool & Mch. Co., Columbus, O.
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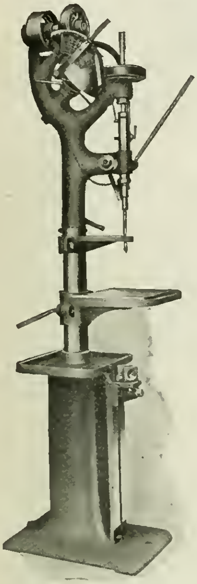

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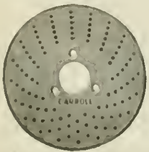

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Wilcox Motor & Mfg. Co., Saginaw, Mich.

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Sprague Electric Works, 527 W. 34th St., New York.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Conveyers, Belt
Link-Belt Company, Chicago, Ill.

Conveyers, Grab Bucket
Northern Engineering Works, Detroit, Mich.

Conveyers, Gravity
Caldwell & Son Co., H. W., 17th St. and Western Ave., Chicago, Ill.
Link-Belt Co., Chicago, Ill.

Cotter Pins
Whitman & Barnes Mfg. Co., 1000 West 120th St., Chicago, Ill.

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Cleveland Twist Drill Co., Cleveland, O.
Detroit Twist Drill Co., Detroit, Mich.
Genesee Mfg. Co., Rochester, N. Y.
Glenzer Co., J. C., Detroit, Mich.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
National Tool Co., Cleveland, O.
National Twist Drill & Tool Co., Detroit, Mich.
Pratt & Whitney Co., Hartford, Conn.
Production Tool Co. of America, Detroit, Mich.
Standard Tool Co., Cleveland, O.
Starrett Co., L. S., Athol, Mass.
Union Twist Drill Co., Athol, Mass.
Wilcox Motor & Mfg. Co., Saginaw, Mich.
Windau Tool Co., Cleveland, O.

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Brown & Sharpe Mfg. Co., Providence, R. I.
Builders Iron Foundry, Providence, R. I.
Cresson-Morris Co., Philadelphia, Pa.
Dalton Manufacturing Corporation, 1911 Park Ave., New York.
Davis Mch. Tool Co., Inc., Rochester, N. Y.
Diamond Mch. Co., Providence, R. I.
Edgemont Mch. Co., 2700 National Ave., Dayton, O.
Garvin Machine Co., Spring and Varick Sts., New York.
Gisholt Machine Co., Madison, Wis.
Hilliard Clutch & Mchy. Co., Elmira, N. Y.
Hyatt Roller Bearing Co., Metropolitan Tower, New York.
Jones Foundry & Mch. Co., W. A., 4409 W. 12th St., Chicago, Ill.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.

Counters, Revolution
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Grant Mfg. & Mch. Co., N. W. Station, Bridgeport, Conn.
Starrett Co. L. S., Athol, Mass.
Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn.

Counting Machines
National Scale Co., Chicopee Falls, Mass.
Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn.

Couplers, Hose
Greene, Tweed & Co., 109 Duane St., New York.
Ingersoll-Rand Co., 11 Broadway, New York.

Couplings, Cut-off, Friction
Johnson, Carlyle, Mach. Co., Manchester, Conn.

Couplings, Flexible Shaft
Boston Gear Works, Norfolk Downs, Mass.
Caldwell & Son Co., H. W., 17th St. and Western Ave., Chicago, Ill.
Cooper Flexible Transmission Co., Inc., Brooklyn, N. Y.
Cresson-Morris Co., Philadelphia, Pa.
Smith-Serrell Co., Inc., 144 Cedar St., New York.
Wood, Sons Co., T. B., Chambersburg, Pa.

Couplings, Pipe
Dart Mfg. Co., E. M., Providence, R. I.
New Haven Screw Co., New Haven, Conn.

Couplings, Shaft
Brown Co., A. & F., 79 Barclay St., New York.
Brown Engineering Co., 133 N. 3rd St., Reading, Pa.
Caldwell & Son Co., H. W., 17th St. and Western Ave., Chicago, Ill.
Cresson-Morris Co., Philadelphia, Pa.
Hilliard Clutch & Mchy. Co., Elmira, N. Y.
Link-Belt Company, Chicago, Ill.
Moore & White Co., 2707-2737 N. 15th St., Philadelphia, Pa.
Nicholson & Co., W. H., 112 Oregon St., Wilkes-Barre, Pa.
Royersford Foundry & Mch. Co., 54 N. 5th St., Philadelphia, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
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Wood, Sons & Co., T. B., Chambersburg, Pa.

Cranes
Box & Co., Inc., Alfred, Philadelphia, Pa.
Chisholm-Moore Mfg. Co., Cleveland, O.
Curtis Pneumatic Mchy. Co., 1568 Kienlen Ave., St. Louis, Mo.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York.
Niles-Bement-Pond Co., 111 Broadway, New York.
Northern Engineering Works, Detroit, Mich.
Q M S Co., 1763 Elston Ave., Chicago, Ill.
Shaw Electric Crane Co., Muskegon, Mich.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Vandyck Churchill Co., 149 Broadway, New York.
Wright Mfg. Co., Lisbon, O.
Yale & Towne Mfg. Co., 9 E. 40th St., New York.

Cranes, Electric Traveling
Biggs-Watterson Co., Cleveland, O.
Box & Co., Inc., Alfred, Philadelphia, Pa.
Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York.
Milwaukee Electric Crane Co., Inc., Milwaukee, Wis.
Northern Engineering Works, Detroit, Mich.
Pawling & Harnischfeger Co., Milwaukee, Wis.
Payne, N. B., 25 Church St., New York.
Shaw Electric Crane Co., Muskegon, Mich.

Cranes, Electric Truck
General Electric Co., Schenectady, N. Y.

Cranes, Hand Traveling
Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York.
Shaw Electric Crane Co., Muskegon, Mich.

Cranes, Locomotive
Curtiss-Wilbs Co., Inc., 30 Church St., New York.
Link-Belt Company, Chicago, Ill.

Cranes, Portable
Canton Fdry. & Mch. Co., Canton, O.

Crank Pin Turning Machines
American Tool Works Co., Cincinnati, O.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mch. Tool Co., Cincinnati, O.
Niles-Bement-Pond Co., 111 Broadway, New York.
Pedrick Tool & Mch. Co., 3639 N. Lawrence St., Philadelphia, Pa.

Crucibles
Dixon Crucible Co., Joseph, Jersey City, N. J.

Cutters, Milling
Adams Co., Dubuque, Iowa.
Advance Tool Co., Cincinnati, O.
Barber-Colman Co., Rockford, Ill.
Becker Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Milling Machine Co., Cleveland, O.
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Columbus Die, Tool & Mch. Co., Columbus, O.
Cowles Tool Co., Cleveland, O.
Detroit Twist Drill Co., Detroit, Mich.
Genesee Mfg. Co., Rochester, N. Y.
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Gould & Eberhardt, Newark, N. J.
Harris Engineering Co., H. E., Bridgeport, Conn.
Illinois Tool Works, Chicago, Ill.
Ingersoll Milling Machine Co., Rockford, Ill.
Kearney & Trecker Co., Milwaukee, Wis.
Krasberg Mfg. Co., 412 Orleans St., Chicago, Ill.
Morse Twist Drill & Machine Co., New Bedford, Mass.
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O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Whitney Mfg. Co., Hartford, Conn.
Windau Tool Co., Cleveland, O.

Cutting Compound
See Compound, Cutting, Grinding, etc.

Cutting-off Machines, Abrasive Wheel
Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill.
Greenfield Tap & Die Corp., Greenfield, Mass.
Peter Bros. Mfg. Co., Algonquin, Ill.

Cutting-off Machines, Cold Saw
See Saws, Rotary Machines.

Cutting-Off Machines, Rotary
Brown & Sharpe Mfg. Co., Providence, R. I.
Curtis & Curtis Co., 8 Garden St., Bridgeport, Conn.
Davis Mch. Tool Co., Inc., Rochester, N. Y.
Etna Mch. Co., Toledo, O.
Fawcus Mch. Co., Pittsburgh, Pa.
Hurlbut, Rogers Mchy. Co., So. Sudbury, Mass.
Modern Mch. Tool Co., Jackson, Mich.
Oster Mfg. Co., Cleveland, O.
Treadwell Engineering Co., Easton, Pa.

Cutting-Off Tools
Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill.
Goodell-Pratt Co., Greenfield, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Ready Tool Co., 650 Railroad Ave., Bridgeport, Conn.
Western Tool & Mfg. Co., Springfield, Mass.

Cyclometers
Veeder Mfg. Co., 38 Sargeant St., Hartford, Conn.

Cylinder Borers
See Boring and Drilling Machines, Vertical.
Beaman & Smith Co., Providence, R. I.
Defiance Machine Works, Defiance, O.

Cylinder Boring Machines, Portable
Pedrick Tool & Mch. Co., 3639 N. Lawrence St., Philadelphia, Pa.

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D & W Fuse Co., Providence, R. I.
Heald Mch. Co., Worcester, Mass.
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Francis & Co., Hartford, Conn.

Diamond Tools
Francis & Co., Hartford, Conn.

Die Blocks
Dyson & Sons, Jos., Cleveland, O.

Die Castings
See Castings, Die or Die-molded.

Die Sinking Machines
Jackson Mch. Tool Co., Jackson, Mich.
Pratt & Whitney Co., Hartford, Conn.
Walcott Lathe Co., Jackson, Mich.

Die Stocks
See Stocks, Die and Taps and Dies.

Dies
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Card Mfg. Co., S. W., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Geometric Tool Co., New Haven, Conn.
Greenfield Tap & Die Corp., Greenfield, Mass.
Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York.
Hardinge Bros. Co., Inc., Berteau and Ravenswood Aves., Chicago, Ill.
Harris Engineering Co., H. E., Bridgeport, Conn.
Hart Mfg. Co., E. 20th St. and Marion Ave., Cleveland, O.
Hjorth Lathe & Tool Co., Boston, Mass.
Landis Mch. Co., Inc., Waynesboro, Pa.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
National Acme Co., Cleveland, O.
Oster Mfg. Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Reed Mfg. Co., Erie, Pa.
Rogers Works, Inc., John M., Gloucester City, N. J.
Saunders Sons, Inc., D., Yonkers, N. Y.
Standard Tool Co., Cleveland, O.
Walworth Mfg. Co., Boston, Mass.

Dies, Lettering and Embossing
Manhattan Mch. & Tool Works, Grand Rapids, Mich.
Matthews & Co., Jas. H., 3946 Forbes Field, Pittsburgh, Pa.
Maute & Sons, J., Buffalo, N. Y.
Noble & Westbrook Mfg. Co., Hartford, Conn.
Schwerdtle Stamp Co., Bridgeport, Conn.

Dies, Sheet Metal, Etc.
Acklin Stamping Co., 1657 Dorr St., Toledo, O.
American Mch. & Foundry Co., 5520 2nd Ave., Brooklyn, N. Y.
American Tool & Mfg. Co., Urbana, O.
Bliss Co., E. W., 17 Adams St., Brooklyn, N. Y.
Bruno Mfg. Co., Buffalo, N. Y.
Columbus Die Tool & Mch. Co., Columbus, O.
Ferracute Mch. Co., Bridgeton, N. J.
Goddard Tool Co., Chicago, Ill.
Harris Engineering Co., H. E., Bridgeport, Conn.
Krasberg Mfg. Co., 536 Lake Shore Drive, Chicago, Ill.
Lansing Stamping & Tool Co., Lansing, Mich.
Manhattan Mch. & Tool Wks., Grand Rapids, Mich.
Marvin Mfg. Co., W. B., Urbana, O.
Maute & Sons, J., Buffalo, N. Y.
Mehl Mch. Tool & Die Co., Roselle, N. J.
Michigan Tool Co., Detroit, Mich.
Modern Tool, Die & Machine Co., Columbus, O.
Moore-Eastwood Mfg. Co., Dayton, O.
Nelson Tool Co., Inc., 781-783 E. 142nd St., New York.
Potter Tool & Mch. Works, S. A., 79 E. 130th St., New York.
Pratt & Whitney Co., Hartford, Conn.
Reliance Die & Stamping Co., 515 N. La Salle St., Chicago, Ill.
Robidoux Mch. Co., 20 Fulton St., New York.
Rockford Metal Specialty Co., Rockford, Ill.
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Taylor-Shantz Co., Rochester, N. Y.
Urbana Tool & Die Co., Urbana, O.
Waltham Mch. Works, Waltham, Mass.

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Butterfield & Co., Derby Line, Vt.
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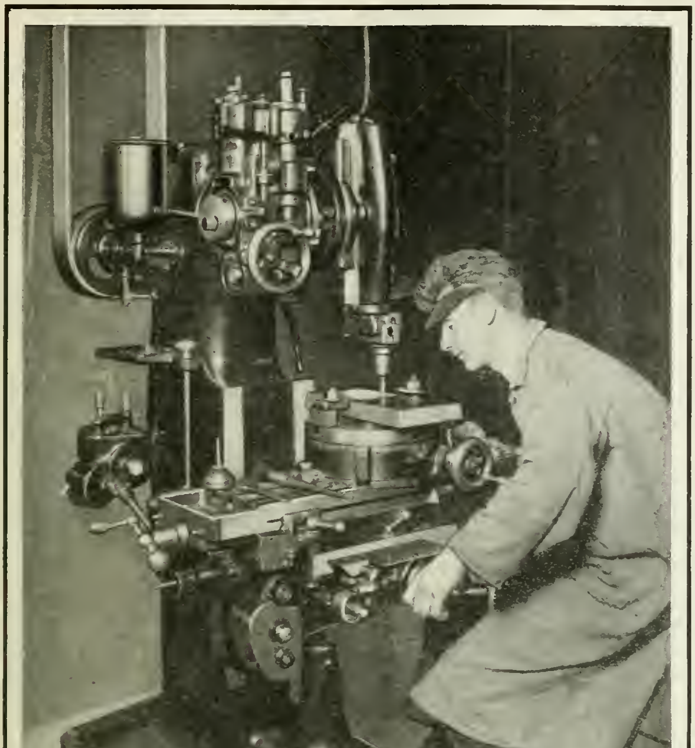
Errington Mechanical Laboratory, 39 Cortlandt St., New York.
Geometric Tool Co., New Haven, Conn.
Greenfield Tap & Die Corp., Greenfield, Mass.
Ideal Tool & Mfg. Co., Beaver Falls, Pa.
Jones & Lamson Mch. Co., Springfield, Vt.
Landis Mch. Co., Inc., Waynesboro, Vt.
Modern Tool Co., 2nd and State Sts., Erie, Pa.
Murchey Mch. & Tool Co., 31 Porter St., Detroit, Mich.
National Acme Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Rickert-Shafer Co., Erie, Pa.
Webster & Perks Tool Co., Springfield, O.

Dividing Heads
See Milling Machines, Universal.
Dickow, Fred O., 37 So. Desplaines St., Chicago, Ill.



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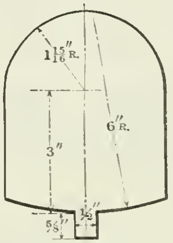

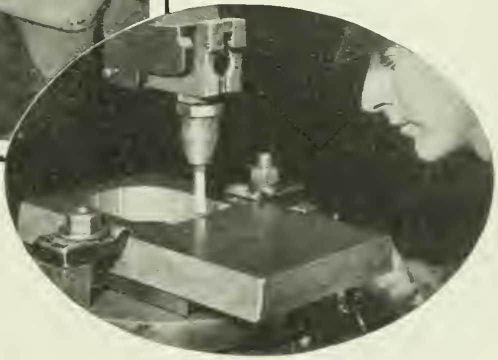

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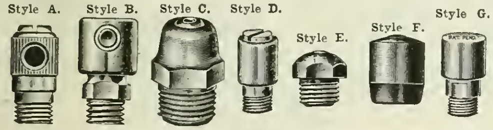
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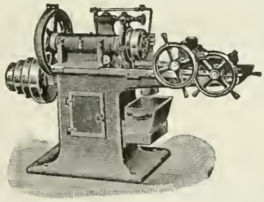

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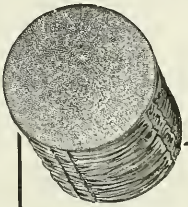

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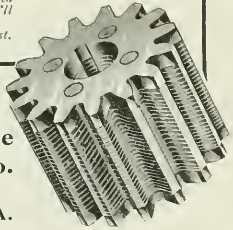

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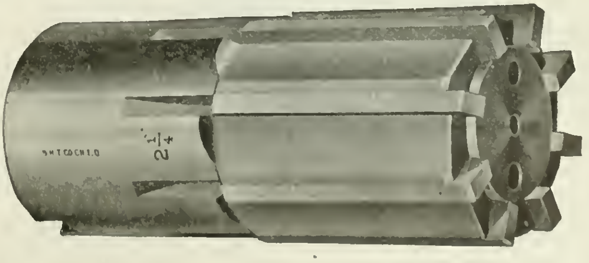

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Brown & Sharpe Mfg. Co., Providence, R. I.
Chicago Flexible Shaft Co., 12th St. and Central Ave., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Hoskins Mfg. Co., 459 Lawton Ave., Detroit, Mich.
Strong, Carlisle & Hammond Co., Cleveland, O.

Furnaces, Case-Hardening
American Gas Furnace Co., 24 John St., New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Chicago Flexible Shaft Co., 12th St. and Central Ave., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Strong, Carlisle & Hammond Co., Cleveland, O.
Tate-Jones & Co., Inc., Pittsburgh, Pa.

Furnaces, Electric
Brown Instrument Co., Philadelphia, Pa.
General Electric Co., Schenectady, N. Y.
Hoskins Mfg. Co., 459 Lawton Ave., Detroit, Mich.
Tate-Jones & Co., Inc., Pittsburgh, Pa.

Furnaces, Hardening
American Gas Furnace Co., 24 John St., New York.
Bennett, W. R., Elmwood, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Chicago Flexible Shaft Co., 12th St. and Central Ave., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Hoskins Mfg. Co., 459 Lawton Ave., Detroit, Mich.
Strong, Carlisle & Hammond Co., Cleveland, O.
Yost Mfg. Co., Meadville, Pa.

Furnaces, Melting
American Gas & Furnace Co., 24 John St., New York.
Chicago Flexible Shaft Co., 12th St. and Central Ave., Chicago, Ill.
Strong, Carlisle & Hammond Co., Cleveland, O.

Furnaces, Tempering
American Gas Furnace Co., 24 John St., New York.
Bennett, W. R., Elmwood, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Chicago Flexible Shaft Co., 12th St. and Central Ave., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Hoskins Mfg. Co., 459 Lawton Ave., Detroit, Mich.
Strong, Carlisle & Hammond Co., Cleveland, O.

Furniture, Drafting-Room
Economy Drawing Table & Mfg. Co., Adrian, Mich.
New Britain Mch. Co., New Britain, Conn.

Furniture, Shop
Manufacturing Equipment & Engineering Co., Framingham, Mass.
New Britain Mch. Co., New Britain, Conn.
Western Tool & Mfg. Co., Springfield, O.

Gages, Amplifying
American Gauge Co., Dayton, O.

Gages, Depth
Brown & Sharpe Mfg. Co., Providence, R. I.
Goddard Tool Co., Chicago, Ill.
Goodell-Pratt Co., Greenfield, Mass.
Harris Engineering Co., H. E., Bridgeport, Conn.
Marvin Mfg. Co., W. B., Urbana, O.
Rogers Works, Inc., John M., Gloucester, N. J.
Seaboldt Corp., B., 25 W. Broadway, New York.
Slocomb Co., J. T., Providence, R. I.
S-P Manufacturing Co., Cleveland, O.
Starrett Co., L. S., Athol, Mass.
Taylor-Shantz Co., Rochester, N. Y.

Gages, Dial
Brown & Sharpe Mfg. Co., Providence, R. I.
Goddard Tool Co., Chicago, Ill.
Harris Engineering Co., H. E., Bridgeport, Conn.
Rogers Works, Inc., John M., Gloucester City, N. J.
S-P Manufacturing Co., Cleveland, O.
Starrett Co., L. S., Athol, Mass.
Taylor-Shantz Co., Rochester, N. Y.

Gages, Height
City Engineering Co., Dayton, O.
Seaboldt Corp., B., 25 W. Broadway, New York.
Starrett Co., L. S., Athol, Mass.

Gages, Plug and Ring
Advance Tool Co., Cincinnati, O.
City Engineering Co., Dayton, O.
Krasberg Mfg. Co., 536 Lake Shore Drive, Chicago, Ill.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Potter Tool & Mch. Wks., S. A., 79 E. 130th St., New York.
Seaboldt Corp., B., 25 Broadway, New York.

Gages, Recording, Steam, Vacuum
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Krasberg Mfg. Co., 536 Lake Shore Drive, Chicago, Ill.
Reliance Gauge Column Co., 6008 Carnegie Ave., Cleveland, O.

Gages, Snap
Brown & Sharpe Mfg. Co., Providence, R. I.
City Engineering Co., Dayton, O.
Cleveland Twist Drill Co., Cleveland, O.
Goddard Tool Co., Chicago, Ill.
Greenfield Tap & Die Corp., Greenfield, Mass.
Harris Engineering Co., H. E., Bridgeport, Conn.
Krasberg Mfg. Co., 536 Lake Shore Drive, Chicago, Ill.
Marvin Mfg. Co., W. B., Urbana, O.
Potter Tool & Mch. Wks., S. A., 79 E. 130th St., New York.
Pratt & Whitney Co., Hartford, Conn.
Reliance Die & Stamping Co., 515 N. La Salle St., Chicago, Ill.
Rogers Works, Inc., John M., Gloucester City, N. J.
Seaboldt Corp., B., 25 W. Broadway, New York.
S-P Manufacturing Co., Cleveland, O.
Starrett Co., L. S., Athol, Mass.
Swedish Gage Co., Inc., 215 W. 55th St., New York.
Taylor-Shantz Co., Rochester, N. Y.
Union Tool Co., Orange, Mass.

Gages, Special Measuring
Wilcox Motor & Mfg. Co., Saginaw, Mich.

Gages, Surface
Brown & Sharpe Mfg. Co., Providence, R. I.
Columbus Die, Tool & Mch. Co., Columbus, O.
Goddard Tool Co., Chicago, Ill.
Goodell-Pratt Co., Greenfield, Mass.
Harris Engineering Co., H. E., Bridgeport, Conn.
Marvin Mfg. Co., W. B., Urbana, O.
Seaboldt Corp., B., 25 W. Broadway, New York.
S-P Manufacturing Co., Cleveland, O.
Starrett Co., L. S., Athol, Mass.
Taylor-Shantz Co., Rochester, N. Y.

Gages, Taper
Pratt & Whitney Co., Hartford, Conn.
Seaboldt Corp., B., 25 W. Broadway, New York.
Starrett Co., L. S., Athol, Mass.

Gages, Thread
Bicknell-Thomas Co., Greenfield, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
City Engineering Co., Dayton, O.
Community Mch. & Tool Works, 151 Grand St., New York
Greenfield Tap & Die Corp., Greenfield, Mass.
Illinois Tool Works, Chicago, Ill.
Lafayette Tool Works, 176 Worth St., New York.
Pratt & Whitney Co., Hartford, Conn.
Reliance Die & Stamping Co., 515 N. La Salle St., Chicago, Ill.
Seaboldt Corp., B., 25 W. Broadway, New York.
Sheffield Mch. & Tool Co., Dayton, O.
Starrett Co., L. S., Athol, Mass.
Union Tool Co., Orange, Mass.

Gaging Machine, Universal
American Gauge Co., Dayton, O.

Gaskets
Graton & Knight Mfg. Co., Worcester, Mass.
Greene, Tweed & Co., 109 Duane St., New York.

Gear Blanks, Bronze
Aluminum Castings Co., Cleveland, O.
Bunting Brass & Bronze Co., 718 Spencer St., Toledo, Ohio.
Johnson Bronze Co., New Castle, Pa.
Light Mfg. & Foundry Co., Pottstown, Pa.
Lumen Bearing Co., Buffalo, N. Y.

Gear Blanks, Rawhide
Chicago Rawhide Mfg. Co., 1301 Elston Ave., Chicago, Ill.

Gear Blanks, Steel
Carnegie Steel Co., Pittsburgh, Pa.

Gear Cutting Machines, Bevel (Generator and Templet Planer)
Bilgram Mch. Works, 1231 Spring Garden St., Philadelphia, Pa.
Gleason Works, Dorchester, N. Y.

Gear Cutting Machines, Bevel (Rotary Cutter)
Bilton Mch. Tool Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Flather Mfg. Co., Nashua, N. H.
Gould & Eberhardt, Newark, N. J.
Newark Gear Cutting Mch. Co., Newark, N. J.
Whiton Mch. Co., D. E., New London, Conn.

Gear Cutting Machines, Helical and Spur (Hob)
Adams Co., Dubuque, Iowa.
Barber-Colman Co., Rockford, Ill.
Boston Gear Works, Norfolk Downs, Mass.
Gould & Eberhardt, Newark, N. J.
Lees-Bradner Co., Cleveland, O.
Meisselbach-Catucci Mfg. Co., 27 Congress St., Newark, N. J.
Newark Gear Cutting Mch. Co., Newark, N. J.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
Reynolds Machine Company, Massillon, O.

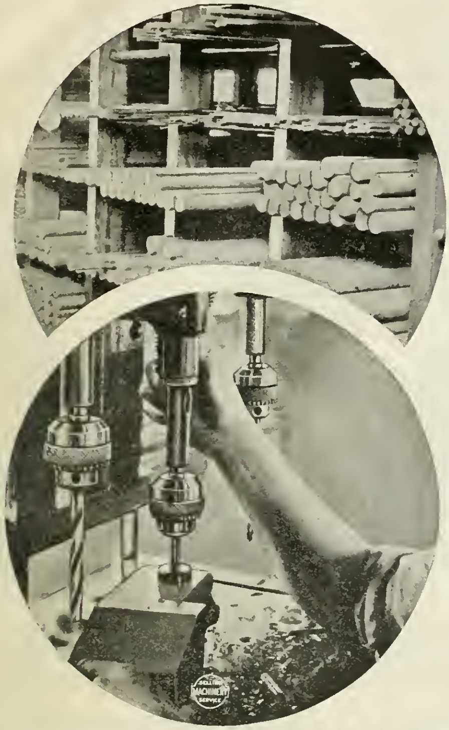
Gear Cutting Machines, Helical and Spur (Shaper and Planer Type)
Bickett Mch. & Mfg. Co., Cincinnati, O.
Fellows Gear Shaper Co., Springfield, Vt.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.

Gear Cutting Machines, Spur (Rotary Cutter)
Bilton Mch. Tool Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Flather Mfg. Co., Nashua, N. H.
Gould & Eberhardt, Newark, N. J.
Newark Gear Cutting Mch. Co., Newark, N. J.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
Waltham Machine Works, Waltham, Mass.
Whiton Mch. Co., D. E., New London, Conn.

Gear Cutting Machines, Worms and Worm Wheels (Hob)
Adams Co., Dubuque, Iowa.
Barber-Colman Co., Rockford, Ill.
Bilton Mch. Tool Co., Bridgeport, Conn.
Boston Gear Works, Norfolk Downs, Mass.
Gould & Eberhardt, Newark, N. J.
Meisselbach-Catucci Mfg. Co., 27 Congress St., Newark, N. J.
Newark Gear Cutting Mch. Co., Newark, N. J.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
Reynolds Machine Company, Massillon, O.

Gears, Bakelite-Micarta
Chicago Rawhide Mfg. Co., 1301 Elston Ave., Chicago, Ill.
Cresson-Morris Co., Philadelphia, Pa.
Crofoot Gear Works, Inc., Cambridge A Branch, Boston, Mass.
Earle Gear & Mch. Co., 4705 Stenton Ave., Philadelphia, Pa.
Foote Bros. Gear & Mch. Co., 210 N. Carpenter St., Chicago, Ill.
Grant Gear Works, Inc., Boston, Mass.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., Cleveland, O.
Meisel Press Mfg. Co., 948 Dorchester Ave., Boston, Mass.
Newark Gear Cutting Mch. Co., Newark, N. J.
New Process Gear Corporation, Syracuse, N. Y.
Nuttall Co., R. D., Philadelphia, Pa.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Gears, Cut
Adams Co., Dubuque, Iowa.
Albaugh-Dover Co., 2100 Marshall Blvd., Chicago, Ill.
Albro-Clem Elevator Co., 601 Erie Ave., East Philadelphia, Pa.
Bilgram Mch. Works, 1231 Spring Garden St., Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown Co., A. & F., 79 Barclay St., New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., 17th St. and Western Ave., Chicago, Ill.
Cincinnati Gear Co., Cincinnati, O.
Colburn Gear & Mfg. Co., Boston, Mass.
Crofoot Gear Works, Inc., Cambridge A Branch, Boston, Mass.
Cross Gear & Engine Co., Detroit, Mich.
Cullman Wheel Co., 1339 Altgeld St., Chicago, Ill.
Davis, Rodney Co., Philadelphia, Pa.
Earle Gear & Mch. Co., 4705 Stenton Ave. Philadelphia, Pa.
Fawcus Machine Co., Pittsburgh, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Flather Mfg. Co., Nashua, N. H.
Foote Bros. Gear & Mch. Co., 210 N. Carpenter St., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Gleason Works, Rochester, N. Y.
Grant Gear Works, Inc., Boston, Mass.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Hindley Gear Co., Philadelphia, Pa.
Horsburgh & Scott Co., Cleveland, O.
Jones Foundry & Mch. Co., W. A., 4409 W. 12th St., Chicago, Ill.
Lees-Bradner Co., Cleveland, O.
Link-Belt Company, Chicago, Ill.
Meisel Press Mfg. Co., 948 Dorchester Ave., Boston, Mass.
Meisselbach-Catucci Mfg. Co., 27 Congress St., Newark, N. J.
Newark Gear Cutting Mch. Co., Newark, N. J.
New Process Gear Corporation, Syracuse, N. Y.
Northern Engineering Works, Detroit, Mich.
Nuttall Co., R. D., Pittsburgh, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Poole Engineering & Mch. Co., Baltimore, Md.
Rhoonds Mfg. Co., Pittsburgh, Pa.
Stahl Gear & Mch. Co., Cleveland, O.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.



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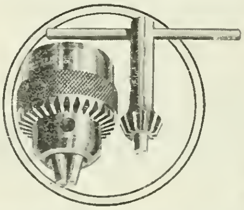

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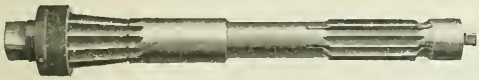

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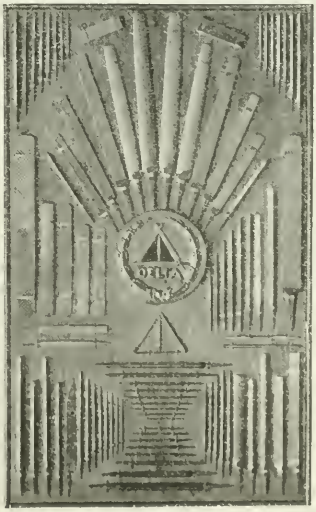

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Newark Gear Cutting Mch. Co., Newark, N. J.

Gears, Fabric
Chicago Rawhide Mfg. Co., 1301 Elston Ave., Chicago, Ill.
Cresson-Morris Co., Philadelphia, Pa.
Crofoot Gear Works, Inc., Cambridge A Branch, Boston, Mass.
General Electric Co., Schenectady, N. Y.
Grant Gear Works, Inc., Boston, Mass.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Stahl Gear & Mch. Co., Cleveland, O.

Gears, Molded
Brown Co., A. & F., 79 Barclay St., New York.
Caldwell & Son Co., H. W., 17th St. and Western Ave., Chicago, Ill.
Cresson-Morris Co., Philadelphia, Pa.
Crofoot Gear Works, Inc., Cambridge A Branch, Boston, Mass.
Horsburgh & Scott Co., Cleveland, O.
Jones Foundry & Mch. Co., W. A., 4409 W. 12th St., Chicago, Ill.
Link-Belt Company, Chicago, Ill.
Philadelphia Gear Works, Philadelphia, Pa.
Poole Engineering & Mch. Co., Baltimore, Md.
Stahl Gear & Mch. Co., Cleveland, O.

Gears, Rawhide
Boston Gear Works, Norfolk Downs, Mass.
Chicago Rawhide Mfg. Co., 1301 Elston Ave., Chicago, Ill.
Cresson-Morris Co., Philadelphia, Pa.
Crofoot Gear Works, Inc., Cambridge A Branch, Boston, Mass.
Earle Gear & Mch. Co., 4705 Stenton Ave., Philadelphia, Pa.
Fawcus Machine Co., Pittsburgh, Pa.
Foote Bros. Gear & Mch. Co., 210 N. Carpenter St., Chicago, Ill.
Grant Gear Works, Inc., Boston, Mass.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., Cleveland, O.
New Process Gear Corp., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburgh, Pa.
Stahl Gear & Mch. Co., Cleveland, O.

Gears, Worm
Albaugh-Dover Co., 2100 Marshall Blvd., Chicago, Ill.
Albro-Clem Elevator Co., 501 Erie Ave., East, Philadelphia, Pa.
Baush Mch. Tool Co., Springfield, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Brown Co., A. & F., 79 Barclay St., New York.
Cincinnati Gear Co., Cincinnati, O.
Crofoot Gear Works, Inc., Cambridge A Branch, Boston, Mass.
Earle Gear & Mch. Co., 4705 Stenton Ave., Philadelphia, Pa.
Fawcus Machine Co., Pittsburgh, Pa.
Foote Bros. Gear & Mch. Co., 210 N. Carpenter St., Chicago, Ill.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Hindley Gear Co., Pittsburgh, Pa.
Horsburgh & Scott Co., Cleveland, O.
Link-Belt Company, Chicago, Ill.
Meisel Press Mfg. Co., 948 Dorchester Ave., Boston, Mass.
Newark Gear Cutting Mch. Co., Newark, N. J.
Nuttall Co., R. D., Pittsburgh, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Poole Engineering & Mch. Co., Baltimore, Md.
Stahl Gear & Mch. Co., Cleveland, O.

Gear Testing Machinery
Adams Co., Dubuque, Iowa.
Gisholt Mch. Co., Madison, Wis.
Gleason Works, Rochester, N. Y.
Morse Twist Drill & Machine Co., New Bedford, Mass.

Gear Tooth Rounders
Cross Gear & Engine Co., Detroit, Mich.
Ingle Machine Co., Rochester, N. Y.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.
Walker Mchy. Co., Chas. H., Detroit, Mich.

Generators, Electric
Curtis-Willis Co., Inc., 30 Church St., New York.
Eck Dynamo & Motor Co., Belleville, N. J.
General Electric Co., Schenectady, N. Y.
Reliance Elec. & Eng. Co., 1056 Ivanhoe Road, Cleveland, O.
Sprague Electric Works, 527 W. 34th St., New York.

Generators, Gas
American Gas Furnace Co., 25 John St., New York.

Generators, Oxygen and Hydrogen
International Oxygen Co., 115 Broadway, New York.

Goggles, Safety
Willson & Co., Inc., T. A., Reading, Pa.

Grease Cups
Michigan Lubricator Co., Detroit, Mich.

Grinding Machines, Abrasive Belt
Blevney Mch. Co., Greenfield, Mass.

Grinding Machines, Bench
Athol Mch. Co., Athol, Mass.
Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Builders Iron Foundry, Providence, R. I.
Cincinnati Elec. Tool Co., Cincinnati, O.
Diamond Mch. Co., Providence, R. I.
Forbes & Myers 178 Union St., Worcester, Mass.
Goodell-Pratt Co., Greenfield, Mass.
Greenfield Tap & Die Corp., Greenfield, Mass.
Hardinge Bros., Inc., Berteau and Ravenswood Aves., Chicago, Ill.
New Britain Mch. Co., New Britain, Conn.
Ransom Mfg. Co., Oshkosh, Wis.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass.
Standard Electric Tool Co., Cincinnati, O.
Webster & Perks Tool Co., Springfield, O.

Grinding Machines, Center
Cincinnati Elec. Tool Co., Cincinnati, O.
Diamond Mch. Co., Providence, R. I.
Standard Elec. Tool Co., Cincinnati, O.
United States Electrical Tool Co., 6th Ave. and Mt. Hope St., Cincinnati, O.

Grinding Machines, Chucking
Bryant Chucking Grinder Co., Springfield, Vt.

Grinding Machines, Cutter
Becker Milling Mch. Co., Hyde Park, Mass.
Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mch. Co., Oakley, Cincinnati, O.
Draper & Hall Co., Middletown, Conn.
Garvin Mch. Co., Spring and Varick Sts., New York.
Gould & Eberhardt, Newark, N. J.
Grand Rapids Grinding Mch. Co., Grand Rapids, Mich.
Greenfield Mch. Co., Greenfield, Mass.
Greenfield Tap & Die Corp., Greenfield, Mass.
Harris Engineering Co., H. E., Bridgeport, Conn.
Ingersoll Milling Mch. Co., Rockford, Ill.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.
Modern Tool Co., 2nd and State Sts., Erie, Pa.
Newark Gear Cutting Mch. Co., Newark, N. J.
Norton Grinding Co., Worcester, Mass.
Oesterlein Mch. Co., Cincinnati, O.
Pratt & Whitney Co., Hartford, Conn.
Royersford Foundry & Mch. Co., 54 N. 5th St., Philadelphia, Pa.
Union Twist Drill Co., Athol, Mass.
United States Electrical Tool Co., 6th Ave. and Mt. Hope St., Cincinnati, O.
Universal Grinding Mch. Co., Fitchburg, Mass.
Waltham Mch. Works, Waltham, Mass.
Wilmarth & Morman Co., 1180 Monroe Ave., N. W., Grand Rapids, Mich.

Grinding Machines, Cylindrical, Plain
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Grinder Co., Cincinnati, O.
Draper & Hall Co., Middletown, Conn.
Fitchburg Grinding Machine Co., Fitchburg, Mass.
Greenfield Mch. Co., Greenfield, Mass.
Landis Tool Co., Waynesboro, Pa.
Modern Tool Co., 2nd and State Sts., Erie, Pa.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Norton Grinding Co., Worcester, Mass.
Ott Grinding Co., 217 W. 10th St., Indianapolis, Ind.
Pratt & Whitney Co., Hartford, Conn.

Grinding Machines, Cylindrical, Universal
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Grinder Co., Cincinnati, O.
Fitchburg Grinding Machine Co., Fitchburg, Mass.
Fraser Co., Warren F., Westboro, Mass.
Grand Rapids Grinding Mch. Co., Grand Rapids, Mich.
Greenfield Mch. Co., Greenfield, Mass.
Landis Tool Co., Waynesboro, Pa.
Modern Tool Co., 2nd and State Sts., Erie, Pa.
Ott Grinding Co., 217 W. 10th St., Indianapolis, Ind.
Pratt & Whitney Co., Springfield, O.
Thompson Grinder Co., Springfield, O.
Universal Grinding Mch. Co., Fitchburg, Mass.

Grinding Machines, Disc
Bealy & Co., Chas. H., 120-B N. Clinton St., Chicago, Ill.
Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Diamond Mch. Co., Providence, R. I.
Gardner Mch. Co., Beloit, Wis.
Greenfield Tap & Die Corp., Greenfield, Mass.
Rowbottom Mch. Co., Waterbury, Conn.
Sellew Mch. Tool Co., Pawtucket, R. I.

Grinding Machines, Drill
Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Grand Rapids Grinding Mch. Co., Grand Rapids, Mich.
Heald Machine Co., Worcester, Mass.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
Sterling Grinding Wheel Co., Tiffin, O.
United States Electrical Tool Co., 6th Ave. and Mt. Hope St., Cincinnati, O.
Wilmarth & Morman Co., 1180 Monroe Ave., N. W., Grand Rapids, Mich.

Grinding Machines, Internal
Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Bryant Chucking Grinder Co., Springfield, Vt.
Cincinnati Electric Tool Co., Cincinnati, O.
Fraser Co., Warren F., Westboro, Mass.
Greenfield Mch. Co., Greenfield, Mass.
Heald Machine Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Lansing Stamping & Tool Co., Lansing, Mich.
Madison Mch. Tool Co., Madison, Wis.
Modern Tool Co., 2nd and State Sts., Erie, Pa.
Ott Grinder Co., 217 W. 10th St., Indianapolis, Ind.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass.
United States Electrical Tool Co., 6th Ave. and Mt. Hope St., Cincinnati, O.
Universal Grinding Co., Fitchburg, Mass.
Van Norman Machine Tool Co., Waltham Ave., Springfield, Mass.
Wood & Safford Mch. Wks., Great Falls, Montana.

Grinding Machines, Knife
Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Defiance Machine Works, Defiance, O.
Diamond Mch. Co., Providence, R. I.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.

Grinding Machines, Motor-Driven, Non-Portable
Dillon Electric Co., Canton, O.
Ransom Mfg. Co., Oshkosh, Wis.
Webster & Perks Tool Co., Springfield, O.

Grinding Machines, Multiple Spindle
Bryant Chucking Grinder Co., Springfield, Vt.

Grinding Machines, Pipe Threading Die
Bignall & Keeler Mch. Works, Edwardsville, Ill.
Landis Mch. Co., Inc., Waynesboro, Pa.
National Mchy. Co., Tiffin, O.

Grinding Machines, Piston Ring
Heald Machine Co., Worcester, Mass.
Pedrick Tool & Mch. Co., 3639 N. Lawrence St., Philadelphia, Pa.
Persons-Arter Mch. Co., Worcester, Mass.
Walker Co., O. S., Worcester, Mass.

Grinding Machines, Portable Electric
Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark Elec. Co., Jas., Jr., Louisville, Ky.
General Electric Co. Schenectady, N. Y.
Haskins, R. G., 541 W. Washington Blvd., Chicago, Ill.
Independent Pneumatic Tool Co., Chicago, Ill.
Neil & Smith Elec. Tool Co. ,Cincinnati, O.
Standard Electric Tool Co., Cincinnati, O.
Stow Mfg. Co., Binghamton, N. Y.
United States Electrical Tool Co., 6th Ave. and Mt. Hope St., Cincinnati, O.
Van Dorn Electric Tool Co., Cleveland, O.
Wisconsin Elec. Co., 2500 16th St., Racine, Wis.

Grinding Machines, Profile
Fisher Mch. Co., Philadelphia, Pa.

Grinding Machines, Radial, Ball Race, Etc.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass.
Van Norman Machine Tool Co., Waltham, Ave., Springfield, Mass.

Grinding Machines, Rotary Surface
Heald Machine Co., Worcester, Mass.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
Persons-Arter Mch. Co., Worcester, Mass.

Grinding Machines, Surface
Abrasive Mch. Tool Co., Providence, R. I.
Blake & Johnson Co., Waterbury, Conn.
Blanchard Machine Co., 64 State St., Cambridge, Mass.
Boston Scale & Mch. Co., Roxbury, Boston, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Diamond Machine Co., Providence, R. I.
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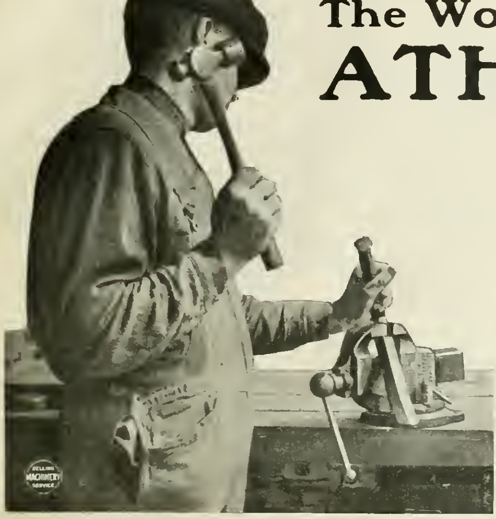

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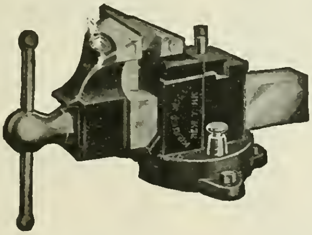

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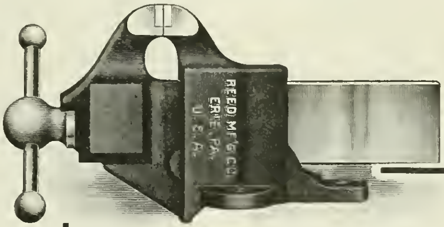

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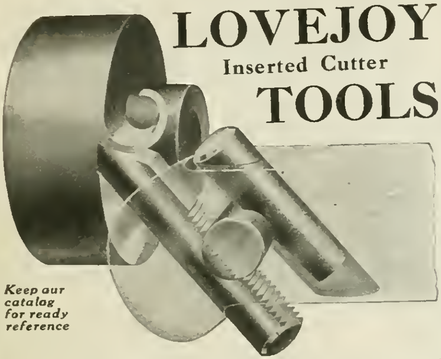

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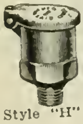

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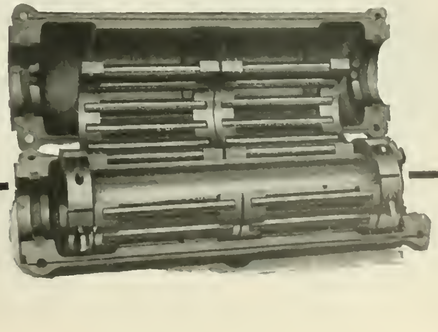

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Bradford Mch. Tool Co., Cincinnati, O. 14" to 42", inclusive.
Bridgeford Mch. Tool Works, 151 Winton Road, Rochester, N. Y. 26" to 60", inclusive.
Carroll-Jamieson Mch. Tool Co., 257 Davis St., Batavia, O. 13" and 14".
Champion Tool Works Co., 4955 Spring Grove Ave., Cincinnati, O. 12" to 18", inclusive.
Chard Lathe Co., Newcastle, Ind. 16" to 28", inclusive.
Cincinnati Iron & Steel Co., Cincinnati, O. 14" to 24", inclusive.
Cincinnati Lathe & Tool Co., Oakley, Cincinnati, O. 16" to 22", inclusive.
Cleveland Mchy. & Supply Co., Cleveland, O. 12", 16", 20", 26½".
Crawford Machine Tool Co., Inc., Erie, Pa. 15" to 25".
Dalton Manufacturing Corporation, 1911 Park Ave., New York. 6" to 18", inclusive
Davis Mch. Co., Inc., C. F., Rochester, N. Y. 11".
Davis Mch. Tool Co., Inc., Rochester, N. Y. 12" to 42", inclusive.
Earle Gear & Mch. Co., Philadelphia, Pa. 14" and 18".
Flather & Co., Inc., Nashua, N. H. 13" to 28", inclusive.
Fulton Mch. Tool Co., 1438 Bryan Place, Chicago, Ill. 18".
Giddings & Lewis Mfg. Co., Fond du Lac, Wis. 15", 16" and 18".
Gisholt Mch. Co., Madison, Wis. 16" and 25".
Greaves-Klusman Tool Co., Cincinnati, O. 16" to 30".
Hamilton Mch. Tool Co., Hamilton, O. 14" to 24".
Hendey Mch. Co., Torrington, Conn. 12" to 24".
Hill, Clarke & Co., Inc., Boston, Mass. 18" to 30", inclusive.
Houston, Stanwood & Gamble Co., Cincinnati, O. 30" to 60", inclusive.
LeBlond Mch. Tool Co., R. K., Cincinnati, O. 12" to 36".
Lehmann Mch. Co., St. Louis, Mo. 16" and 18".
Lodge & Shipley Mch. Tool Co., Cincinnati, O. 14" to 48", inclusive.
Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York. 12" to 84", inclusive.
Monarch Mch. Tool Co., Sidney, O. 10" to 30", incl.
Morris Mch. Tool Co., Cincinnati, O. 16" to 21", incl.
Mueller Mch. Tool Co., Cincinnati, O. 18".
Mullmer-Enlund Tool Co., Inc., Syracuse, N. Y. 12" and 14".
National Lathe Co., Cincinnati, O. 16", 17", 18", 22" and 24".
Niles-Bement-Pond Co., 111 Broadway, New York. 26" to 120", inclusive.
Oliver Machinery Co., Grand Rapids, Mich. 16" to 26", inclusive.
Porter-Cable Mch. Co., Syracuse, N. Y. 12".
Pratt & Whitney Co., Hartford, Conn. 10" to 16", inclusive.
Reed-Prentice Co., F. E. Reed Dept. and Prentice Bros. Dept., Worcester, Mass. 12" to 27", inclusive.
Rockford Lathe & Drill Co., Rockford, Ill. 13", 14", 16", 17", 18".
Rockford Tool Co., Rockford, Ill. 15" and 16".
Sebastian Lathe Co., Cincinnati, O. 13", 14", 15".
Shepard Lathe Co., Cincinnati, O. 12".
Sidney Tool Co., Sidney, O. 17" and 19".
Smith Mfg. Co., Philip, Sidney, O. 13" and 14".
South Bend Lathe Works, South Bend, Ind. 13" to 24", inclusive.
Springfield Mch. Tool Co., Springfield, O. 14" to 36", inclusive.
Summit Mch. Works, Worcester, Mass. 10".
Superior Mch. Tool Co., Kokomo, Ind. 18" and 20".
Victor Lathe Co., 151 Lafayette St., New York. 9".
Walcott Lathe Co., Jackson, Mich. 14" to 20", incl.
Whitcomb-Blaisdell Mch. Tool Co., Worcester, Mass. 14" to 30", inclusive.
Willard Mch. Tool Co., Cincinnati, O. 13".
Worcester Lathe Co., Worcester, Mass. 11", 13" and 16".

Lathes, Extension Bed and Gap
Barnes Drill Co., Inc., 814 Chestnut St., Rockford, Ill.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Manning, Maxwell & Moore, Inc., 119 West 40th St., New York.
Sebastian Lathe Co., Cincinnati, O.

Lathes, Foot Power
Barnes Co., W. F. and John, 231 Ruby St., Rockford, Ill.
Reed-Prentice Co., F. E. Reed Dept. and Prentice Bros. Dept., Worcester, Mass.

Lathes, Gun Boring
Amalgamated Machinery Corp., 72 W. Adams St., Chicago, Ill.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.

Lathes, Patternmakers'
Blount Co., J. G., Everett, Mass.
Defiance Machine Works, Defiance, O.
Greenfield Tap & Die Corp., Greenfield, Mass.
Oliver Machinery Co., Grand Rapids, Mich.
Summit Mch. Works, Worcester, Mass.

Lathes, Pulley
Cincinnati Pulley Mchy. Co., Cincinnati, O.

Lathes, Shaft
Bridgeford Mch. Tool Works, 151 Winton Road, Rochester, N. Y.
Fitchburg Machine Works, Fitchburg, Mass.
Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York.
Niles-Bement-Pond Co., 111 Broadway, New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Lathes, Speed
Blount Co., J. G., Everett, Mass.
Diamond Mch. Co., Providence, R. I.
Greenfield Tap & Die Corp., Greenfield, Mass.
Oliver Machinery Co., Grand Rapids, Mich.
Potter Tool & Mch. Wks., S. A., 79 E. 130th St., New York.
Summit Machine Works, Worcester, Mass.

Lathes, Turret
See also Chucking Machines.
Acme Mch. Tool Co., Cincinnati, O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Bullard Mch. Tool Co., Bridgeport, Conn.
Davis Mch. Tool Co., Inc., Rochester, N. Y.
Dreses Mch. Tool Co., Cincinnati, O.
Foster Mch. Co., Elkhart, Ind.
Fulton Mch. Tool Co., 1438 Bryan Pl., Chicago, Ill.
Garvin Mch. Co., Spring and Varick Sts., New York.
Gisholt Mch. Co., Madison, Wis.
Greaves-Klusman Tool Co., Cincinnati, O.
International Mch. Tool Co., Indianapolis, Ind.
Jones & Lamson Mch. Co., Springfield, Vt.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mch. Tool Co., Cincinnati, O.
Morris Mch. Tool Co., Cincinnati, O.
New Britain Mch. Co., New Britain, Conn.
Niles-Bement-Pond Co., 111 Broadway, New York.
Oliver Machinery Co., Grand Rapids, Mich.
Pratt & Whitney Co., Hartford, Conn.
Reed-Prentice Co., F. E. Reed Dept. and Prentice Bros. Dept., Worcester, Mass.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass.
Southworth Mch. Co., Portland, Maine
Springfield Mch. Tool Co., 631 Southern Ave., Springfield, O.
Steinle Turret Mch. Co., Madison, Wis.
Warner & Swasey Co., Cleveland, O.
Wood Turret Mch. Co., Brazil, Ind.

Lathes, Woodworkers'
Barnes Co., W. F. and John, 231 Ruby St., Rockford, Ill.
Defiance Machine Works, Defiance, O.
Oliver Machinery Co., Grand Rapids, Mich.
Reed-Prentice Co., F. E. Reed Dept. and Prentice Bros. Dept., Worcester, Mass.

Laying-out Fixture for Tool Work
Craley Mfg. Co., Mount Joy, Pa.

Leather Belting, Round
Schieren Co., Chas. A., 73 Ferry St., New York.

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Goodell-Pratt Co., Greenfield, Mass.
Keuffel & Esser Co., Hoboken, N. J.
Starrett Co., L. S., Athol, Mass.

Light Brackets, Electric, Adjustable
Newman Mfg. Co., Cincinnati, O.

Lockers, Metal
Manufacturing Equipment & Eng. Co., Framingham, Mass.

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American Petroleum Products Co., Cleveland, O.
Besly & Co., Chas. A., 120-B N. Clinton St., Chicago, Ill.
Cataract Refining & Mfg. Co., Buffalo, N. Y.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Fiske Bros. Refining Co., 24 State St., New York.
Haws, Inc., Geo. A., 135 Front St., New York.
Lumen Bearing Co., Buffalo, N. Y.
Oakley Chemical Co., 26 Thames St., New York.
Royersford Foundry & Mch. Co., 54 N. 5th St., Philadelphia, Pa.
S K F Ball Bearing Co., Hartford, Conn.
Texas Company, 17 Battery Place, New York.

Lubricators
Besly & Co., Chas. A., 120-B N. Clinton St., Chicago, Ill.
Greene, Tweed & Co., 109 Duane St., New York.
Michigan Lubricator Co., Detroit, Mich.

Machinery Dealers
Besly & Co., Chas. A., 120-B N. Clinton St., Chicago, Ill.
Brownell Mchy. Co., Providence, R. I.
Davis Mch. Tool Co., Inc., Wm. F., 519 W. Washington Blvd., Chicago, Ill.
Dickow, Fred Co., 37 So. Desplaines St., Chicago, Ill.
Earle Gear & Mch. Co., 4705 Stenton Ave., Philadelphia, Pa.
Easley Mchy. Co., E. L., 555 Washington Blvd., Chicago, Ill.
Garvin Mch. Co., Spring and Varick Sts., New York.
Hill, Clarke & Co., Inc., Boston, Mass.
Hill, Clarke & Co. of Chicago, 625 Washington Blvd., Chicago, Ill.
Kinsey Co., E. A., Cincinnati, O.
Lucas & Son, Inc., J. L., Bridgeport, Conn.
Lynd-Farquhar Co., Boston, Mass.
Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York.
Marshall & Huschart Mchy. Co., 17 So. Jefferson St., Chicago, Ill.
McDonough Mfg. Co., Eau Claire, Wis.
Motch & Merryweather Mchy. Co., Cleveland, O.
Niles-Bement-Pond Co., 111 Broadway, New York.
Osgood Tool Co., J. L., Buffalo, N. Y.
Pattison Supply Co., W. M., Cleveland, O.
Simmons Mch. Co., Inc., Albany, N. Y.
Vandyck Churchill Co., 110 Broadway, New York.
Young, Corley & Dolan, Inc., 115 Broadway, New York.

Machinists' Small Tools
See Calipers, Hammers, Wrenches, Drills, Taps, etc.

Mallets, Rawhide
Chicago Rawhide Mfg. Co., 1301 Elston Ave., Chicago, Ill.

Mandrels, Expanding and Solid
See Arbors and Mandrels, Expanding and Solid.

Marking Machines
Grant Mfg. & Mch. Co., N. W. Station, Bridgeport, Conn.
Greenfield Tap & Die Corp., Greenfield, Mass.
Noble & Westbrook Mfg. Co., Hartford, Conn.

Marking Machines, Electric
Swedish Gage Co., Inc., 215 W. 55th St., New York.

Measuring Machines, Precision
American Gauge Co., Dayton, O.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Inc., J. M., Gloucester City, N. J.

Metallographic Apparatus
Holz, Herman A., Metropolitan Bldg., New York.

Metals, Bearing
See Bearings, Bronze, Babbitt, etc., and Bushings, Brass, Bronze, etc.

Microscopes (Metallurgical)
Holz, Herman A., Metropolitan Bldg., New York.

Milling and Drilling Machines, Upright
Knight Mchy. Co., W. B., St. Louis, Mo.

Milling Attachments
Adams Co., Dubuque, Iowa.
Becker Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Carroll, William, Cincinnati, O.
Cincinnati Milling Mch. Co., Oakley, Cincinnati, O.
Garvin Mch. Co., Spring and Varick Sts., New York.
Hendey Machine Co., Torrington, Conn.
Ingersoll Milling Machine Co., Rockford, Ill.
Kearney & Trecker Co., Milwaukee, Wis.
Kempsmith Mfg. Co., Milwaukee, Wis.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.
Oesterlein Mch. Co., Cincinnati, O.
Porter-Cable Mch. Co., Syracuse, N. Y.
Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass.
Rockford Milling Machine Co., Rockford, Ill.
Standard Engineering Works, Pawtucket, R. I.
Whitney Mfg. Co., Hartford, Conn.

Milling Machines, Automatic
Pratt & Whitney Co., Hartford, Conn.

Milling Machines, Bench
Ames Co., B. C., Waltham, Mass.
Burke Machine Tool Co., Conneaut, O.
Carter Hakes Co., Sterling Place, Winsted, Conn.
Greenfield Tap & Die Corp., Greenfield, Mass.
Hardinge Bros., Inc., Berteau and Ravenswood Aves., Chicago, Ill.
Rockford Milling Machine Co., Rockford, Ill.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Van Norman Mch. Tool Co., Waltham Ave., Springfield, Mass.

Milling Machines, Circular Continuous
Becker Milling Machine Co., Hyde Park, Mass.
Gould & Eberhardt, Newark, N. J.

Milling Machines, Hand
Adams Co., Dubuque, Iowa.
Becker Milling Machine Co., Hyde Park, Mass.
Bickett Mch. & Mfg. Co., Cincinnati, O.
Biggs-Watterson Co., Cleveland, O.
Burke Machine Tool Co., Conneaut, O.
Carter & Hakes Co., Sterling Place, Winsted, Conn.
Cleveland Milling Machine Co., Cleveland, O.
Davenport Mfg. Co., Meadville, Pa.
Defiance Machine Works, Defiance, O.
Garvin Mch. Co., Spring and Varick Sts., New York.
Greenfield Tap & Die Corp., Greenfield, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rockford Milling Mch. Co., Rockford, Ill.
Standard Engineering Works, Pawtucket, R. I.
Steptoe Co., John, Brighton, Cincinnati, O.
Van Norman Mch. Tool Co., Waltham Ave., Springfield, Mass.
Whitney Mfg. Co., Hartford, Conn.

Milling Machines, Horizontal, Plain
Adams Co., Dubuque, Iowa.
Beaman & Smith Co., Providence, R. I.
Becker Milling Machine Co., Hyde Park, Mass.
Bilton Mch. Tool Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mch. Co., Oakley, Cincinnati, O.
Cleveland Milling Machine Co., Cleveland, O.
Davenport Mfg. Co., Meadville, Pa.
Defiance Machine Works, Defiance, O.
Garvin Mch. Co., Spring and Varick Sts., New York.
Gooley & Edlund, Inc., Cortland, New York.
Hendey Machine Co., Torrington, Conn.
Ingersoll Milling Machine Co., Rockford, Ill.
Kearney & Trecker Co., Milwaukee, Wis.
Kempsmith Mfg. Co., Milwaukee, Wis.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
Niles-Bement-Pond Co., 111 Broadway, New York.
Oesterlein Mch. Co., Cincinnati, O.
Pratt & Whitney Co., Hartford, Conn.
Rockford Milling Mch. Co., Rockford, Ill.
Standard Engineering Works, Pawtucket, R. I.
Steptoe Co., John, Cincinnati, O.

Milling Machines, Horizontal, Universal
Becker Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mch. Co., Oakley, Cincinnati, O.
Cleveland Milling Machine Co., Cleveland, O.
Defiance Machine Works, Defiance, O.
Hendey Machine Co., Torrington, Conn.
Kearney & Trecker Co., Milwaukee, Wis.
Kempsmith Mfg. Co., Milwaukee, Wis.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
Niles-Bement-Pond Co., 111 Broadway, New York.
Oesterlein Mch. Co., Cincinnati, O.
Rockford Milling Mch. Co., Rockford, Ill.
Rowbottom Mch. Co., Waterbury, Conn.
Van Norman Mch. Tool Co., Waltham Ave., Springfield, Mass.

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Beaman & Smith Co., Providence, R. I.
Becker Milling Machine Co., Hyde Park, Mass.
Garvin Mch. Co., Spring and Varick Sts., New York.
Hendey Machine Co., Torrington, Conn.
Kempsmith Mfg. Co., Milwaukee, Wis.
Reynolds Mch. Co., Massillon, O.
Van Norman Mch. Tool Co., Waltham Ave., Springfield, Mass.

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Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
Pedrick Tool & Mch. Co., 3039 N. Lawrence St., Philadelphia, Pa.

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Many Times

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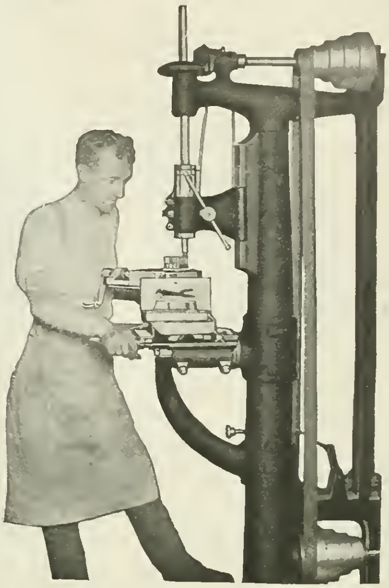

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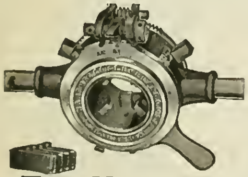

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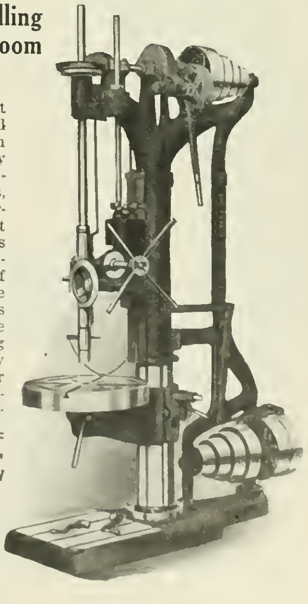

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Newman Mfg. Co., Cincinnati, O.
Schwerdtle Stamp Co., Bridgeport, Conn.

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Schwerdtle Stamp Co., Bridgeport, Conn.

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Oster Mfg. Co., Cleveland, O.
Saunders Sons, D., Inc., Yonkers, N. Y.
Standard Engineering Co., Ellwood City, Pa.

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Cincinnati Screw Co., Twightwee, Cincinnati, O.
National Acme Co., Cleveland, O.

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Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn.

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Bowen Products Corp., Detroit, Mich.
Gits Bros. Mfg. Co., 551 Monroe St., Chicago, Ill.
Michigan Lubricator Co., Detroit, Mich.
Tucker, W. M. & C. F., Hartford, Conn.

Oilers, Loose Pulley
Brown Engineering Co., 133 N. 3rd St., Reading, Pa.
Michigan Lubricator Co., Detroit, Mich.

Oil Gages
Michigan Lubricator Co., Detroit, Mich.

Oil Hole Covers
Bowen Products Corp., Detroit, Mich.
Gits Bros. Mfg. Co., 551 Monroe St., Chicago, Ill.
Tucker, W. M. & C. F., Hartford, Conn.

Oil Pans, Sheet Steel
[illegible] Bros., Cincinnati, O.

Oils, Fuel
American Petroleum Products Co., Cleveland, O.

Oils, Lubricating
American Petroleum Products Co., Cleveland, O.
Besly & Co., Chas. H., 120-B N. Clinton St., Chicago, Ill.
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Fiske Bros. Refining Co., 24 State St., New York.
Hass, Inc., Geo. A., 135 Front St., New York.
Royersford Foundry & Mch. Co., 54 N. 5th St., Philadelphia, Pa.
Texas Company, 17 Battery Place, New York.

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Cataract Refining & Mfg. Co., Buffalo, N. Y.
Fiske Bros. Refining Co., 24 State St., New York.
Hass, Inc., Geo. A., 135 Front St., New York.
Texas Company, 17 Battery Place, New York.

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American Gas Furnace Co., 24 John St., New York.
General Electric Co., Schenectady, N. Y.

Ovens, Tempering
[illegible] & Co., Inc., H., 101 Duane St., New York.
General Electric Co., Schenectady, N. Y.

Oxygen
International Oxygen Co., 115 Broadway, New York.
Linde Air Products Co., 42nd St. Bldg., New York.

Packings, Leather
Chicago Rawhide Mfg. Co., 1301 Elston Ave., Chicago, Ill.
Graton & Knight Mfg. Co., Worcester, Mass.
Williams & Sons, I. B., Dover, N. H.

Pans, Shop and Lathe
New Britain Mch. Co., New Britain, Conn.

Parallels
Walker Co., O. S., Worcester, Mass.

Patents
Parker, C. L., Washington, D. C.

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Pattern Shop Machinery
Crescent Machine Co., 56 Main St., Leetonia, O.
Defiance Machine Works, Defiance, O.
Oliver Machinery Co., Grand Rapids, Mich.

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Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York.
Oliver Machinery Co., Grand Rapids, Mich.

Patterns, Metal
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Anderson Mfg. Co., Elyria, O.
Grant Mfg. & Machine Co., N. W. Station, Bridgeport, Conn.
S-P Manufacturing Co., Cleveland, O.

Patterns, Wood
Aluminum Castings Co., Cleveland, O.
S-P Manufacturing Co., Cleveland, O.

Pencils, Drawing
Dixon Crucible Co., Joseph, Jersey City, N. J.

Phosphor Bronze
See Bronze.

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Newman Mfg. Co., Cincinnati, O.
Walworth Mfg. Co., Boston, Mass.

Pipes
National Tube Co., Pittsburgh, Pa.
Newman Mfg. Co., Cincinnati, O.

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Armstrong Mfg. Co., 297 Knowlton St., Bridgeport, Conn.
Bignall & Keeler Mch. Works, Edwardsville, Ill.
Curtis & Curtis Co., 8 Garden St., Bridgeport, Conn.
Foote-Burt Co., Cleveland, O.
Greenfield Tap & Die Corp., Greenfield, Mass.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Hart Mfg. Co., E. 20th St. and Marion Ave., Cleveland, O.
Landis Mch. Co., Inc., Waynesboro, Pa.
Merrell Mfg. Co., 15 Curtis St., Toledo, O.
Murchey Mch. & Tool Co., 34 Porter St., Detroit, Mich.
Oster Mfg. Co., Cleveland, O.
Saunders Sons, Inc., D., Yonkers, N. Y.
Southwark Foundry & Mch. Co., Philadelphia, Pa.
Standard Engineering Co., Ellwood City, Pa.
Treadwell Engineering Co., Easton, Pa.
Trimont Mfg. Co., Roxbury, Mass.
Victor Tool Co., Waynesboro, Pa.
Walworth Mfg. Co., Boston, Mass.

Pistons
Aluminum Castings Co., Cleveland, O.

Planer Attachments
Cincinnati Planer Co., Cincinnati, O.
Gray Co., G. A., Cincinnati, O.
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Cleveland Planer Co., 3152 Superior Ave., Cleveland, O.
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Morton Mfg. Co., Muskegon Heights, Mich.
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Whitcomb-Blaisdell Mch. Tool Co., Worcester, Mass.
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Diamond Machine Co., Providence, R. I.
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Sundstrom Mfg. Co., 3201 Shields Ave., Chicago, Ill.

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Swaine Mfg. Co., F. J., St. Louis, Mo.
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Presses, Foot
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Ferracute Mch. Co., Bridgeton, N. J.
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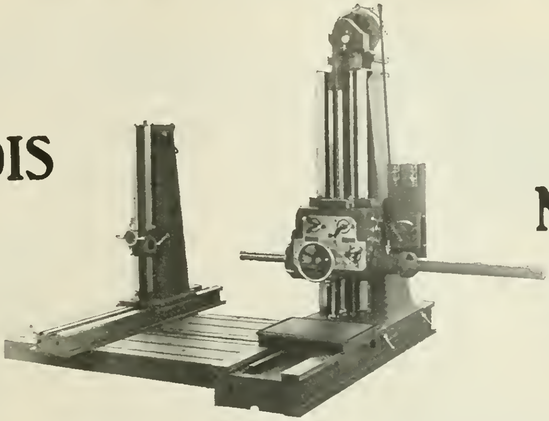

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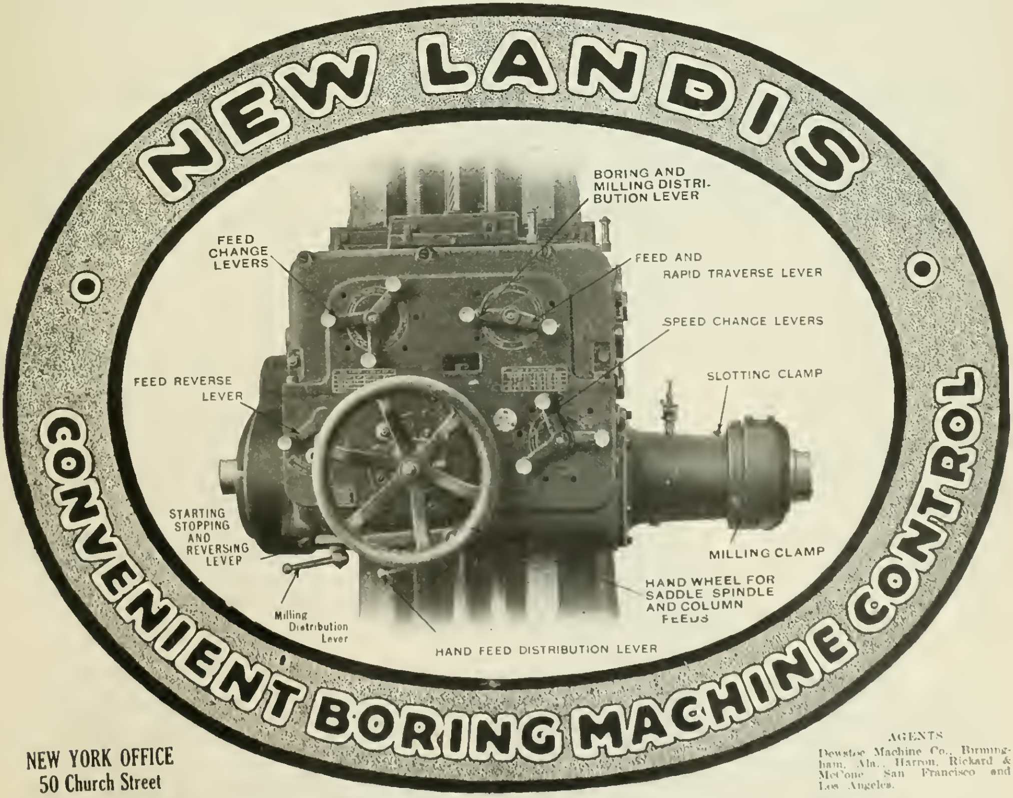
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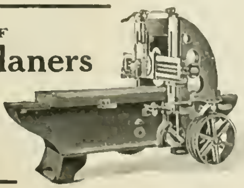

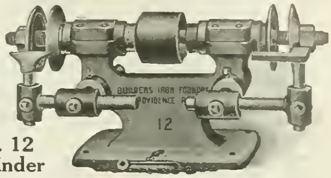

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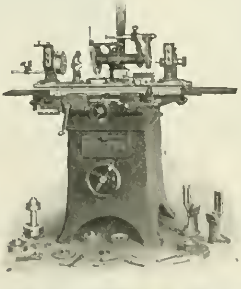

The WALKER No. 2 Grinder is an accurate, economical machine and deserves investigation.

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Greenfield Tap & Die Corp., Greenfield, Mass.
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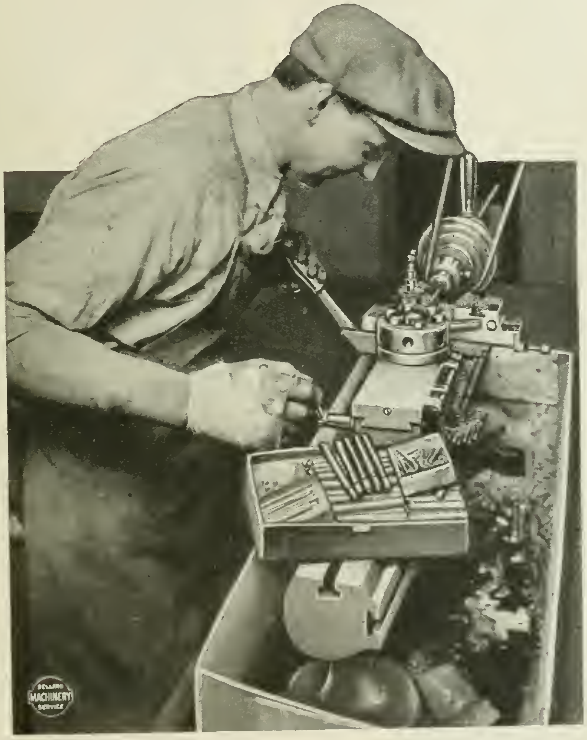
A CATARACT BENCH LATHE

With Turret Attachment



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Vulcan Crucible Steel Co., Aliquippa, Pa.

Steel, Machine
Aborn Steel Co., Inc., 26 Clarke St., New York.
Apex Steel Corporation, 50 Church St., New York.
Blum & Co., Julius, 510 W. 24th St., New York.
Boker & Co., Inc., H., 101 Duane St., New York.
Colonial Steel Co., Pittsburgh, Pa.
Firth-Sterling Steel Co., McKeesport, Pa.
Halcomb Steel Co., Syracuse, N. Y.
Hawkridge Bros. Co., Boston, Mass.
Latrobe Electric Steel Co., Latrobe, Pa.
Standard Alloys Co., Pittsburgh, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Vanadium-Alloys Steel Co., Pittsburgh, Pa.
Vulcan Crucible Steel Co., Aliquippa, Pa.

Steel Shelving, Racks, Barrels, Tables, Etc.
Manufacturing Equipment & Eng. Co., Framingham, Mass.
National Scale Co., Chicopee Falls, Mass.
New Britain Mch. Co., New Britain, Conn.

Stellite
Haynes Stellite Co., Kokomo, Ind.

Stocks, Die
Armstrong Mfg. Co., 297 Knowlton St., Bridgeport, Conn.
Bay State Tap & Die Co., Mansfield, Mass.
Brubaker & Bros., W. L., 50 Church St., New York.
Butterfield & Co., Derby Line, Vt.
Card Mfg. Co., S. W., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Curtis & Curtis Co., Bridgeport, Conn.
Greenfield Tap & Die Corp., Greenfield, Mass.
Hart Mfg. Co., E. 20th St. and Marion Ave., Cleveland, O.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Oster Mfg. Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Reed Mfg. Co., Erie, Pa.
Saunders Sons, Inc., D., Yonkers, N. Y.
Standard Engineering Co., Ellwood City, Pa.
Walworth Mfg. Co., Boston, Mass.

Stones, Oil
Norton Co., Worcester, Mass.
Vitrified Wheel Co., Westfield, Mass.

Stools, Steel
See Furniture, Shop and Drafting-room.

Straightening Machinery
Morse Twist Drill & Machine Co., New Bedford, Mass.
Niles-Bement-Pond Co., 111 Broadway, New York.
Springfield Mch. Tool Co., Springfield, O.

Stud Setters, Opening
Errington Mechanical Laboratory, 39 Cortlandt St., New York.

Swaging Machines
Etna Machine Co., Toledo, O.
Langelier Mfg. Co., Providence, R. I.
Torrington Co., Torrington, Conn.

Switchboards
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Switches
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Tachometers
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn.

Taper and Form Turning Attachment
Townsend Mfg. Co., H. P., Hartford, Conn.

Taper Arbors
Parker Mfg. Co., Ann Arbor, Mich.

Tapes, Measuring
Keuffel & Esser Co., Hoboken, N. J.
Starrett Co., L. S., Athol, Mass.

Tap Extensions
Allen Mfg. Co., Hartford, Conn.

Tap Extractors
Walton Co., Hartford, Conn.

Tapping Attachments and Devices
American Tool Works Co., Cincinnati, O.
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, 231 Ruby St., Rockford, Ill.
Beaman & Smith Co., Providence, R. I.
Bicknell-Thomas Co., Greenfield, Mass.
Cincinnati Bickford Tool Co., Oakley, Cincinnati, O.
Defiance Machine Works, Defiance, O.
Errington Mechanical Laboratory, 39 Cortlandt St., New York.
Geometric Tool Co., New Haven, Conn.
Greenfield Tap & Die Corp., Greenfield, Mass.
Hammond Mfg. Co., Cleveland, O.
Leland-Gifford Co., Worcester, Mass.
Modern Tool Co., 2nd and State Sts., Erie, Pa.
Newman Mfg. Co., Cincinnati, O.
Peter Bros. Mfg. Co., 135 Railroad Ave., Algonquin, Ill.
Procunier, Wm. L., 549 Washington Blvd., Chicago, Ill.
Whitney Mfg. Co., Hartford, Conn.

Tapping Machines
Acme Machinery Co., Cleveland, O.
Baker Bros., Toledo, O.
Burke Mch. Tool Co., Conneaut, O.
Defiance Machine Works, Defiance, O.
Fenn Mfg. Co., Hartford, Conn.
Garvin Mch. Co., Spring and Varick Sts., New York.
Geometric Tool Co., New Haven, Conn.
Hammond Mfg. Co., Cleveland, O.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Harris Engineering Co., H. E., Bridgeport, Conn.
Langelier Mfg. Co., Providence, R. I.
Moline Tool Co., Moline, Ill.
National Acme Co., Cleveland, O.
National Mchy. Co., Tiffin, O.
Paragon Gear Works, Taunton, Mass.
Peter Bros. Mfg. Co., 135 Railroad Ave., Algonquin, Ill.
Procunier, Wm. L., 549 W. Washington Blvd., Chicago, Ill.
Rickert-Shafer Co., Erie, Pa.
Rockford Drilling Mch. Co., Rockford, Ill.
Saunders' Sons, Inc., D., Yonkers, N. Y.
Webster & Perks Tool Co., Springfield, O.

Taps
Advance Tool Co., Cincinnati, O.
Bay State Tap & Die Co., Mansfield, Mass.
Bealy & Co., Chas. H., 120-B N. Clinton St., Chicago, Ill.
Brubaker & Bros., W. L., 50 Church St., New York.
Butterfield & Co., Derby Line, Vt.
Card Mfg. Co., S. W., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Geometric Tool Co., New Haven, Conn.
Greenfield Tap & Die Corp., Greenfield, Mass.
Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York.
Hardinge Bros., Inc., Berteau and Ravenswood Aves., Chicago, Ill.
Harris Engineering Co., H. E., Bridgeport, Conn.
Landis Mch. Co., Inc., Waynesboro, Pa.
Morse Twist Drill & Mch. Co, New Bedford, Mass.
National Acme Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Reiff & Nestor Co., Lykens, Pa.
Saunders' Sons, Inc., D., Yonkers, N. Y.
Sheffield Mch. & Tool Co., Dayton, O.
Standard Tool Co., Cleveland, O.
Walworth Mfg. Co., Boston, Mass.

Taps, Collapsing
Errington Mechanical Laboratory, 39 Cortlandt St., New York.
Geometric Tool Co., New Haven, Conn.
Manufacturers Equipment Co., 200 N. Jefferson St., Chicago, Ill.
Modern Tool Co., 2nd and State Sts., Erie, Pa.
Murchey Mch. & Tool Co., 31 Porter St., Detroit, Mich.
National Acme Co., Cleveland, O.
Victor Tool Co., Waynesboro, Pa.

Testing Machines, Sheet Metal
Hols, Herman A., Metropolitan Bldg., New York.

Testing Outfits, Hydraulic
Metalwood Mfg. Co., Detroit, Mich.

Thermometers
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Taylor Instrument Companies, Rochester, N. Y.

Thermometers, Indicating and Recording
Brown Instrument Co., Philadelphia, Pa.
Taylor Instrument Companies, Rochester, N. Y.

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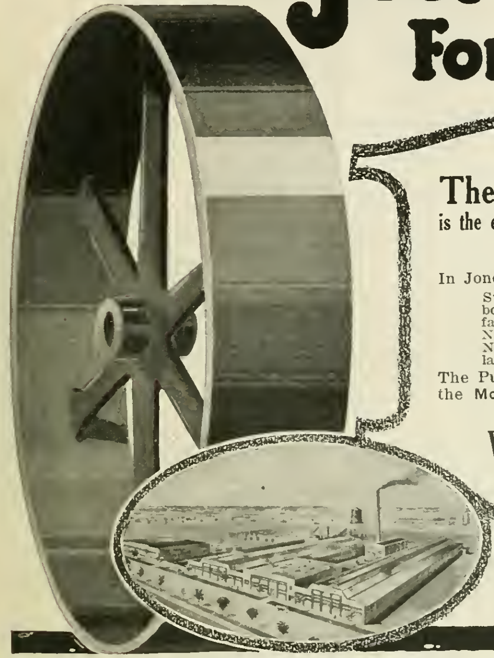

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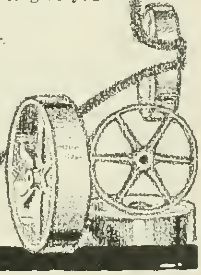

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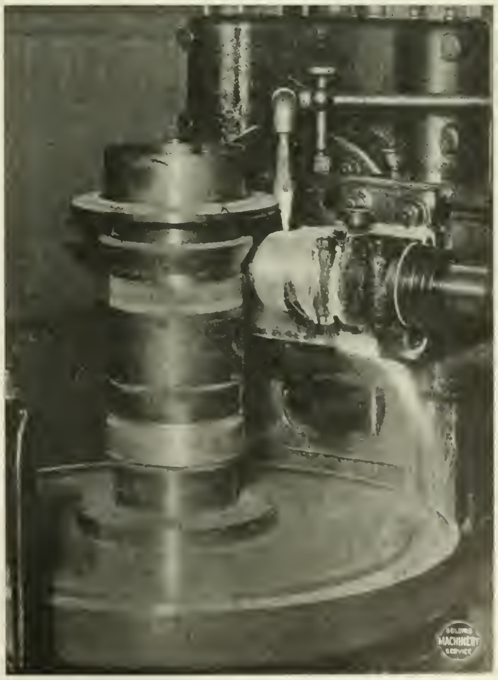

Thread Cutting Machinery
Automatic Machine Co., Bridgeport, Conn.
Boston Gear Works, Norfolk Downs, Mass.
Geometric Tool Co., New Haven, Conn.
Greenfield Tap & Die Corp., Greenfield, Mass.
Landis Mch. Co., Inc., Waynesboro, Pa.
Lees-Bradner Co., Cleveland, O.
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National Mchy. Co., Tiffin, O.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
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Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass.
Webster & Perks Tool Co., Springfield, O.

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Davis Mch. Tool Co., Inc., Wm. F., 549 W. Washington Blvd., Chicago, Ill.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.

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Rivett Lathe & Grinder Co., Brighton, Boston, Mass.
Goddard Tool Co., Chicago, Ill.

Thread Gages
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Thread Lead Indicator
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Gray Mch. Tool Co., Inc., Buffalo, N. Y.
Greenfield Tap & Die Corp., Greenfield, Mass.
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Lees-Bradner Co., Cleveland, O.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Smalley-General Co., Bay City, Mich.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Waltham Mch. Works, Waltham, Mass.

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Starrett Co., L. S., Athol Mass.
Union Tool Chest Company, 10 Railroad St., Rochester, N. Y.

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Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill.
Bruno Mfg. Co., Buffalo, N. Y.
Cleveland Twist Drill Co., Cleveland, O.
Gisholt Machine Co., Madison, Wis.
Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York.
Lovejoy Tool Co., Inc., Springfield, Vt.
O. K. Tool Holder Co., Shelton, Conn.
Osgood Tool Co., J. L., Buffalo, N. Y.
Ready Tool Co., 650 Railroad Ave., Bridgeport, Conn.
Western Tool & Mfg. Co., Springfield, O.
Williams & Co., J. H., 61 Richards St., Brooklyn, N. Y.
Windau Tool Co., Cleveland, O.

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Gorham Tool Co., Detroit, Mich.
Milwaukee Electric Crane Co., Inc., Milwaukee, Wis.

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Tracing Filing Cabinets
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Northern Engineering Works, Detroit, Mich.
Yale & Towne Mfg. Co., 9 E. 40th St., New York.

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Reliance Elec. & Eng. Co., 1056 Ivanhoe Road, Cleveland, O.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

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Q. M. S. Co., 1763 [illegible], Chicago, Ill.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Wright Mfg. Co., Lisbon, O.
Yale & Towne Mfg. Co., 9 E. 40th St., New York.

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Cowan Truck Co., 88 Water St., Holyoke, Mass.
Elwell-Parker Electric Co., Cleveland, O.
Holyoke Truck Co., 112 Race St., Holyoke, Mass.
Greenfield Tap & Die Corp., Greenfield, Mass.
National Scale Co., Chicopee Falls, Mass.
Transmission Ball Bearing Co., Inc., Buffalo, N. Y.

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Elwell-Parker Electric Co., Cleveland, O.

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National Scale Co., Chicopee Falls, Mass.
Transmission Ball Bearing Co., Inc., Buffalo, N. Y.

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Watson-Stillman Co., 192 Fulton St., New York.

Tubing, Flexible
Almond Mfg. Co., T. R., 2 Maple Ave., Ashburnham, Mass.
Wheelock Mfg. Co., Wheelock, Vermont.

Tubing, Seamless Steel
Blum & Co., Julius, 510 W. 24th St., New York.
Frasse & Co., Inc., Peter A., 417 Canal St., N. Y.
National Tube Co., Pittsburgh, Pa.
Standard Parts Co., Cleveland, O.

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Blum & Co., Julius, 510 W. 24th St., New York.
Frasse & Co., Inc., Peter A., 417 Canal St., N. Y.
National Tube Co., Pittsburgh, Pa.

Tumbling Barrels
Abbott Ball Co., Elmwood, Hartford, Conn.
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Royersford Fdry. & Mch. Co., 54 N. 5th St., Philadelphia, Pa.

Turntables
Canton Foundry & Mch. Co., Canton, O.
Link-Belt Company, Chicago, Ill.

Turret Attachments
Almond Mfg. Co., T. R., 2 Maple Ave., Ashburnham, Mass.
Meisselbach-Catucci Mfg. Co., 27 Congress St., Newark, N. J.
Newman Mfg. Co., Cincinnati, O.
Phoenix Mfg. Co., Eau Claire, Wis.

Turret Lathes, Vertical
Bullard Mch. Tool Co., Bridgeport, Conn.
Pratt & Whitney Co., Hartford, Conn.

Twist Drills
See Drills, Twist.

Unions
Dart Mfg. Co., E. M., Providence, R. I.

Universal Joints
Baush Mch. Tool Co., Springfield, Mass.
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Cooper Flexible Transmission Co., Inc., Brooklyn, N. Y.

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Chicago Rawhide Mfg. Co., 1301 Elston Ave., Chicago, Ill.
Graton & Knight Mfg. Co., Worcester, Mass.
Williams & Sons, I. B., Dover, N. H.

Valves
Elmes Engineering Works, Chas. F., 222 N. Morgan St., Chicago, Ill.
Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, O.
Metalwood Mfg. Co., Detroit, Mich.
Watson-Stillman Co., 192 Fulton St., New York.

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Hohnsbeen Mfg. Co., Minneapolis, Minn.

Vises, Bench
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Goodell-Pratt Co., Greenfield, Mass.
New Britain Mch. Co., New Britain, Conn.
Prentice Vise Co., 106 Lafayette St., New York.
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Western Tool & Mfg. Co., Springfield, O.
Yost Mfg. Co., Meadville, Pa.

Vises, Drill
Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill.
Brown Engineering Co., 133 N. 3rd St., Reading, Pa.
Carter & Hakes Co., Sterling Place, Winstead, Conn.
Graham Mfg. Co., Providence, R. I.
Skinner Chuck Co., New Britain, Conn.
Yost Mfg. Co., Meadville, Pa.

Vises, Milling
Cleveland Milling Mch. Co., Cleveland, O.
New Jersey Mchy. Exchange, Newark, N. J.

Vises, Pipe
Bignall & Keeler Mch. Works, Edwardsville, Ill.
Butterfield & Co., Derby Line, Vt.
Curtis & Curtis Co., 8 Garden St., Bridgeport, Conn.
Greenfield Tap & Die Corp., Greenfield, Mass.
Oster Mfg. Co., Cleveland, O.
Reed Mfg. Co., Erie, Pa.
Saunders' Sons, Inc., D., Yonkers, N. Y.
Walworth Mfg. Co., Boston, Mass.
Williams & Co., J. H., 61 Richards St., Brooklyn, N. Y.
Yost Mfg. Co., Meadville, Pa.

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American Tool Works Co., Cincinnati, O.
Cincinnati Planer Co., Cincinnati, O.
Hendey Machine Co., Torrington, Conn.
Sellew Mch. Tool Co., Pawtucket, R. I.
Skinner Chuck Co., New Britain, Conn.

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Brown Engineering Co., 133 N. 3rd St., Reading, Pa.
Graham Mfg. Co., Providence, R. I.
New Jersey Mchy. Exchange, Newark, N. J.
Skinner Chuck Co., New Britain, Conn.

Vise, Universal Jaws for
Universal Equalizer Co., Cincinnati, O.

Voltmeters
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
General Electric Co., Schenectady, N. Y.

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Kales Stamping Company, Detroit, Mich.

Washers, Leather
Chicago Rawhide Mfg. Co., 1301 Elston Ave., Chicago, Ill.
Graton & Knight Mfg. Co., Worcester, Mass.
Schieren Co., Chas. A., 73 Ferry St., New York
Williams & Sons, I. B., Dover, N. H.

Washers, Spacing
See Collars, Spacing, etc.

Washstands and Bowls
Manufacturing Equipment & Eng. Co., Framingham, Mass.

Waste, Cotton and Wool
Royal Mfg. Co., Rahway, N. J.

Water Coolers
Manufacturing Equipment & Eng. Co., Framingham, Mass.

Welding and Cutting, Job
Davis-Bournonville Co., Jersey City, N. J.
General Electric Co., Schenectady, N. Y.
Metzger Welding Co., Cincinnati, O.
Standard Parts Co., Cleveland, O.
Thomas Elec. Welding Co., Lynn, Mass.
Thomson Spot Welder Co., Lynn, Mass.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.

Welding and Cutting, Oxy-Acetylene Equipment
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Welding Equipment, Electric Arc
Westinghouse Elec. & Mfg. Co., East Pitsburgh, Pa.

Welding Machines, Electric
Federal Mch. & Welder Co., Warren, O.
General Electric Co., Schenectady, N. Y.
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Thomson Spot Welder Co., Lynn, Mass.

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Driver-Harris Co., Harrison, N. J.

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Wires, Standard Thread Measuring
Seaboldt Corp., B., 25 W. Broadway, New York.

Wire Working Machinery
American Pipe Bending Mch. Co., 73 Pearl St., Boston, Mass.
Baird Machine Co., Bridgeport, Conn.

Wood Working Machinery
Crescent Mch. Co., 56 Main St., Leetonia, O.
Defiance Machine Works, Defiance, O.
New Britain Mch. Co., New Britain, Conn.
Oliver Machinery Co., Grand Rapids, Mich.
Sidney Tool Co., Sidney, O.

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Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill.
Armstrong Mfg. Co., 297 Knowlton St., Bridgeport, Conn.
Athol Mch. Co., Athol, Mass.
Billings & Spencer Co., Hartford, Conn.
Coes Wrench Co., Worcester, Mass.
Goodell-Pratt Co., Greenfield, Mass.
Greene, Tweed & Co., 109 Duane St., New York.
Greenfield Tap & Die Corp., Greenfield, Mass.
Peck, Stow & Wilcox Co., 203 W. Center St., Southington, Conn.
Trimont Mfg. Co., Roxbury, Mass.
Walworth Mfg. Co., Boston, Mass.
Whitman & Barnes Mfg. Co., 1000 W. 120th St., Chicago, Ill.
Williams & Co., J. H., 61 Richards St., Brooklyn, New York.

Wrenches, Pipe
Greene, Tweed & Co., 109 Duane St., New York.
Greenfield Tap & Die Corp., Greenfield, Mass.
Peck, Stow & Wilcox Co., 203 W. Center St., Southington, Conn.
Reed Mfg. Co., Erie, Pa.
Trimont Mfg. Co., Roxbury, Mass.
Walworth Mfg. Co., Boston, Mass.
Whitman & Barnes Mfg. Co., 1000 W. 120th St., Chicago, Ill.
Williams & Co., J. H., 61 Richards St., Brooklyn, New York.

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Goodell-Pratt Co., Greenfield, Mass.
Greene, Tweed & Co., 109 Duane St., New York.
Trimont Mfg. Co., Roxbury, Mass.
Williams & Co., J. H., 61 Richards St., Brooklyn, New York.

Wrenches, Tap
Healy & Co., Chas. H., 1204 N. Clinton Street, Chicago, Ill.
Brubaker & Bros., W. L., 50 Church St., New York.
Butterfield & Co., Derby Line, Vt.
Card Mfg. Co., S. W., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Greenfield Tap & Die Corp., Greenfield, Mass.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.
Starrett Co., L. S., Athol, Mass.
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Union Tool Co., Orange, Mass.
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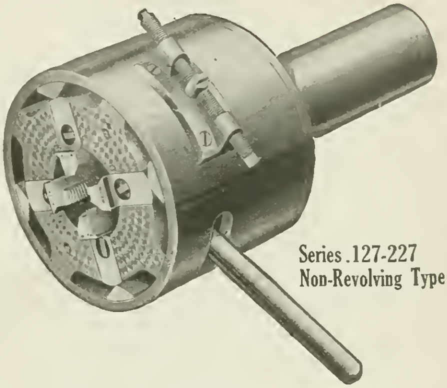

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